UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

TECHNICAL CONSUMER PRODUCTS, INC., NICOR INC., and AMAX LIGHTING,)	
Petitioners,)	No. IPR2017-01280
vs.)	No. IPR2017-01285
LIGHTING SCIENCE GROUP CORP.,)	No. IPR2017-01287
Patent Owner.)	

The deposition of ZANE COLEMAN, Ph.D., called by the Patent Owner for examination, pursuant to Notice, and pursuant to the Rules of Civil Procedure for the United States District Courts, taken before Sandra L. Rocca, CSR License No. 084-003435, CRR, at 233 SouthWacker Drive, Chicago, Illinois, on the 17th of January, 2018, at the hour of 8:49 a.m.

APPEARANCES:

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I N D E X

EXHIBITS

(Witness sworn.)

MR. HAYES: For the record, we'll mark your declaration in the '968 patent IPR as Exhibit 1.

(Coleman Exhibit 1 marked for identification.).

MR. HAYES: And then for the record, we will mark your declaration for the '844 patent IPR as Exhibit 2.

(Coleman Exhibit 2 marked for identification.)

MR. HAYES: And then we'll mark for the record as Exhibit 3, Dr. Coleman's declaration for the '518 patent IPR.

(Coleman Exhibit 3 marked for identification.)

MR. HAYES: For the record, we will mark the '968 patent as Exhibit 4.

(Coleman Exhibit 4 marked for identification.)

MR. HAYES: Dr. Coleman, you're comfortable if I refer to the patents by their last three numbers?

THE WITNESS: Yes.

MR. HAYES: And then we'll mark -- for the record we will mark as Exhibit 5, the '844 patent.

(Coleman Exhibit 5 marked for identification.)

MR. HAYES: Let's mark for the record as Exhibit 6, the '518 patent.

(Coleman Exhibit 6 marked for identification.)

ZANE COLEMAN, Ph.D.,

having been first duly sworn, was examined and testified as follows:

CROSS EXAMINATION

BY MR. HAYES:

Q Okay. Good morning, Dr. Coleman.

A Morning.

Q Thanks for being here. Is there any reason, medication, illness or otherwise, that you can't answer my questions fully and truthfully today?

A No. I will say that I may have a head cold or flu coming on.

Q So if you don't hear a question or understand, just let me know.

A Okay.

Q Exhibit 1 is your declaration with respect to the '968 patent IPR. Dr. Coleman, does Exhibit 1 contain all of your opinions in this case with respect to the '968 IPR?

A Yes.
Q And Dr. Coleman, Exhibit 2 is your declaration with respect to the '844 patent IPR. Does Exhibit 2 contain all of your opinions with respect to the '844 IPR in this case?
A It contains all my opinions related to the arguments I made. There may --
Q With respect to the '844 patent?
A Right.
Q Okay. I'm just asking do you have any other opinions in this case with respect to the '844 IPR that are not contained in your declaration?
A These are my opinions related to the -- and all the grounds. If you'd like to ask me other questions, there could be other opinions.
Q So sitting here today, do you have other opinions?
A No.
Q And then with respect to Exhibit 3, which is your declaration for the '518 patent IPR, does Exhibit 3 include all your opinions in this case with respect to the '518 patent IPR?
A It includes all my opinions. There are some clarifications.
Q What are those clarifications?

A In Ground 3, it was implied -- in Ground 3, with respect to Claim 10, it was implied that Claim 10 was obvious by Soderman in light of Wegner and Barnett and/or Van Elmpt. And likewise, Claim 6 was obvious by Zhang in light of Wegner and Barnett or Van Elmpt, just for clarification.
Q But those are implied opinions, those are not set forth in your declaration, is that right?
A The information is in there and my discussion of Wegner is disclosed in there and the reasoning.
Q Okay. So in addition to these two implied opinions, anything else with respect to '518?
MS. HARTMAN: I object to the form of the question.
THE WITNESS: I wouldn't designate these as implied opinions. My opinions are in there that -- of the obviousness in light of Wegner. They are not explicitly stated.
Q Any other opinions that are not explicitly stated in your declaration or declarations?
A There is another clarification on page 51 of the '518 declaration, paragraph 77.
Q Okay.
A To be more clear, it should read, the wire

64 connected to the driver, i.e. power conditioner, which is connected via connector 68 to the LEDs. It is written more clearly in the '944 declaration -- I'm sorry, the '844 declaration.

Q You kind of said that quickly. So you want it to read the wire 64 connected to the driver and then insert, which is connected?

A Correct, which is connected via connector 68 to the LEDs.

Q Okay. So just to make sure we have it for the record there, paragraph 77 on page 51 of Exhibit 3, which is the '518 declaration, you want the last -- you want what appears to be the last sentence on page 51, paragraph 77 to read, the wire 64 connected to the driver which is connected via connector 68 to the LEDs?

A Correct.

Q Anything else?

A That's all I can recall at this moment.

Q Okay. What's your understanding of a heat sink in the context of these three IPRs?

A A heat sink is a component that dissipates heat into the environment.

Q What's your understanding of a heat spreader in the context of these three IPRs?

A A heat spreader is a component that transfers heat to another component.
Q So is it your understanding that the difference between a heat sink and a heat spreader in this context is that the heat sink dissipates heat to the environment and the heat spreader transfers heat to another component, not the environment, is that fair?
A I would repeat what I said, that the heat sink transfers heat -- the heat sink dissipates heat to the environment and the heat spreader transfers heat to another component.
Q Prior to your work on these three cases, '968, '844 and '518 IPRs, were you familiar with the term heat spreader?
A Yes.
Q In what context?
A It was used and it's a common term used initially with a lot of computer chips for spreading the heat off of a computer chip onto a heat sink.
Q Would you agree that a vertically oriented heat sink is more efficient than a horizontally oriented heat sink?
A It would depend on the configuration of the heat sink and the environment.

Q All else being equal, with respect to the configuration and the environment -- let me be a little more specific.

Is a vertically oriented fin on a heat sink a more efficient transfer of heat than a horizontally aligned fin on a heat sink?

A The efficiency of the heat sink would depend on numerous variables in the environment and would require complex modeling to determine the actual efficiency and relate to the actual design, shape, structure, length and then the environmental variables to determine efficiency of the heat sink fin.

Q But if we kind of normalize out all of those other variables, environment -- and let's just focus on one fin-shaped heat sink. If I orient it -- put the axis in a vertical direction, is that, you know, vertically oriented fin on the heat sink more efficient than transferring heat as compared to me rotating that heat sink 90 degrees so that the fin is in a horizontal direction?

MS. HARTMAN: Object to form and incomplete hypothetical.

THE WITNESS: It would depend on the configuration. The efficiency of the heat sink is related to the ambient environment and air flow around the fin, for example.

Q In performing your analysis with respect to these three IPRs, the '968, '844 and '518, did you consider the angle of the surface of each of the heat transfer fins?

A I'm sorry. Could you be more specific?

Q Yeah, in performing your analysis in these three IPRs, did you consider the angle or the orientation of the surface of the heat sinks that you were analyzing?

A With respect to -- I'm trying to understand the context.

Q Any of the prior art or patents that you looked at in this case.

A I'm not sure I'm understanding your question. My analysis was with respect to anticipation and obviousness of the LSG patents.

Q In that context of doing your anticipation and obviousness of the LSG patents, you looked at a number of pieces of prior art that include heat sinks, correct?

A Yes.

Q So kind of in the context of your analysis of anticipation and obviousness, did you consider --

I didn't see it anywhere in your declarations, but did you consider the angles of the surfaces that you were looking at?

A That were claims that referenced fins and recesses, which would inherently have angles.

Q In the context of those claims that reference fins and recesses, did you analyze the angles of the fins, if you will?

A I don't recall an angle being specified in a claim.

Q Okay. So is the answer no?

A The answer is I don't recall an angle being specified in a claim for a claim analysis.

Q So I mean, I didn't see anywhere in your declarations that you ever kind of talked about the angle of the fins, for example, in relation to the X/Y axis or any other axis, is that fair?

MS. HARTMAN: Object to form.

THE WITNESS: I don't recall discussing the angle of the fins in my declarations specifically.

Q What is a Nusselt number?

A I'm sorry?

Q What is a Nusselt number, n-u-s-s-e-l-t?

A Right here and right now, I can't think of what that refers to.

Q Would you agree that water is a better heat transfer medium than air?
MS. HARTMAN: Objection, relevance.
THE WITNESS: It can be.
Q In what instances is water not a better heat transfer medium than air?
A For example, if the water was very hot.
Q As compared to the air, is that what you're saying?
A In that example.
Q Okay. Any others?
A I can't recall any additional right now at this time.
Q So if we kind of take out this idea that the water is hot, if you're passing water and air over a heat source and the water and the air that you're passing over the heat source are the same temperature, would you agree that water is a better medium -- transfer medium than air?
MS. HARTMAN: Objection, relevance.
THE WITNESS: I'm not sure I understand the context of your question.
Q You understand the difference between convection and conduction, right?
A Yes.

Q Is conduction a more efficient means of transferring heat than convection, generally speaking?

MS. HARTMAN: Objection, relevance.

THE WITNESS: Generally speaking, conduction is more effective than convection, all things being equal.

Q Would you agree that one of the reasons -- or it's important to transfer heat away from LEDs because the warmer generally LEDs are over the life, the shorter of life span of the LEDs?

MS. HARTMAN: Objection, form.

THE WITNESS: That is one potential effect.

Q Would you agree that, generally speaking, all else equal, the temperature or the amount of heat in an LED packet over its life span is kind of inversely related to the life of the LED package? In other words, the warmer the LEDs, the shorter the life span?

MS. HARTMAN: Objection, form, incomplete hypothetical.

THE WITNESS: It is my understanding right here right now, it would depend on how warm is warm.

Q But generally, I mean there's a -- I mean, you folks try to remove heat from LEDs to keep them cooler because they're more efficient and they're longer lived, if you will, if you keep them cooler?

A Those are two reasons for removing heat from an LED.

Q What's another reason for removing heat from an LED?

A Efficiency, lifetime, color temperature.

Q What do you mean by color temperature?

A Some LEDs can shift in color over temperature.

Q Okay. So efficiency, lifetime or life span and color temperature. Any other reasons why folks try to keep LEDs cool?

A Sitting here right now, that's all I can recall at this moment.

Q Are you familiar with the term "chimney effect" in the context of heat transfer?

MS. HARTMAN: Objection, relevance.

THE WITNESS: Yes.

Q What is chimney effect in the context of heat transfer?

MS. HARTMAN: Objection, relevance.

THE WITNESS: Sitting here right now at this time, I can't recall a full definition, but as I understand it, it relates to convection of heat from a surface.

Q Any other understanding of chimney effect in the context of heat transfer?

A I believe it relates also to the convection through an opening or channel.

Q Did you consider the chimney effect in any of your analysis in these cases?

A No.

Q Do you have an understanding of what a power conditioner is in the context of these '968, '844 and '518 patents?

A Yes.

Q What is it?

A As generally used in the LSG patents, it's a device converting alternating current to DC current for driving LEDs.

Q Would you agree that a power conditioner is a heat source?

A As I understand it, power conditioners do generate some heat.

Q For the record, I'll mark as Exhibit 7 the Chou reference.

(Coleman Exhibit 7 marked for identification.)

Q The Chou reference is the 7,670,021 patent.

Dr. Coleman, is it okay if I refer to this as the Chou reference?

A Yes.

Q Dr. Coleman, you analyzed the Chou reference in performing your analysis in these cases, correct?

A Yes.

Q You're familiar with the Chou reference?

A Yes.

Q Did you look at the figures of the Chou reference, Figures 1 through 10D in performing your analysis in this case?

A I reviewed the entire specification in performing my analysis in this case.

Q Including the figures?

A Yes.

Q Chou discloses an LED light bulb, right?

A I believe Chou references it as a light fixture.

Q What are you looking at when you say Chou references a light fixture?

A For example, in the summary of invention, Chou references light fixture.

Q What do you understand light fixture to be in the context of the Chou reference? So I'll withdraw that question.

It looks to me that they refer to light fixture as fixture 10 in Figure 3. It's kind of the entire -- I understand that to be the entire LED light bulb plus the recessed can plus the power conditioner. Is that a fair reading of what Chou refers to as fixture 10?

A Well, fixture 10 is referenced, for example, in Figure 2B.

Q Okay. You think what's disclosed in Figure 2B is a light fixture, is that right?

A Yes.

Q What's disclosed in Figure 1 of the Chou reference? Go ahead. I've been looking for what element 36 is described as and I was going to withdraw the question and say at least I found on bottom of Column 9, element 36 is a light source.

Would you agree that Figure 1 of Chou discloses a light source?

MS. HARTMAN: Do you have a line number?

Q It's way at the bottom, line 60 of Column 9.

A I read in Chou where he describes Figure 1 as a light-emitting diode LED-based light source and as you referenced as well, he refers to it as a light source.

Q If you look at Figures 6A, 6B, 7A and 7B, would you agree those disclose an LED-based light bulb?

A Sorry. Could you repeat the question, please?

Q With respect to Figures 6A, 6B, 7A and 7B of the Chou reference, would you agree that those four figures disclose a LED-based light bulb?

A Chou references Figures 6A to 6B as a fixture.

Q I understand that, but does it appear to you that Figures 6A and 6B of Chou disclose a specific type of fixture they're disclosing as an LED-based light bulb?

A Figures 6A and 6B disclose an LED-based light fixture.

Q Is there a difference between an LED-based light fixture and an LED-based light bulb in your understanding?

A Yes.

Q What is the difference?

A An LED bulb is a device that could be installed in a wide range of fixtures generally. And a fixture is an installed light-emitting device.

Q Is what's disclosed in Figures 6A, 6B, 7A and 7B installable in a fixture?

A As Chou states, Figures 6A and 6B are -- can be -- are fixtures that can be installed in a recessed can housing.

Q Is the disclosure of Chou for the most part about recessed light fixtures?

MS. HARTMAN: Objection, form.

THE WITNESS: Could you repeat the question, please?

Q Is the disclosure in Chou about recessed light fixtures?

A Chou discloses LED light fixtures for recessed can houses in his specification.

Q Does it disclose any type of light fixtures that are not designed for recessed fixtures, either a recessed can or otherwise?

A Sitting here right here and now, I don't recall any additional applications, but I would need to review to be sure that's the case.

Q What's a junction box?

MS. HARTMAN: Object to form.

THE WITNESS: Are you referring to an electrical junction box?

Q In the context of the '968, '844 and '518 patents, do you have an understanding what a junction box is?

A Yes.
Q What is a junction box in the context of the '968, '844 and '518 patents?
A It is an electrical housing generally providing connections -- a place for connections.
Q In the context of these three patents, is a junction box different than a recessed can?
A In the context of these patents, both electrical junction boxes and recessed can housing house electrical components and components of light fixtures.
Q I take it your answer is you're trying to identify the similarities between junction boxes and recessed cans, is that right?
A There are similarities between them.
Q Are there differences between recessed cans and junction boxes?
A Yes.
Q What are the differences?
A Recessed can housings have a slightly different shape, typically a round opening. Although some junction boxes have round openings. And they are typically deeper than some junction boxes.
Q Do you remember in your review of the

patents in this case, some of them refer to the combination of the heat sink and the heat spreader forming a base?

A Yes.

Q What is a base in the context of the, for example, '968 patent?

A I don't recall the '968 patent expanding on the definition of a base.

Q What's your understanding of a base in the context of '968, '844 and '518 patents? So you can look obviously at whatever you'd like to, but there's at least a reference to it here in Column 9. Are you looking at the '968 patent?

A Yes.

Q At about line 5 of Column 9 of the '968, it says, "In Figure 29 as discussed above, the heat sink is integrally formed with the heat spreader to form a base."

Do you see that?

A Which line are you referring to?

Q I'm in Column 9 of the '968 patent. I was reading from about lines 5 to 8. That's at least one reference to base. There's likely more, but that's the first one I found.

A Okay. Your question is?

Q What is your understanding of base in the context of the, for example, '968 patent?

A A base is a component including a heat spreader and heat sink and possibly other elements.

Q If you turn back to Exhibit 7, which is the Chou reference, there on Figure 2B, does that disclose a base?

A In Figure 2B of Chou, trim 12 includes a heat spreader and a heat sink.

Q So are you -- is that your answer, yes, Chou discloses a base?

A Chou discloses a heat sink and a heat spreader.

Q Does it disclose a base?

A Based on the disclosure of the '968 patent, it includes a base.

Q Would you take this highlighter and highlight what your opinion is of what the base is in Chou?

A The base can include other components.

Q Go ahead and highlight what your opinion is of the base in Chou.

A The definition of base can include other components, so I could highlight the whole fixture to include other components. It's not necessarily limited to just a heat sink and heat spreader.

Q Okay. Did you form an opinion in this case that Chou discloses a base in the context of the '968 patent?

A I formed an opinion that Chou discloses an integrated heat sink and heat spreader.

Q And it's your opinion that an integrated heat sink and heat spreader is a base in the context of the '968 patent?

A Could you repeat question, please?

Q Is it your opinion that an integrated heat sink and heat spreader in Chou is a base in the context of the '968 patent?

A My opinions with respect to the '968 patent were to the claims which refer to a integrally formed heat spreader and heat sink form a base.

Q Right. So you're looking at Claim 3 as one of the places -- I think you just read from --

A Correct.

Q So Claim 3 of the '968 patent requires that the integrally formed heat spreader and heat sink form a base. Do you see that?

A Correct.

Q Does the Chou reference disclose that limitation?

A Yes.

Q Can you identify for me on the Chou reference with that highlighter what you're relying on in the disclosure of Chou to meet the limitation integrally formed heat spreader and heat sink form a base?

A In the context of Claim 3?

Q Sure.

A Figure 2B is a cross-section, so for example, for me to -- I could highlight the entire trim or I could highlight the -- portions of that as representing the cross-sectional shape.

Q Okay.

A Do you have a preference?

Q No. I just want it to be clear -- I mean, what I would ask you to do is be clear in identifying in Chou what you're relying on, what disclosure in Chou you're relying on to meet the limitation in the '968 patent, the integrally formed heat spreader and heat sink form a base?

MS. HARTMAN: Object to form.

THE WITNESS: (Indicating).

Q Are you done?

A It's difficult -- I have highlighted a cross-section portion of the base, not the entire base.

Q Okay. Do you have an understanding of what the back surface of the base is? Do you have an opinion that what you identified as the base or what you're relying on as the base in Chou includes a back surface?

A There is a back surface of the base of Chou.

Q Can you take my pen and identify, via arrow or otherwise, what the back surface of the base is in Chou?

A The back surface is a -- this is a cross-section of the side and it's not clearly showing the back surface as something that would be readily highlightable.

Q I understand maybe it's not readily highlightable, but can you draw an arrow to what you consider the back surface of the base to be in Chou?

A (Indicating).

Q Could you just identify next to that arrow "back surface"?

A (Indicating).

Q The claims require that the back side of the base comprise a plurality of heat sink fins and air flow channels.

Is it your opinion that the back side of the base of Chou discloses a plurality of heat sink fins?

MS. HARTMAN: Objection, form.

THE WITNESS: Would you repeat the question, please?

Q Yeah. The '968 patent talks about the back side of the base including a plurality of heat sink fins. Does the back side of the base of Chou disclose a plurality of heat sink fins?

MS. HARTMAN: Objection, form.

THE WITNESS: In the '968 patent, it states that the heat spreader and heat sink are collectively herein referred to as a base. And as used similarly in other parts of the patent, collectively referred to may include additional components. And the person of ordinary skill in the art would understand that a broadest reasonable construction would be that the base could include portions -- or in this example of Chou, portions of heat sink 14.

Q Okay. And so are you relying on Chou or the disclosure in Chou to meet the limitation of the '968 patent that requires wherein a back side of the base comprises a plurality of heat sink fins?

MS. HARTMAN: If you're reading from a

specific claim, would you like to identify it?
Q Sure. Claim 4. I think 3 and 4 we've been focusing on.
A In addition to it being obvious, a person of ordinary skill in the art to include heat sink fins that may have radially oriented recesses therein on the back surface, that would be obvious to a person of ordinary skill in the art to include that. In addition, that is disclosed by Chou.
Q What specifically are you relying on Chou for the disclosure wherein a back side of the base comprises the plurality of heat sink fins? If you could just mark on Chou what it is you're relying on, I'd appreciate that.
A Could you repeat the question one more time, please?
Q Sure. With respect to the limitation of the '968 patent wherein a back side of the base comprises a plurality of heat sink fins, could you identify for me what it is you're relying on in Chou to meet that limitation?
A A person of ordinary skill in the art under the broadest reasonable construction would understand that Claim 4, read in light of the specification, that base could comprise additional

components. Thereupon, the back surface of the base could include portions of heat sink 14 that are radially oriented fins.

Q So with respect to this limitation of the '968 patent wherein a back side of the base comprises a plurality of heat sink fins, is my understanding correct that you're relying on element 14 of Chou to meet that limitation?

A Portions of element 14.

Q What portions?

A The fin-like structures.

MR. HAYES: Okay. We've been going about an hour and ten minutes. Let's take a break.

(Short recess.)

BY MR. HAYES:

Q Dr. Coleman, welcome back. In performing your analysis in these cases, did you consider the challenges of dissipating heat from low profile lights or lamps?

A A person of ordinary skill in the art would understand that heat sinks are a very common method for dissipating heat from a light fixture, thin profile or not.

Q Fair enough. Did you consider the challenges of dissipating heat from low profile heat sinks in the context of the '968, '844 and '518 patents?

A A heat sink will dissipate heat whether it's low profile or not. And the amount of heat that needs to be dissipated can vary from fixture to fixture.

Q Is a low profile heat sink more or less efficient at dissipating heat than a high profile heat sink?

MS. HARTMAN: Objection, form, incomplete hypothetical.

THE WITNESS: One of the factors affecting the heat dissipation from a heat sink and perhaps the main factor would be the surface area and a low profile heat sink or a non-low profile heat sink can have a large surface area.

Q If you assume for a minute that when you're trying to make as low a profile of heat sink as possible, there's pressure to decrease the surface area of the heat sink, did you consider that in forming your opinions in this case?

MS. HARTMAN: Objection, form.

THE WITNESS: Whether a heat sink is low profile in the context of these patents is the height relative to the diameter or depth. And if one was trying to achieve a low profile heat sink, those are two factors to obtain a low profile heat sink. Obviously there would be a surface area associated with those.

Q In coming to your conclusions with respect to obviousness in these cases, did you consider the overall surface area of the resulting combinations that you're relying on?

MS. HARTMAN: Objection, form.

THE WITNESS: A person of ordinary skill in the art understands that a wide variety of heat sinks, low profile or thick profile, can be chosen based on the need to dissipate the amount of heat for a given fixture.

Q What is a thick profile heat sink?

A I was using that as a relative, thick as being not thin.

Q So hypothetical for you. All else equal, if you've got a -- including equal surface area, right, if you've got a lamp with an H/D -- you're familiar with the H/D limitation in these claims, right?

A Yes.

Q All else being equal, including the surface area, if you have a lamp with an H/D of 4 and an H/D of 0.25, which one is more efficient at removing heat?

MS. HARTMAN: Objection, form and incomplete hypothetical.

THE WITNESS: It would depend on the exact design of the heat sink. If they had the same surface area, it could possibly dissipate the same amount of heat.

Q Would you agree if there's two heat sinks that have the same amount of heat -- sorry, the same amount of surface area and one has an H/D of 4 and one has an H/D of 0.25, the one of with an H/D of 4 is much more vertically oriented?

A Could you repeat question, please?

Q Well, so in the context of these claims, the H/D limitation essentially is getting at the ratio of height to diameter, right?

A Correct.

Q So an H/D of 4 as compared to an H/D of 0.25 suggests the H/D of 4 is a much more vertically oriented or taller heat sink, right?

A It would have a larger dimension in the height direction.

Q Okay. Would you agree, generally speaking, that a heat sink that has a larger dimension in the height direction is more efficient at dissipating heat than one that has a smaller dimension in the height direction?

MS. HARTMAN: Objection, form, asked and answered.

THE WITNESS: That would depend on the design. For example, in your -- you mentioned in one example they had the same surface area. They could potentially dissipate the same amount of heat.

Q Does the amount of surface area or the height of a heat sink have more of an effect on the heat sink's ability to dissipate heat?

A Could you repeat the question, please?

Q Does a heat sink's surface area or amount of height have more of an effect on the heat sink's ability to efficiently dissipate heat?

A That's -- I believe that's an incomplete hypothetical in that without knowing the other terms or the other dimensions, for example, of the heat sink, it's not an easy comparison, arbitrarily a height.

Q Assuming all else is equal, is there any way you can answer the question?

MS. HARTMAN: Object to form.

THE WITNESS: Could you repeat the question, please?

Q Assume all the other assumptions you have to make are equal as to the two different heat sinks, could you answer the question?

A I would need to understand the full question again because you've made some assumptions and if you could restate the question.

Q My question is getting at whether or not surface area or vertical orientation has more of an effect on a heat sink's ability to efficiently dissipate heat. Do you have any opinion as to that?

A They both could affect the dissipation of heat. The exact configuration would need to be known to determine whether the effect -- the height is more or less than the effect of surface area.

Q Would you agree that both surface area and height affect a heat sink's ability to efficiently dissipate heat?

A Height is a subcomponent of surface area, for example. You would need to know the height of various parts of the heat sink to determine the surface area. So in some ways -- you would need to know the exact configuration to understand how much height effects relative to the surface area effects.

Q In your experience, have you designed heat sinks for LED lamps?

A Yes.
Q And in your experience of designing heat sinks for LED lamps, did you consider both the surface area of the heat sink and the height of the heat sink?
A Both directly and indirectly, the surface area and height are considerations one looks at to determine an optimal heat sink for different -- for a particular configuration.
Q We've talked a little bit about power conditioners in the context of these patents. Do you remember that?
A Yes.
Q I'm looking at the '844 patent. That's Exhibit 8, I think.
A It looks like Exhibit 5.
Q Could you pull that out, Exhibit 5?
A Okay.
Q So for example, Claim 9 talks about the power conditioner being configured and sized to fit completely within an interior space of a nominally sized can light fixture and a nominally sized electrical junction box. Do you see that?
A Yes.
Q What considerations, if any, did you take

into account in your obviousness analysis in this case when you had an opinion that you could fit a power conditioner into a nominally sized junction box?

A A person of ordinary skill in the art would, at the time of the invention -- at the time of the LSG patents, would understand that there are a wide selection of drivers that could be used in the interior of a junction box. And as shown and represented -- for example, as examples of the state of the art, I reference a few publications where the driver is in the interior of the junction box.

Q So is it your opinion that reducing the size of a power conditioner is nothing more than finding a smaller driver?

MS. HARTMAN: Objection, incomplete hypothetical.

THE WITNESS: I view the term "power conditioner" as used in the LSG patents as including a driver. Drivers are normally used to convert AC to DC.

Q Okay.

A And a person of ordinary skill in the art understood at the time that there were many drivers that fit inside the interior of a junction box.

Q Let's say, for example, you want to fit a junction box inside a five-inch can. You need to reduce the size of the junction box and it's got to include a power conditioner. And in your design, you've got to reduce the size of the power conditioner.
What step or steps would one of ordinary skill in the art have to consider in reducing the size of a power conditioner in that context?
A I'm sorry. I'm not sure I understand your question. You referenced putting a -- could you repeat the question, please?
Q In your design -- this is a hypothetical. You're designing an LED lamp to fit within a certain size -- four-inch can and you want to put your power conditioner also within that four-inch can and the power conditioner you have requires a reduction in size.
What consideration or considerations would one of skill in the art take into account when redesigning a power conditioner to make it smaller?
A I believe you're making many suppositions in that statement. If you could repeat it so that I could fully understand it.
Q In these cases you've got an opinion that

one of skill in the art could combine, for example, a larger power conditioner, a power conditioner with art, and in doing so, reduce the size of the power conditioner. Remember that?

A I'm sorry. You referenced larger power conditioner?

Q Yeah. The claims require that the power conditioner fit within a certain size, right, nominally sized junction box or a four-inch sized junction box. Remember that?

A That is what the claim says.

Q So if you want to design a power conditioner to fit within a certain size, what are some of the considerations that one of the skill in the art must take into account?

A Typically it's -- you're not designing power conditioners from scratch. They're readily available and people of ordinary skill in the art could just look for ones with specifications that you need and just choose that. And smaller ones that would fit in a junction box are readily available and used in junction boxes for light fixtures.

Q So the power -- so the prior art power conditioners that you're relying on in these cases disclose dimensions, is that right? Is that what you're telling me?

A There may be some that disclose dimensions. I know that the references show and indicate and disclose that they fit in a junction box.

Q A particular size junction box or any junction box?

A I believe at least a four-inch junction box was referenced in one of the publications.

Q What are the typical components of a power conditioner in the context of an LED lamp, in addition to a driver?

A The LSG patent broadly references a power conditioner including being able to convert AC to DC. In the context of the patents, the broadest reasonable interpretation of that term would include a driver, what is traditionally referred to in the industry as a driver, which converts AC to DC.

Q Would it include anything else?

A I'm sorry. The reference to "it"?

Q Would the power conditioner include anything else? Within your understanding of power conditioner in the context of these patents, would the power conditioner include any other components in addition to a driver?

A The power conditioner in the LSG patents is not disclosed to the level of detail of what electronics are specifically included in there. It discloses that it can convert AC to DC, for an example, and that is a device that's commonly referred to in the industry as a driver.

Q Okay. So in the context of these patents, if one of ordinary skill uses the term "power conditioner," what would one of ordinary skill understand the components of that power conditioner to be in addition to a driver?

A A person of ordinary skill in the art understands that, as disclosed in the LSG patents, a driver essentially -- sorry, a power conditioner converts AC to DC, which is a function performed by a driver as the term is normally used in the industry. So there would not necessarily need to be any other components because I could use the terms synonymously.

Q So in the prior art, are you relying on -- when you're looking at power conditioner limitations, are you relying on drivers alone?

A In the context of the other publications I reference, a driver is one term used for a device to convert AC to DC. I believe there may be other components or terms referred -- that perform the same function.

Q Do you have the '844 patent in front of you?

A Yes.

Q Would you look at Claim 7? Do you see there in Claim 7 it says, the heat spreader and heat sink are integrally formed such as the heat flow path through the heat spreader to the heat sink is continuous and uninterrupted.

Do you see that?

A Yes.

Q Does this requirement that the heat flow path from the heat spreader to the heat sink be continuous and uninterrupted connote conduction, not convection?

A In the context of the LSG patents, the heat flow is conducted through -- from the heat spreader into the heat sink.

Q So in the context then of the '844 patent here in Claim 7, is this limitation requiring that the heat flow be continuous and uninterrupted suggesting or connoting conduction, not convection?

A A person of ordinary skill in the art would understand Claim 7 that the heat flow from the heat spreader to the heat sink would be conduction.

Q With respect to Claim 14 where it talks about -- Claim 14 in the '844 patent where it talks about heat sink is disposed in direct thermal communication with the heat spreader, what would one ordinary skill in the art understand in direct thermal communication with the heat spreader to mean?

A A person of ordinary skill in the art would understand that with respect to Claim 14, heat flows from the heat spreader to the heat sink.

Q So my specific question was whether or not -- or what's your understanding of what one of ordinary skill in the art would understand the limitation in direct thermal communication with a heat spreader to mean and your answer was a person of ordinary skill in the art would understand that with respect to Claim 14, heat flows from the heat spreader to the heat sink, is that right?

A That's what I said.

Q Does the in direct thermal -- does in Claim 14 of the '844 patent, the language "in direct thermal communication with the heat spreader" connote conduction?

A A person of ordinary skill in the art would understand in the context of Claim 14 that heat flowing from a heat spreader to a heat sink would include conduction.

Q But not necessarily be limited to conduction?

A It doesn't specify that it has to be limited to conduction in the claim.

Q So claim '844 -- sorry.

The '844 patent talks about an accessory kit. So does the '518 patent. Do you understand what an accessory kit is in the context of these patents?

A Yes.

Q What is it?

A Broadly speaking, a person of ordinary skill in the art would understand that it includes additional components supplied with a light fixture.

Q What are those additional components that make up the accessory kit?

A Are you referring to a specific claim?

Q Sure. Claim 1 of the '518 patent.

A Claim 1 of the '518 patent describes an accessory kit comprising at least one of a first prewired jumper comprising a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an

Edison-based electrically connected at the other end, and a second prewired jumper comprising a pair of insulated electrical wires having a second plug-in connector electrically connected at one end and cut wire ends at the other end.

Q In the context of the '518 patent, what is the function of the accessory kit?

A Generally speaking, as I understand it a person of ordinary skill in the art would be to ease installation.

Q Do you mean ease installation of the LED lamp into a socket?

A The '518 patent references luminaires and those claims reference the luminaire. So the accessory kit would ease the installation of the luminaire.

Q What is a luminaire?

A I would read luminaire as synonymous with a light fixture.

Q So if I were to say to you, Dr. Coleman, in the context of LED lamps, what is an accessory kit, what would your answer be?

MS. HARTMAN: Objection, form.

THE WITNESS: The accessory kit with reference to the patents of interest, the LSG patents, is reference to a luminaire, as I recall. I don't recall ever being an accessory kit for a bulb.

Q So outside of your work on this case, you're an expert in the field, is the term "accessory kit" something you were familiar with before your work on this case?

A The accessories disclosed in the LSG patents were common accessories included with light fixtures. Sometimes they're referenced as kits, sometimes not.

Q Does the term "accessory kit" have a well-understood meaning within the art?

A A person of ordinary skill in the art would understand that the jumpers, wires and connectors, et cetera, that are included -- referenced as accessories in the LSG patents are common accessories included with light fixtures. Sometimes they may be called kits, sometimes not.

Q Okay. I'm just trying to understand because when I originally asked you what an accessory kit was or what your understanding of it was, you kind of referred to the language of the claim, the specific language of the '518 claim.

So I was just trying to determine, kind of outside of looking at the specific claims and what they say an accessory kit requires, whether or not there's kind of a well-understood meaning of accessory kit to one of ordinary skill in the art?

MS. HARTMAN: Objection, form. I'm not sure that was a question.

Q I think that's probably right. So I'll ask a question. I'll get -- if you think there's one pending, I'll withdraw it.

You suggested -- or your answer earlier suggested that one of the ordinary skill in the art would understand that jumpers, wires and connectors, et cetera, are common accessories included with light fixtures. My question was a little bit different. It's with respect to the actual term here used in the patents and that's "accessory kit."

Prior to your work on this case, do you have any understanding of what one of ordinary skill in the art would understand the term "accessory kit" to mean?

A You're referencing the accessory kit as defined in the '518 patent. The accessory kit includes common jumpers and accessories that were common and known to be used and provided with light fixtures as accessories.

Q What does it mean for one component to be in thermal communication with another in the context of the '844, '968 and '518 patents?
A A person of ordinary skill in the art would understand that a broadest reasonable construction of thermal communication, as used in the patent, would include heat transfer from one component to another.
Q Is it fair to say then that for one component to be in thermal communication with another, it has to be a different temperature than the other?
A In the context of the claims, there's no restriction on thermal communication having to have that limitation.
Q For heat transfer to occur from one component to another, does there have to be a difference in the temperature of the two components?
A There's typically a temperature difference.
Q Can heat transfer occur between two components if they're the exact same temperature?
A With two components that are transferring heat from one another, typically there are localized spots that may be hotter than adjacent spots in another component, in which case there's thermal

transfer. But the average temperature, for example, could be the same of the two devices. But it could have localized hot spots, for example, that could transfer from one to another.

Q As a matter of thermodynamics, heat always transfers from the hotter or warmer component to the cooler component, correct?

A Generally speaking, yes.

Q Some of the claims in these patents talk about the heat sink being substantially ring-shaped. Do you remember that?

A Yes.

Q Is there an advantage to designing a heat sink in a ring shape when it comes to transferring heat?

A Could you repeat the question?

Q Is there any advantage to designing a heat sink in a ring shape as compared to, for example, a square shape when it comes to transferring heat?

A It would depend on the exact configuration, surface area, for example. Shape is one of many components that would determine how you would choose a heat sink or design a heat sink.

Q So the shape of a heat sink can have an effect on the efficiency with which it transfers heat?

A As I mentioned before, the surface area has a significant factor on how well a heat sink dissipates heat. And surface area is something that is changed when the shape of an object changes.

Q Separate from the surface area discussion that we had, my question now is kind of focused on the shape. Some of these claims specifically call for a ring-shaped, or substantially ring-shaped heat sink. So my question is does the geometry of a heat sink affect its ability to efficiently transfer heat?

A Again as I said before, the shape or geometry of a heat sink can affect its ability to transfer heat, dissipate heat.

Q Do you have an understanding of the term "outer optic" in the context of these claims?

A In the context of these claims, yes.

Q What is an outer optic? For example, Claim 1 of the '844 patent calls for an outer optic. I don't know if you're looking for kind of an example or discussion about it, but that is one example.

A Could you repeat the question, please?

Q What's your understanding of an outer optic in the context of the '844 patent?

A Under our broadest reasonable construction, a person of ordinary skill in the art would understand an outer optic to be an optic disposed outwardly from the LED.

Q What's the function of an outer optic?

A It can vary.

Q What are -- what's your understanding of all the functions an outer optic can serve?

A It can diffuse light, for example. It can protect parts of the fixture, for example. It can provide other optical functions.

Q Do you have an understanding of what a reflector is in the context of these patents?

A I think a broadest reasonable construction of reflector in the context of these patents is something that reflects light.

Q Anything else, serve any other purposes or have any other functions?

A It may have other functions.

Q Are you aware of any?

A Are you referencing a claim specifically?

Q No.

A The '844 patent in the specification references the reflector may be used for certain optical preferences or to mask the electronics of the power conditioner.

Q What does it mean by mask the electronics of the power conditioner?

A I would presume that you could not see the electronics of the power conditioner through the reflector.

Q So by mask, like just make it unable to physically see it? Is that what you understand that to mean?

A I don't know that I would -- I don't believe a person of ordinary skill in the art under the broadest reasonable construction would say mask precludes the complete ability to see it. It may, for example, blur it. It may, for example, make it unclear.

Q Other than aesthetic reasons, is there any reason to mask the power conditioner in an LED lamp?

A As I sit here right now, I can't think of any other reasons why masking a power conditioner would include any other reasons other than aesthetics when masking is referencing how it appears.

MR. HAYES: Okay. Let's take a quick break.

(Short recess.)

MR. HAYES: I don't have any further questions at this time, but I'll reserve the right to ask questions if you guys ask any.

MR. RAMMER: We have just a couple of questions.

REDIRECT EXAMINATION

BY MR. RAMMER:

Q Dr. Coleman, looking at the Chou reference, does the trim 12 include a heat spreader and a heat sink?

A Yes.

Q And does heat transfer from the heat spreader to the heat sink in trim 12 of Chou?

A Yes.

Q Is the majority of the heat dissipated by trim 12 in Chou?

MR. HAYES: Objection, form.

THE WITNESS: The majority of the heat is dissipated by the flange portion of 12 in Chou.

Q So is the heat sink 14 of Chou necessary to dissipate the heat from the LEDs in the power conditioner?

MR. HAYES: Objection, form.

THE WITNESS: No.

MR. RAMMER: No further questions.

RECROSS EXAMINATION

BY MR. HAYES:

Q Just one follow-up. Can you explain -- in response to counsel's question that it's your opinion that heat sink 14 is not necessary to dissipate heat from Chou, what do you mean by that?

A As Chou discloses, the majority of the heat is dissipated from the flange 12 -- or the trim -- portion of the trim that is the heat sink.

Q What's the purpose of heat sink 14 in Chou?

A Chou states that the heat sink 14 facilitates the removal of heat energy from both trim and circuit board, but the majority of it is dissipated -- the heat from the LEDs is dissipated through the trim.

Q What do you mean by majority, more than half?

A Chou states in Column 7, the first sentence, "As such, trim 12 dissipates approximately 65 percent of the heat energy generated by the LED light source."

Q If you took away trim 14 and removed --

A I'm sorry?

Q If you took away heat sink 14 from Chou and that 35 percent of the heat that it dissipates, would that negatively affect the performance of the LEDs in Chou?

A Could you repeat the question, please?

Q If you took away heat sink 14 from Chou, would that negatively affect the performance of the LEDs in Chou?

A Not necessarily.

Q Why?

A It could be that the flange is sufficient to dissipate enough heat from the LEDs.

Q What's the purpose of heat sink 14 in Chou?

MS. HARTMAN: Objection, asked and answered.

THE WITNESS: I believe I answered that.

Q Would you agree that one of the purposes of heat sink 14 in Chou is to remove 35 percent of the heat from the LEDs?

A Heat sink 14 does remove some heat from the LEDs, but it's possible that the trim alone could remove sufficient heat.

Q You referenced Column 7 of the Chou reference. So sticking with that, there in Column 7, lines 11 to 13 state "As such, heat sink 14 dissipates approximately 35 percent of the heat energy generated by the LED light source."

Do you agree with that statement?

MS. HARTMAN: Objection, form.

THE WITNESS: That is what Chou states.

Q Do you have any reason to disagree with that statement of Chou?

A No.

MR. HAYES: No further questions.

MR. RAMMER: No further questions at this time.

COURT REPORTER: Do you want a copy?

MS. HARTMAN: Yes, please.

(Whereupon, the deposition concluded at 11:25 a.m.)

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

TECHNICAL CONSUMER PRODUCTS, INC., NICOR INC., and AMAX LIGHTING,

Petitioners,

vs.

LIGHTING SCIENCE GROUP CORP.,

Patent Owner.

No. IPR2017-01280
No. IPR2017-01285
No. IPR2017-01287

I, ZANE COLEMAN, Ph.D., being first duly sworn, on oath say that I am the deponent in the aforesaid deposition taken on January 17, 2018; that I have read the foregoing transcript of my deposition, consisting of pages 1 through 58 inclusive, and affix my signature to same.

________ as it now appears
________ as it now appears with corrections

ZANE COLEMAN, Ph.D.

SUBSCRIBED and sworn to
before me this _____ day of
_______________, 2018.

____
Notary Public

DEPOSITION OFFICER'S CERTIFICATE

STATE OF CHICAGO)
) ss.
COUNTY OF ILLINOIS)

I, Sandra L. Rocca, hereby certify:

I am a duly qualified Certified Shorthand Reporter in the State of California, holder of CSR License No. 084-003435 issued by the Court Reporters Board of California and which is in full force and effect. (Fed. R. Civ. P. 28(a)).

I am authorized to administer oaths or affirmations pursuant to California Code of Civil Procedure, Section 2093(b) and prior to being examined, the witness was first duly sworn by me. (Fed. R. Civ. P. 28(a), 30(f)(1)).

I am not a relative or employee or attorney or counsel of any of the parties, nor am I a relative or employee of such attorney or counsel, nor am I financially interested in this action. (Fed. R. Civ. P. 28).

I am the deposition officer that stenographically recorded the testimony in the foregoing deposition and the foregoing transcript is a true record of the testimony given by the witness. (Fed. R. Civ. P.

30(f)(1)).

The persons who appeared at the deposition are set forth on Page 2 of the foregoing transcript.

The deposition was taken at 233 South Wacker Drive, Chicago, Illinois, and began at 8:49 a.m, on the 17th of, January, 2018 and ended at 11:25 a.m.

Before completion of the deposition, review of the transcript was requested.

Changes made by the deponent, are appended hereto and have also been made to the transcript.

(Fed. R. Civ. P. 30(e)).

Dated: January 29, 2018

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TECHNICAL CONSUMER PRODUCTS, INC.,
NICOR INC.,
AMAX LIGHTING,
Petitioners,
v.

LIGHTING SCIENCE GROUP CORP.
Patent Owner

IPR Trial No.: Unassigned

DECLARATION OF DR. ZANE COLEMAN IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,201,968

LIST OF EXHIBITS

Exhibit	Description
Ex. 1001	U.S. Patent No. 8,201,968
Ex. 1002	Declaration of Dr. Zane Coleman in Support of Petition for *Inter Partes* Review of U.S. Patent No. 8,201,968 ("Coleman Decl.")
Ex. 1003	Declaration of Daryl Soderman in Support of Petition for *Inter Partes* Review of U.S. Patent No. 8,201,968 ("Soderman Decl.")
Ex. 1004	Provisional Application 61/248665
Ex. 1005	Original Application 12/775310
Ex. 1006	Original claims of Application 12/775310
Ex. 1007	Office Action
Ex. 1008	Reply to Office Action
Ex. 1009	Notice of Allowance
Ex. 1010	U.S. Patent No. 7,670,021 ("Chou")
Ex. 1011	U.S. Patent No. 7,828,465 ("Roberge")
Ex. 1012	Roberge Provisional Appl. No. 60/916,053
Ex. 1013	U.S. Patent No. 7,980,736 ("Soderman")
Ex. 1014	Silescent S100LP2 Installation Instructions and Cut Sheet ("Silescent")
Ex. 1015	U.S. Patent No. 6,616,291 ("Love")
Ex. 1016	U.S. Patent No. 5,463,280 ("Johnson")
Ex. 1017	U.S. Patent No. 7,038,399
Ex. 1018	U.S. Patent No. 7,102,172 ("Lynch")
Ex. 1019	U.S. Patent Application Publication No. US2008/0297060 ("Ko")
Ex. 1020	Introducing the LED Driver, EC&M Magazine ("DiLouie")
Ex. 1021	U.S. Patent No. 7,993,034 ("Wegner")
Ex. 1022	U.S. Patent Application Publication No. 2008/0232116 ("Kim")

I, Zane Coleman, declare as follows:

1. I am over the age of 18 and am competent to make this declaration in support of the Petition for *Inter Partes* Review by Technical Consumer Products, Inc., Nicor Inc., and Amax Lighting (collectively, "Petitioners"). The information set forth here is from my own personal knowledge. If called to testify, I could and would provide testimony regarding the substance, contents, and reasons and bases for these statements.

2. I have been retained as an expert witness by Petitioners to address issues concerning the validity of U.S. Patent No. 8,201,968 ("the '968 Patent") for the above captioned *inter partes* review. I am being compensated for my time at a rate of $400 per hour.

3. I am familiar with the technology at issue (*i.e.* LED luminaires). I am also familiar with the level of skill of a person of ordinary skill in the art ("POSITA") with respect to the technology at issue as of October, 2009. In preparing this declaration, I reviewed the '968 Patent and considered each of the documents cited below in light of my knowledge of the technology at issue. I have also reviewed Dr. Jonathan Leeper's declaration in support of Generation Brands LLC's *inter partes* review petition against the '968 Patent, IPR No. IPR2016-01458, Paper No. 2 (Ex. 1002), and I agree with Dr. Leeper's opinion about the validity of the '968 Patent.

When forming my opinions I considered the viewpoint of a POSITA as of October, 2009.

QUALIFICATIONS

4. In 1992, I received a Bachelor of Science degree in Applied Physics, including a Certificate in Optics from the Georgia Institute of Technology. I received my doctorate in Physics at the Loughborough University in the United Kingdom in 1997, focusing on applied rigorous coupled wave diffraction theory to model and analyze recorded edge-lit holograms and their applications as illuminators. My analysis included modeling and measuring optical and thermal properties of illumination systems including Light Emitting Diode (LED) illumination systems.

5. From 1993-1997, I worked as an Optical Engineer at ImEdge Technology Inc. While at ImEdge Technology I conducted research for a start-up company developing holographic illumination technology which included analyzing optical and thermal performance of different recording systems and materials for illumination systems including LED based illumination systems. During this time, I also invented new methods directed to recording edge-lit holograms and edge-lit devices for display and biometric applications; responsible for seven issued patents.

6. From 1997 to 2002, I worked as a Senior Physicist for Motorola Labs. I helped optically design and construct the world's first personal micro-projector

(US Patent 6,637,896). I also designed optical films for LCDs as well as 3 new optical film products with suppliers, including an optical film with 3M, which was shipped in over 100 million cellular phones. I also analyzed thermal and optical properties of products including developing new measurement techniques. During my time at Motorola, I was also responsible for 4 issued patents and 26 patent disclosures.

7. From 2003-2005, I served as the President of Phostech, where my roles included the optical design, analysis, and invention of new diffusing films, refractive and total internal reflection (TIR) films, optical lenses, projection screens and systems, LCD backlights, lightguides, illuminated signs, head-up displays, and light fixtures.

8. From 2005-2006, I was the Manager of Optical Engineering at Fusion Optix Inc. where I helped to develop and prototype micro-replicated, multi-functional optical films, components and lenses for displays and light fixtures through optical modeling, prototyping, analysis, and specification. I designed, installed, and managed the optical film, LED backlight, and light fixture characterization lab including optical, thermal, and environmental characterization. I consulted with the product development group and contributed to the optical design, thermal design, packaging, and accessories for LED light fixtures and other products.

9. From 2006-2009, I was the VP of Technology & Director of Technology at Fusion Optix Inc. In this role, I lead the research strategy and transfer of technology to product engineering in a fast-paced small company providing innovation in the display and LED lighting industries. I also oversaw the research and development of optical films, LED backlights, and LED light fixture projects. I also co-developed a Lightfair 2009 Innovation Award-winning light fixture.

10. In 2009, I rejoined Phostech as President and am presently responsible for optical consulting and patent strategy & drafting services.

11. As noted above, I am a named inventor on forty-nine issued patents and numerous pending patent applications related to the areas of optics, optical films, LED backlights, LED light fixtures, LED light bulbs, personal micro-projectors, projection screens, and other light emitting devices. I am also a registered patent agent at the U.S. Patent and Trademark Office (Reg. No. 65,754). My curriculum vitae includes a more detailed summary of my background and experience including issued patents and publications and is attached as an exhibit to this declaration.

REVIEW AND USE OF DOCUMENTS

12. In forming the opinions presented in this report, I have reviewed and relied upon relied upon the following documents:

- U.S. Patent No. 8,201,968;
- U.S. Patent No. 7,828,465 ("Roberge");

- U.S. Patent No. 7,980,736 ("Soderman");
- U.S. Patent No. 7,670,021 ("Chou");
- Silescent S100 LP2 Installation Instructions and Cut Sheet ("Silescent");
- Declaration of Daryl Soderman in Support of Petition for *Inter Partes* Review of U.S. Patent No. 8,201,968;
- U.S. Patent No. 6,616,291 ("Love");
- U.S. Patent No. 5,463,280 ("Johnson");
- U.S. Patent No. 7,038,399;
- U.S. Patent No. 7,102,172 ("Lynch");
- U.S. Patent Application Publication No. US2008/0297060 ("Ko");
- U.S. Patent No. 7,993,034 ("Wegner"); and
- Dr. Jonathan Leeper's declaration in support of Generation Brands LLC's *inter partes* review petition against the '968 Patent.

LEGAL STANDARDS

13. I am not an attorney but I am a patent agent. I have prosecuted patents for others and am therefore both familiar and well informed in aspects of patent law, particularly novelty (35 U.S.C. §102), obviousness (35 U.S.C. §103) and enablement (35 U.S.C. §112). While I understand these aspects through my patent prosecution experience, I am writing this declaration based on my expertise in optical and LED

lighting technologies. For the purposes of this declaration, I have been informed about certain aspects of the law relevant to my opinions. My understanding of the law is as follows:

14. I have been informed that a patent's claims determine the scope of the invention. How those claims are construed is a matter of law that will ultimately be determined by the Board.

15. I have been informed that, for purposes of my opinions as to the validity of the claims of the '968 Patent, I am to give the claims the broadest reasonable interpretation in light of the specification.

16. I have been informed and understand that a patent claim can be invalid as anticipated if all of the limitations of a claim are disclosed in a single reference and are arranged in a similar manner. I understand that a reference does not have to use the same terminology as the claim. I understand that a reference can anticipate a claim even if the reference discloses additional functions or components not in the claim.

17. I have been informed and understand that a patent claim can also be invalid as being obvious to a POSITA at the time the application was filed. I understand this to mean that even if all of the elements of a claim are not found in a single reference, the claim is still not patentable if the differences between the

subject matter disclosed in the reference and what is claimed would have been obvious to a POSITA at the time the application was filed.

18. I have been informed and understand that the determination of whether a claim would have been obvious should be based on several factors, including, among others:

- The level of ordinary skill in the art at the time the application was filed;
- The scope and content of the prior art;
- What differences, if any, existed between the claim and the prior art;
- Objective indicia of nonobviousness, such as recognition of a problem or failure of others.

19. I have been informed and understand that the teachings of two or more references may be combined in the same way as disclosed in the claims, if such a combination would have been obvious to one having ordinary skill in the art. In determining whether a combination would have been obvious, it is appropriate to consider, among other factors:

- Whether the teachings of the prior art references disclose known concepts combined in familiar ways, and when combined, would yield predictable results;

- Whether a POSITA could implement a predictable variation, and would see the benefit of doing so;
- Whether the claimed elements represent one of a limited number of known design choices, and a POSITA would have a reasonable expectation of success;
- Whether a POSITA would have recognized a reason to combine known elements in the manner described in the claim;
- Whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent;
- Whether the innovation applies a known technique that has been used to improve a similar device or method in a similar way.

20. I understand that one of ordinary skill in the art has ordinary creativity and is not an automaton.

21. I understand that in considering obviousness, it is important not to use the benefit of hindsight (*i.e.* having the benefit of knowing the claimed invention).

LEVEL OF ORDINARY SKILL

22. A POSITA in the field of LED luminaire design as of October, 2009, would have had at least a bachelor's degree in either mechanical engineering,

electrical engineering, or physics and at least 3-4 years of experience designing light fixtures.

23. At the time of the patent I was a POSITA. I had a doctorate in physics and, in 2009, had six years of experience designing light fixtures.

24. When I refer to a POSITA elsewhere in this declaration, I am referring to a POSITA as of October, 2009. I understand this is sometimes referred to as the "time of the invention," although I do not believe the '968 Patent represents an actual invention.

OVERVIEW OF THE '968 PATENT

Technology

25. Lighting fixtures come in a variety of shapes and sizes. Most lighting companies produce fixtures that come with numerous options or customizable components (*e.g.* color temperature, wattage, dimming, shape, etc.). It is also not uncommon for lighting designers to create custom designs for a particular customer request or application.

26. One particular luminaire shape is a low-profile fixture such as a low-profile ceiling fixture. Low-profile fixtures generally sit close to the wall or ceiling and do not protrude substantially into the room. Low-profile fixtures are commonly constructed of metal and glass in a wide variety of forms or trims, reflecting a wide variety of aesthetic choices.

27. Low-profile fixtures are typically placed over existing 4-inch, 5-inch, or 6-inch downlight "cans" (in the case of retrofitting applications) or over 4-inch, 5-inch, or 6-inch junction boxes (in the case of new construction). Junction boxes are typically 1.5"-3" deep, while cans are typically 5-10" deep. Four-inch junction boxes are very common. 4" cans are somewhat less common, but well known in the industry.

28. Some low-profile lighting fixtures are illuminated by light emitting diodes ("LEDs"). LEDs began to be used in general illumination fixtures beginning around 2006. LEDs produce heat. One of the most important aspects of fixture design is determining the maximum operating temperature of the LEDs. Excess heat must be dissipated.[1]

29. There are only a handful of ways to dissipate heat from an LED fixture. The most common method is to use the fixture's frame to passively dissipate the heat away from the LEDs and driver. This requires mounting the LEDs and drive circuitry on a thermally conductive (*e.g.*, metal) frame. The frame naturally draws

[1] Subjecting an LED to excessive heat shortens its lifespan. Subjecting drive circuitry to excessive heat will cause it to fail prematurely. Excess heat also can lower the overall light output (*i.e.* brightness) and can negatively affect the color temperature of the emitted light.

the heat away from the LEDs and drive circuitry. The heat is then dissipated into the surrounding environment. An appropriate temperature for the LEDs and drive circuitry can be maintained by using the frame as a heat sink, provided that it has sufficient thermal conductivity, sufficient exposed surface area, and other design characteristics. The ultimate shape of the heat sink will be determined by aesthetic or form-factor considerations as well as by performance considerations. Once the preliminary design is complete, prototypes are subjected to extensive thermal testing (and iterative design changes as needed) to ensure that the heat sink is capable of maintaining an appropriate temperature for the LEDs.

30. Using the frame to heat sink a luminaire was well-known in the lighting industry by 2009. Because they do not require fans or additional components, such passive cooling designs were and are often the cheapest and simplest heat management option. As a result, most residential and light-commercial LED fixtures use passive cooling.

31. LEDs also require power conditioning. LEDs generally do not tolerate standard AC current that comes from a standard wall outlet (*e.g.* 120 volts AC). Rather, LEDs commonly require lower-voltage, current-limited, DC power. Power converters (referred to as "drivers") come in a wide variety of sizes and shapes. A

common arrangement in LED downlight fixtures is to use a "light engine"[2] and a separate, stand-alone driver that conditions the power before supplying it to the light engine.

32. An alternative to the light-engine-plus-driver arrangement is to use an integrated light engine that includes a printed circuit board with LEDs as well as the circuitry necessary to provide the current to drive the LEDs. These arrangements typically consolidate the functionality of a driver and the functionality of a light engine into a single component.

The '968 Patent

33. The '968 Patent generally concerns heat dissipation in a low-profile LED lighting fixture. '968 Patent at Abstract, 1:21-28. The luminaire of the '968 Patent includes an LED light source, a heat spreader, a heat sink, and an optic for focusing or diffusing light into the illuminated area. *Id.* at 1:44-50. The LED generates heat; the heat spreader transfers the heat to a heat sink; and the heat sink dissipates the heat into the air. *Id.* at 1:59-67. The '968 Patent defines "low-profile" in terms of the height-to-diameter ratio of the combined heat spreader, heat sink, and

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[2] LEDs typically come mounted on printed circuit boards that include the ancillary wiring necessary to supply power to the LEDs while providing appropriate insulation, often referred to as "light engines."

optic. *Id.* at 1:50-58, 2:13-19, 4:1-5. Essentially, the '968 Patent describes using the fixture's own trim as the heat sink in order to keep the fixture cool and low-profile.

34. Specifically, the '968 Patent claims a luminaire comprising a heat spreader, a "ring shaped" heat sink around its outer periphery, an optic, and an LED light source, wherein the heat sink, heat spreader and optic in combination have a combined height-to-diameter ratio of 0.25 or less and are sized to cover the opening of a standard 4-inch light can fixture or junction box. Claim 1 is illustrative:

> 1. A luminaire, comprising:
>
> a heat spreader and a heat sink thermally coupled to the heat spreader, the heat sink being substantially ring-shaped and being disposed around and coupled to an outer periphery of the heat spreader;
>
> an outer optic securely retained relative to at least one of the heat spreader and the heat sink; and
>
> a light source disposed in thermal communication with the heat spreader, the light source comprising a plurality of light emitting diodes (LEDs) that are disposed on the heat spreader such that the heat spreader dissipates heat from the LEDs;
>
> wherein the heat spreader, the heat sink and the outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25;
>
> wherein the combination defined by the heat spreader, the heat sink and the outer optic, is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

'968 Patent at Claim 1. Figure 12 of the '968 Patent illustrates an embodiment of Claim 1.

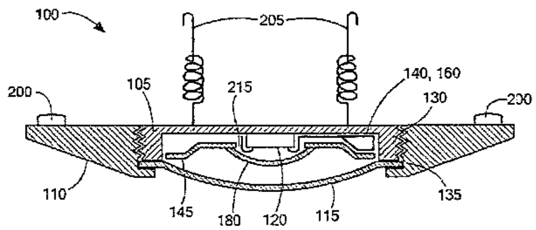

FIG. 12

'968 Patent at Fig. 12.

35. As shown in Figure 12, the LED light source 120 is mounted on the "heat spreader" 105 which is in thermal communication with heat sink 110. An outer optic 115 spans the heat spreader 105. A power conditioner 140, 160 mounted on the heat spreader 105 provides supply voltage to the LEDs 120. The heat spreader 105, heat sink 110, and outer optic 115 in combination define an overall outer dimension (*i.e.* diameter) of the light fixture large enough to cover the opening of a standard four-inch light can fixture and standard four-inch junction box (not shown). '968 Patent at 5:23-46.

36. Claim 1 does not describe any improvements on these generic components.

OVERVIEW OF THE PRIOR ART

37. As set forth below, several prior art references accomplish the same goal in the same manner as the '968 Patent: dissipating heat from a low-profile LED fixture by using the fixture's own trim or periphery as a heat sink.

A. Overview of Chou

38. U.S. Pat. No. 7,670,021 ("Chou") (Ex. 1010)[3] discloses a low-profile ceiling LED luminaire that dissipates heat into the surrounding air via an exterior trim. Chou at 1. Chou discloses one embodiment as follows:

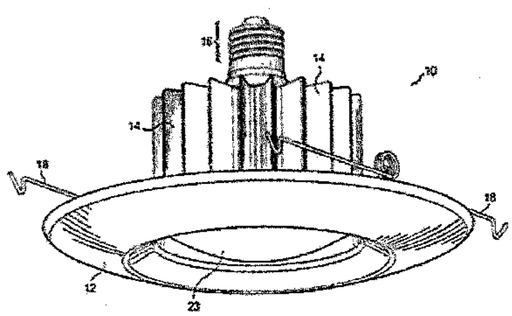

FIG. 2a

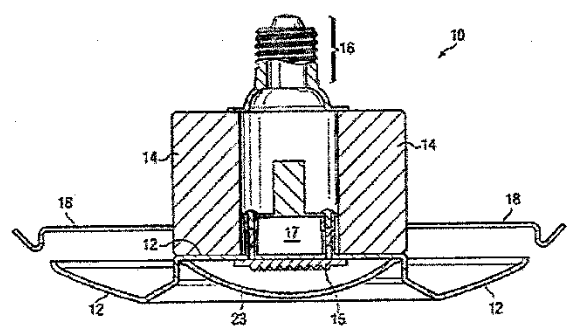

FIG. 2b

Chou (Ex. 1005) at Fig. 2a, 2b.

39. Chou dissipates heat in two ways. The first is through a metal trim 12 on the underside of the fixture. *Id.* at 3:44-47, 4:4-16, Fig. 2b at 12. LEDs 15 are mounted on the underside of the trim 12. An LED driver, circuit board 17, is

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[3] For convenience, I refer to the Exhibits as numbered and attached to the IPR Petition which my Declaration supports.

mounted on the top side. *Id.* at 4:21-27. The center portion of the trim transfers heat out to the outer portion of the trim, flange 22. *Id.* at 5:1-11. From there it is dissipated into the air. *Id.* at 5:5-11, 7:44-46. The "trim" in Chou thus has two portions: (1) a flat interior portion that spreads the heat, and (2) an outer, ring-shaped flange that dissipates the heat into the air. *See also* Figs. 4a and 4b (showing flat portion and flange). Chou illustrates an embodiment in Fig. 2b of the trim formed using a one-piece stamping manufacturing process, however, Chou also states that the trim can be formed by combining multiple pieces. *Id.* at 7:24-26. Thus the flat interior portion of the trim, the central attachment area 20 (heat spreader), and the outer ring-shaped flange (heat sink) could be separate components combined to form the trim. The trim's height (including optic) is 42 mm; its diameter 200 mm; the ratio is 0.21. *Id* at 5:24-28 and Fig. 2b at 12.

40. The second way in which Chou dissipates heat is through an additional, secondary heatsink 14, mounted on the top side of the fixture, which extends up into a conventional ceiling "can." *Id.* at Fig. 2b, 3, 8; 4:40-54. Because the upper heat sink is trapped up inside the can, "a majority of the heat [is] dissipated [through the] trim 12 outside the housing," *i.e.*, into the room. *Id.* at 5:9-10.

B. Overview of Roberge

41. U.S. Pat. No. 7,828,465 ("Roberge") (Ex. 1011) likewise discloses a low-profile ceiling fixture that dissipates heat to the surrounding air via an exterior

ring-shaped heat sink. Roberge at 1. An illustration of the Roberge fixture is as follows:

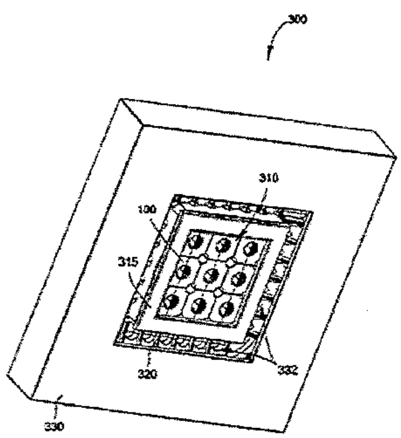


FIG. 3A

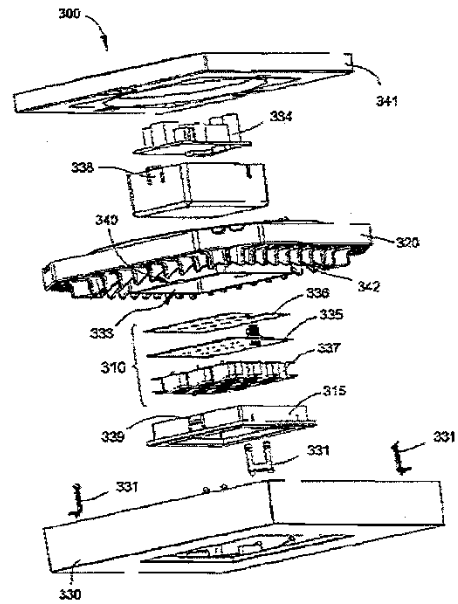


FIG. 3B

Roberge at Fig. 3A, 3B.

42. Roberge dissipates LED heat as follows: A printed circuit board bearing LEDs 335 and an associated gap pad 336 are mounted onto a flat, middle portion of the frame 320. *Id.* at 22:66 – 23:4, 23:27-33. Heat generated by the LEDs passes from the printed circuit board, through this middle portion, out to the outer portion of the frame 320. *Id.* at 22:66 – 23:4, 23:27-33, 23:54-57, Fig. 4. The outer portion of the frame 320 surrounds the LED/gap-pad sandwich. *Id.* at Fig. 3B. The outer

portion of the frame then dissipates heat into the air. *Id.* at 25:15-27, 25:57-60, Fig. 4B (showing airflow).

43. The overall shape is square or, if desired, round. *Id.* at 24:21-24; *see also* Roberge Provisional at ¶112. The entire fixture is low-profile; the ratio of its height (2") to its diameter (8") is 0.25. *Id.* at 24:21-25. It is designed to cover a standard 4-inch junction box in the ceiling. *Id.* at 23:18.

C. Overview of Soderman

44. U.S. Pat. No. 7,980,736 ("*Soderman*") (Ex. 1013) likewise discloses a low-profile ceiling fixture that dissipates heat to the surrounding air via a ring-shaped trim. Soderman at 1. An illustration of the Soderman fixture is as follows:

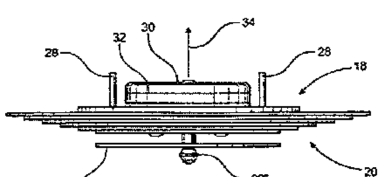


FIG. 1

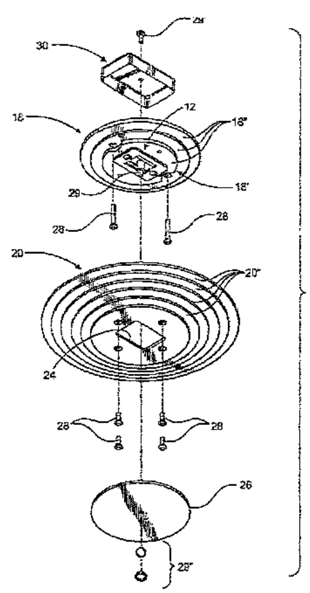


FIG. 5

Soderman at Figs. 1 and 5.

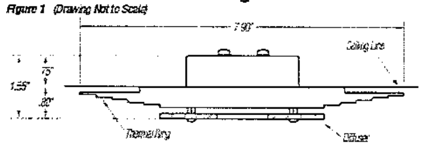
45. Soderman dissipates LED heat as follows: The LEDs 12 are attached to the lower surface of a mounting assembly 18. *Id.* at 3:5-22, 6:14-17, 6:38-45, 8:5-10, Figs. 1, 5. Heat generated by the LEDs spreads through the mounting assembly out to a surrounding cover 20. *Id.* at 7:36-41. The cover is ring-shaped; it is round with a hole through the middle. *Id.* at Fig. 5 (20), 7:24. It is made of thermally conductive material. *Id.* at 6:49-59, 7:11-24. The cover dissipates the heat into the surrounding air. *Id.* at 6:38-45, 7:37-41.

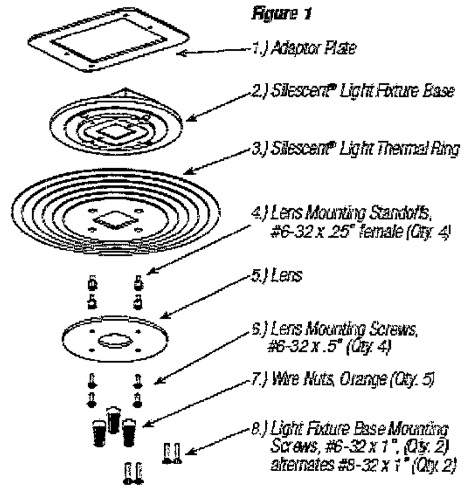
D. Overview of Silescent S100 LP2

46. The Silescent S100 LP2 Installation Instructions and associated product sheet (Ex. 1014) (collectively "Silescent"), which I understand was distributed to Silescent customers on or before June 2009, likewise discloses a low-profile ceiling fixture that dissipates heat to the surrounding air via a ring-shaped trim. *See* Decl. of Daryl Soderman in Supt. of Petition for IPR of U.S Pat. No. 8,201,968 ("Soderman Decl.") ¶3. Illustrations of Silescent are as follows:

S100 LP2 - Ultra Low Profile Light and Fixture

Figure 1 (Drawing Not to Scale)





Silescent at 2 (Fig. 1) and 3 (Fig. 1).

47. Silescent is substantially identical to Soderman's preferred embodiment. I understand Silescent is a commercial embodiment of Soderman. Soderman Decl. ¶6 (Mr. Soderman is the co-founder of Silescent Corp.). The Silescent product literature adds two details that are implied but not expressly disclosed in the Soderman patent. First, Silescent includes actual dimensions: 0.8" (H) by 7.9" (W), a ratio of .101. *Id.* at 2. Second, Silescent discloses an AC/DC power conditioner that fits into "Any UL Approved Junction Box." *Id.* at 4 at Figs. 3, 5.

E. Overview of Love

48. U.S. Pat. No. 6,616,291 ("Love") (Ex. 1015) discloses a low-profile LED fixture for use in underwater applications. Illustrations of Love are as follows:

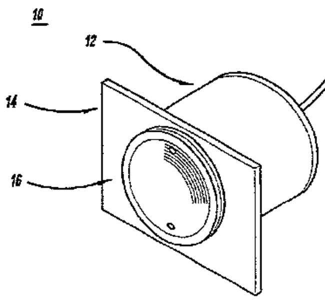


Figure - 1

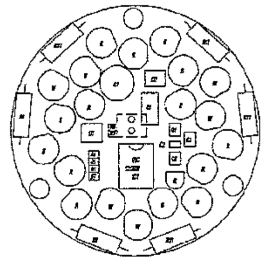


Figure - 10

Love at Figs. 1, 10

49. Of relevance to this Petition, Love discloses the use of an AC/DC power conditioner located on the LED PCB. According to Love: "Fig. 10 is a front view of a circuit board and LEDs." Love at 2:47. The Love PCB contains an AC/DC power conditioner: "A bridge rectifier D1 and on-board circuitry converts the standard incoming 12 VAC supply to 18 VDC." *Id.* at 4:39-41; *see also id.* at 5:41-43 (same).

F. Overview of Wegner

50. U.S. Patent No. 7,993,034 ("Wegner") (Ex. 1021), filed on September 22, 2008, discloses an LED luminaire with an Edison base adaptor for mounting the luminaire into an existing recessed can light fixture. Wegner at Fig. 14-16. An illustration of Wegner is as follows:

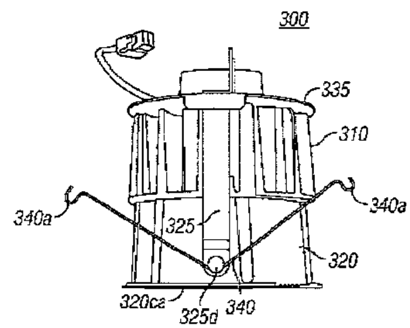


FIG. 6

Wegner at 10 (Fig. 15 and 16).

51. For the purposes of the Petition, the relevant portion of Wegner is "a reflector housing 320 is coupled to the bottom surface 310a of the heat sink 310." Wegner at 8:1-2; *see also id.* at 8:16-18. The reflector housing is configured to receive a reflector 1205 (Fig. 12) composed of a material for reflecting light emitted by the LED. *Id.* at 8:33-35.

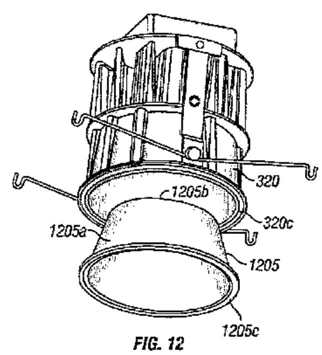


FIG. 12

CLAIM CONSTRUCTION

52. The broadest reasonable interpretation of "integrally formed" in Claims 2 and 12 is: "formed together as one thing." *See, e.g., id.* at 7:34-37 ("heat spreader

305 integrally formed with a heat sink 310 … are collectively referred to as base 302”), *id.* at 5:64-65 (contrasting “standalone” inner optic with inner optic “integrally formed” with a reflector). The unitary construction heat spreader/sink shown in Figs. 27-30 supports this construction.

OPINIONS AS TO INVALIDITY

Ground	Reference(s)	Basis	Claims
1	Anticipated by Chou	§102	1, 2, 3, 4, 6, 14-15
2	Rendered obvious by Chou	§103	3, 4, 19-23
3	Rendered obvious by Chou in light of Roberge	§103	7, 8, 11, 12
4	Rendered obvious by Chou in light of Love	§103	16
5	Rendered obvious by Chou in light of Wegner	§103	17
6	Rendered obvious by Soderman in light of Silescent	§103	1, 5, 9, 10, 14-15, 19-23
7	Rendered obvious by Soderman in light of Silescent and Roberge	§103	11
8	Rendered obvious by Soderman in light of Silescent and Wegner	§103	17

I. GROUND 1: CLAIMS 1, 2, 3, 4, 6, AND 14-15 ARE ANTICIPATED BY CHOU

53. Chou teaches elements corresponding to each and every limitation of claims 1, 2, 3, 4, 6, and 14-15, arranged as in the claims.

Claim 1

1. ***“a heat spreader and a heat sink thermally coupled to the heat spreader”***

54. Chou discloses a heat spreader thermally coupled to a heat sink. With respect to the heat spreader, Chou teaches that trim 12 spreads the heat generated by LED light source 15. "Trim 12 includes a light source attachment point located inwardly from the flange. The attachment point provides a mount for physically mounting the light source to trim 12." Chou at 7:37-40. "As the light source generates heat, the heat is transferred into trim 12 at the attachment point. From there, the heat is transferred into … the flange of trim 12." *Id.* at 7:44-46; *see also id.* at 7:63-8:1 ("heat energy enters trim 12 and moves to flange 22"). *See generally id.* at Figs. 2b, 4a and 4b. Thus, while not referring to it as a "heat spreader," Chou teaches that the interior portion of trim 12 moves the heat away from the light source, corresponding exactly to the "heat spreader" of the '968 Patent. Heat would naturally flow outwards from the light engine and driver to the outer perimeter of the trim, referred to by Chou as the flange 22. *Id.* at 4:46-50.

55. With respect to the heat sink, Chou states that "[i]n the present embodiment, . . . as the light source operates, heat is transferred into trim 12 from the light source. As the temperature of trim 12 increases, heat is vented from the flange [22] portion of trim 12 that resides outside the recessed can housing." *Id.* at 5:1-5 (emphasis added); *id.* at 7:63-8:3 ("flange 22 dissipates the heat from fixture 10 outside the recessed can housing into a room or office rather than into the housing itself."). Indeed, "a majority of heat is dissipated from trim 12 outside the housing.

Accordingly, fixture 10 minimizes heat build-up within the recessed housing." *Id.* at 5:9-11. "As shown in the example, fixture 10 efficiently dissipates a majority of heat generated by the light source through trim 12 and outside of the recessed can housing and mitigates the deleterious effects of heat on the light source fixture 10." *Id.* at 7:14-19. Thus, while Chou calls the heat-sinking perimeter of the trim a heat-dissipating "flange" rather than a "heat sink,"[4] the flange portion of the trim clearly is a "heat sink" as recited in the '968 Patent, *i.e.*, it dissipates heat transferred to it by the heat spreader into the air.

56. The limitation "a heat spreader and a heat sink thermally coupled to the heat spreader" is thus squarely met.

2. *"the heat sink being substantially ring shaped and is disposed around and coupled to an outer periphery of the heat spreader"*

57. Chou teaches this limitation. "The trim has thermally conductive properties and includes a flange around a perimeter of the trim." *Id.* at 2:54-55. *See generally id.* at Figs. 2b, 4a and 4b *and compare with* '968 Patent at Figs 12, 13. While the inner portion of trim 12 is flat, *see* Chou at 7:50-51 ("central attachment area 20"), Fig 4a (20), the outer flange 22 of the trim is raised, round, and has a hole

---

[4] Chou also identifies "heatsink 14," but as discussed below, this is merely an extra element.

in the middle. See Fig. 4a (22). Furthermore, the embodiment of Chou where the trim is formed by combining multiple pieces, *see id.* at 7:23-26, would include the flange 22 as one part and the interior part of the trim (central attachment area 20) combined together to form the trim 12. Thus, the outer flange is ring-shaped. Furthermore, the portion or piece of the trim that is the heat sink of Chou is coupled to the outer periphery of the heat spreader of Chou. Figure 2b illustrates of this. The portion or piece of the trim that is the heat sink (*i.e.* exposed to the air) is immediately next to and flows into to the inner, heat spreader, portion or piece of the trim; indeed, they are stamped from the same piece of metal or the pieces are combined. *Id.* at 7:23-26 and Fig. 2b. The outer periphery of the heat spreader portion or piece is therefore coupled to the inner periphery of the heat sink portion or piece. Figures 2b and 4a illustrate the relative positions of the "central attachment area 20" (heat spreader) and the outer flange 22 (heat sink).

3. *"outer optic securely retained . . ."*

58. Chou discloses an optic – a "clear cover lens" – securely retained relative to the heat sink. "Lens 23 is attached to trim 12 using a friction coupling, adhesive, or a fastener." *Id.* at 8:16-23; see also Fig 2b (lens 23).

4. *"light source [LEDs] disposed in thermal communication with the heat spreader . . . such that the heat spreader dissipates heat from the LEDs"*

59. Chou discloses LEDs disposed on, and in thermal communication with, the heat spreader. Chou states: "In one embodiment, the light source is a light engine that includes a plurality of LEDs." Chou at 8:53-54. Further, "the light engine includes a single printed circuit board (PCB) having a plurality of connected LEDs." *Id.* at 8:62-64. "Light source 15 (shown on FIG. 2b) is directly mounted to a front surface of trim 12 and acts as the light source for the device." *Id.* at 4:14-17. "To facilitate transmission of thermal energy from light source 15 to the attachment area of trim 12, a layer of thermally conductive material is deposited between light source 15 and trim 12." *Id.* at 8:44-48. Chou goes on to note that the heat spreader transfers the thermal energy from the light source to the heat sink. *Id.* at 7:44-46, 7:63-8:1. In short, a POSITA would understand that the light source 15 is disposed upon and dissipates heat through the heat spreader.

5. ***"wherein the heat spreader, the heat sink and the outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25"***

60. Chou discloses this limitation. "In the example, trim 12 includes a thermally conductive material such as aluminum, and has an outer diameter of 200 mm, an inner diameter of 130 mm and a depth of 42 mm (*see* FIG. 4a)." *Id.* at 5:24-27. We know that the total depth (the trim depth protruding from the ceiling surface) must be 42 mm, because this depth is used in the calculation of trim surface area, which is used in all the subsequent calculations of heat dissipation by the trim. *Id.*

at 5:27-28 ("Accordingly, trim 12 has an approximate surface area of A_{trim}=0.0296 m^{2}"). We also know from Figs. 2a and 2b that the optic does not protrude beyond trim 12, and thus the height of trim 12 is the height of the combination of heat spreader, heat sink, and optic. That height to diameter (H/D) ratio is 42/200 = 0.21, which is less than 0.25. *Id.*

6. *"dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box."*

61. Chou discloses a combination of a heat spreader, heat sink, and optic "dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; [and] four-inch electrical junction box." Chou teaches that the fixture is drawn up against the ceiling: "The outer flange of trim 12 may contact a structural surface that surrounds the recessed housing such as a ceiling or wall surface (not shown). . . . [C]lips 18 exert force on fixture 10 and, specifically, pull the flange portion of trim 12 against the surface surrounding the recessed can application." *Id.* at 4:46-54. The torsion spring tries to open and walks or pulls the fixture up into the ceiling. A POSITA would understand that Chou is referring to covering the opening of the can with the heat sink (*i.e.* flange). Figure 3 confirms this. Chou at Fig. 3.

62. Furthermore: "Fixture 10 is configured to install into both conventional 12.7 cm (5 inch) and 15.24 cm (6 inch) recessed can housings." *Id.* at 3:65-66. A POSITA would recognize that if Chou covers a 5 inch can, it will also cover the

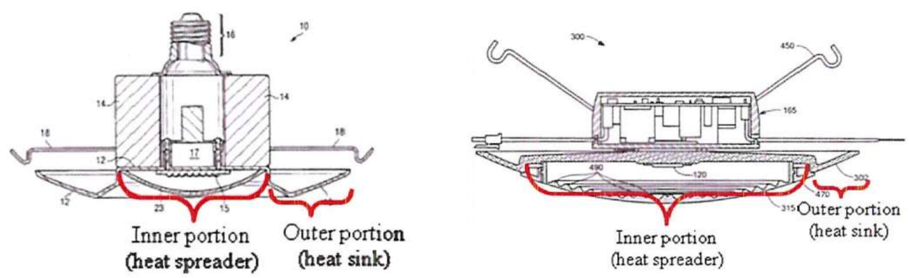
opening defined by a four-inch can and four-inch electrical junction box. The diameter of a 5-inch or 6-inch can is larger than the diameter of a 4-inch can. It is also larger than the opening of a standard 4-inch junction box. If the Chou fixture covers a 5 or 6-inch can, it also covers the opening of a standard 4-inch can and a standard 4-inch junction box.

63. In my opinion, Claim 1 of the '968 Patent is invalid as anticipated by Chou.

Claim 2

64. Dependent claim 2 is further limited by "the heat spreader and the heat sink are *integrally formed* such that a heat flow path . . . is continuous and uninterrupted." '968 at Claim 2 (emphasis added). Chou discloses an integrally formed heat spreader and heat sink such the heat flow path through the heat spreader to the heat sink is continuous and uninterrupted. As noted above, Chou describes the inner portion of the trim 12 as functioning as a heat spreader and describes the outer portion of the trim 12 (*i.e.* flange 22) as functioning as a heat sink, dissipating the heat into the air. Furthermore, Chou discloses that these two elements can be as formed from one piece: "Trim 12 is manufactured as a single piece of stamped aluminum." Chou at 7:49-50, 7:24-25 (same). The heat path from the heat spreader to the heat sink is also continuous and uninterrupted, so the heat flow is continuous

and uninterrupted. Chou illustrates these elements in the same manner they are shown and described in the '968 Patent:



Chou Fig. 2b and '968 Patent Fig. 30 (brackets and annotations added). Thus, as the '968 Patent description and figures show the heat sink and heat spreader are integrally formed, Chou also discloses a heat sink and a heat spreader that are integrally formed.

65. In my opinion, Claim 2 of the '968 Patent is invalid as anticipated by Chou.

<u>Claim 3</u>

66. Dependent Claim 3 is further limited by "the integrally formed heat spreader and heat sink form a base, the base having a back surface with radially oriented recesses therein." '968 Patent at Claim 3. The '968 Patent's specification explains that heat sink fins alternate with the recesses to enable greater heat transfer. *Id.* at 9:13-15. Chou discloses this limitation: "Heatsink 14 includes a plurality of fin structures to facilitate dissipation of heat energy collected within heatsink 14 into

the surrounding air." Chou at 8:32-35, Fig. 2a(14). Fin structures of Chou necessarily create an alternating arrangement of fins and recesses. *See id.*

67. In my opinion, Claim 3 of the '968 Patent is invalid as anticipated by Chou.

Claim 4

68. Dependent Claim 4 is further limited by "the heat spreader and the heat sink are integrally formed to define a base, wherein a back side of the base comprises a plurality of heat sink fins and air flow channels configured and disposed to transport heat generated by the light source away from the light source." '968 Patent at Claim 4. As discussed for Claim 3 above, Chou expressly discloses "a plurality of fin structures to facilitate dissipation of heat energy collected within heatsink 14 into the surrounding air," Chou at 8:32-35, and that the fin structures of Chou necessarily create an alternating arrangement of fins and recesses. *See id.* In the same vein, the alternating fin-and-recess arrangement of Chou would create a star pattern to provide air flow channels to dissipate heat.

69. In my opinion, Claim 4 of the '968 Patent is invalid as anticipated by Chou.

Claim 6

70. Dependent Claim 6 is further limited by "a phosphor disposed over the plurality of LEDs comprising material to produce a color temperature output of 2700

deg-Kelvin." '968 patent at claim 6. Chou teaches this limitation. "In one embodiment, the selected combination of LED devices . . . achieve a particular white light correlated color temperature (CCT) having a temperature of approximately 2700K, 3000K or 3500K." Chou at 9:7-12. "In addition to the use of RAGB or RGB LEDs to emit white light, other combinations of LEDs may be used. For example, the light energy may include blue LEDs coated with phosphor or uV LEDs coated with phosphor." *Id.* at 9:37-40.

71. In my opinion, Claim 6 of the '968 Patent is invalid as anticipated by Chou.

Claim 14

72. Dependent Claim 14 is further limited by "at least some of the LEDs are connected to a circuit board, the circuit board being disposed substantially flat on the heat spreader inside a recessed portion of the heat sink." '968 patent at claim 14. Chou teaches this limitation. "Light source 15 (shown on FIG. 2b) is directly mounted to a front surface of trim 12 and acts as the light source for the device." Chou at 4:14-17. "In one installation, the light engine includes a single printed circuit board (PCB) having a plurality of connected LEDs." *Id.* at 8:62-64; *see also* Figs. 2b, 4a and 4b. "Trim 12 is manufactured as a single piece of stamped aluminum and includes a central attachment area 20. Attachment point 20 serves as a mount point for the light source." *Id.* at 7:49-52. The light source 15 includes the circuit

board which is visible as flat against the front surface portion or piece of the trim 12 which is disposed in a recessed portion of the outer portion of the trim 12 ("flange," heat sink) in the cross section shown in Fig. 2b.

73. In my opinion, Claim 14 of the '968 Patent is invalid as anticipated by Chou.

Claim 15

74. Dependent Claim 15 is further limited by "a power conditioner mechanically supported by the heat spreader, the power conditioner being configured and disposed to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs." '968 patent at claim 15.

75. Chou teaches this limitation. "If the power source is an AC power source and the light source is configured to operate using a DC power source, an AC to DC converter circuit may be connected between socket 16 and the light source to convert the AC power source into a DC source." Chou at 4:22-26. This type of AC to DC converter is more commonly known by persons of ordinary skill in the art as a "driver" and would receive AC voltage and, as the name indicates, deliver DC voltage to the light source. Further: "In one embodiment, the conversion circuit includes circuit board 17." *Id.* at 4:26-28. As shown in Fig. 2b, the power conditioner on circuit board 17, sitting within heatsink 14, is disposed upon and

supported by the upper surface of trim 12 (*i.e.* supported by the heat spreader). *See id.* at Fig. 2b (17).

76. In my opinion, Claim 15 of the '968 Patent is invalid as anticipated by Chou.

* * *

77. As the foregoing discussion of claims 1, 2, 3, 4, 6, and 14-15 makes clear, the inner and outer portions or pieces of trim 12 meet the "heat spreader" and "heat sink" limitations of claim 1 (and its dependents), respectively. Chou further discloses an additional element not claimed in the '968 Patent: heatsink 14. Although I understand this to be legally irrelevant to anticipation, this element warrants some discussion here.

78. Chou refers to trim 12 as a "trim" rather than a heat sink, despite its heat sinking function. In fact, Chou notes that "[a]lthough some heat is vented into the recessed housing by the heatsink 14, *a majority of heat is dissipated from trim 12* outside the housing." *Id.* at 5:8-10 (emphasis added). "Trim 12 and the flange of trim 12 [flange 22] generally dissipates *more* heat energy from the light source *than heatsink 14*. By doing so, trim 12 minimizes heat build-up within the can housing." *Id.* at 5:18-21 (emphasis and bracketed text added); *see also id.* at 5:15-17 (element 14 "may be regarded as acting as a heatsink for trim 12 rather than the light source directly.") Chou then quantifies the heat transfer for both elements, *id.*

at 5:18 – 7:13, and determines that "trim 12 dissipates approximately 65% of the heat energy generated by the LED light source," *id.* at 7:1-3.

79. Put differently, once trim 12 is shown to disclose the "heat spreader" and "heat sink" elements, the presence of other elements (such as heatsink 14 or any other feature) has no bearing on whether trim 12 and the optic have the requisite H/D ratio or meet the other claim limitations.

II. GROUND 2: CLAIMS 3, 4, AND 19-23 ARE RENDERED OBVIOUS BY CHOU

Claim 3

80. Dependent Claim 3 is further limited by "the integrally formed heat spreader and heat sink form a base, the base having a back surface with radially oriented recesses therein." '968 Patent at Claim 3. The '968 Patent's specification explains that heat sink fins alternate with the recesses to enable greater heat transfer. *Id.* at 9:13-15. As discussed above, Chou discloses this limitation because it discloses "a plurality of fin structures" as part of the heat sink "to facilitate dissipation of heat energy," Chou at 8:32-35, and therefore, Chou anticipates Claim 3. Nonetheless, to the extent the Board finds that Chou does not disclose the "radially oriented recesses," Chou renders them obvious. As POSA would be motivated to enhance heat dissipation (the primary goal of the alleged invention of the '968 Patent) by incorporating the alternating fin and recess arrangement because

such an arrangement would have more exposed surface area compared to a flat surface and therefore better heat conduction and flow.

Claim 4

81. Dependent Claim 4 is further limited by "the heat spreader and the heat sink are integrally formed to define a base, wherein a back side of the base comprises a plurality of heat sink fins and air flow channels configured and disposed to transport heat generated by the light source away from the light source." '968 Patent at Claim 4. As discussed for Claim 3 above, Chou renders obvious the alternating fin-and-recess arrangement. Such an arrangement, in turn, would necessarily create, and therefore render obvious, a star pattern providing air flow channels to dissipate heat.

Claim 19

82. Claim 19 depends from claim 15 and has two additional limitations: "[1] the power conditioner is disposed on an opposite side of the heat spreader as the plurality of LEDs, [2] the power conditioner being so dimensioned as to fit within: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box." '968 Patent at claim 19.

83. Chou already teaches limitation [1], an AC/DC power conditioner: "If the power source is an AC power source and the light source is configured to operate using a DC power source, an AC to DC converter circuit may be connected between

socket 16 and the light source to convert the AC power source into a DC source." Chou at 4:22-26. Further, "[i]n one embodiment, the conversion circuit includes circuit board 17 mounted within heatsink 14." *Id.* at 4:22-27. Chou in Fig. 2b further discloses that circuit board 17 is disposed above trim 12 on the opposite side of light source 15. *Id.* at Fig. 2b (17). The power conditioner is thus disposed on the upper surface of trim 12, opposite the LEDs. *Id.*

84. As to limitation [2], Chou already discloses light fixtures fitting within 5-inch and 6-inch light cans. *Id.* at 3:65-66 ("Fixture 10 is configured to install into both conventional 12.7 cm (5 inch) and 15.24 cm (6 inch) recessed can housings."). The power conversion circuit board 17, positioned inside heatsink 14 which itself is inserted into the can, therefore fits within a 5-inch can. *Id.* at 4:46-54 (above the ceiling line), 4:28 (within), Fig. 2b (inside). Chou further teaches that "fixture 10 may be configured to be installed into a recessed can housing *having other geometries*." *Id.* at 3:67-4:1 (emphasis added).

85. It would have been obvious to a POSITA to modify the light fixture of Chou (if necessary)[5] by scaling the driver 17 and ancillary heatsink 14 to fit within

[5] The Board will appreciate that Chou does *not* actually state that heatsink 14 as depicted would be unable to fit into a 4-inch junction box, as is. For the sake of

a 4-inch can and a 4-inch junction box. At the time of the '968 Patent 4-inch cans and 4-inch junction boxes were widely used. Four-inch cans are most often legacy incandescent fixtures. Four-inch junction boxes are very common in residential settings. A POSITA would have appreciated that sizing the Chou luminaire for use with 4-inch cans and 4-inch junction boxes would increase the number of potential installations and likely the number of sales. A POSITA would therefore have been motivated to modify Chou in such a way as to make a version of Chou suitable for fitting into and covering 4-inch cans and 4-inch junction boxes – thus serving more of the residential and commercial lighting market.

86. A POSITA would have also understood that the Chou fixture was capable of being sized to fit within a 4-inch can and a 4-inch junction box. At the time of the invention there were many AC-to-DC power conditioners, *i.e.* drivers, commercially available. An LED fixture designer would have chosen from this wide range of driver options, including different sizes, different shapes, different outputs, and different functionalities (*e.g.* dimmable or non-dimmable). At the time of the invention there were a number of drivers with a small enough form-factor to fit within a 4-inch can and a 4-inch junction box. It would have been obvious to modify

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completeness, I nevertheless assume that the Chou disclosure would require some modification.

the secondary heat sink and driver of Chou to also fit within a nominally sized junction box – including sizes from 4" to 6" – by selecting an alternative driver and heat sink scaled/sized to fit in the shallower dimension of an electrical junction box.[6] *See* DiLouie at 28 ("[LED drivers] are usually compact enough to fit inside a junction box");[7] Lynch at 15:8-15 (A driver including a power converter module "configured to accept … 120VAC … and convert the electricity to a desired voltage, such as 3VDC, 9VDC, 12VDC …" is part of the "assembled LED luminaire 200 … adapted to mount to a conventional electrical junction box 210.;" *see also* Lynch at Figs. 25A and 25B (showing the driver 206 positioned within the junction box 210); Ko at ¶¶ [0032], [0042], and Fig. 5 (the housing 200 contains the driver circuit 600 which has an initial AC/DC conversion circuit 602 and the housing is configured to fit within a single-gang junction box). To the extent the driver (17) already disclosed

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[6] The Board will appreciate that Chou does *not* actually state the depicted heatsink 14 would be unable to fit into a 4-inch junction box, as is.

[7] Indeed, 110V AC/DC power converters came in sizes all the way down to sub-one-inch. *See* U.S. Patent No. 5,463,280 ("Johnson") (Ex. 1017) at Fig. 2 (diode bridge 22), 4:11-14 (circuitry fits within a standard T6½ bulb, 0.8125 inch diameter); 5:2-4 ("The diode bridge 22 functions to convert AC line voltage to DC and provides full wave operation of the lamp").

in Chou did not fit within a 4-inch can, a POSITA would have simply chosen one of these other smaller drivers. To the extent that heatsink 14 would not have fit within a 4-inch junction box, a POSITA would understand that it could be reduced in size. Although this would mean less heat sinking, a POSITA would understand that they could choose to use a light engine with fewer LEDs (or a more efficient, cooler running, driver), which would reduce the amount of heat generated by the fixture. This would allow for the use of a smaller heat sink while maintaining an appropriate operating temperature for the driver and light engine. Or the designer could have used a lower lumen light engine or more efficient LEDs. As Chou points out, the majority of the heat is dissipated via the trim anyway. Chou at 5:8-10. For the designer, there were many options. For example, I personally designed fixtures to fit particular sizes and form factors. In short, substituting one of these smaller drivers and a correspondingly smaller heat sink would have yielded the predictable result of the driver and accompanying heat sink fitting inside a 4-inch can or 4-inch junction box.

87. In my opinion, Claim 19 of the '968 Patent is rendered obvious by Chou.

<u>Claim 20</u>

1. ***"a heat spreader and a ring-shaped heat sink thermally coupled to and disposed diametrically outboard of the heat spreader"***

88. As noted in the discussion of claim 1, the interior portion of trim 12 is a heat spreader, thermally coupled to the outer portion of the trim, flange 22, which is a heat sink. Chou further teaches that the heat sink has an outer "diameter" outside the inner "diameter" encircling the heat spreader portion. Chou at Fig. 4a. Chou also states that the trim can be formed by combining multiple pieces. *Id.* at 7:24-26, which would include the flange 22 (heat sink) as one part and the interior part of the trim (central attachment area 20, heat spreader) combined together to form the trim 12. The heat sink is completely exterior to the heat spreader portion. *See id.* It is also ring-shaped. *See id.* at Flange 22. Chou thus teaches the sink is diametrically outboard of the spreader.

2. *"an outer optic securely retained . . ."*

89. As noted in the discussion of claim 1, Chou discloses this limitation.

3. *"[LEDs] disposed on the heat spreader such that the heat spreader dissipates heat from the LEDs"*

90. As noted in the discussion of claim 1, Chou discloses this limitation.

4. *"the heat spreader, the heat sink, and the outer optic define a combination having an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25"*

91. As noted in the discussion of claim 1, Chou discloses this limitation.

5. *"a power conditioner disposed in electrical communication with the light source, configured to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs, the power*

> ***conditioner being so dimensioned as to fit within at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box."***

92. As noted in the discussion of claim 19, Chou discloses an AC/DC power conditioner, in electrical communication with the light source. Chou at 4:14-26 (describing power flow to LEDs). Furthermore, as noted, Chou renders obvious the dimensional limitation of the power conditioner fitting within an industry-standard 4-inch light can *and* 4-inch junction box. Therefore, Chou renders obvious the power conditioner fitting within *at least one of* a 4-inch light can or 4-inch junction box.

93. In my opinion, Claim 20 of the '968 Patent is rendered obvious by Chou.

Claim 21

94. Dependent claim 21 is further limited by a "power conditioner [] so dimensioned as to fit *completely* within at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box." '968 Patent at claim 21 (emphasis added).

95. As noted in the discussion of claim 19, the power conditioner in Chou (circuit 17) and accompanying heat sink (heatsink 14) already fit entirely within a 5-inch or 6-inch light can. It would have been obvious to one of ordinary skill to scale these components (and the LEDs as necessary) to likewise fit entirely within a

standard 4-inch can or 4-inch box. *See* claim 19 *supra* (obvious to scale using available components, motivated by market demand, and known examples of LED drivers in junction boxes such as Lynch and Ko). Thus, Chou renders obvious the power conditioner fitting completely within *at least one of* a 4-inch light can or 4-inch junction box.

96. In my opinion, Claim 21 of the '968 Patent is rendered obvious by Chou.

Claim 22

97. Dependent claim 22 is further limited by "the defined combination is so dimensioned as to cover a circular opening defined by at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box." '968 Patent at claim 22. Chou discloses this limitation. As noted in the discussion of claim 1, Chou is wide enough to cover the opening defined by a 5-inch or 6-inch can; it will therefore also cover a circular opening defined by at least one of: a nominally sized 4-inch can light fixture; and, a nominally sized 4-inch electrical junction box.

98. In my opinion, Claim 22 of the '968 Patent is rendered obvious by Chou.

Claim 23

99. Dependent claim 23 is further limited by "the heat sink forms a trim plate that is disposed completely external of the can light fixture or electrical junction box." '968 Patent at claim 23. Chou discloses this element. As the name suggests, trim 12 is a trim plate. Fig. 3 shows the flange 22 portion of trim 12 entirely outside the light fixture can. Chou at Fig 3 (showing the flange portion of trim 12 sitting outside the can), Fig. 4a (identifying the perimeter of trim 12 as flange 22), 7:63 ("Trim 12 includes flange 22").

100. Figure 2b likewise shows the flange 22 portion of trim 12 entirely below the ceiling plane and thus external of the can light fixture or electrical junction box. *Id.* at Fig. 2b; *compare with* Fig. 4A; *see also id.* at 4:46-54 ("clips 18 exert force on fixture 10 and, specifically, pull the flange portion of trim 12 against the surface surrounding the recessed can application"). This would make sense given Chou's discussion of the heat sink/flange dissipating the majority of the heat generated by the fixture. Locating the heat sink/flange within the can would negatively impact its heat sinking ability.

101. In my opinion, Claim 23 of the '968 Patent is rendered obvious by Chou.

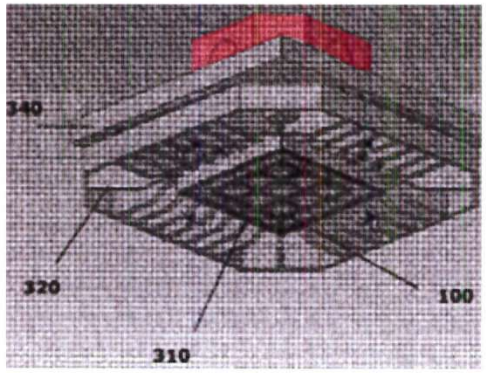
III. GROUND 3: CLAIMS 7, 8, 11, AND 12 ARE RENDERED OBVIOUS BY CHOU IN LIGHT OF ROBERGE

Claim 7

102. Dependent claim 7 further limits claim 1 as further comprising:

> a mounting bracket; and
> a power conditioner, the power conditioner being configured and disposed to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs;
> wherein the power conditioner is supported by the mounting bracket on one side thereof, and the heat spreader and heat sink are supported by the mounting bracket on another opposing side thereof;
> and wherein the mounting bracket comprises mounting holes disposed to secure the luminaire to an electrical junction box.

'968 Patent claim 7. Roberge discloses this limitation. Roberge discloses a configuration whereby a mounting bracket supports the power conditioner on one side and the heat spreader and the heat sink on the other side. Roberge at 23:54-24:3. The hook 338 attaches to the mounting plate 341, *id.* at 23:57-60, which collectively form a mounting bracket. This mounting bracket supports the power/control module 334 (power conditioner) on a top side (see Fig. 3B) and the mounting bracket (via the mounting plate) supports the heat sink 320 and heat spreader (the heat spreader is the upper portion of the recess 333 in the heat sink): "... heat sink 320 has a recess 333 for receiving LED module 310 which is mounted therein with, for example, screws." *Id.* at 23:20-22. Roberge also discloses that the apparatus 300 (light fixture) can be surface mounted to a junction box. *Id.* at 23:16-19. *See also* Roberge Provisional at ¶105 and Fig. 3B (junction box highlighted in red below):



Id. at 3B (highlight added). The mounting plate (341) of Roberge is referenced as the ceiling plate (340) of Roberge Provisional which describes the "screw holes 348 through which screws are passed to facilitate coupling of the ceiling plate [mounting plate] to a conventional junction box mounted to the ceiling." *Id.* at ¶105.

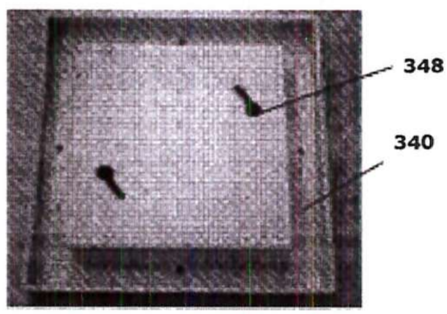


FIG. 4B

Id. at Fig. 4B. A POSITA would understand that one uses screws to mount light fixtures to junction boxes and the top component would be component to have holes through which screws to the junction box could be used for mounting.[8]

[8] *See, e.g.*, Soderman at Fig. 6 (29); Ko at Fig. 5 (104); Lynch at Fig. 25B (230)).

103. To the extent that the Board finds the mounting bracket of Roberge incomplete, a POSITA would have been motivated to include the mounting bracket because mounting brackets are commonly used as an accessory such that a fixture could be mounted to a particular size junction box or receptacle simply by using a different bracket. Furthermore, the drivers would be commonly attachable to one side of the bracket since the drivers are often in the junction box (where the incoming electrical power is connected to the fixture),[9] where the brackets include a mounting structure as opposed to having the driver simply lay in the junction box unsafely. A POSITA would be motivated to install a driver into a junction box to keep the high voltage AC connection within a safe enclosure and to reduce the profile of the light fixture. Also, the heat sink and heat spreader would not readily fit within the junction box, thus they would be supported by the bracket on the side opposite the bracket.

Claim 8

104. Dependent claim 8 further limits claim 7 as "further comprising: at least one torsion spring configured and disposed so as to secure the luminaire to a can light fixture." '968 Patent at Claim 8. Chou discloses the specific mounting

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[9] *See, e.g.*, DiLouie at 28; Ko at ¶32, Fig. 5 (the housing 200 containing driver circuitry is configured to fit within a single-gang junction box); Lynch at 18:66 – 19:1, Fig. 25B (the driver 206 is installed into a junction box 210).

mechanism. Chou at 4:31-38. A POSITA would have been motivated to include the mounting bracket because torsion springs are very common methods for securing a retrofit fixture or trim to a recessed can. A POSITA would want a bracket or selection of brackets to be able to provide for mounting to a recessed can to capture the retrofit market for recessed can downlights.

Claim 11

105. Dependent claim 11 is further limited by "an inner optic disposed over the plurality of LEDs." '968 Patent at claim 11. As noted in the discussion of claim 1, Chou already discloses an "outer" optic. It would have been obvious to one of ordinary skill to add a second, additional, "inner" optic.

106. The use of optics was well-known in the art at the time of the '968 Patent. A POSITA would have understood that inner optics can provide any number of benefits, including directing the light, such as changing from a flood light to a spot light, mixing the color from the LEDs, coloring the light, filtering the light, and blending the light output pattern to provide a smooth transition.

107. Chou already teaches the desirability of using optics to modify the raw LED light. Chou says: "Lens 23 may include one or more optical features that alter light passing through lens 23 to provide a desired optical effect. For example, lens 23 may be translucent or frosty and may include polarizing filters, colored filters or additional lenses . . . ." Chou at 8:21-26.

108. Roberge likewise discloses the use of optics – both inner and outer – to modify the raw LED light. Roberge discloses an outer "cover lens 315" and an inner "polycarbonate reflector optics 337 with a vacuum metalized reflective coating for collimating the light," Roberge at 23:12-13, Fig. 3B, 23:34-36. Roberge further teaches the use of "add[ing] accessories for modifying optical functionality, for example, a hexagonal cell louver, a cross baffle, or a spread lens." Roberge at 23:65-67. Roberge thus teaches the use of inner and outer optics to modify light.

109. The use of an inner optic in conjunction with an outer optic was also well known in the art as of October, 2009. Using a reflective inner optic with an outer optic, as seen in Roberge, would also result in a pleasing light pattern. The design would also be safe and effective given that there would be an extra barrier between the LEDs and the dirt, moisture and fingers that could find their way up into the fixture if the outer optic was removed.

110. A POSITA would therefore have recognized that an additional optic, as taught in Roberge, could be added to Chou in order to advance the goal suggested by Chou: further modifying the raw light from the LEDs (*e.g.* directing, diffusing, coloring, collimating). Chou at 8:21-26. A POSITA would recognize that adding an inner optic – for example, fitted between the LEDs and the outer optic, *see id.* at Fig. 2b – would have yielded a predictable result of further modifying the raw light from the LEDs.

Claim 12

111. Dependent Claim 12 is further limited by "the inner optic is integrally formed with the reflector." '968 Patent at Claim 12. As discussed for Claim 11 above, Roberge discloses a "reflector optic" containing material having reflective properties. Roberge at 23:34-36. Therefore, Roberge's inner optic and reflector are formed together as one thing. A POSITA would be motivated, based on the teachings of Roberge, to modify Chou to add an optic with reflective material for the additional advantage of light collimation for a "spot illumination" type light fixture as opposed to a "flood illumination" type light fixture.

112. In my opinion, Claims 7, 8, 11, and 12 of the '968 Patent are rendered obvious by Chou in light of Roberge.

IV. GROUND 4: CLAIM 16 IS RENDERED OBVIOUS BY CHOU IN LIGHT OF LOVE

113. Dependent claim 16 is further limited by "the power conditioner is disposed on the same side of the heat spreader as the plurality of LEDs." '968 Patent at claim 16. It would have been obvious to a POSITA to modify Chou to meet this limitation. As noted above with regard to claims 1 and 15, Chou already discloses an AC/DC power conditioner and a "light engine includ[ing] a single printed circuit board (PCB) having a plurality of connected LEDs." Chou at 8:62-64; *see also* Figs. 2b, 4a.

114. At the time of the invention of the '968 Patent, lighting designers were aware that AC/DC power conditioners came in a variety of shapes and sizes, including AC/DC power conditioners that could be mounted directly on a PCB along with the LEDs. One such design is disclosed in Love:

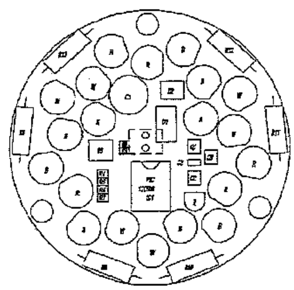


Figure-10

Love at Fig. 10. According to Love: "Fig. 10 is a front view of a circuit board and LEDs." Love at 2:47. Furthermore: "A bridge rectifier D1 and on-board circuitry converts the standard incoming 12 VAC supply to 18 VDC." *Id.* at 4:39-41. *See also id.* at 5:41-43 ("Separate circuitry for the conversion of incoming 12 VAC conversion to 18 VDC and for the addition of a programmable IC has been added to the LED PCB."). Love thus teaches placing an AC/DC power conditioner on the PCB, on the same side as the LEDs. *Id.* A POSITA would have understood that the integrated light engine disclosed in Love contains all of the circuitry necessary to drive the LEDs on the circuit board itself.

115. A POSITA would have been motivated at the time of the invention to place the AC/DC driver on the LED PCB as taught by Love – and thus on the same

side of the heat spreader – because such an integrated light engine would combine the functions of circuit board 17 and light engine 15. By placing both components on the PCB, manufacturing would be simpler because the fixture would no longer require a separate milled space for circuit 17 in heatsink 14. Further, the device's overall wiring would be made simpler because there would be no separate wire connecting the power conditioner to the PCB. Further, such integrated light engines were available and comparatively cheap.

116. I note that while the AC/DC conditioner shown in Love is operating at 12 VAC instead of 120 VAC (the typical residential line voltage), the principle of rectification is exactly the same as in Chou's circuit board 17: turning AC into DC so that it can drive LEDs.

117. Moreover, it was well known in the industry that circuits could be modified to accommodate different voltages. Things like rectifiers and resistors come in different voltage ratings. Persons of ordinary skill understood that circuits at one voltage could be adapted to another voltage. Indeed, when I worked at Phostech, I routinely chose electronics of different voltages for different applications.

118. Moreover, it was well known – and there are other examples – to persons of ordinary skill in the art to utilize a 120VAC AC/DC power conditioners to drive LEDs on a printed circuit board, on the same side as the LEDs. *See, e.g.*,

U.S. Pat. Nos. 5,463,280 ("Johnson," Ex. 1016) at Figs. 1-7, 10 (retrofit LED light bulb, using a rectifier at 120 VAC), 7,038,399 (retrofit LED light bulb, using a rectifier at 120 VAC).

119. It would therefore be obvious to adapt the AC/DC power conditioner circuit described in Love to work in a 120 VAC residential (or 240VAC commercial) environment. Or put differently, it would be obvious how to apply the teaching of Love – the idea of placing a AC/DC power conditioner on a PCB – to the 120 VAC residential (or 240VAC commercial) environment. It would have predictably resulted in a simpler, cheaper implementation of Chou.

120. I also note that persons of ordinary skill understood that higher voltages circuits required a cover over them, but this too was a trivial and widely understood adaptation of well-known circuits.

121. I note finally that the '968 Patent is agnostic as to voltage. Further, Chou itself does not specify a fixed voltage at which it must operate, *see* Chou at 4:21-22 ("other AC or DC power source"). Another possibility would be to combine Love, as is, with a lower-voltage Chou.

122. In my opinion, Claim 16 of the '968 Patent is rendered obvious by Chou in light of Love.

V. GROUND 5: CLAIM 17 IS RENDERED OBVIOUS BY CHOU IN LIGHT OF WEGNER

123. Dependent claim 17 further limits claim 15 as "further comprising: a reflector disposed on the heat spreader, the reflector having an aperture in which the plurality of LEDs are disposed." '968 Patent at Claim 17. Wegner discloses this limitation. Wegner discloses "a reflector housing 320 is coupled to the bottom surface 310a of the heat sink 310." Wegner at 8:1-2; *see also id.* at 8:16-18. The reflector housing is configured to receive a reflector 1205 (Fig. 12) composed of a material for reflecting light emitted by the LED. *Id.* at 8:33-35. The reflector 1205 has an upper aperture in which the plurality of LEDs are disposed when the reflector is 1205 is positioned in the reflector housing 320 onto the heat spreader as shown in Fig. 12. A POSITA would therefore have recognized that the assembly in Chou could additionally include a reflector. A POSITA would have been motivated to include the reflector of Wegner for the purpose of reflecting light towards the outer optic and to create a smooth, blended light pattern and blend out what would otherwise be a hard visible line. *Id.* at 13:41-43.

124. Thus, in my opinion, Claim 17 of the '968 Patent is rendered obvious by Chou in light of Wegner.

VI. GROUND 6: CLAIMS 1, 5, 9, 10, 14-15, AND 19-23 ARE RENDERED OBVIOUS BY SODERMAN IN LIGHT OF SILESCENT

125. While Soderman itself does not include every single element in claims 1, 5, 9, 10, 14-15, and 19-23 arranged as in the claims, Soderman combined with the more detailed literature of Silescent does. Moreover, the combination would have been obvious to a POSITA because Silescent, as I understand, is the commercial embodiment of Soderman.

<u>Claim 1</u>

1. *"a heat spreader and a heat sink thermally coupled to the heat spreader"*

126. Soderman discloses a heat spreader and a heat sink. With respect to the heat spreader, Soderman teaches that the "[LED] illumination assembly 12" transfers heat to "mounting assembly 18." Soderman at 6:22-28, Fig. 5. "[T]he heat being removed from the illumination assembly 12 is transferred there from, through the mounting assembly 18." *Id.* at 7:36-38. "The mounting assembly 18 may be formed from a metallic or other material which facilitates the conductivity or transfer of heat." *Id.* at 6:34-36 (emphasis added). "Such confronting engagement between the illumination assembly 12 and the mounting assembly 18 . . . facilitates the transfer and dissipation of heat from the illumination assembly." *Id.* at 6:39-44, see also *Id.* at Fig. 5(18). The mounting assembly 18 is thus a heat spreader, transferring heat away from the illumination assembly 12. *Id.* at Fig. 3.

127. With respect to the "heat sink," Soderman discloses a "cover structure 20" made of a "heat conductive material" that conducts heat from the heat spreader out to the air. *Id.* at 6:53, Fig. 5(20), Fig 6(20). Soderman states: "As such, heat is transferred from the illumination assembly 12 through the mounting assembly 18 and to the cover structure 20 for eventual dissipation to the surrounding area." *Id.* at 8:31-34, 7:36-41 (similar). The heat spreader is thermally coupled to the heat sink.

2. *"the heat sink being substantially ring shaped and is disposed around and coupled to an outer periphery of the heat spreader"*

128. Soderman teaches a ring-shaped heat sink. Cover 20 is round with a hole through the center. *Id.* at Fig. 5 (20); *cf.* Silescent at 2 (referring to this as "Thermal Ring"). Soderman's ring-shaped heat sink, in turn, is disposed around and coupled to an outer periphery of the heat spreader. *See generally* Soderman at Fig. 3 (showing the heat sink/cover 20 disposed around the outside of heat spreader/assembly 18). This heat sink is disposed around and coupled to the perimeter of the mounting assembly 18, specifically the vertical risers 18'. *Id.* at Fig. 5.

129. The Figures distinguish between the vertical perimeter 18' of each disc comprising the mounting assembly 18, on the one hand, and the flat surface 18" constituting the perimeter of each disc, on the other. See *id.* at Figs. 5 (showing both

the 18' vertical surface and the 18" horizontal surface), 6 (same). Under the broadest reasonable interpretation, either surface constitutes a perimeter of the mounting assembly. *Cf.* also '968 Patent at Fig. 12 (likewise showing the heat sink disposed around and overlapping the heat spreader).

130. Soderman further discloses the coupling at the outer periphery of the mounting assembly (i.e. the boundary between the mounting assembly and cover). The heat sink/cover is "disposed in substantially continuous confronting engagement" around the mounting assembly." Soderman at 6:64-65; *see also id.* at 7:4 (cover "mating" with corresponding assembly surfaces). The heat sink is mechanically coupled to the mounting assembly via a series of connectors. *Id.* at Fig. 5 (28), 8:1-5 (discussing connectors).

131. Soderman therefore discloses a "heat spreader and a heat sink thermally coupled to the heat spreader, the heat sink being substantially ring-shaped and being disposed around and coupled to an outer periphery of the heat spreader;" as well as "a light source disposed in thermal communication with the heat spreader, the light source comprising a plurality of light emitting diodes (LEDs) that are disposed on the heat spreader such that the heat spreader dissipates heat from the LEDs." '968 Patent at claim 1.

3. *"outer optic securely retained . . ."*

132. Soderman discloses an optic securely retained relative to the heat sink. *See generally* Soderman at Fig. 3 (26). Soderman discloses "a light shield 26 which may be formed of a transparent and/or translucent material," *id.* at 7:54-61, affixed to a bolt, 29", see Fig. 6 (29"), Fig. 7 (29"), which is itself bolted to the heat spreader 18.

133. Figure 5 also discloses an optic (26), attached to the heat spreader (i.e. mounting assembly) via an "attachment assembly" (29 and 29'). Figure 5 shows the attachment assembly secured through the mating assembly/heat spreader and cover/heat sink. *Id.* at Fig. 5. Thus, Soderman discloses an "outer optic securely retained relative to at least one of the heat spreader and the heat sink." '968 Patent at claim 1.

4. *"light source [LEDs] disposed in thermal communication with the heat spreader . . . such that the heat spreader dissipates heat from the LEDs"*

134. Soderman discloses LEDs disposed on, and in thermal communication with, the heat spreader. Soderman discloses: "an illumination assembly generally indicated as 12 comprising one or more light emitting diodes 14." Soderman at 6:14-17. These LEDs are mounted on the heat spreader/mounting assembly 18, *see* Fig. 5 (12), in "heat transferring relation" to the heat spreader, *id.* at 7:26-28. *See also id.* at Fig. 5 (12), Fig. 6 (12, 14).

135. Soderman discloses a "mating assembly" onto which is mounted an "illumination assembly," which includes multiple LEDs. *Id.* at 2:54-55, 6:22-28, 7:36-41, Fig. 5. Soderman discusses the mating assembly drawing heat away from the illumination assembly (*i.e.* LEDs) and transferring it to the "cover," where it is dissipated into the air. *Id.* at 6:53, 8:31-34. Thus, Soderman disclose a heat spreader (*i.e.* the mating assembly) and a heat sink (*i.e.* the cover), as those terms are used in the '968 Patent.

5. *"an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25"*

136. While Soderman does not disclose individualized dimensions for the heat spreader, heat sink, and optic, see *Id.* at Fig. 1 (showing low profile but not exact dimensions), it would have been obvious to a POSITA to implement Soderman using such a H/D ratio of less than 0.25 based on the teachings of Silescent, which discloses precisely such an embodiment:

137. Silescent at Fig. 1. Silescent discloses a height (including mounting assembly, cover, and light shield) of 0.80 inches. Silescent at Fig. 1. It has a diameter of 7.90 inches. *Id.* The H/D ratio is thus .101. It would have been obvious to a POSITA to use these dimensions to implement Soderman (as indeed they were), yielding the predictable result of a low-profile fixture.

138. A POSITA would have appreciated the benefit of implementing the Soderman fixture with the Silescent fixture's dimensions. The resulting fixture is a

very low-profile fixture that is visually unobtrusive and thermally efficient due to the surface area available for heat dissipation.

6. ***"wherein the combination . . . is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box"***

139. As noted above, while Soderman does not expressly disclose individualized dimensions for the heat spreader, heat sink, and optic, it would have been obvious to a POSITA to implement Soderman using the dimensions disclosed in Silescent. Silescent discloses a diameter of 7.90 inches. *Id.* Implementing Silescent with a 7.90" diameter would have yielded the predictable result of a thin, low-profile heatsink (and fixture) with sufficient surface area (the large 7.9" diameter relative to the thickness) for heat dissipation and covering a 4-inch box or 4-inch can, a necessary design element for this type of light fixture in a retrofit application.

140. In my opinion, Claim 1 of the '968 Patent is rendered obvious by Soderman in light of Silescent.

Claim 5

141. Dependent claim 5 is further limited by "mounting holes suitably spaced apart to receive mounting fasteners to secure the heat spreader to an electrical junction box." '968 Patent at claim 5.

142. Soderman discloses this limitation. As seen in Fig. 6, mounting holes 44 are suitably spaced to permit fasteners 28 to secure the fixture to junction box 30. Soderman at Fig. 6. Furthermore, this same feature would have been obvious to a POSITA based on the teaching of Silescent. *See* Silescent at Fig. 4 (showing holes through the fixture base to attach to a "UL Approved Junction Box" in the ceiling). At the time of the invention, lighting designers routinely included mounting holes to attach to ceiling boxes for the convenience of installers. Adding such holes would predictably allow the fixture to be supported from the ceiling.

143. Figure 6 of Soderman discloses two holes (44) through which fasteners (42) secure the light engine (12) to the heat spreader (i.e. mounting assembly) (18). Soderman at Fig. 6. The fastener also secures the heat spreader to backing plates (32) help couple the heat spreader to the junction box (30). Soderman at 8:1-19. Soderman, therefore, discloses "mounting holes suitably spaced apart to receive mounting fasteners to secure the heat spreader to an electrical junction box." '968 Patent at claim 5.

144. Even if Soderman did not disclose claim 5's additional "mounting holes" limitation, Silescent does. Figure 4 of Silescent discloses two screw holes that a POSITA would understand to be used to mount the fixture to what Silescent discloses is a "Junction Box." Silescent at 4. Lighting fixture designers routinely included mounting holes to attach ceiling boxes for the convenience of installers.

For the reasons discussed above, a POSITA would have been motivated to implement the Soderman fixture with Silescent's mounting holes. Thus, it would have been obvious to a POSITA to provide Soderman with "mounting holes suitably spaced apart to receive mounting fasteners to secure the heat spreader to an electrical junction box." '968 Patent at claim 5.

145. In my opinion, Claim 5 of the '968 Patent is rendered obvious by Soderman in light of Silescent.

Claim 9

146. Dependent Claim 9 is further limited by "a trim ring; wherein the outer optic is securely retained relative to at least one of the heat spreader and the heat sink via fasteners; and wherein the trim ring snap-fits onto the outer optic in such a manner as to cover the fasteners securely retaining the outer optic." Ex. 1001 at Claim 9. As discussed above, Soderman already discloses an outer optic that is secured relative to at least one of the heat spreader and the heat sink via fasteners. Soderman further teaches a "decorative or utilitarian attachment assembly" for the components of the fixture. Soderman at 8:1-4. A snap-fitting trim ring is a very common means of attachment and cover. *See, e.g.*, U.S. Patent Application Publication No. 2008/0232116 ("Kim") (Ex. 1022) at [0081], [0084], Figure 5A (beauty ring 508). A POSITA would therefore be motivated, based on knowledge and practice in the art, to consider adding to Soderman a trim ring placed on the

outer optic in a snap-fit arrangement to further hold the fixture assembly (utilitarian) and to cover the fasteners (decorative).

Claim 10

147. Dependent Claim 10 is further limited by "a back surface of the heat spreader is substantially planar with a back surface of the heat sink." '968 Patent at Claim 10. Soderman discloses this limitation. Figure 3 in Soderman shows that the back surface of the heat spreader (mounting assembly 18) is substantially planar with the back surface of the heat sink (cover structure 20):

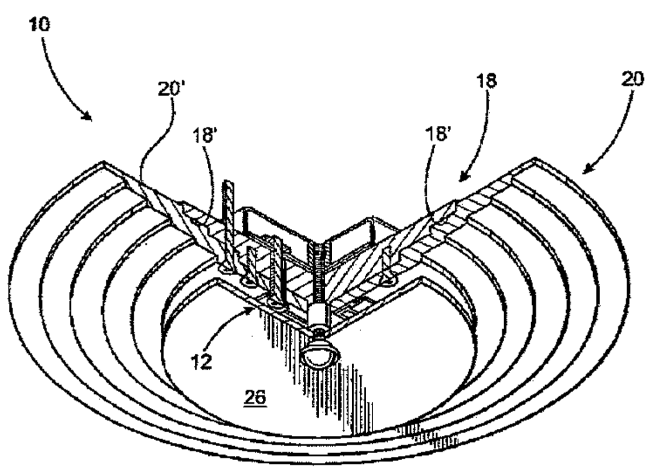


FIG. 3

Soderman at Fig. 3.

Claim 14

148. Dependent Claim 14 is further limited by "at least some of the LEDs are connected to a circuit board, the circuit board being disposed substantially flat on the heat spreader inside a recessed portion of the heat sink." '968 Patent at Claim

14. Soderman discloses this limitation. Soderman discloses LEDs connected to a circuit board and disposed on the heat spreader inside a recessed portion of the heat sink. Soderman discloses that the illumination assembly 12 "comprises one or more light emitting diodes 14 connected to electrical control circuitry 16." Soderman at 6:15-17. The circuit 16, in turn, is "preferably in the form of . . . a printed circuit board." *Id.* at 6:17-18. The LEDs are thus on a PCB. The PCB, in turn, is mounted on the heat spreader/mounting assembly 18. The cover 20 contains a hole 24, *see id.* at Fig. 5, such that the hole in the cover (once placed around the assembly) creates a "recess" in the heat sink. The LED is mounted on the heat spreader and tucked just below the recessed opening 24 of the heat sink 20. *See also id.* at 7:49-50 ("As such, the light generated by the one or more light emitting diodes 14 pass through the opening 24").

149. Soderman describes the illumination assembly, including control circuitry, as "preferably in the form of … a printed circuit board." *Id.* at 6:17-18. Figure 5 shows the illumination assembly (12) (including the printed circuit board) lying flat on the heat spreader and in a recessed portion of the heat sink defined by the aperture (24). *Id.* at Fig. 5. Soderman discloses "at least some of the LEDs are connect to a circuit board, the circuit board being disposed substantially flat on the heat spreader inside a recessed portion of the heat sink." '968 Patent at claim 14.

150. In my opinion, Claim 14 of the '968 Patent is rendered obvious by Soderman in light of Silescent.

Claim 15

151. Dependent Claim 15 is further limited by "a power conditioner mechanically supported by the heat spreader, the power conditioner being configured and disposed to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs." *Id.* at Claim 15. While Soderman does not expressly disclose an AC/DC power conditioner supported by the heat spreader, it would have been obvious to a POSITA to add such a power conditioner based on the teachings of Silescent. Soderman teaches that LEDs are used "extensively . . . in conventional domestic and commercial environments." Soderman at 1:31-33. A POSITA would recognize that residential and commercial power is typically 110 VAC or more, whereas LEDs themselves are typically driven by lower voltage DC. A POSITA would therefore be motivated – based on the teaching in Soderman itself – to add an AC/DC power conditioner to Soderman in order to make it operable in the vast majority of environments. *Id.*, *see also* 6:14-17 (light emitting diodes 14 are to be driven by "an appropriate source of electrical energy"), 8:16-18. Furthermore, Soderman teaches that "a housing, enclosure, junction box or like structure 30 is provided for the housing of wiring, conductors, and other electrical components." *Id.* at 8:5-7. A person ordinary skill in the art

would understand the scope of the "other electrical components" to include a driver or AC to DC power conditioner resulting in the driver supported by the heat spreader (the mounting base 18 heat spreader is screwed into (connectors 17) and supports the structure 30 (such as a junction box) and therefore components (AC/DC power conditioner) therein) within the junction box as shown in Fig. 9. A person ordinary skill in the art would understand that AC/DC power conditioners are commonly disposed within junction boxes as seen in DiLouie, Ko, and Lynch. *See* ¶¶86, 103 *supra.*

152. Silescent discloses such an AC/DC power conditioner located on the top side of – and mechanically supported by – the light fixture base (i.e. the heat spreader). *Compare* Soderman at Fig. 5 and 6:31-45 (referring to "mounting assembly 18") *with* Silescent at Fig. 5 (corresponding component is called the "Silescent Light Fixture Base"). Silescent at Fig. 3. As the figure makes clear, the box on top of the figure accepts "Line" (i.e. AC) power from the building and sends out power to the LEDs. *See also* Silescent at 4 (Troubleshooting, identifying "90-132 VAC" as the line input).

153. A POSITA would therefore have recognized that Silescent thus discloses the use of an AC/DC power conditioner mechanically attached to and supported by the light fixture base. *Id.* at Fig. 3. It would have been obvious to a POSITA at the time to combine Soderman with the teaching of Silescent, yielding

the predictable result of a functioning low-profile fixture capable of running on line AC voltage.

154. Claim 15 depends on claim 1 and adds the limitation of a "power conditioner mechanically supported by the heat spreader, the power conditioner being configured and disposed to receive AC voltage from an electrical supply and to deliver DC voltage to the plurality of LEDs." '968 Patent at claim 15.

155. Soderman discloses "control circuitry" that is encompassed in the illumination assembly. Soderman at 4:31-35. Figures 5 and 6 show the control circuitry (16) and illumination assembly (12) disposed directly on the mounting assembly/heat spreader. *Id.* at Figs. 5, 6. Soderman does not discuss what comprises the control circuitry.

156. A POSITA would understand that Silescent discloses an AC-to-DC power condition. Silescent discloses operating voltage of "103.5-126.5 VAC . . . Nominal[ly] 115 VAC." Silescent at 2. Elsewhere Silescent states "[f]or use with 120 VAC power source." *Id.* at 3. A POSITA would understand that the voltages in Silescent refer to standard AC line voltages (*e.g.* 110, 115, 120 VAC) such as one would find in a typical residential and commercial installation.

157. A POSITA would have appreciated that the fixture disclosed in Silescent (lit by LEDs) could not operate from pure, un-modified AC power. Most residential and commercial power is AC. LEDs are diodes: they can only be driven

by current flowing in a single direction, *i.e.* DC, and typically require only limited current. LED fixtures operating off of AC power must have some means to convert the AC power to unidirectional, limited-current power. As noted above, a POSITA would have appreciated that the fixture disclosed in Silescent was intended to operate off of AC input voltage. As a result, a POSITA would have understood that the Silescent fixture must have had some form of AC-to-DC converter. A POSITA would have understood that the box mounted on the backside of "light fixture base" included such an AC-to-DC converter. Silescent at Fig. 1, 4 ("Composite View"). Otherwise, there is no indication of how the fixture could operate off of the 120 VAC input power that Silescent requires.

158. A POSITA would have appreciated the benefit of implementing the Soderman fixture with the AC-to-DC converter disclosed in Silescent. The resulting fixture could operate from 120 VAC power: the standard line voltage in nearly all houses and commercial buildings. This would open the door to a wide range of applications and potentially installations, resulting in additional sales. As noted above, Silescent, in fact, discloses a commercial embodiment of the Soderman fixture. Thus, it would have been obvious to a POSITA to have combined the AC-to-DC converter disclosed in Silescent with the Soderman fixture.

159. In my opinion, Claim 15 of the '968 Patent is rendered obvious by Soderman in light of Silescent.

Claim 19

160. Dependent claim 19 further limits claim 15 by "the power conditioner is disposed on an opposite side of the heat spreader as the plurality of LEDs, the power conditioner being so dimensioned as to fit within: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box." '968 Patent at Claim 19. For dependent claim 19, as in claim 15, while Soderman itself does not expressly disclose an AC/DC power conditioner [1] disposed on the opposite side of the heat spreader as the plurality of LEDs, and [2] dimensioned as to fit within a nominally sized 4-inch can or junction box, it would have been obvious to a POSITA to add such a power conditioner based on the teachings of Silescent.

161. As to limitation [1], as noted above in claim 15, Silescent discloses an AC/DC power conditioner located on the top side of – and mechanically supported by – the light fixture base (i.e. the heat spreader). Silescent at 4 (Composite View); *id.* at Fig. 3 (showing "Line" power into the power conditioner). The LEDs are disclosed on the underside of the fixture. The AC/DC power conditioner is thus on the opposite side of the heat spreader as the LEDs.

162. As to limitation [2], it would have been obvious to a POSITA to select an appropriately-sized AC/DC power conditioner capable of fitting inside a 4-inch can or electrical junction box in implementing Soderman (as indeed I understand it was). Silescent shows the AC/DC power conditioner box as fitting within "Any UL

Approved Junction Box." This includes 4-inch junction boxes, which are commonly UL listed. Further, as noted above, drivers came in a variety of sizes. A POSITA would have known to select among various drivers fitting inside the box depicted on the top of the Silescent fixture base, thereby facilitating the fixture's mounting into "Any UL Approved Junction Box."

163. Furthermore, any power conditioner capable of fitting in a 4-inch junction box would also fit within a 4-inch can, since the latter had the same diameter but greater height than the former.

164. A POSITA would have recognized that AC/DC power conditioners came in a variety of shapes and sizes, including shapes and sizes capable of fitting inside the box on top of the Light Fixture Base (*i.e.*, the heat spreader). Using a power conditioner like the one shown in Silescent would have yielded the predictable result of the driver and accompanying heat sink fitting inside a 4-inch can or 4-inch junction box. In short, it would have been obvious to implement Soderman the way Mr. Soderman actually implemented it at the time. *See* Silescent at Fig. 5.

165. In my opinion, Claim 19 of the '968 Patent is rendered obvious by Soderman in light of Silescent.

Claim 20

1. *"a heat spreader and a ring-shaped heat sink thermally coupled to and disposed diametrically outboard of the heat spreader"*

166. As noted in the discussion of claim 1, Soderman discloses that mounting assembly 18 spreads the heat generated by LED illumination assembly 12 out to cover 20. Soderman at 6:22-28, 6:34-36, 7:36-38, Fig. 5 (18). The mounting assembly 18 is thus a heat spreader, transferring heat away from the illumination assembly 12. *Id.* at Fig. 3. Soderman likewise discloses a heat sink, cover 20. It is made of a "heat conductive material" and dissipates the heat from the heat spreader out to the air. *Id.* at 6:53, Fig. 5 (20), Fig 6 (20). "As such, heat is transferred from the illumination assembly 12 through the mounting assembly 18 and to the cover structure 20 for eventual dissipation to the surrounding area." *Id.* at 8:31-34; *Id.* at 7:36-41 (similar). The cover is ring-shaped. See *id.* at Fig. 5.

167. As shown in Fig. 5, cover 20 is diametrically outboard of the mounting assembly 18. Every point on the perimeter mounting assembly 18 has a mating and corresponding portion of cover 20 outside the diameter of the mounting assembly at that particular height. The fact that the cover also covers the mounting assembly is of no consequence. The '968 Patent uses the term "diametrically outboard" to encompass precisely this same configuration. The '968 Patent states: "Referring to FIGS. 1-26 collectively, a luminaire 100 includes a heat spreader 105, a heat sink

110 thermally coupled to and disposed diametrically outboard of the heat spreader." '968 Patent at 3:61-64. The preferred embodiment heat sink to which the '968 is referring both surrounds and covers a portion of the heat spreader. See *id.* at Fig. 12 (lower-most portion of inner periphery of heat sink 110 overlapping with outer periphery of heat sink 105 and optic 115).

2. *"an outer optic securely retained . . ."*

168. As noted in the discussion of claim 1, Soderman discloses this limitation.

3. *"[LEDs] disposed on the heat spreader such that the heat spreader dissipates heat from the LEDs"*

169. As noted in the discussion of claim 1, Soderman discloses this limitation.

4. *"the heat spreader, the heat sink, and the outer optic define a combination having an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25"*

170. As noted in the discussion of claim 1, Soderman in light of Silescent renders obvious this limitation.

5. *"a power conditioner disposed in electrical communication with the light source, configured to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs, the power conditioner being so dimensioned as to fit within at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box"*

171. As noted in the discussion of claim 19, Soderman-in-light-of-Silescent renders obvious the use of an AC/DC power conditioner. See claim 19 *supra*; *see generally* Silescent at Fig. 3 (converter box taking in AC "line" voltage and driving LEDs). Further, a POSITA would recognize that the AC/DC power conditioner must be "in electrical communication with the light source" in order to drive it. Further, as noted, Soderman-in-light-of-Silescent renders obvious the dimensional limitation of the power conditioner fitting within an industry-standard 4-inch light can and 4-inch junction box. Therefore, Soderman-in-light-of-Silescent renders obvious the power conditioner fitting within at least one of a 4-inch light can or 4-inch junction box.

172. In my opinion, Claim 20 of the '968 Patent is rendered obvious by Soderman in light of Silescent.

Claim 21

173. Claim 21 is further limited by "the power conditioner is so dimensioned as to fit completely within at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box." '968 Patent at Claim 21. As noted above in claim 19, Soderman-in-light-of-Silescent renders obvious a power conditioner (and requisite heat sink, if any) fitted entirely within a 4-inch junction box or can. *See generally* claim 19 *supra*. Silescent shows the AC/DC power conditioner box as fitting entirely within "Any UL Approved

Junction Box." Silescent at Fig. 5. This includes 4-inch boxes and thus, as noted above, 4-inch cans.

174. In my opinion, Claim 21 of the '968 Patent is rendered obvious by Soderman in light of Silescent.

Claim 22

175. Claim 22 is further limited by "the defined combination is so dimensioned as to cover a circular opening defined by at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box." '968 Patent at Claim 22. As noted in claim 1, it would have been obvious to one of ordinary skill to implement Soderman such that it covered the opening of a 4-inch junction box or can. Specifically, while Soderman does not expressly disclose dimensions, it would have been obvious to a POSITA to implement Soderman using the dimensions disclosed in Silescent since, as I understand it, Silescent is the commercial embodiment of the Soderman patent. Silescent discloses a diameter of 7.90 inches. Silescent at Fig. 1. A 7.90" diameter would have yielded the predictable result of covering a 4-inch box or 4-inch can.

176. In my opinion, Claim 22 of the '968 Patent is rendered obvious by Soderman in light of Silescent.

Claim 23

177. Dependent claim 23 is further limited by "the heat sink forms a trim plate that is disposed completely external of the can light fixture or the electrical junction box." '968 Patent at Claim 23. Soderman discloses a heat sink forming a trim plate disposed completely external of the can light fixture or electrical junction box. Soderman discloses cover 20 as a trim plate. The cover/heat sink of Soderman is disclosed as a room-facing cover for the mounting assembly. Soderman at Fig. 5. Figures 1 and 5 shows the cover as a comparatively thin and wide component. Soderman at Figs. 1 and 5. A POSITA would have understood the cover to be a trim plate, as that term is used in the '968 Patent. Soderman at Fig. 1, 7:36-41. Soderman teaches that the cover 20 "trim plate" sits below the ceiling plane and thus external of the can light fixture or electrical junction box. Soderman at Fig. 1. Similarly, Silescent shows the "light fixture ring" (the cover trim plate of Soderman) being completely external of the junction box. Silescent at Fig. 3, 5. Both Soderman and Silescent, therefore, disclose this limitation.

178. Looking at Figure 5, a POSITA would appreciate that the cover (20) is mounted on the junction box (30) but is larger than the junction box and sits completely outside of the junction box. Soderman at Fig. 5.

179. In my opinion, Claim 23 of the '968 Patent is rendered obvious by Soderman in light of Silescent.

VII. GROUND 7: CLAIM 11 IS RENDERED OBVIOUS BY SODERMAN/SILESCENT IN LIGHT OF ROBERGE

180. Dependent Claim 11 is further limited by "an inner optic disposed over the plurality of LEDs." '968 Patent at Claim 11. While Soderman does not disclose an "inner" optic, it would have been obvious to one of ordinary skill to add a second, additional, "inner" optic to the existing light shield 26.

181. As noted above, the use of both inner and outer optics was known at the time of the invention. Roberge discloses the use of both an inner and an outer optic. *See generally* Roberge at 23:34-36 (inner "polycarbonate reflector optics 337"), Fig. 3B ("cover lens 315"), 23:12-13, 23:65-67 (additional optics).

182. Soderman likewise teaches the desirability of using optics to mask or modify the raw LED light. Soderman says: "light shield 26 . . . may be formed of a transparent and/or translucent material such as glass, plastic, etc. The light shield 26 may be structured to further direct or channel, in a more efficient manner, the illumination generated by the LEDs 14 of the illumination assembly 12." Soderman at 7:59-61.

183. A POSITA would also have recognized that an additional optic – for example, placed between the LEDs and the light shield 26, *see* Soderman at Fig. 1 – would have performed the same function as the inner optic of Roberge to yield the predictable and desirable result of further modifying the raw light from the LED.

184. In my opinion, Claim 11 of the '968 Patent is rendered obvious by Soderman/Silescent in light of Roberge.

VIII. GROUND 8: CLAIM 17 IS RENDERED OBVIOUS BY SODERMAN/SILESCENT IN LIGHT OF WEGNER

185. Dependent Claim 17 is further limited by "a reflector disposed on the heat spreader, the reflector having an aperture in which the plurality of LEDs are disposed." '968 Patent at Claim 17. While Soderman does not disclose a "reflector," it would have been obvious to one of ordinary skill to add a reflector to the assembly covered by claims 1 and 15. Wegner discloses "a reflector housing 320 is coupled to the bottom surface 310a of the heat sink 310." Wegner at 8:1-2; *see also id.* at 8:16-18. The reflector housing is configured to receive a reflector 1205 (Fig. 12) composed of a material for reflecting light emitted by the LED. *Id.* at 8:33-35. The reflector 1205 has an upper aperture in which the plurality of LEDs are disposed when the reflector is 1205 is positioned in the reflector housing 320 onto the heat spreader as shown in Fig. 12. A POSITA would therefore have recognized that the assembly in Chou could additionally include a reflector. A POSITA would have been motivated to include the reflector of Wegner for the purpose of reflecting light towards the outer optic and to create a smooth, blended light pattern and blend out what would otherwise be a hard visible line. *Id.* at 13:41-43.

186. In my opinion, Claim 17 of the '968 Patent is rendered obvious by Soderman/Silescent in light of Wegner.

Signed under the penalty of perjury this 17th day of April, 2017

Dr. Zane Coleman

ATTACHMENT

Zane Coleman

119 S Arlington Ave
Elmhurst, IL 60126

(773) 789-9263
zane.coleman@phostech.com

OPTICAL TECHNOLOGY EXPERT

PROFILE

- Optical technology, lighting, and display expert
- Inventor on 49 issued patents, Inventor on 30+ pending patent applications
- Expertise and analytical skills for optical and physical product analysis
- USPTO Registered Patent Agent

EMPLOYMENT

Phostech **President** *2009 – Present*

- Optical consulting
- Patent strategy & drafting services
- Expert declaration and deposition in Morgan Solar, Inc. v. Banyan Energy Inc., USPTO PTAB Interference No. 105,972
- Submitted declarations for 9 USPTO *Inter partes* reviews related to backlights
- Non-testifying expert ITRI v. LG Corp., ITC CASE 337-TA-805 (consultant for Steptoe & Johnson on behalf of defendants) on backlight technology
- Invented backlights, flexible lightguide technology, waveguide configurations, LED bulbs based on waveguides, LED light fixture configurations, concentrating solar collection systems, and other illumination devices

Fusion Optix Inc. **VP Technology & Dir. of Technology** *2006-2009*

Led the research strategy and transfer of technology to product engineering in a fast-paced small company providing innovation in the display and LED lighting industries

- Developed technology roadmaps, intellectual property strategy, & competitive benchmarking
- Invented more than 35 unique, patentable products and drafted & prosecuted 60+ patent applications
- Managed and researched optical films, display backlights, LED light fixture, and LED light bulb projects
- Co-developed the optical system of a Lightfair 2009 Innovation Award-winning LED light fixture

Manager, Optical Engineering *2005-2006*

- Developed and prototyped micro-replicated, multi-functional optical films for displays and light fixtures through optical modeling, prototyping, optical and thermal analysis, and specification
- Designed and managed optical film, LED backlight, and light fixture optical and thermal characterization lab
- Led polymer based optical film research including production and optical characterization

Phostech **President** *2003-2005*

- Optical design & analysis of diffusing films, refractive-TIR films, displays, LCD backlights, lightguides, illuminated signs and light fixtures
- Invented new optical films, light fixtures, projection screens, backlights and displays

Motorola Labs **Senior Physicist** *1997-2002*

- Optically designed & constructed world's first personal micro-projector (US Patent 6,637,896)
- Designed reflection and transmission micro-structured optical films for display backlights and illumination
- Designed and developed 3 new optical film products with suppliers, including an optical film with 3M which was shipped in over 100 million cellular phones
- Analyzed thermal and optical properties of products including developing new measurement techniques
- 4 issued Patents, 26 patent disclosures

ImEdge Technology Inc. **Optical Engineer** *1993-1997*

- Co-invented new methods for recording edge-lit lightguide based holograms and edge-lit devices for display illumination and biometric applications (7 issued patents)
- Modeled, recorded, and performed optical and thermal analysis of optical components and systems

EDUCATION

Ph.D. in Physics, Loughborough University (UK) 1997
Applied rigorous coupled wave diffraction theory to model and analyze recorded edge-lit holograms
BSc. in Applied Physics, Certificate in Optics, Georgia Institute of Technology 1992

Issued Patents

1) 9,566,751 Methods of forming film-based lightguides
2) 9,557,473 Reflective spatial light modulator display with stacked lightguides and method
3) 9,523,807 Device comprising a film-based lightguide and component with angled teeth
4) 9,110,200 Illumination device comprising a film-based lightguide
5) 9,103,956 Light emitting device with optical redundancy
6) 9,028,123 Display illumination device with a film-based lightguide having stacked incident surfaces
7) 8,958,698 Versatile remote control device and system
8) 8,950,902 Light emitting device with light mixing within a film
9) 8,917,962 Method of manufacturing a light input coupler and lightguide
10) 8,905,610 Light emitting device comprising a lightguide film
11) CA2702600 Light emitting devices and applications thereof
12) CA2702690 Light emitting devices and applications thereof
13) CA2702685 Light emitting devices and applications thereof
14) 8,794,812 Light emitting devices and applications thereof
15) 8,783,898 Light emitting devices and applications thereof
16) 8,761,565 Arcuate lightguide and light emitting device comprising the same
17) 8,721,152 Light emitting devices and applications thereof
18) 8,619,363 Light redirecting element comprising a forward diffracting region and a scattering region
19) 8,434,909 Light emitting display with light mixing within a film
20) 8,430,548 Enhanced light fixture with volumetric scattering
21) 8,408,775 Light recycling directional control element and light emitting device using the same
22) 8,249,408 Method of manufacturing an optical composite
23) 8,233,803 Versatile remote control device and system
24) 8,231,256 Light fixture comprising a multi-functional non-imaging optical component
25) 8,177,408 Light filtering directional control element and light fixture incorporating the same
26) 8,033,706 Lightguide comprising a low refractive index region
27) 8,033,674 Optical components and light emitting devices comprising asymmetric scattering domains
28) 7,991,257 Method of manufacturing an optical composite
29) 7,914,192 Enhanced light diffusing sheet
30) 7,784,954 Polarization sensitive light homogenizer
31) 7,758,227 Light fixture with curved light scattering region comprising ellipsoidal domains
32) 7,722,224 Illuminating device incorporating a high clarity scattering layer
33) 7,542,635 Dual illumination anisotropic light emitting device
34) 7,453,636 High contrast optical path corrected screen
35) 7,453,635 Imaging material with improved contrast
36) 7,431,489 Enhanced light fixture
37) 7,408,707 Multi-region light scattering element
38) 7,278,775 Enhanced LCD backlight
39) 7,015,893 Photoluminescent electrophoretic display
40) 6,861,788 Switchable display/mirror method and apparatus
41) 6,637,896 Compact projection system and associated device
42) 6,636,285 Reflective liquid crystal display with improved contrast
43) 6,151,142 Grazing incidence holograms and system and method for producing the same
44) 6,061,463 Holographic fingerprint device
45) 5,986,746 Topographical object detection system
46) 5,974,162 Device for forming and detecting fingerprint images with valley and ridge structure
47) 5,822,089 Grazing incidence holograms and system and method for producing the same
48) 5,710,645 Grazing incidence holograms and system and method for producing the same
49) EP0749610 Compact device for producing an image of the topological surface

US Patent Application Publications

1) **20170045669** Light emitting device comprising a film-based lightguide and reduced cladding layer at the input surface
2) **20150253487** Reflective display comprising a frontlight with extraction features and a light redirecting optical element
3) **20150219834** Display with a film-based lightguide and light redirecting optical element
4) **20150078035** Device comprising a film-based lightguide and component with angled teeth
5) **20140360578** Solar energy system including a lightguide film
6) **20140063853** Film-based lightguide including a wrapped stack of input couplers and light emitting device including the same
7) **20140056028** Light emitting device with adjustable light output profile
8) **20140049983** Light emitting device comprising a lightguide film and aligned coupling lightguides
9) **20130314942** Packaging comprising a lightguide
10) **20130250618** Light emitting device with light mixing within a film
11) **20130208508** Light emitting device with optical redundancy
12) **20130155723** Replaceable lightguide film display
13) **20120294620** Versatile remote control device and system
14) **20120288283** Versatile remote control device and system
15) **20120287674** Illumination device comprising oriented coupling lightguides
16) **20120082461** Versatile remote control device and system
17) **20110286222** Method of manufacturing an optical composite
18) **20110277361** Sign comprising a film-based lightguide
19) **20110273906** Front illumination device comprising a film-based lightguide
20) **20110255303** Illumination device comprising a film-based lightguide
21) **20110227487** Light emitting display with light mixing within a film
22) **20110013420** Light emitting devices and applications thereof
23) **20100321953** Light emitting devices and applications thereof
24) **20100321952** Light emitting devices and applications thereof
25) **20080094854** Dual illumination anisotropic light emitting device
26) **20080043490** Enhanced Light Guide
27) **20070201246** Enhanced Light Diffusing Sheet
28) **20060290253** Enhanced Diffusing Plates, Films and Backlights
29) **20060227546** Enhanced light fixture
30) **20060215958** Enhanced electroluminescent sign
31) **20060066945** High contrast optical path corrected screen
32) **20060056166** Enhanced LCD backlight
33) **20060056022** Imaging material with improved contrast
34) **20060056021** Multi-region light scattering element
35) **20050259302** Holographic light panels and flat panel display systems and method and apparatus for making same
36) **20040245902** Switchable display/mirror method and apparatus
37) **20040151491** Apparatus and method concerning a passive multi-indicia visual position indicator
38) **20040150613** Photoluminescent electrophoretic display
39) **20030081184** Compact projection system and associated device
40) **20030081154** Reflective liquid crystal display with improved contrast
41) **20030020975** Holographic light panels and flat panel display systems and method and apparatus for making same
42) **20020001110** Holographic light panels and flat panel display systems and method and apparatus for making same

International Patent Application Publications

1) **JP2013525955** Illumination device comprising a film-based lightguide
2) **JP2013525836** Sign comprising a film-based lightguide
3) **JP2013530412** Front illumination device comprising a film-based lightguide
4) **AU2012225244** Light emitting device with adjustable light output profile
5) **CA2829388** Light emitting device with adjustable light output profile
6) **EP2683980** Light emitting device with adjustable light output profile
7) **KR20130096155** Illumination device comprising a film-based lightguide
8) **MX2012012033** Illumination device comprising a film-based lightguide
9) **MX2012012035** Sign comprising a film-based lightguide
10) **MX2012012034** Front illumination device comprising a film-based lightguide
11) **CN103038568** Front illumination device comprising a film-based lightguide
12) **CN103038567** Illumination device comprising a film-based lightguide
13) **WO2012158460** Solar energy system including a lightguide film
14) **KR20130096155** Illumination device comprising a film-based lightguide
15) **KR20130055598** Front illumination device comprising a film-based lightguide
16) **KR20130054263** Sign comprising a film-based lightguide
17) **EP2558775** Illumination device comprising a film-based lightguide
18) **EP2558893** Sign comprising a film-based lightguide
19) **EP2558776** Front illumination device comprising a film-based lightguide
20) **CN102918435** Sign comprising a film-based lightguide
21) **GB2492398** Manufacturing an optical composite using inverted light collimating surface features
22) **WO2012122511** Light emitting device with adjustable light output profile
23) **WO2012088315** Packaging comprising a lightguide
24) **WO2012068543** Light emitting device comprising a lightguide film and aligned coupling lightguides
25) **WO2012044972** Versatile remote control device, system, and method
26) **WO2012016047** Light emitting device with optical redundancy
27) **CA2796515** Sign comprising a film-based lightguide
28) **CA2796518** Illumination device comprising a film-based lightguide
29) **CA2796519** Illumination device comprising a film-based lightguide
30) **WO2011130715** Illumination device comprising a film-based lightguide
31) **WO2011130718** Front illumination device comprising a film-based lightguide
32) **WO2011130720** Sign comprising a film-based lightguide
33) **CA2702600** Light emitting devices and applications thereof
34) **CA2702685** Light emitting devices and applications thereof
35) **CA2702690** Light emitting devices and applications thereof
36) **WO2007002317** Enhanced diffusing plates, films and backlights
37) **WO2006055872** Enhanced light fixture
38) **WO2006055873** Enhanced electroluminescent sign
39) **WO2006032002** High contrast optical path corrected screen
40) **WO2006026743** Enhanced light diffusing sheet
41) **WO2006031545** Enhanced LCD backlight
42) **WO2006020583** Imaging material with improved contrast
43) **WO2006017585** Multi-region light scattering element
44) **CN1573448** Switchable display/mirror method and apparatus
45) **KR20040104427** Switchable display/mirror method and apparatus including switchable mirror with display operation mode and mirror operation mode
46) **WO2003038509** Reflective liquid crystal display with improved contrast
47) **WO2003038517** Compact projection system and associated device
48) **AT195189** Device for forming and detecting fingerprint images with valley and ridge structure

49) **JPH09509490** Device for forming and detecting fingerprint images with valley and ridge structure
50) **AU1925595** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same
51) **CA2183567** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same
52) **WO199522804** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same

Publications and Presentations

1) "LED Technology," LED Lighting Panel Discussion at Heartland Angel's "LEDs: What are they and why are they important" Chicago, IL, (2010)
2) "Challenges and opportunities for light management optics in LED lighting systems," LEDs 2008 Conference, San Diego, CA, (2008)
3) "Optically efficient displays and solid-state lighting systems using anisotropic polymer films," SID, New England Chapter, Dec. (2006)
4) "Novel high brightness LED backlight design and optimization," Mark Chu, Zane Coleman, Kurt Henrickson, Terry Yeo, Americas Display Engineering and Applications Conference, Atlanta, GA (2006)
5) "Head-mounted displays for visual communication," Zane Coleman, George Valliath, Motorola Hermes, internal conference (2000)
6) "LCD glare avoidance using a surface relief diffractive optical element," Zane Coleman, George Valliath, Motorola Publication via www.IP.com
7) "Display optical enhancement films," Zane Coleman, George Valliath, Robert Akins, Kevin Jelley" Motorola Hermes, internal conference (1999)
8) "Design of hologram for brightness enhancement in color LCDs," G.T. Valliath, Z.A. Coleman, J.L. Schindler, R. Polak, R.B. Akins, K.W. Jelley, Society for Information Display '98, Conference Proceedings Vol. 29, p. 1139, Anaheim, CA (1998)
9) "Modern holographic recording and analysis techniques applied to edge-lit holograms and their applications," Ph.D. in Physics Thesis, Loughborough University, Loughborough, England (1997)
10) "Holographic optical element for compact fingerprint imaging system", M.H. Metz, N. J. Phillips, Z. A. Coleman, C. Flatow, Optical Security and Counterfeit Deterrence Techniques, SPIE Proceedings vol. 2660, San Jose, CA (1996)
11) "Holograms in the extreme edge illumination geometry", Zane A. Coleman, Michael H. Metz, Nicholas J. Phillips, Holographic Materials II, SPIE Proceedings vol. 2688, San Jose, CA (1996)
12) "The use of edge-lit holograms for compact fingerprint capture", M. Metz, C. Flatow, Z. Coleman, N.J. Phillips, CardTec SecureTec, April 10th, (1995)
13) "Links between holography and lithography," Phillips, Nicholas J.; Barnett, Christopher A.; Wang, Ce; Coleman, Zane A., Proc. SPIE Vol. 2333, p. 206-214, Fifth International Symposium on Display Holography, Tung H. Jeong; Ed. (1995)
14) "Dichromated gelatin--some heretical comments", N.J. Phillips, R. D. Rallison, C. A. Barnett, S. R. Schicker, Z. A. Coleman, Practical Holography VII:Imaging Materials, SPIE vol. 1914, pp 101-114 (1993)
15) "Novel methods for the creation of silver-free images in holography, using conventional silver halide emulsion", N.J. Phillips, Z.A. Coleman, C. Wang, Holographic Systems, Components, and Applications, IEE Conf. Publication No 379, Neuchatel, Switzerland (1993)
16) "Holograms in the edge-illuminated geometry-new materials developments", N.J. Phillips, C. Wang, Z. Coleman, Practical Holography VII:Imaging Materials, SPIE vol. 1914, pp 75-81 (1993)

Legal Consulting

Type of Matter:	Expert in Optics
Client:	Foley and Lardner LLP
Case Name:	USPTO Patent Interference 105,972
Services provided:	Two declarations, Two-day deposition
Date:	March 2104 – September 2015

Type of Matter:	Expert in Optics
Client:	Fried, Frank, Harris, Shriver & Jacobson
Case Name:	IPR2015-01044, Mercedes-Benz v. IDT LLC
Services provided:	One Declaration
Date:	April 2015 – June 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00831, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00832, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00834, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00835, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00843, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00855, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00857, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00897, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Steptoe & Johnson LLP
Case Name:	ITC 337-TA-805, ITRI v. LG Corp.
Services provided:	Non-testifying consulting
Date:	Dec. 2011 – May 2013

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TECHNICAL CONSUMER PRODUCTS, INC.,
NICOR INC.,
AMAX LIGHTING
Petitioners,

v.

LIGHTING SCIENCE GROUP CORPORATION,
Patent Owner

IPR Trial No.: Unassigned

DECLARATION OF DR. ZANE COLEMAN IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,967,844

EXHIBIT 2
WIT: Coleman
DATE: 1-17-18
S. Rocca, CSR, RMR, CRR

EXHIBIT LIST

Exhibit	Description
Ex. 1001	U.S. Patent No. 8,967,844
Ex. 1002	Declaration of Dr. Zane Coleman in Support of Petition for *Inter Partes* Review of U.S. Patent No. 8,967,844 ("Coleman Decl.")
Ex. 1003	Declaration of Daryl Soderman in Support of Petition for *Inter Partes* Review of U.S. Patent No. 8,967,844 ("Soderman Decl.")
Ex. 1004	Preliminary Amendment
Ex. 1005	Office Action (FOAM)
Ex. 1006	Reply to Office Action (FOAM)
Ex. 1007	Notice of Allowance
Ex. 1008	Petition to Withdraw
Ex. 1009	Office Action
Ex. 1010	Reply to Office Action
Ex. 1011	Notice of Allowance
Ex. 1012	U.S. Patent No. 7,670,021 ("Chou")
Ex. 1013	U.S. Patent No. 7,980,736 ("Soderman")
Ex. 1014	Silescent S100LP2 *Installation Instructions and Cut Sheet* ("Silescent")
Ex. 1015	U.S. Patent No. 7,722,227 ("Zhang")
Ex. 1016	U.S. Patent No. 7,993,034 ("Wegner")
Ex. 1017	U.S. Patent No. 5,463,280 ("Johnson")
Ex. 1018	*Introducing the LED Driver*, EC&M Magazine ("DiLouie")
Ex. 1019	U.S. Patent No. 7,102,172 ("Lynch")
Ex. 1020	U.S. Patent Application Publication No. US2008/0297060 ("Ko")
Ex. 1021	U.S. Provisional Patent Application Ser. No. 60/979,068 ("Zhang Provisional")

I, Zane Coleman, declare as follows:

1. I am over the age of 18 and am competent to make this declaration in support of the Petition for *Inter Partes* Review of Technical Consumer Products, Inc., Nicor Inc., and Amax Lighting (collectively, "Petitioners"). The information set forth here is from my own personal knowledge. If called to testify, I could and would provide testimony regarding the substance, content, and reasons and bases for these statements.

2. I have been retained as an expert witness by Petitioners to address issues concerning the validity of U.S. Patent No. 8,967,844 ("the '844 Patent") (Ex. 1001) for the above captioned *inter partes* review. I am being compensated for my time at a rate of $400 per hour.

3. I am familiar with the technology at issue (*i.e.* LED luminaires). I am also familiar with the level of skill of a person of ordinary skill in the art with respect to the technology at issue as of October, 2009. In preparing this declaration, I reviewed the '844 Patent and considered each of the documents cited below in light of my knowledge of the technology at issue. I have also reviewed Dr. Jonathan Leeper's declaration in support of Generation Brands LLC's *inter partes* review petition against the '844 Patent, IPR No. IPR2016-01546, Paper No. 2, and I agree with Dr. Leeper's opinion about the validity of the '844 Patent. When forming my opinions I considered the viewpoint of a person of ordinary skill in the art as of

October, 2009. When forming my opinions, I considered the viewpoint of a person of ordinary skill in the art as of October, 2009.

QUALIFICATIONS

4. In 1992, I received a Bachelor of Science degree in Applied Physics, including a Certificate in Optics from the Georgia Institute of Technology. I received my doctorate in Physics at the Loughborough University in the United Kingdom in 1997, focusing on applied rigorous coupled wave diffraction theory to model and analyze recorded edge-lit holograms and their applications as illuminators. My analysis included modeling and measuring optical and thermal properties of illumination systems including Light Emitting Diode (LED) illumination systems.

5. From 1993-1997, I worked as an Optical Engineer at ImEdge Technology Inc. While at ImEdge Technology I conducted research for a start-up company developing holographic illumination technology which included analyzing optical and thermal performance of different recording systems and materials for illumination systems including LED based illumination systems. During this time, I also invented new methods directed to recording edge-lit holograms and edge-lit devices for display and biometric applications and was responsible for seven issued patents.

6. From 1997 to 2002, I worked as a Senior Physicist for Motorola Labs. I helped optically design and construct the world's first personal micro-projector (US Patent 6,637,896). I also designed optical films for LCDs as well as 3 new optical film products with suppliers, including an optical film with 3M, which was shipped in over 100 million cellular phones. I also analyzed thermal and optical properties of products including developing new measurement techniques. During my time at Motorola, I was also responsible for 4 issued patents and 26 patent disclosures.

7. From 2003-2005, I served as the President of Phostech, where my roles included the optical design, analysis, and invention of new diffusing films, refractive and total internal reflection (TIR) films, optical lenses, projection screens and systems, LCD backlights, lightguides, illuminated signs, head-up displays, and light fixtures.

8. From 2005-2006, I was the Manager of Optical Engineering at Fusion Optix Inc. where I helped to develop and prototype micro-replicated, multi-functional optical films, components and lenses for displays and light fixtures through optical modeling, prototyping, analysis, and specification. I designed, installed, and managed the optical film, LED backlight, and light fixture characterization lab including optical, thermal, and environmental characterization. I consulted with the product development group and contributed to the optical

design, thermal design, packaging, and accessories for LED light fixtures and other products. From 2006-2009, I was the VP of Technology & Director of Technology at Fusion Optix Inc. In this role, I lead the research strategy and transfer of technology to product engineering in a fast-paced small company providing innovation in the display and LED lighting industries. I also oversaw the research and development of optical films, LED backlights, and LED light fixture projects. I also co-developed a Lightfair 2009 Innovation Award-winning light fixture.

9. In 2009, I rejoined Phostech as President and am presently responsible for optical consulting and patent strategy & drafting services. As noted above, I am a named inventor on 49 issued patents and numerous pending patent applications related to the areas of optics, optical films, LED backlights, LED light fixtures, LED light bulbs, personal micro-projectors, projection screens, and other light emitting devices. I am also a registered patent agent at the U.S. Patent and Trademark Office (Reg. No. 65,754).

10. My curriculum vitae includes a more detailed summary of my background and experience including issued patents and publications and is attached to this declaration.

REVIEW AND USE OF DOCUMENTS

11. In forming the opinions presented in this report, I have reviewed and relied upon relied upon the following documents:

- U.S. Patent No. 8,967,844;
- U.S. Patent No. 7,722,227 ("Zhang");
- U.S. Patent No. 7,980,736 ("Soderman");
- Declaration of Daryl Soderman, dated July 15, 2016 ("Soderman Decl.");
- U.S. Patent No. 7,670,021 ("Chou");
- Silescent S100 LP2 Installation Instructions and Cut Sheet ("Silescent");
- U.S. Patent No. 5,463,280 ("Johnson");
- U.S. Patent No. 7,993,034 ("Wegner");
- U.S. Patent No. 7,828,465 ("Roberge");
- Introducing the LED Driver, EC&M Magazine ("DiLouie");
- U.S. Patent No. 7,102,172 ("Lynch");
- U.S. Patent Application Publication No. US2008/0297060 ("Ko");
- U.S. Provisional Patent Application Ser. No. 60/979,068 ("Zhang Provisional"); and
- Dr. Jonathan Leeper's declaration in support of Generation Brands LLC's *inter partes* review petition against the '844 Patent.

LEGAL STANDARDS

12. I am not an attorney but I am a patent agent. I have prosecuted patents for others and am therefor both familiar and well informed in aspects of patent law, particularly novelty (35 U.S.C. §102), obviousness (35 U.S.C. §103) and enablement

(35 U.S.C. §112). While I understand these aspects through my patent prosecution experience, I am writing this declaration based on my expertise in optical and LED lighting technologies. For the purposes of this declaration, I have been informed about certain aspects of the law relevant to my opinions. My understanding of the law is as follows:

13. I have been informed that a patent's claims determine the scope of the invention. How those claims are construed is a matter of law that will ultimately be determined by the Board.

14. I have been informed that, for purposes of my opinions as to the validity of the claims of the '844 Patent, I am to give the claims the broadest reasonable interpretation in light of the specification.

15. I have been informed and understand that a patent claim can be invalid as anticipated if all of the limitations of a claim are disclosed in a single reference and are arranged in a similar manner. I understand that a reference does not have to use the same terminology as the claim. I understand that a reference can anticipate a claim even if the reference discloses additional functions or components not in the claim.

16. I have been informed and understand that a patent claim can also be invalid as being obvious to a person of ordinary skill in the art at the time the application was filed. I understand this to mean that even if all of the elements of a

claim are not found in a single reference, the claim is still not patentable if the differences between the subject matter disclosed in the reference and what is claimed would have been obvious to a person of ordinary skill in the art at the time the application was filed.

17. I have been informed and understand that the determination of whether a claim would have been obvious should be based on several factors, including, among others:

- The level of ordinary skill in the art at the time the application was filed;
- The scope and content of the prior art;
- What differences, if any, existed between the claim and the prior art;
- Objective indicia of nonobviousness, such as recognition of a problem or failure of others.

18. I have been informed and understand that the teachings of two or more references may be combined in the same way as disclosed in the claims, if such a combination would have been obvious to one having ordinary skill in the art. In determining whether a combination would have been obvious, it is appropriate to consider, among other factors:

- Whether the teachings of the prior art references disclose known concepts combined in familiar ways, and when combined, would yield predictable results;

- Whether a person of ordinary skill in the art could implement a predictable variation, and would see the benefit of doing so;
- Whether the claimed elements represent one of a limited number of known design choices, and a person of ordinary skill in the art would have a reasonable expectation of success;
- Whether a person of ordinary skill in the art would have recognized a reason to combine known elements in the manner described in the claim;
- Whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent;
- Whether the innovation applies a known technique that has been used to improve a similar device or method in a similar way.

19. I understand that one of ordinary skill in the art has ordinary creativity and is not an automaton.

20. I understand that in considering obviousness, it is important not to use the benefit of hindsight (*i.e.* having the benefit of knowing the claimed invention).

LEVEL OF ORDINARY SKILL

21. A person of ordinary skill in the field of LED luminaire design as of October, 2009, would have had at least a bachelor's degree in either mechanical engineering, electrical engineering, or physics and at least 3-4 years of experience designing light fixtures.

22. At the time of the patent I was a person of ordinary skill in the art. I had a doctorate in physics and, in 2009, had six years of experience designing light fixtures.

23. When I refer to a person of ordinary skill in the art elsewhere in this declaration, I am referring to a person of ordinary skill in the art as of October, 2009. I understand this is sometimes referred to as the "time of the invention," although I do not believe the '884 Patent represents an actual invention.

I. OVERVIEW OF THE '844 PATENT

Technology

24. Lighting fixtures come in a variety of shapes and sizes. One option is a low-profile ceiling fixture. Low-profile fixtures generally sit close to the ceiling and do not protrude substantially into the room. Low-profile fixtures are commonly constructed of metal and glass in a wide variety of forms or trims, reflecting a wide variety of aesthetic choices.

25. Some low-profile lighting fixtures are illuminated by light emitting diodes ("LEDs"). LEDs produce heat. That heat must be dissipated. LED is commonly dissipated by means of a heat sink – one or more pieces of thermally conductive material (*e.g.* metal) that draws heat away from the LEDs and dissipate.

26. LEDs also require power conditioning.[1] Rather than using residential or commercial line voltage (*e.g.* 120 volts AC), LEDs commonly require lower-voltage, current-limited, DC power. Power converters (commonly referred to as "drivers") come in many sizes and shapes.

The '844 Patent

27. The '844 Patent generally concerns heat dissipation in a low-profile LED lighting fixture. '844 Patent at Abstract; 1:21-28. The luminaire of the '844 Patent includes an LED, a heat spreader, a heat sink, and an optic for focusing or diffusing light into the illuminated area. *Id.* at 1:49-55. The LED generates heat; the heat spreader transfers the heat to a heat sink; and the heat sink dissipates the heat into the air. *Id.* at 1:66-2:8. The fixture's outer trim functions as a heat sink, keeping the fixture cool and low-profile.

28. Specifically, the '844 Patent claims a luminaire comprising a heat spreader, a "ring shaped" heat sink around its outer periphery, an optic, an LED light source, and an AC/DC power conditioner disposed to fit within the interior of a nominally sized can light fixture and electrical junction box. Claim 1 is illustrative:

1. A luminaire, comprising:

---

[1] *See generally* Craig DiLouie, *Introducing LED Driver*, EC&C Magazine, Sept. 2004, pp. 28, 30, 32 ("DiLouie") (Ex. 1018).

a heat spreader and a heat sink, the heat sink being substantially ring-shaped and being disposed around and in thermal communication with an outer periphery of the heat spreader;

a light source disposed in thermal communication with the heat spreader, the light source comprising a plurality of light emitting diodes (LEDs) that are disposed in thermal communication with the heat spreader such that the heat spreader facilitates transfer of heat from the LEDs to the heat sink;

an outer optic disposed in optical communication with the plurality of LEDs; and

a power conditioner disposed and configured to receive AC voltage from an electrical supply and to provide DC voltage for the plurality of LEDs;

wherein the power conditioner is disposed, configured and sized to fit at least partially within an interior space of: a nominally sized can light fixture; and, a nominally sided electrical junction box.

Id. at Claim 1. Figures 11 and 12 of the '844 Patent illustrate an embodiment:

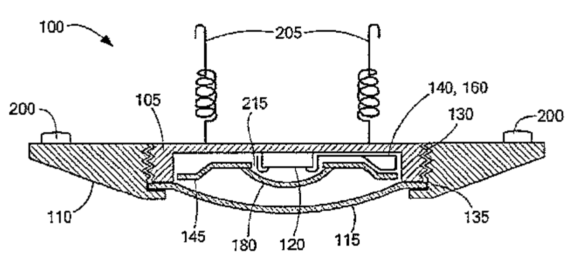


FIG. 12

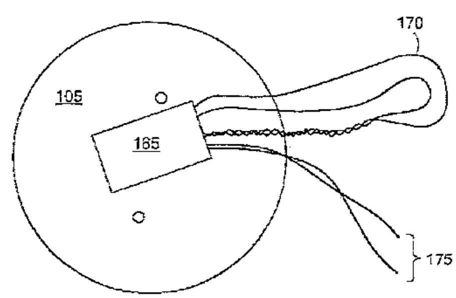


FIG. 11

Id. at Figs. 11, 12.

29. As shown in Figure 12, the LED light source 120 is in thermal communication with the heat spreader 105. The heat spreader 105 transfers heat to

heat sink 110. An outer optic 115 spans the heat spreader 105. *See generally id.* at 5:37-44. Figure 11 shows a power conditioner 165 mounted on the top of the heat spreader 105 to supply voltage to the LEDs 120. The power conditioner 165 is configured to fit at least partially within the interior space of a nominally sized light can fixture or nominally sized junction box.[2]

II. OVERVIEW OF THE PRIOR ART

30. As set forth below, several prior art references accomplish exactly the same goal in exactly the same manner as the '844 Patent: dissipating heat from a low-profile LED fixture by using the fixture's own trim or periphery as a heat sink.

A. Overview of Chou

31. U.S. Pat. No. 7,670,021 ("Chou") (Ex. 1012), which issued on March 2, 2010 from an application filed on May 20, 2008, claiming priority to provisional application 60/975,657 filed on October 10, 2007, discloses a low-profile ceiling LED luminaire that dissipates heat into the surrounding air via an exterior trim. Chou at 1. Chou discloses one embodiment as follows:

[2] Figure 12 shows the alternative embodiment of placing the power conditioner 140 or 160 on the underside.

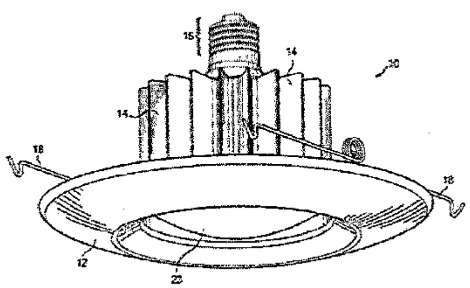


FIG. 2a

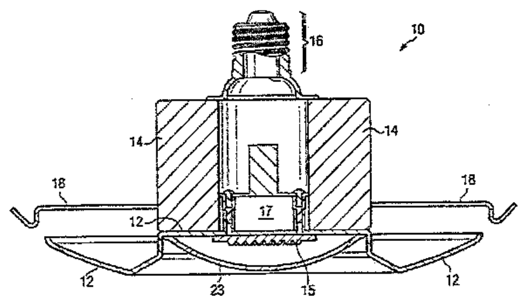


FIG. 2b

Chou at Fig. 2a, 2b.

32. Chou dissipates heat in two ways. The first is through a metal trim 12 on the underside of the fixture. *Id.* at 3:44-47, 4:4-16, Fig. 2b at 12. LEDs 15 are mounted on the underside of the trim 12. An LED driver, circuit board 17, is mounted on the top side. *Id.* at 4:21-27. The center portion of the trim transfers heat out to the outer portion of the trim, flange 22. *Id.* at 5:1-11. From there it is dissipated into the air. *Id.* at 5:5-11, 7:44-46. The "trim" in Chou thus has two portions: (1) a flat interior portion that spreads the heat, and (2) an outer, ring-shaped flange that dissipates the heat into the air. *See also* Figs. 4a and 4b (showing flat portion and flange). Chou illustrates an embodiment in Fig. 2b of the trim formed using a one-piece stamping manufacturing process, however, Chou also states that the trim can be formed by combining multiple pieces, *id.* at 7:24-26, thus the flat interior portion of the trim, the central attachment area 20 (heat spreader), and the outer ring-shaped flange (heat sink) could be separate components combined to form

the trim. The trim's height (including optic) is 42 mm; its diameter 200 mm; the ratio is 0.21. *Id.* at 5:24-28 and Fig. 2b at 12.

33. The second way in which Chou dissipates heat is through an additional, secondary heatsink 14, mounted on the top side of the fixture, which extends up into a conventional ceiling "can." *Id.* at Fig. 2b, 3, 8; 4:40-54. Because the upper heat sink is trapped up inside the can, "a majority of the heat [is] dissipated [through the] trim 12 outside the housing," *i.e.*, into the room. *Id.* at 5:9-10.

B. Overview of Soderman

34. U.S. Pat. No. 7,980,736 ("*Soderman*") (Ex. 1013), which issued on July 19, 2011 upon an application filed November 13, 2007, likewise discloses a low-profile ceiling fixture that dissipates heat to the surrounding air via a ring-shaped trim. Soderman at 1. An illustration of the Soderman fixture is as follows:

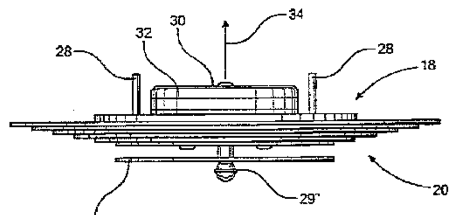


FIG. 1

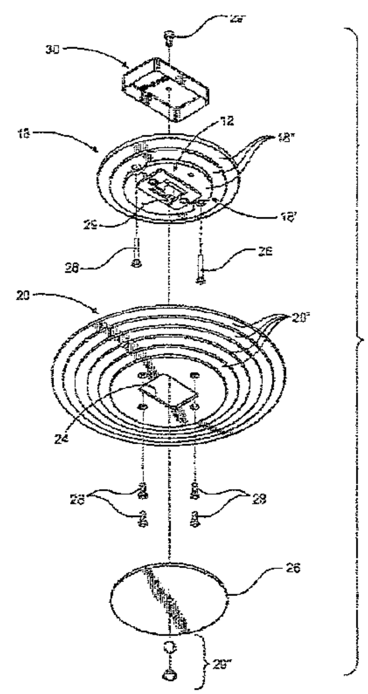


FIG. 5

Soderman at Figs. 1 and 5.

35. Soderman dissipates LED heat as follows: The LEDs 12 are attached to the lower surface of a mounting assembly 18. *Id.* at 3:5-22, 6:14-17, 6:38-45, 8:5-10, Figs. 1, 5. Heat generated by the LEDs spreads through the mounting assembly out to a surrounding cover 20.*Id.* at 7:36-41. The cover is ring-shaped; it is round with a hole through the middle. *Id.* at Fig. 5 (20), 7:24. It is made of thermally conductive material. *Id.* at 6:49-59, 7:11-24. The cover dissipates the heat into the surrounding air. *Id.* at 6:38-45, 7:37-41.

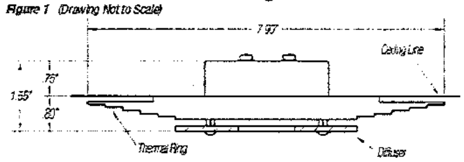
C. Overview of Silescent S100 LP2

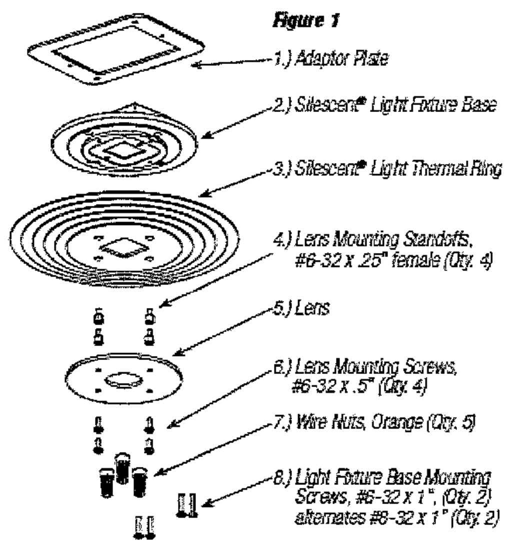
36. The Silescent S100 LP2 Installation Instructions and Cut Sheet (Ex. 1014) (collectively "Silescent"), publicly distributed on or before June 2009,

likewise discloses a low-profile ceiling fixture that dissipates heat to the surrounding air via a ring-shaped trim. *See* Decl. of Daryl Soderman in Support of Petition for IPR of U.S Pat. No. 8,967,844 ("Soderman Decl.") ¶3 (Ex. 1003). Illustrations of Silescent are as follows:

S100 LP2 - Ultra Low Profile Light and Fixture

Figure 1 (Drawing Not to Scale)





Silescent at 2 (Fig. 1) and 3 (Fig. 1).

37. Silescent is substantially identical to Soderman's preferred embodiment because Silescent is a commercial embodiment of Soderman. Soderman Decl. ¶6 (Mr. Soderman is the co-founder of Silescent Corp.). The Silescent product literature adds two details that are implied but not expressly disclosed in the Soderman patent. First, Silescent includes actual dimensions: 0.8" (H) by 7.9" (W), a ratio of 0.101. *Id.* at 2. Second, Silescent discloses an AC/DC power conditioner that fits into "Any UL Approved Junction Box." *Id.* at 4, Figs. 3, 5.

D. Overview of Zhang

38. U.S. Pat. No. 7,722,227 ("Zhang") (Ex. 1015), which issued on May 25, 2010 upon an application filed on October 10, 2008 claiming priority to provisional application 60/979068, filed on October 10, 2007, likewise discloses a low-profile ceiling fixture that dissipates heat to the surrounding air via a ring-shaped trim. Zhang at 1. An illustration of Zhang is as follows:

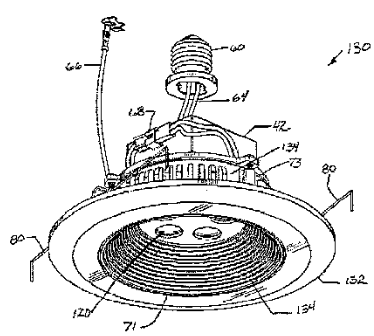


FIG. 10

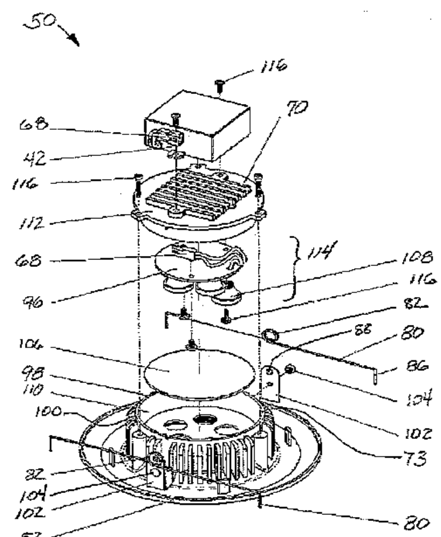


FIG. 5

Zhang at Figs. 5, 10.

39. Zhang dissipates heat as follows. The LEDs and a driver are mounted onto a thermally-conductive "trim cup" (112) at the top of the fixture. *Id.* at 8:10-12, 9:44-48. The trim cup spreads the LED-generated heat to a peripherally surrounding baffle/heat sink/trim combination (98, 100, 52). *Id.* at 7:63- 8:1, 9:37-47, Fig. 5. The baffle/heat sink/trim combination is shaped like a top hat. The trim

portion of the top hat is ring-shaped. *Id.* at Fig 5 (item 52). The trim portion dissipates the heat into the air. *Id.* at 7:9-13, 7:31-34.

E. Overview of Wegner

40. U.S. Patent No. 7,993,034 ("Wegner") (Ex. 1016), filed on September 22, 2008, discloses an LED luminaire with an Edison base adaptor for mounting the luminaire into an existing recessed can light fixture. Wegner at Fig. 14-16. An illustration of Wegner is as follows:

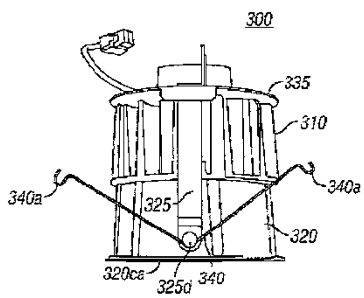


FIG. 6

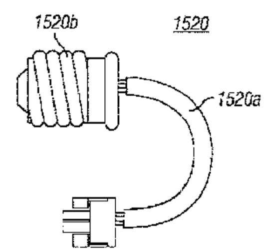


FIG. 16

Wegner at 10 (Fig. 15 and 16).

41. For purposes of the Petition, the relevant portion of Wegner is the adaptor kit 1520 comprising a plug-in connector 1520c at one end and a screw-in Edison plug 1520b at the other end. *Id.* at 10:46-60. The plug-in connector 1520c connects to a corresponding connector on the Wegner fixture, and the Edison plug 1520b screws into the existing light socket. *Id.* at 10:40-44; *see also* Fig. 14.

III. SUMMARY OF SPECIFIC GROUNDS FOR PETITION

Ground	Reference(s)	Basis	Claims

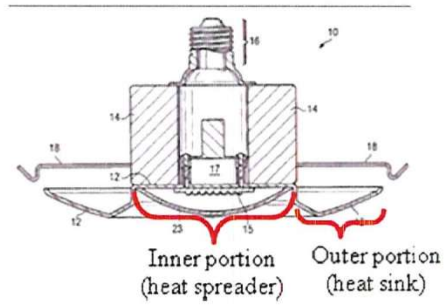
1	Rendered Obvious by Chou in Light of Wegner	§103	1-3, 5, 7, 8, 9, 11, 12, 14, 16, 21-24
2	Rendered Obvious by Chou and/or Zhang in light of Wegner	§103	8
3	Rendered Obvious by Zhang	§103	1, 2, 8, 9, 16, 21, 22
4	Rendered Obvious by Zhang in Light of Soderman/Silescent	§103	3, 4
5	Rendered Obvious by Zhang in Light of Wegner	§103	11, 17, 19

IV. GROUND 1: CLAIMS 1-3, 5, 7, 8, 9, 11, 12, 14, 16, 21-24 ARE RENDERED OBVIOUS BY CHOU IN LIGHT OF WEGNER

Claim 1

1. *"a heat spreader and a heat sink"*

42. Chou discloses a heat spreader and a heat sink. With respect to the heat spreader, Chou teaches that trim 12 spreads heat generated by LED light source 15. Chou at 7:44-46. The LED light source is mounted on trim 12. *Id.* at 7:37-40. Chou explains: "As the light source generates heat, the heat is transferred into trim 12 at the attachment point. From there, the heat is transferred into … the flange of trim 12." *Id.* at 7:44-46; *see also id.* at 7:63-8:1 ("heat energy enters trim 12 and moves to flange 22"), Figs. 2b, 4a and 4b. Thus, while not employing the label, "heat spreader," Chou discloses that the interior portion of trim 12 moves the heat away from the light source, corresponding exactly to the "heat spreader" of the '844 Patent. Heat would naturally flow outwards from the light engine and driver to the outer perimeter of the trim, referred to by Chou as the flange 22. *Id.* at 4:46-50.



Chou at Fig. 2b.

43. With respect to the heat sink, Chou states that "[i]n the present embodiment, ... as the light source operates, heat is transferred into trim 12 from the light source. As the temperature of trim 12 increases, *heat is vented from the flange* [22] portion of trim 12 that resides outside the recessed can housing." Chou at 5:1-5 (emphasis added); *id.* at Fig. 4a (labeling flange 22), 7:63-8:3 ("flange 22 dissipates the heat from fixture 10 outside the recessed can housing into a room or office rather than into the housing itself."). Indeed, "a majority of heat is dissipated from trim 12 outside the housing." *Id.* at 7:14-19 ("fixture 10 efficiently dissipates a majority of heat generated by the light source through trim 12 and outside of the recessed can housing…."). "Accordingly, fixture 10 minimizes heat build-up within the recessed housing." *Id.* at 5:9-11. Thus, while Chou calls the heat-sinking perimeter of the trim a heat-dissipating "flange" rather than a "heat sink," the flange

portion of the trim clearly is a "heat sink" as recited in the '844 Patent, *i.e.*, it dissipates heat transferred to it by the heat spreader into the air.[3]

2. *"the heat sink being substantially ring shaped and being disposed around and in thermal communication with an outer periphery of the heat spreader"*

44. Chou discloses this limitation. "The trim has thermally conductive properties and includes a flange around a perimeter of the trim." Chou at 2:54-55. *See generally id.* at Figs. 2b, 4a and 4b *and compare with* '844 Patent at Figs. 12, 13. While the inner portion of trim 12 is flat, *see* Chou at 7:50-51 ("central attachment area 20"), Fig 4a (20), this outer flange 22 portion of the trim is raised, round, and has a hole in the middle. *See id.* at Fig. 4a(22). Furthermore, the embodiment of Chou where the trim is formed by combining multiple pieces, *see id.* at 7:23-26, would include the flange 22 as one part and the interior part of the trim (central attachment area 20) combined together to form the trim 12. Thus, the outer flange is ring-shaped. *Id.* It is disposed around and in thermal communication with the inner portion (indeed, it is part of the same piece of metal or the pieces are combined). *Id.* at 7:49-50, 7:24-26 (same). Furthermore, the heat sink of Chou is coupled to the outer periphery of the heat spreader of Chou. Figures 2b and 4a

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[3] Chou identifies a secondary "heatsink 14," but, for the reasons discussed below, this unclaimed element has no bearing in this case.

illustrate the relative positions of the "central attachment area 20" (heat spreader, see Fig. 4a) and the outer flange 22 (heat sink). The portion or piece of the trim that is the heat sink (*i.e.* exposed to the air) is immediately next to and flows into to the inner, heat spreader, portion or piece of the trim; indeed, they are stamped from the same piece of metal or are multiple pieces combined. *Id.* at 7:23-26, Fig. 2b. The outer periphery of the heat spreader portion is therefore coupled to the inner periphery of the heat sink portion or piece. That is, where the heat spreader ends and the heat sink begins.

3. *"[LEDs] that are disposed in thermal communication with the heat spreader such that the heat spreader facilitates transfer of heat from the LEDs to the heat sink"*

45. Chou discloses LEDs disposed in thermal communication with the heat spreader, which transfers the heat from the LEDs to the heat sink. Chou states: "In one embodiment, the light source is a light engine that includes a plurality of LEDs." *Id.* at 8:53-54. This LED light source is "directly mounted to a front surface of trim 12 and acts as the light source for the device." *Id.* at 4:14-17. *See also id.* at 7:37-40 ("Trim 12 includes a light source attachment point located inwardly from the flange. The attachment point provides a mount for physically mounting the light source to trim 12."). Heat from the LEDs passes into the heat spreader. "As the light source generates heat, the heat is transferred into trim 12 at the attachment point." *Id.* at 7:44-46. *See also id.* at 8:44-48 ("To facilitate transmission of thermal

energy from light source 15 to the attachment area of trim 12, a layer of thermally conductive material is deposited between light source 15 and trim 12."). The heat spreader then transfers the LED heat to the heat sink so that it can dissipate into the air. "From there, the heat is transferred into ... the flange of trim 12." *Id.* at 7:44-46. *See also id.* at 5:1-5 (light source heat is transferred into trim 12 and then dissipated by trim 12), 7:63-8:1 ("heat energy enters trim 12 and moves to flange 22"), Figs. 2b and 4b. Chou goes on to note that the heat spreader transfers the thermal energy from the light source to the heat sink. In short, the light source 15 is disposed upon and dissipates heat through the heat spreader to the heat sink.

4. *"outer optic disposed in optical communication with the [LEDs]"*

46. Chou discloses this limitation. Chou discloses an optic: clear cover lens 23. *See id.* at Fig. 2b (lens 23), 8:16-23. The LEDs are on one side of the optic; the room is on the other. *Id.* at Fig. 2b. The light from the LEDs thus passes through the optic. *Id.* The optic is thus in optical communication with the LEDs. *Id.*

5. *"a power conditioner disposed and configured to receive AC voltage from an electrical supply and to provide DC voltage for the [LEDs]"*

47. Chou discloses this limitation. "If the power source is an AC power source and the light source is configured to operate using a DC power source, an AC to DC converter circuit may be connected between socket 16 and the light source to convert the AC power source into a DC source." Chou at 4:22-26. Further: "In one

embodiment, the conversion circuit includes circuit board 17." *Id.* at 4:26-28. As shown in Fig. 2b, the power conditioner on circuit board 17, sitting within heatsink 14, is disposed upon and supported by the upper surface of trim 12 (*i.e.* supported by the heat spreader), on the opposite side of light source 15. *See id.* at Fig. 2b (17).

6. *"wherein the power conditioner is disposed, configured and sized to fit at least partially within an interior space of: a nominally sized can light fixture; and, a nominally sized electrical junction box"*

48. Chou already discloses an AC/DC power conditioner disposed and fitting within a nominally sized 5-inch or 6-inch can light fixture. *Id.* at 3:65-66 ("Fixture 10 is configured to install into both conventional 12.7 cm (5 inch) and 15.24 cm (6 inch) recessed can housings."). The power conversion circuit board 17 is positioned within secondary heatsink 14, and therefore must fit within a 5-inch can. *Id.* at 4:46-54 (above the ceiling line), 4:28 (within), Fig. 2b (inside). Chou also teaches that "fixture 10 may be configured to be installed into a recessed can housing *having other geometries*," *Id.* at 3:67-4:1 (emphasis added), and that "[a]s new *recessed housings* are developed *with different geometries*, new attachment mechanisms with different lengths or other attributes can be manufactured for coupling to and *installing fixture 10 into those housings*." *Id.* at 4:3-7 (emphasis added).

49. It would have been obvious to modify the secondary heat sink and driver of Chou to also fit within a nominally sized junction box – including sizes

from 4" to 6" – by selecting an alternative driver and heat sink scaled/sized to fit in the shallower dimension of an electrical junction box.[4] *See* DiLouie at 28 ("[LED drivers] are usually compact enough to fit inside a junction box");[5] Lynch at 15:8-15 (disclosing a driver including a power converter module "configured to accept … 120VAC … and convert the electricity to a desired voltage, such as 3VDC, 9VDC, 12VDC …" is part of the "assembled LED luminaire 200 … adapted to mount to a conventional electrical junction box 210"); *see also* Lynch at Figs. 25A and 25B (showing the driver 206 positioned within the junction box 210); Ko at ¶¶ [0032], [0042], and Fig. 5 (showing that the housing 200 contains the driver circuit 600 which has an initial AC/DC conversion circuit 602 and the housing is configured to fit within a single-gang junction box). A person of ordinary skill in the art would have recognized that LED power conditioners came in a variety of shapes and sizes,

---

[4] The Board will appreciate that Chou does *not* actually state the depicted heatsink 14 would be unable to fit into a 4-inch junction box, as is.

[5] Indeed, 110V AC/DC power converters came in sizes all the way down to sub-one-inch. *See* U.S. Patent No. 5,463,280 ("Johnson") (Ex. 1017) at Fig. 2 (diode bridge 22), 4:11-14 (circuitry fits within a standard T6½ bulb, 0.8125 inch diameter); 5:2-4 ("The diode bridge 22 functions to convert AC line voltage to DC and provides full wave operation of the lamp").

including shapes and sizes capable of fitting inside a nominally sized junction box – albeit likely having a lower total power output and lesser heat sinking requirements than a physically larger driver. *See* DiLouie at 28 ("[LED drivers] are usually compact enough to fit inside a junction box"). And as noted above, most of the heat is already dissipated through trim 12. Chou at 5:18-21. Many commercially available drivers at the time required very little heat sinking.

50. At the time of the invention there were many AC-to-DC power conditioners, *i.e.* drivers, commercially available. An LED fixture designer could have chosen from this wide range of driver options, including different sizes, different shapes, different outputs, and different functionalities (e.g. dimmable or non-dimmable). At the time of the invention there were a number of drivers with a small enough form-factor to fit within an electrical junction box. To the extent the driver (17) already disclosed in Chou did not fit within an electrical junction box, a person of ordinary skill could have simply chosen one of these other smaller drivers.

51. Substituting one of these available smaller drivers and correspondingly smaller secondary heat sink would have yielded the predictable result of the driver and accompanying heat sink fitting inside a nominally sized junction box.

52. To the extent such a smaller driver and smaller heat sink would be dissipating heat into a smaller volume space, a person of ordinary skill in the art would have known to employ more efficient LEDs or an appropriately reduced

number of LEDs (thus consuming less power) in order to match/accommodate the heat dissipating characteristics of the smaller driver, heat sink, and volume.[6]

53. When modified for use in an electrical junction box, of course, the male Edison base would be removed and the underlying wires exposed for direct wiring (*e.g.* via wire nuts). This was known in the art. Removal of an Edison base to expose and connect wires in an LED light fixture was also taught by Wegner. *See* Wegner at 11:3-32 (describing removal of Edison base to allow direct wiring; "the person cuts wires 1520a on the Edison base adapter 1520 to remove an Edison screw-in plug 1520b on the adapter 1520. The person connects the wires . . . to wires (not shown) in the existing fixture . . . .").

54. With respect to motivation, a person of ordinary skill in the art would have recognized that 4-inch, 5-inch, and 6-inch junction boxes were widely used and well known in new construction applications at the time. A person of ordinary skill

[6] For example, Zhang makes clear, AC/DC power conditioners could be sufficiently cooled without using a large secondary heat sink. *See* Zhang at Fig. 3 (driver 62, with no additional heat sink); *see also* Johnson at Fig. 2 (no heat sink). Many commercially available drivers at the time did not require substantial heat sinking, particularly where, as here, the heat could be dissipated out through the trim into the room.

in the art would therefore have been motivated to modify Chou to make a version suitable for fitting into nominally sized electrical junction boxes, thus serving not just retrofit but also new construction market.

55. In short, it would have been obvious to scale the AC/DC power conditioner (and corresponding secondary heat sink, as needed) of Chou to fit inside a nominally sized junction box.

56. Claim 1 of the '844 Patent is rendered obvious by Chou in light of Wegner.

Claim 2

57. Dependent claim 2 is further limited by "the heat spreader, the heat sink and the outer optic, in combination, have an overall outside dimension D so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box." '844 Patent at claim 2. Chou discloses this limitation. Chou teaches that the fixture is drawn up against the ceiling: "The outer flange of trim 12 may contact a structural surface that surrounds the recessed housing such as a ceiling or wall surface (not shown) .... [C]lips 18 exert force on fixture 10 and, specifically, pull the flange portion of trim 12 against the surface surrounding the recessed can application." Chou at 4:46-54. The torsion spring tries to open and walks or pulls the fixture up into the ceiling. A person of ordinary skill in the art would understand

that Chou is referring to covering the opening of the can with the heat sink (*i.e.* flange). Figure 3 confirms this. '844 Patent at Fig. 3.

58. Furthermore: "Fixture 10 is configured to install into both conventional 12.7 cm (5-inch) and 15.24 cm (6-inch) recessed can housings." Chou at 3:65-66. A person of ordinary skill in the art would recognize that if Chou covers a 5-inch can, it will also cover the opening defined by a four-inch can and four-inch electrical junction box. The diameter of a 5-inch or 6-inch can is larger than the diameter of a 4-inch can. It is also larger than the opening of a standard 4-inch junction box. If the Chou fixture covers a 5 or 6-inch can, it can also cover the opening of a standard 4-inch can and a standard 4-inch junction box.

59. Claim 2 of the '844 Patent is rendered obvious by Chou.

Claim 3

60. Dependent claim 3 is further limited by "the heat spreader, the heat sink and the outer optic, in combination, further have an overall height H such that the ratio of H/D is equal to or less than 0.25." '844 Patent at claim 3. Chou discloses this limitation. "In the example, trim 12 includes a thermally conductive material such as aluminum, and has an outer diameter of 200 mm, an inner diameter of 130 mm and a depth of 42 mm (*see* FIG. 4a)." Chou at 5:24-27. The total depth (the trim depth protruding from the ceiling surface) must be 42 mm, because this depth is used in the calculation of trim surface area, which is used in all the subsequent

calculations of heat dissipation by the trim. *Id.* at 5:27-28 ("Accordingly, trim 12 has an approximate surface area of A_{trim} =0.0296 m^2"). Figs. 2a and 2b show that the optic does not protrude beyond trim 12, and thus the height of trim 12 is the height of the combination of heat spreader, heat sink, and optic. That height to diameter (H/D) ratio is 42/200 = 0.21, which is less than 0.25. *Id.*

61. Claim 3 of the '844 Patent is rendered obvious by Chou in light of Wegner.

Claim 5

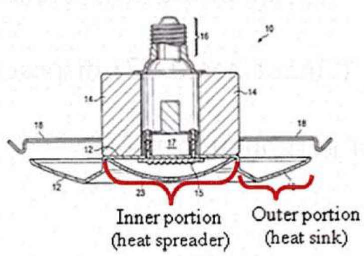
62. Dependent claim 5 is further limited by "the overall outside dimension D is equal to or greater than 7 inches." '844 Patent at claim 5. As mentioned above in claim 3, Chou discloses that the outer periphery of trim 12 is 200 mm (*i.e.* 7.87 inches). Chou at 5:24-27. Thus, Chou discloses this limitation.

63. Claim 5 of the '844 Patent is rendered obvious by Chou in light of Wegner.

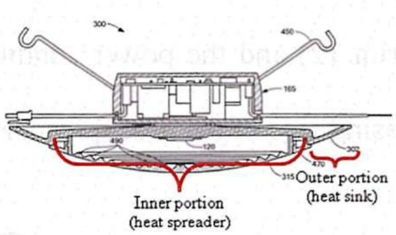
Claim 7

64. Dependent claim 7 is further limited by "the heat spreader and the heat sink are *integrally formed* such that a heat flow path ... is continuous and uninterrupted." '844 at claim 7 (emphasis added). Chou discloses an integrally formed heat spreader and heat sink such the heat flow path through the heat spreader to the heat sink is continuous and uninterrupted. As noted above, Chou describes

the inner portion of trim 12 as functioning as a heat spreader and describes the outer portion of trim 12 (*i.e.* flange 22) as functioning as a heat sink, dissipating the heat into the air. Furthermore, Chou discloses that these two elements can be formed from one piece: "Trim 12 is manufactured as a single piece of stamped aluminum." Chou at 7:49-50, 7:24-25 (same). The heat path from the heat spreader to the heat sink is also continuous and uninterrupted, so the heat flow is continuous and uninterrupted. Chou illustrates these elements in the same manner they are shown and described in the '844 Patent:



Chou Fig. 2b
(annotations added)



'844 Patent Fig. 30
(annotations added)

Id. at Fig. 2b; '844 Patent at Fig. 30 (brackets and annotations added). Thus, as the '844 Patent description and figures show the heat sink and heat spreader are integrally formed, Chou also discloses a heat sink and a heat spreader that are integrally formed.

65. Claim 7 of the '844 Patent is rendered obvious by Chou in light of Wegner.

Claim 8

66. Dependent claim 8 is further limited by "the LEDs are disposed on one side of the heat spreader and the power conditioner is disposed on another opposing side of the heat spreader." '844 Patent at claim 8. Chou discloses this arrangement: "If the power source is an AC power source and the light source is configured to operate using DC power source, an AC to DC converter circuit may be connected between socket 16 and the light source to convert the AC power source into a DC source." Chou at 4:21-25. In fact, figure 3 in Chou depicts such an arrangement of the LEDs (light source 15) disposed on one (lower) side of the heat spreader (inner portion of trim 12) and the power conditioner (circuit board 17) disposed on the (upper) opposing side of the heat spreader (inner portion of trim 12):

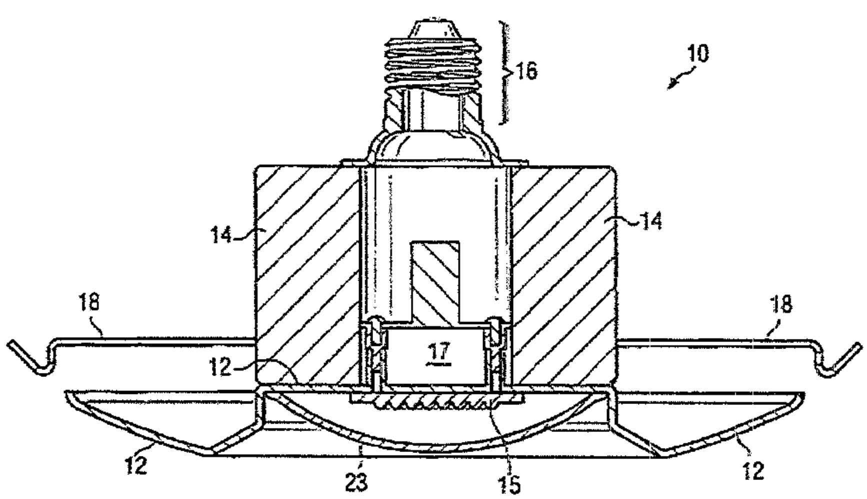


FIG. 2b

67. Claim 8 of the '844 Patent is rendered obvious by Chou in light of Wegner.

Claim 9

68. Dependent claim 9 is further limited by "the power conditioner is configured and sized to fit *completely within* an interior space of a nominally sized can light fixture, and, a nominally sized electrical junction box." '844 Patent at claim 9 (emphasis added). As noted in the discussion of claim 1, the power conditioner in Chou (circuit 17) and accompanying heat sink (heatsink 14) already fit completely within a 5-inch or 6-inch light can. It would have been obvious to one of ordinary skill to scale these components (and the LEDs as necessary) to likewise fit completely within a nominally sized can and electrical junction box. *See* claim 1 *supra* (obvious to scale using available components, motivated by market demand, and known examples of LED drivers in junction boxes, such as Lynch and Ko). Thus, Chou renders obvious the power conditioner fitting completely within a nominally sized can light fixture and a nominally sized electrical junction box.

69. Claim 9 of the '844 Patent is rendered obvious by Chou in light of Wegner.

Claim 11

70. Dependent claim 11 is further limited by "a reflector fixedly disposed in optical communication with the plurality of LEDs to reflect incident light from

the plurality of LEDs to the outer optic." '844 Patent at claim 11. Wegner discloses this limitation: "A reflector housing [that] can be mounted substantially around the LED package." Wegner at 2:41-42. Wegner further discloses that "reflector can be composed of any material for reflecting, refracting, transmitting, or diffusing light from the LED package." *Id.* at 2:48-50. Wegner also discloses that the reflector can have different configurations such as "a cross-sectional profile of the reflector [having] a substantially bell-shaped geometry that includes a smooth curve comprising an inflection point." *Id.* at 2:52-56. Next, Wegner discloses "[a]n optic coupler [that] can be mounted to the reflector housing, for covering electrical connections at the substrate of the LED package and/or for guiding or reflecting light emitted by the LED package." *Id.* at 2:62-65. Wegner further explains that "the optic coupler can include a member with a central channel that is aligned with one or more of the LEDs of the LED package such that the channel guides light emitted by the LEDs while portions of the member around the channel cover the electrical connections at the substrate of the LED package." *Id.* at 2:65-3:3. The reflector of Wegner is designed to be more diverging, *Id.* at 13:28-30 (direct more light at higher angles, *Id.* at 13:32-35) to create a smooth, blended light pattern and blend out what would otherwise be a hard visible line. *Id.* at 13:41-43.

71. It would have been obvious to modify Chou to include a reflector such as the one disclosed in Wegner. A person of ordinary skill in the art would have

been motivated to include a reflector to provide a smooth, blended light pattern and blend out what would otherwise be a hard, visible cut-off line. Wegner confirms this:

> "As is well known to a person of ordinary skill in the art having the benefit of the present disclosure, reflectors within a downlight need to create a specific light pattern that is pleasing to the eye, taking into account human visual perception. Most visually appealing downlights are designed such that the reflected image of the source light begins at the top of the reflector and works its way downward as an observer walks toward the fixture. This effect is sometimes referred to as 'top down flash.' It is generally accepted that people prefer light distributions that are more or less uniform, with smooth rather than abrupt gradients. Abrupt gradients are perceived as bright or dark bands in the light pattern."

Id. at 12:62-13:6.

Claim 12

72. Dependent claim 12 is further limited by "the heat sink forms a trim plate that is disposed completely external to the can light fixture or the electrical junction box." '844 Patent at claim 12. Chou discloses this element. Trim 12 forms a trim plate, specifically flange 22. *Cf.* '844 Patent at 5:10-11 (referring to a "trim plate" as "a heat sink that also serves as the trim plate of the luminaire."); Fig. 12 (heat sink 110); Fig. 30 (heat sink 320).

73. Figure 3 in Chou shows the flange 22 portion of trim 12 completely outside the light fixture can. Chou at Fig 3 (showing the flange portion of trim 12 sitting outside the can), Fig. 4a (identifying the perimeter of trim 12 as flange 22),

7:63 ("Trim 12 includes flange 22."). Figure 2b likewise shows the flange 22 portion of trim 12 completely below the ceiling plane and thus external of the can light fixture or electrical junction box. *Id.* at Fig. 2b; *see also id.* at 4:46-54 (same), 4:46-54 ("clips 18 exert force on fixture 10 and, specifically, pull the flange portion of trim 12 against the surface surrounding the recessed can application"). This would make sense given Chou's discussion of the heat sink/flange dissipating the majority of the heat generated by the fixture. Locating the heat sink/flange within the can would negatively impact its heat sinking ability.

74. Claim 12 of the '844 Patent is rendered obvious by Chou.

Claim 14

75. Dependent claim 14 is further limited by "the heat sink is disposed in direct thermal communication with the heat spreader." '844 Patent at claim 14. As discussed in claim 1, Chou discloses a heat sink disposed in thermal communication with the heat spreader. The communication is "direct" in that the heat spreader and heat sink are formed from one piece of metal or are two pieces combined to form the trim; they are not thermally separated. *See* Chou at Fig. 2b (heat spreader and heat sink portions of trim 12 formed from single piece of metal).

76. Claim 14 of the '844 Patent is rendered obvious by Chou in light of Wegner.

Claim 16

77. Dependent claim 16 is further limited by "the outer optic is securely retained relative to at least one of the heat spreader and the heat sink." '844 Patent at claim 16. Chou discloses an optic – a "clear cover lens" – securely retained relative to the heat sink. "Lens 23 is attached to trim 12 using a friction coupling, adhesive, or a fastener." Chou at 8:16-23; *see also id.* at Fig 2b (lens 23).

78. Claim 16 of the '844 Patent is rendered obvious by Chou in light of Wegner.

Claim 21

79. Dependent claim 21 is further limited by "the nominally sized can light fixture is a nominally sized *four-inch* can light fixture, and the nominally sized electrical junction box is a nominally sized *four-inch* electrical junction box." '844 Patent at claim 21 (emphasis added). That is, it is limited to a subset of the nominally sized boxes encompassed by claim 1. At the time of the '844 Patent 4-inch cans and 4-inch junction boxes were widely used. Four-inch cans (as an additional geometry in addition to the 5 inch and 6 inch recessed can housings disclosed, *see* Chou at 3:65-4:1) are most often legacy incandescent fixtures. Four-inch junction boxes are very common in residential settings. A person of ordinary skill would have appreciated that sizing the Chou luminaire for use with 4-inch cans and 4-inch junction boxes would increase the number of potential installations and likely the

number of sales. As discussed in claim 1 above, it would have been obvious to modify Chou by selecting a suitably sized driver and heat sink from the many available at the time, scaled/sized to fit in a junction box – including a 4-inch box. *See generally* claim 1 *supra*.

80. Claim 21 of the '844 Patent is rendered obvious by Chou in light of Wegner.

Claim 22

81. Dependent claim 22 is further limited by "the heat sink is disposed diametrically outboard of the heat spreader." '844 Patent at claim 22. As noted in the discussion of claim 1 *supra*, the interior portion of trim 12 is a heat spreader, thermally coupled to the outer portion of the trim, flange 22, which is a heat sink. Chou further discloses that the heat sink has an outer "diameter" outside the inner "diameter" encircling the heat spreader portion. Chou at Fig. 4a. Chou also states that the trim can be formed by combining multiple pieces, *id.* at 7:24-26, which would include the flange 22 (heat sink) as one part and the interior part of the trim (central attachment area 20, heat spreader) combined together to form the trim 12. The heat sink is completely exterior and disposed outboard of the heat spreader portion. *See id.* at Fig. 4a (flange 22). Chou thus discloses that the heat sink is diametrically outboard of the spreader.

82. Claim 22 of the '844 Patent is rendered obvious by Chou in light of Wegner.

Claim 23

83. Dependent claim 23 is further limited by "the heat sink also serves as a trim plate; the combination of the trim plate and the outer optic have an overall height H; the trim plate has an overall diameter D; and the ratio of H/D is equal to or less than .25." '844 Patent at claim 23. As discussed above in claim 12, Chou discloses a heat sink trim 12 that also forms a trim plate, flange 22. *See* Chou at Figs. 2b, 4a, and 4b, 5:1-5; 7:63-8:3. Further, as discussed in claim 3, Chou discloses that the ratio of the H/D is 0.21. *Id.* at 5:24-28; Figs. 2a and 2b.

84. Claim 23 of the '844 Patent is rendered obvious by Chou in light of Wegner.

Claim 24

85. Independent claim 24 is identical to claim 2, with the additional limitation of claim 12, depending from claim 1.

1. *"a heat spreader and a heat sink"*

86. As discussed in claim 1, Chou discloses this element.

2. *"the heat sink being substantially ring-shaped and being disposed around and in thermal communication with an outer periphery of the heat spreader"*

87. As discussed in claim 1, Chou discloses this element.

3. ***"[LEDs] that are disposed in thermal communication with the heat spreader such that the heat spreader facilitates transfer of heat from the LEDs to the heat sink"***

88. As discussed in claim 1, Chou discloses this element.

4. ***"an outer optic disposed in optical communication with the plurality of LEDs"***

89. As discussed in claim 1, Chou discloses this element.

5. ***"a power conditioner disposed and configured to receive AC voltage from an electrical supply and to provide DC voltage for the plurality of LEDs"***

90. As discussed in claim 1, Chou discloses this element.

6. ***"wherein the power conditioner is disposed, configured and sized to fit at least partially within an interior space of a nominally sized can light fixture; and a nominally sized electrical junction box"***

91. As discussed in claim 1, this limitation is rendered obvious by Chou in light of Wegner.

7. ***"wherein the heat spreader, heat sink and the outer optic, in combination, have an overall dimension D so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box"***

92. As discussed in claim 2, Chou discloses this element.

8. ***"wherein the heat sink forms a trim plate that is disposed completely external of the can light fixture or the electrical junction box"***

93. As discussed in claim 12, Chou discloses this element.

94. Claim 24 of the '844 Patent is rendered obvious by Chou in light of Wegner.

* * *

95. As the foregoing discussion makes clear, the inner and outer portions of trim 12 meet the "heat spreader" and "heat sink" limitations of claim 1. Chou further discloses an additional element not claimed in the '844 Patent: heatsink 14. Although not the relevant heat sink for obviousness purposes, this element warrants further discussion here.

96. Chou refers to trim 12 as a "trim" rather than a heat sink, despite its heat sinking function. In fact, Chou notes that "[a]lthough some heat is vented into the recessed housing by the heatsink 14, *a majority of heat is dissipated from trim 12* outside the housing." Chou at 5:8-10 (emphasis added). "Trim 12 and the flange of trim 12 [flange 22] generally dissipates *more* heat energy from the light source *than heatsink 14*. By doing so, trim 12 minimizes heat build-up within the can housing." *Id.* at 5:18-21 (emphasis and bracketed text added); *see also id.* at 5:15-17 (element 14 "may be regarded as acting as a heatsink for trim 12 rather than the light source directly.") Chou then quantifies the heat transfer for both elements, *id.* at 5:18-7:13, and determines that "trim 12 dissipates approximately 65% of the heat energy generated by the LED light source," *id.* at 7:1-3.

97. Trim 12 discloses the "heat spreader" and "heat sink" elements.

V. GROUND 2: CLAIM 8 IS RENDERED OBVIOUS BY CHOU AND/OR ZHANG IN LIGHT OF WEGNER

98. Dependent claim 8 is further limited by "the LEDs are disposed on one side of the heat spreader and the power conditioner is disposed on another opposing side of the heat spreader." '844 Patent at claim 8. As explained in Section VII above, Chou discloses this limitation. To the extent the Board finds Chou does not disclose the limitation, Zhang discloses this limitation. Zhang discloses "[a] drive unit 62 [that] is wired 64 to the adapter and [that] processes the received electrical energy for use by the light sources 57." Zhang at 8:24-26. Further, Fig. 13 provides an exploded view of a trim unit 130 of the invention disclosed in Zhang. *Id.* at 11:48-49. The LEDs on the underside of the printed circuit board 96 of Fig. 13, are on the lower side of the trim cup 112 (heat spreader) and the driver 68 is on the opposing (upper) side of the trim cup 112 (heat spreader). It would have been obvious to modify Chou to include the arrangement as disclosed by Zhang. It would have been obvious to modify Chou to include the arrangement as disclosed by Wegner. A person of ordinary skill in the art would have been motivated to have the LEDs and the power conditioner disposed on opposing sides of the heat spreader because the heat spreader could effectively conduct heat away from both elements. Having the power conditioner on the same side as the LEDs would block light from the LEDs and increase the lateral size of heat spreader unnecessarily. Therefore, one of ordinary skill in the art would position the LEDs and the power conditioner on

opposite sides of the heat spreader. Claim 8 of the '844 Patent is rendered obvious by Chou in light of Wegner and Zhang.

VI. GROUND 3: CLAIMS 1, 2, 8, 9, 16, 21 AND 22 ARE RENDERED OBVIOUS BY ZHANG

Claim 1

1. ***"a heat spreader and a heat sink"***

99. Zhang discloses a heat spreader and a heat sink. With respect to the heat spreader, Zhang teaches that the LEDs (which are mounted on a printed circuit board) are located on the bottom of trim cup 112. Zhang at 9:46-48; Fig. 5 (LED PCB 96, trim cup 112). The trim cup is made of thermally conductive material. *Id.* at 8:37-38 ("single piece of cast aluminum"); 9:44-48 (trim cup made of "single piece of … thermally conductive material"). "[T]rim cup 72 is attached to the frustoconical shaped baffle 54 to effect heat transfer from the LED trim cup to the baffle drawing heat away from the LED trim cup…." *Id.* at 12:43-48. Trim cup 72 is, therefore, a heat spreader as recited in the '844 Patent. *Id.* at 12:43-48.

100. With regard to the heat sink, Zhang discloses a "trim unit" comprising a trim ring 52, a baffle 54 with a "low profile" heat sink 56. *Id.* at 3:6-18, 4:23-39. *See also id.* at Fig. 1 (trim unit 38), 1A (same), 3 (identifying the baffle, heat sink and trim ring as portions of fixture frame). "[T]he trim ring 52 and integrated baffle and heat sink 54 are formed as a single piece of cast aluminum." *Id.* at 8:34-36, *see also id.* at 8:58-61 ("baffle, integrated heat sink and trim ring … are formed of …

thermally conductive metal."). *Cf. id.* at 7:3 ("the trim unit [38] *includes* a trim ring 44") (emphasis added).

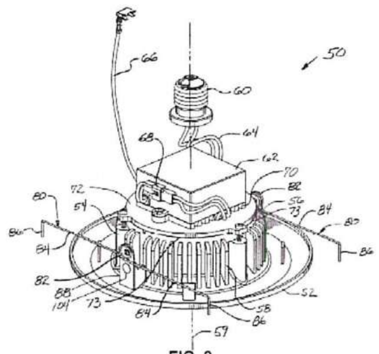


FIG. 3

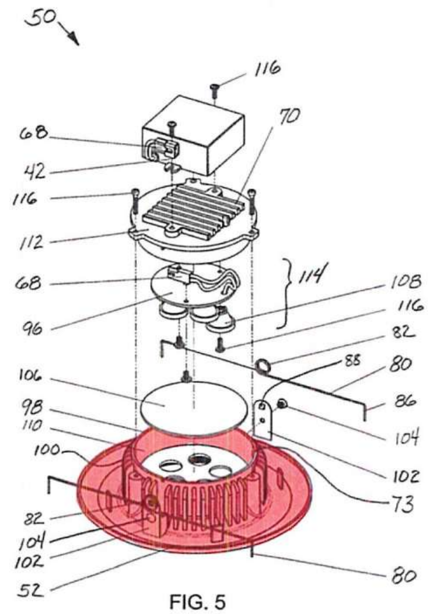


FIG. 5

Id. at Figs. 3 and 5 (highlighting added). The heat sink and baffle are "used to draw heat from the light sources 57 mounted within the baffle." *Id.* at 7:65-8:1. *See also id.* at Fig. 3 (54, 56). The trim ring portion, in turn, "draw[s] heat away from the trim unit 38 and conduct[s] it to the room 47 for dissipation." *Id.* at 7:8-13. Thus, the integrated trim unit (consisting of trim ring 52, baffle 54, and heat sink 56 portions) dissipates LED heat into the room. *See id.* While its constituent portions are given separate labels, the integrated aluminum "trim unit" is a "heat sink" as recited in the '844 Patent.

2. *"the heat sink being substantially ring-shaped and being disposed around and in thermal communication with an outer periphery of the heat spreader"*

101. Zhang discloses this limitation. The perimeter portion of the trim unit is circular. *Id.* at Fig. 3 (52, 54, 56). There is a hole in the middle of this portion. *Id.* at Fig. 2 (recess into which light sources 57 mounted). Furthermore, the trim unit is round and comprises five holes in the middle of the divider through which the light exiting the lenses 108 passes in order to exit the light fixture. See id. at Figs. 5, 13. It is, as the claim requires, *substantially* ring-shaped.

102. The interior perimeter of the baffle cavity (*i.e.* the upper portion of the integrated trim unit) surrounds the exterior perimeter of the bottom of the trim cup on which the LEDs are mounted. *See id.* at Fig. 5 (96, 110, 112). The baffle draws heat away from the trim cup. *Id.* at 7:65-8:1. The heat sink (*i.e.*, trim unit 38) is therefore in thermal communication with an outer periphery of the heat spreader (trim cup 72).

3. *"[LEDs] that are disposed in thermal communication with the heat spreader such that the heat spreader facilitates transfer of heat from the LEDs to the heat sink"*

103. Zhang discloses this limitation. A "plurality of light emitting diodes (LEDs) 57 are used for the light source," *id.* at 8:10-12, and are mounted on a printed circuit board (PCB). *Id* at 9:44-48.

104. "The trim cup 112 and second heat sink 70 are formed as a single piece of … thermally conductive material and serve as a mounting platform for the … LED printed circuit board 96 and the LEDs." *Id.* at 9:44-48. The trim cup transfers

heat from the LEDs to the baffle. *Id.* at 12:43-48. The heat then flows from the baffle down to the trim ring, where it is dissipated into the room. *Id.* at 7:8-13.

4. *"an outer optic disposed in optical communication with the plurality of LEDs"*

105. Zhang discloses this limitation. "A tempered glass plate 106" is "disposed in the cavity of the baffle 98 below the LED light sources . . . ." *Id.* at 9:41-44. This glass plate 106, is in optical communication with the plurality of LEDs as it receives light from the LEDs and passes the light from LEDs into the room. *Id.* 9:41-44, Fig. 5 (glass plate 106, LED lens 108), Fig. 8 (LEDs 120).

5. *"a power conditioner disposed and configured to receive AC voltage from an electrical supply and to provide DC voltage for the plurality of LEDs"*

106. Zhang discloses this limitation. "[D]river 42 [supplied by power line 48] provides the necessary electrical energy to cause the LEDs to emit light." *Id.* at 7:26-27; *see also id.* at 8:24-26 ("[A] driver unit 62 is wired 64 to the adaptor and processes the received electrical energy for use by the light sources 57."), 5:37-39 ("AC light socket adaptor for engaging a mains power connector" receives AC power), 7:27-29 (driver provides "the necessary electrical energy to cause the LEDs to emit light"). A person of ordinary skill in the art would have understood the reference to a "driver" "process[ing]" the incoming AC power as disclosing an AC-to-DC power converter. A person of ordinary skill in the art would have understood that residential and commercial power is typically 110 VAC, multi-directional

current. LEDs, on the other hand, can only be driven by current flowing in a single direction, *i.e.* DC, and typically require only limited current. LED fixtures operating off of AC power must have some means to convert the AC power to unidirectional, limited-current power. A person of ordinary skill in the art would therefore have appreciated that the fixture disclosed in Zhang (lit by LEDs powered by a driver) could not operate from pure, un-modified AC power and that the driver (which "processes" the AC power) is, among other things, converting the AC power to uni-directional DC power.

6. *"wherein the power conditioner is disposed, configured and sized to fit at least partially within an interior space of: a nominally sized can light fixture; and, a nominally sized electrical junction box"*

107. In implementing Zhang, it would have been obvious to a person of ordinary skill in the art to select a driver that would fit completely within a nominally sized can or junction box.

108. With regard to a can, Zhang already discloses driver 42 on top of the trim cup and completely within the internal space 49 of recessed can 36. *Id.* at Fig. 1A (driver 42); *id.* at 2:23-24, 6:66-67 (recessed housing is "can"), 7:26-30 (driver 42 located within can).

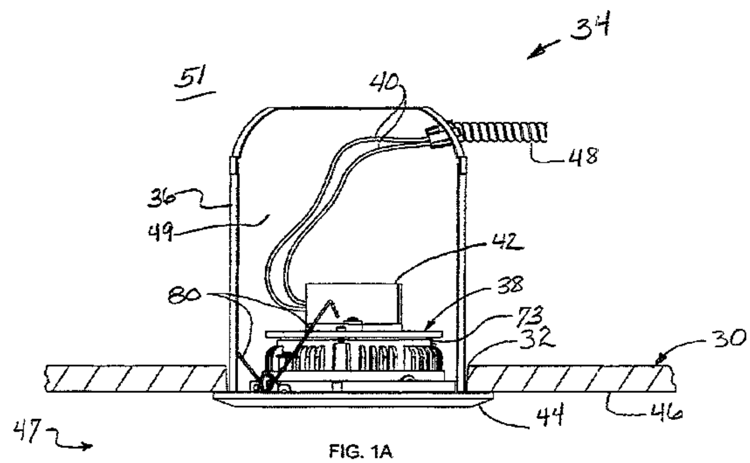


FIG. 1A

Id. at Fig. 1A. Thus, Zhang discloses a power conditioner disposed, configured and sized at least partially within an interior space of a nominally sized can light fixture.

109. With regard to an electrical junction box, it would have been obvious to a person of ordinary skill in the art to select a AC/DC power conditioner from the many available at the time that would have fit inside an electrical junction box. *See generally* Ground 1, claim 1 (power conditioners came in a variety of shapes and sizes, some small enough to fit inside 4-inch cans and 4-inch junction boxes, heat dissipation and power could be scaled), *supra*; *see also* DiLouie at 28 ("[LED drivers] are usually compact enough to fit inside a junction box"). A person of ordinary skill in the art would have been motivated to modify Zhang (if necessary)[7]

[7] The Board will appreciate that Zhang does *not* actually state the depicted driver 42 would be unable to fit into a 4-inch junction box, as is. *Cf.* Fig. 1A.

by selecting a suitable and appropriately sized driver that fits within an electrical junction box in order to serve more of the market for lighting fixtures. *Cf.* Silescent at Fig. 3 (teaching the deployment of a low profile fixture into "any UL approved junction box."). Fitting the driver completely within the electrical junction box would also preserve Zhang's shape, design, function, heat dissipation system, and aesthetic.[8] Given Zhang's configuration (driver mounted on top of the fixture) the

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[8] As discussed with regard to claims 1 and 2, to the extent such a smaller driver would be operating in a smaller volume space (and therefore may get hotter), a person of ordinary skill in the art would employ an appropriately reduced number of LEDs (thus consuming less power and generating less heat) in order to accommodate the smaller heat sink necessary to for the fixture to fix over a junction box. A person of ordinary skill in the art would likewise have understood that the trim cup could be reduced in size if necessary. A shorter trim cup might provide less heat sinking up into the can or junction box but a person of ordinary skill in the art could choose a light engine with fewer LEDs (or a more efficient, cooler running, driver), which would have reduced the amount of heat generated by the fixture. This would allow for the use of a smaller heat sink while maintaining an appropriate operating temperature for the driver and light engine. Or the designer could have used a lower

first step in designing Zhang to be installed in a junction box would have been selecting a driver small enough to fit at least partially within the junction box.

110. In short, Zhang already discloses an AC/DC driver fitted within a nominally sized can and it would have been obvious to select a different driver (if needed) to make a corresponding version for the new construction/junction box market.

111. Claim 1 of the '844 Patent is rendered obvious by Zhang.

Claim 2

112. Dependent claim 2 is further limited by "the heat spreader, the heat sink and the outer optic, in combination, have an overall outside dimension D so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box." '844 Patent at Claim 2. While Zhang does not expressly disclose dimensions in the explicit text of non-provisional application specification, the provisional application, which is incorporated by reference into the non-provisional specification, Zhang at 1:7-11, provides explicit reference that the fixture could be a

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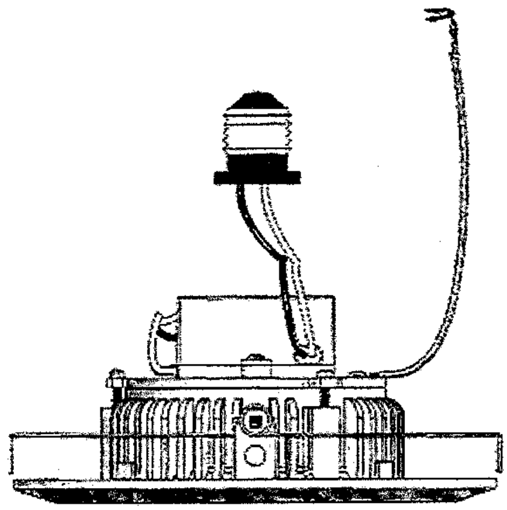
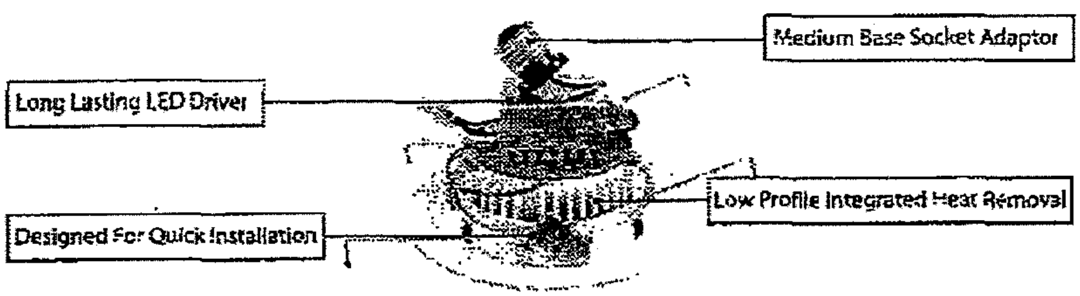
lumen light engine or more efficient LEDs that generate less heat. For example, I personally designed fixtures to fit particular sizes and form factors.

6” LED Shower Trim and come in 4” Trim or 6” trim for 4” or 6” recessed housings as shown below.



6” LED SHOWER TRIM



SKU#	DESCRIPTIONS	WHITE	BRUSHED NICKEL
901-093	4" GIMBAL TRIM	√	
770-582	4" GIMBAL TRIM		√
772-756	6" GIMBAL TRIM	√	
772-743	6" SHOWER TRIM	√	

Zhang Provisional at pp. 17, 19, 20.

113. Furthermore, it would have been obvious to a person of ordinary skill in the art to implement Zhang so as to cover a four-inch can or four-inch junction box. Zhang already teaches covering the ceiling opening: "torsion springs 80 . . . pull[] and hold[] the trim unit up in the housing with the trim ring 44 held against the outer side of 46 of the surface 30." Zhang at 7:46-50; *see also id.* at Fig. 1A (trim ring 44 covering the opening 32), 6:64-67. A person of ordinary skill in the art would understand, as noted above, the Zhang could be scaled (if necessary) to fit into and thus cover a range of sizes, including 4-inch junction box or 4-inch can. As to motivation, four-inch cans and 4-inch junction boxes were widely used and scaling Zhang would allow a person of ordinary skill in the art to serve more of the market for lighting fixtures.

114. Claim 2 of the '844 Patent is rendered obvious by Zhang.

Claim 8

115. Dependent claim 8 is further limited by "the LEDs are disposed on one side of the heat spreader and the power conditioner is disposed on another opposing side of the heat spreader." Zhang discloses "[a] drive unit 62 is wired 64 to the adapter and processes the received electrical energy for use by the light sources 57." Zhang at 8:24-26. Further, Figure 13 provides an exploded view of a trim unit 130 of the invention disclosed in Zhang. *Id.* at 11:48-49. The LEDs on the underside of the printed circuit board 96 of Fig. 13, are on the lower side of the trim cup 112 (heat

spreader) under the lenses 108, *id.* at 9:43-44, and the driver 68 is on the opposing (upper) side of the trim cup 112 (heat spreader).

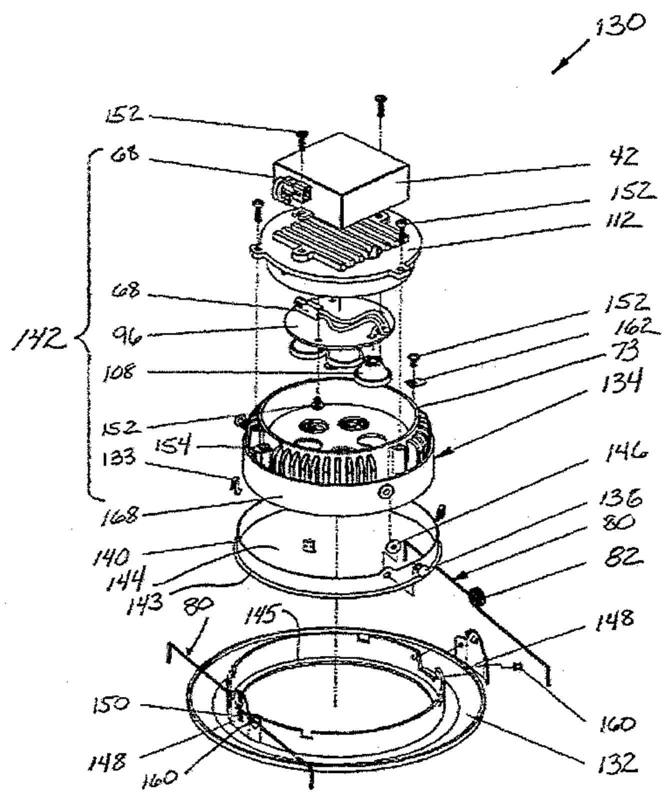


FIG. 13

116. Claim 8 of the '844 Patent is rendered obvious by Zhang.

<u>Claim 9</u>

117. For dependent claim 9, as noted above, it would have been obvious to a person of ordinary skill in the art to select a suitable and appropriately sized power conditioner capable of fitting "completely" within a nominally sized can or junction box. As noted, Zhang already discloses a power conditioner that fits completely within a nominally sized can. Zhang at 8:24-26, 7:26-30, Fig. 1A (driver 42

completely within can 36). And as noted, selecting a driver suitable for an electrical box would open up a greater market. Fitting the driver completely within the electrical junction box would also preserve Zhang's shape, design, function, heat dissipation system, and aesthetic.

118. Claim 9 of the '844 Patent is rendered obvious by Zhang.

Claim 16

119. For dependent claim 16, Zhang discloses an outer optic secured relative to the heat sink or heat spreader. As discussed with regard to claim 1, the tempered glass plate 106 located below the LEDs is an outer optic. *Id* at 9:41-44; Fig. 5 (glass plate 106). The glass plate rests on the divider, which comprises five holes for light from the lenses 108, and is located within the baffle cavity at the lower end. *Id.* at Fig. 5 (cavity 110). When the fixture is fully assembled, the glass plate is secured in a fixed position relative to the trim cup, *i.e.* heat spreader when the trim cup is screwed downward into the cavity 110 of the baffle 98. *See id.* A person of ordinary skill in the art would have appreciated that the glass plate is securely sandwiched between the lens and the divider. Doing so minimizes, or avoids, any sound that could occur if the glass plate were left free to move around within the Zhang fixture. Otherwise, vibrations, for instance heavy footsteps, could cause the glass plate to audibly rattle.

120. Claim 16 of the '844 Patent is rendered obvious by Zhang.

Claim 21

121. For dependent claim 21, just as it would have been obvious for a person of ordinary skill to select a suitably sized driver to permit a Zhang-like device to fit inside a nominally sized can or electrical junction box, it would have been obvious to a person of ordinary skill in the art to have implemented Zhang in a 4-inch can or 4-inch junction box. Four-inch cans and boxes are a subset of the implementations taught by Zhang in light of knowledge in the art. Furthermore, as discussed above with respect to claim 2, the provisional application of Zhang discloses an embodiment of a 4" trim for a 4" can.

122. Claim 21 of the '844 Patent is rendered obvious by Zhang.

Claim 22

123. For dependent claim 22, Zhang discloses a heat sink diametrically outboard of the heat spreader. As discussed with regard to claim 1, the trim cup (*i.e.* heat spreader) sits within the cavity of the baffle. *See id.* at Fig. 5 (96, 110, 112).

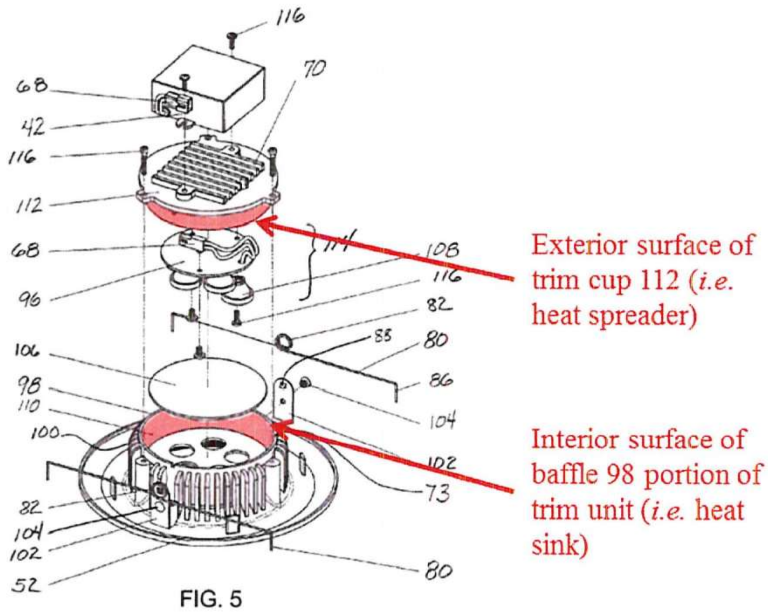


FIG. 5

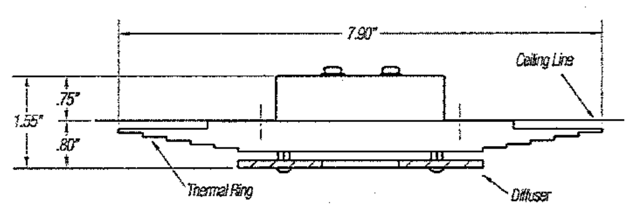
Id. at Fig. 5 (annotations added). The interior perimeter of the baffle cavity surrounds and is exterior to the outer perimeter of the trim cup on which the LED PCB is mounted, *i.e.* the lower plane of the trim cup. *Id.* at Fig. 5 (96, 110, 112). The interior perimeter of the baffle is completely exterior to the external perimeter of the surface on which the LED PCB is mounted. *See id.* Although the shoulder sits on top of the upper plane of the baffle, its diameter is no greater than that of the baffle. *See id.* at Fig. 3. When the fixture is fully assembled, the diameter of the outer perimeter of the shoulder of the trim cup is approximately the same diameter as the diameter of the top of the baffle. *See id.* I note also that one of the preferred embodiments in the '844 Patent discloses a heat sink that overlaps with a heat spreader. *See* '844 Patent at 5:37-40 ("Referring to FIGS. 1-26 collectively, a luminaire 100 includes a heat spreader 105, a heat sink 110 thermally coupled to and disposed *diametrically outboard* of the heat spreader") (emphasis added); Fig. 12 (heat sink 110 overlapping heat spreader 105).

124. Claim 22 of the '844 Patent is rendered obvious by Zhang.

VII. GROUND 4: CLAIMS 3 AND 4 ARE RENDERED OBVIOUS BY ZHANG IN LIGHT OF SODERMAN/SILESCENT

Claim 3

125. Dependent Claim 3 is further limited by "the heat spreader, the heat sink and the outer optic, in combination, further have an overall height H such that the ratio of H/D is equal to or less than 0.25." '844 Patent at Claim 3. As discussed above, it would have been obvious to a POSITA to implement Zhang to cover a four-inch can or four-inch junction box. It would have likewise been obvious to a POSITA to implement Soderman using the dimensions disclosed in Silescent since Silescent is a commercial embodiment of Soderman, Soderman Decl. at ¶6, and implementing Silescent would have yielded the predictable result of covering a four-inch box or a four-inch can. Silescent discloses a height (including mounting assembly, cover, and light shield) of 0.80 inches and a diameter of 7.90 inches.



Ex. 1014 at Fig. 1. The H/D ratio is thus 0.101. *Id.* It would have been obvious to a POSITA to use these dimensions to implement Soderman, yielding the predictable result of a low-profile fixture with a H/D ratio less than 0.25.

Claim 4

126. Dependent Claim 4 is further limited by "the overall height H is equal to or less than 1.5 inches." '844 Patent at Claim 4. As discussed above, Silescent discloses an overall height (including mounting assembly, cover, and light shield) of 0.80 inches, which is less than 1.5 inches. It would likewise have been obvious to a POSITA to use these dimensions to implement Soderman, yielding the predictable result of a low-profile fixture with an overall height equal to or less than 1.5 inches.

VIII. GROUND 5: CLAIMS 11, 17, AND 19 ARE RENDERED OBVIOUS BY ZHANG IN LIGHT OF WEGNER

Claim 11

127. Dependent claim 11 is further limited by "a reflector fixedly disposed in optical communication with the plurality of LEDs to reflect incident light from the plurality of LEDs to the outer optic." '844 Patent at claim 11. Wegner discloses this limitation: "A reflector housing [that] can be mounted substantially around the LED package." Wegner at 2:41-42. Wegner further discloses that "reflector can be composed of any material for reflecting, refracting, transmitting, or diffusing light from the LED package." *Id.* at 2:48-50. Wegner also discloses that the reflector can have different configurations such as "a cross-sectional profile of the reflector

[having] a substantially bell-shaped geometry that includes a smooth curve comprising an inflection point." *Id.* at 2:52-56. Next, Wegner discloses "[a]n optic coupler [that] can be mounted to the reflector housing, for covering electrical connections at the substrate of the LED package and/or for guiding or reflecting light emitted by the LED package." *Id.* at 2:62-65. Wegner further explains that "the optic coupler can include a member with a central channel that is aligned with one or more of the LEDs of the LED package such that the channel guides light emitted by the LEDs while portions of the member around the channel cover the electrical connections at the substrate of the LED package." *Id.* at 2:65-3:3. The reflector of Wegner is designed to be more diverging, *Id.* at 13:28-30 (direct more light at higher angles, *Id.* at 13:32-35) to create a smooth, blended light pattern and blend out what would otherwise be a hard visible line. *Id.* at 13:41-43.

128. It would have been obvious to modify Zhang to include a reflector such as the one disclosed in Wegner. A person of ordinary skill in the art would have been motivated to include the reflector to provide a smooth, blended light pattern and blend out what would otherwise be a hard, visible cut-off line. Wegner confirms this: "As is well known to a person of ordinary skill in the art having the benefit of the present disclosure, reflectors within a downlight need to create a specific light pattern that is pleasing to the eye, taking into account human visual perception. Most visually appealing downlights are designed such that the reflected image of the

source light begins at the top of the reflector and works its way downward as an observer walks toward the fixture. This effect is sometimes referred to as 'top down flash.' It is generally accepted that people prefer light distributions that are more or less uniform, with smooth rather than abrupt gradients. Abrupt gradients are perceived as bright or dark bands in the light pattern." *Id.* at 12:62-13:6.

Claim 17

129. It would have been obvious to a person of ordinary skill in the art to modify Zhang such that it included an accessory kit comprised of a "pre-wired jumper comprising a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an Edison base electrically connected at the other opposing end" to electrically connect the fixture to an Edison socket. '844 Patent at claim 17. Indeed, Zhang nearly includes the entire kit already. Zhang would require only one modification: inserting a connector set somewhere along the line 64 connecting the fixture 50 to Edison base 60.[9]

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[9] A jump wire, or jumper, refers to a short electrical wire used to connect electrical components. A jumper typically consists of insulated wires with a connector on each end. The connectors vary depending on what is being connected. In lighting fixtures, jumpers are used to connect a fixture to the power source.

130. Zhang already discloses an Edison adaptor connected to a power conditioner via an electrical supply line. Zhang discloses a "light socket adapter 60 to provide power for light source operation, although other means may be used. In this embodiment, a driver unit 62 is wired 64 to the adapter and processes the received electrical energy for use by the light sources 57." Zhang at 8:22-26. The wires 64 connect to the driver 42 (*i.e.*, power conditioner) which is connected via a connector 68 to the LEDs. *Id.* at Fig. 3 (wires 64, driver 62, adaptor 60, connector 68).

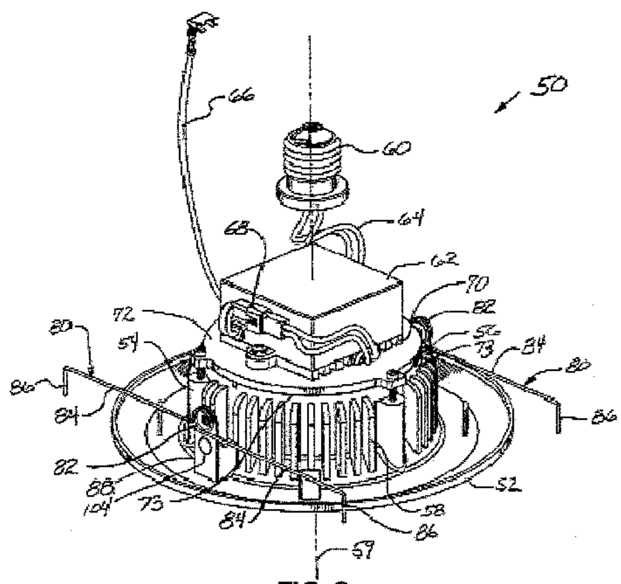

FIG. 3

Id. at Fig. 3. The existing combination of wires 64 and Edison base 60 could be turned into an "accessory kit" by inserting a male/female connector pair along the path of wires 64. Wegner explicitly teaches this:

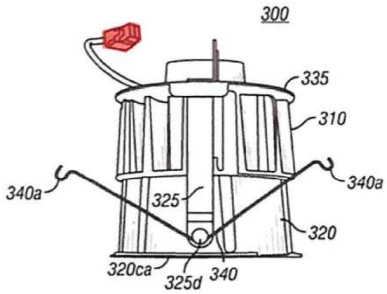

FIG. 6

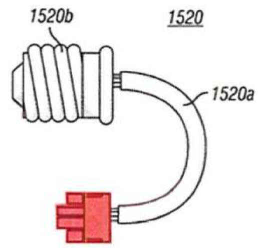

FIG. 16

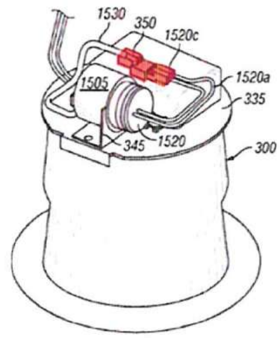

FIG. 15

Wegner at Figs. 6, 15, and 16 (highlighting added). Wegner teaches an adaptor kit 1520 comprising a plug-in connector 1520c at one end and a screw-in Edison plug 1520b at the other end. *Id.* 10:46-60. A person of ordinary skill in the art would have understood that the wires 1520a are insulated. The Edison adaptor is meant to be installed in an electrical circuit by a human hand. Leaving bare wires would invite a dangerous shock. Bare wires would also lead to a risk of a short-circuit once the circuit is energized. Furthermore, a person of ordinary skill in the art would understand that the plug connector is also sometimes called a quick connect. It allows electrical components to be connected quickly and easily by detachably connecting electrical wiring via small plastic clips. The connector is configured to engage in a plug-in connector on an electrical supply line. Wegner at Fig. 15 (plug connectors 350); *id.* at 10:46-50 ("the person can plug one or more quick-connect or plug connectors 350 from the driver 315 into the Edison base adaptor 1520").

131. In short, a person of ordinary skill in the art would have understood that including a connector such as that disclosed in Wegner on wire 64 (*i.e.* making it an Edison jumper) would have made Zhang's non-detachable Edison base 60 detachable, and thus easier to install. Using an Edison jumper (as opposed to a hardwired Edison adaptor) would allow a person installing the fixture to screw in the Edison adapter without having to hold the entire fixture. The installer could just screw in the adaptor and, once that is in place, the fixture can be connected via the plug-in connectors and then secured in place itself. Such a combination would be desirable and obvious.

132. Claim 17 of the '844 Patent is rendered obvious by Zhang in light of Wegner.

Claim 19

133. Dependent claim 19 further limits the accessory kit of claim 17 by "at least one twist-on wire connector." '844 Patent at Claim 19. According to the '844 Patent, the twist-on wire connectors are used to pigtail the wire ends of the second pre-wired jumper to pre-existing wire ends in the junction box. *Id.* at 12:11-14. Twist-on wire connectors contain a metal insert to maintain electrical continuity in the twisted wire-to-wire contact. Twist-on wire connectors are an extremely common type of electrical connectors. *See, e.g.*, Ex. 1014 at Fig. 1 (teaching the installation of a fixture, one step of which includes connecting protruding wires

using wire nuts). While Wegner does not expressly disclose twist-on wire connectors, it generally discloses the use of connectors to connect the various modules of the fixture. Wegner at 10:46-50, 11:8-19. A POSA, therefore, would be motivated to implement twist-on wire connectors based on general knowledge and common practice in the art as well as the disclosures in Wegner.

134. Claim 19 of the '844 Patent is rendered obvious by Zhang in light of Wegner.

IX. CONCLUSION

135. Several prior art references accomplish exactly the same goal, in the same manner, as the '844 Patent: dissipating heat from a low-profile LED fixture by using the fixture's own trim or periphery as a heat sink. To the '968 patent, the '844 adds a "kit" – nothing more than a pigtail connector. They place the ancillary components (AC/DC power conditioner, optics) in exactly the same places. The '844 Patent claims nothing new.

Signed under the penalty of perjury this 17th day of April, 2017.

Dr. Zane Coleman

ATTACHMENT

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OPTICAL TECHNOLOGY EXPERT

PROFILE

- Optical technology, lighting, and display expert
- Inventor on 49 issued patents, Inventor on 30+ pending patent applications
- Expertise and analytical skills for optical and physical product analysis
- USPTO Registered Patent Agent

EMPLOYMENT

Phostech **President** *2009 – Present*

- Optical consulting
- Patent strategy & drafting services
- Expert declaration and deposition in Morgan Solar, Inc. v. Banyan Energy Inc., USPTO PTAB Interference No. 105,972
- Submitted declarations for 9 USPTO *Inter partes* reviews related to backlights
- Non-testifying expert ITRI v. LG Corp., ITC CASE 337-TA-805 (consultant for Steptoe & Johnson on behalf of defendants) on backlight technology
- Invented backlights, flexible lightguide technology, waveguide configurations, LED bulbs based on waveguides, LED light fixture configurations, concentrating solar collection systems, and other illumination devices

Fusion Optix Inc. **VP Technology & Dir. of Technology** *2006-2009*

Led the research strategy and transfer of technology to product engineering in a fast-paced small company providing innovation in the display and LED lighting industries

- Developed technology roadmaps, intellectual property strategy, & competitive benchmarking
- Invented more than 35 unique, patentable products and drafted & prosecuted 60+ patent applications
- Managed and researched optical films, display backlights, LED light fixture, and LED light bulb projects
- Co-developed the optical system of a Lightfair 2009 Innovation Award-winning LED light fixture

Manager, Optical Engineering *2005-2006*

- Developed and prototyped micro-replicated, multi-functional optical films for displays and light fixtures through optical modeling, prototyping, optical and thermal analysis, and specification
- Designed and managed optical film, LED backlight, and light fixture optical and thermal characterization lab
- Led polymer based optical film research including production and optical characterization

Phostech **President** *2003-2005*

- Optical design & analysis of diffusing films, refractive-TIR films, displays, LCD backlights, lightguides, illuminated signs and light fixtures
- Invented new optical films, light fixtures, projection screens, backlights and displays

Motorola Labs **Senior Physicist** *1997-2002*

- Optically designed & constructed world's first personal micro-projector (US Patent 6,637,896)
- Designed reflection and transmission micro-structured optical films for display backlights and illumination
- Designed and developed 3 new optical film products with suppliers, including an optical film with 3M which was shipped in over 100 million cellular phones
- Analyzed thermal and optical properties of products including developing new measurement techniques
- 4 issued Patents, 26 patent disclosures

ImEdge Technology Inc. **Optical Engineer** *1993-1997*

- Co-invented new methods for recording edge-lit lightguide based holograms and edge-lit devices for display illumination and biometric applications (7 issued patents)
- Modeled, recorded, and performed optical and thermal analysis of optical components and systems

EDUCATION

Ph.D. in Physics, Loughborough University (UK) 1997
Applied rigorous coupled wave diffraction theory to model and analyze recorded edge-lit holograms
BSc. in Applied Physics, Certificate in Optics, Georgia Institute of Technology 1992

Issued Patents

1) **9,566,751 Methods of forming film-based lightguides**
2) **9,557,473 Reflective spatial light modulator display with stacked lightguides and method**
3) **9,523,807 Device comprising a film-based lightguide and component with angled teeth**
4) **9,110,200 Illumination device comprising a film-based lightguide**
5) **9,103,956 Light emitting device with optical redundancy**
6) **9,028,123 Display illumination device with a film-based lightguide having stacked incident surfaces**
7) **8,958,698 Versatile remote control device and system**
8) **8,950,902 Light emitting device with light mixing within a film**
9) **8,917,962 Method of manufacturing a light input coupler and lightguide**
10) **8,905,610 Light emitting device comprising a lightguide film**
11) **CA2702600 Light emitting devices and applications thereof**
12) **CA2702690 Light emitting devices and applications thereof**
13) **CA2702685 Light emitting devices and applications thereof**
14) **8,794,812 Light emitting devices and applications thereof**
15) **8,783,898 Light emitting devices and applications thereof**
16) **8,761,565 Arcuate lightguide and light emitting device comprising the same**
17) **8,721,152 Light emitting devices and applications thereof**
18) **8,619,363 Light redirecting element comprising a forward diffracting region and a scattering region**
19) **8,434,909 Light emitting display with light mixing within a film**
20) **8,430,548 Enhanced light fixture with volumetric scattering**
21) **8,408,775 Light recycling directional control element and light emitting device using the same**
22) **8,249,408 Method of manufacturing an optical composite**
23) **8,233,803 Versatile remote control device and system**
24) **8,231,256 Light fixture comprising a multi-functional non-imaging optical component**
25) **8,177,408 Light filtering directional control element and light fixture incorporating the same**
26) **8,033,706 Lightguide comprising a low refractive index region**
27) **8,033,674 Optical components and light emitting devices comprising asymmetric scattering domains**
28) **7,991,257 Method of manufacturing an optical composite**
29) **7,914,192 Enhanced light diffusing sheet**
30) **7,784,954 Polarization sensitive light homogenizer**
31) **7,758,227 Light fixture with curved light scattering region comprising ellipsoidal domains**
32) **7,722,224 Illuminating device incorporating a high clarity scattering layer**
33) **7,542,635 Dual illumination anisotropic light emitting device**
34) **7,453,636 High contrast optical path corrected screen**
35) **7,453,635 Imaging material with improved contrast**
36) **7,431,489 Enhanced light fixture**
37) **7,408,707 Multi-region light scattering element**
38) **7,278,775 Enhanced LCD backlight**
39) **7,015,893 Photoluminescent electrophoretic display**
40) **6,861,788 Switchable display/mirror method and apparatus**
41) **6,637,896 Compact projection system and associated device**
42) **6,636,285 Reflective liquid crystal display with improved contrast**
43) **6,151,142 Grazing incidence holograms and system and method for producing the same**
44) **6,061,463 Holographic fingerprint device**
45) **5,986,746 Topographical object detection system**
46) **5,974,162 Device for forming and detecting fingerprint images with valley and ridge structure**
47) **5,822,089 Grazing incidence holograms and system and method for producing the same**
48) **5,710,645 Grazing incidence holograms and system and method for producing the same**
49) **EP0749610 Compact device for producing an image of the topological surface**

US Patent Application Publications

1) 20170045669 Light emitting device comprising a film-based lightguide and reduced cladding layer at the input surface
2) 20150253487 Reflective display comprising a frontlight with extraction features and a light redirecting optical element
3) 20150219834 Display with a film-based lightguide and light redirecting optical element
4) 20150078035 Device comprising a film-based lightguide and component with angled teeth
5) 20140360578 Solar energy system including a lightguide film
6) 20140063853 Film-based lightguide including a wrapped stack of input couplers and light emitting device including the same
7) 20140056028 Light emitting device with adjustable light output profile
8) 20140049983 Light emitting device comprising a lightguide film and aligned coupling lightguides
9) 20130314942 Packaging comprising a lightguide
10) 20130250618 Light emitting device with light mixing within a film
11) 20130208508 Light emitting device with optical redundancy
12) 20130155723 Replaceable lightguide film display
13) 20120294620 Versatile remote control device and system
14) 20120288283 Versatile remote control device and system
15) 20120287674 Illumination device comprising oriented coupling lightguides
16) 20120082461 Versatile remote control device and system
17) 20110286222 Method of manufacturing an optical composite
18) 20110277361 Sign comprising a film-based lightguide
19) 20110273906 Front illumination device comprising a film-based lightguide
20) 20110255303 Illumination device comprising a film-based lightguide
21) 20110227487 Light emitting display with light mixing within a film
22) 20110013420 Light emitting devices and applications thereof
23) 20100321953 Light emitting devices and applications thereof
24) 20100321952 Light emitting devices and applications thereof
25) 20080094854 Dual illumination anisotropic light emitting device
26) 20080043490 Enhanced Light Guide
27) 20070201246 Enhanced Light Diffusing Sheet
28) 20060290253 Enhanced Diffusing Plates, Films and Backlights
29) 20060227546 Enhanced light fixture
30) 20060215958 Enhanced electroluminescent sign
31) 20060066945 High contrast optical path corrected screen
32) 20060056166 Enhanced LCD backlight
33) 20060056022 Imaging material with improved contrast
34) 20060056021 Multi-region light scattering element
35) 20050259302 Holographic light panels and flat panel display systems and method and apparatus for making same
36) 20040245902 Switchable display/mirror method and apparatus
37) 20040151491 Apparatus and method concerning a passive multi-indicia visual position indicator
38) 20040150613 Photoluminescent electrophoretic display
39) 20030081184 Compact projection system and associated device
40) 20030081154 Reflective liquid crystal display with improved contrast
41) 20030020975 Holographic light panels and flat panel display systems and method and apparatus for making same
42) 20020001110 Holographic light panels and flat panel display systems and method and apparatus for making same

International Patent Application Publications

1) **JP2013525955** Illumination device comprising a film-based lightguide
2) **JP2013525836** Sign comprising a film-based lightguide
3) **JP2013530412** Front illumination device comprising a film-based lightguide
4) **AU2012225244** Light emitting device with adjustable light output profile
5) **CA2829388** Light emitting device with adjustable light output profile
6) **EP2683980** Light emitting device with adjustable light output profile
7) **KR20130096155** Illumination device comprising a film-based lightguide
8) **MX2012012033** Illumination device comprising a film-based lightguide
9) **MX2012012035** Sign comprising a film-based lightguide
10) **MX2012012034** Front illumination device comprising a film-based lightguide
11) **CN103038568** Front illumination device comprising a film-based lightguide
12) **CN103038567** Illumination device comprising a film-based lightguide
13) **WO2012158460** Solar energy system including a lightguide film
14) **KR20130096155** Illumination device comprising a film-based lightguide
15) **KR20130055598** Front illumination device comprising a film-based lightguide
16) **KR20130054263** Sign comprising a film-based lightguide
17) **EP2558775** Illumination device comprising a film-based lightguide
18) **EP2558893** Sign comprising a film-based lightguide
19) **EP2558776** Front illumination device comprising a film-based lightguide
20) **CN102918435** Sign comprising a film-based lightguide
21) **GB2492398** Manufacturing an optical composite using inverted light collimating surface features
22) **WO2012122511** Light emitting device with adjustable light output profile
23) **WO2012088315** Packaging comprising a lightguide
24) **WO2012068543** Light emitting device comprising a lightguide film and aligned coupling lightguides
25) **WO2012044972** Versatile remote control device, system, and method
26) **WO2012016047** Light emitting device with optical redundancy
27) **CA2796515** Sign comprising a film-based lightguide
28) **CA2796518** Illumination device comprising a film-based lightguide
29) **CA2796519** Illumination device comprising a film-based lightguide
30) **WO2011130715** Illumination device comprising a film-based lightguide
31) **WO2011130718** Front illumination device comprising a film-based lightguide
32) **WO2011130720** Sign comprising a film-based lightguide
33) **CA2702600** Light emitting devices and applications thereof
34) **CA2702685** Light emitting devices and applications thereof
35) **CA2702690** Light emitting devices and applications thereof
36) **WO2007002317** Enhanced diffusing plates, films and backlights
37) **WO2006055872** Enhanced light fixture
38) **WO2006055873** Enhanced electroluminescent sign
39) **WO2006032002** High contrast optical path corrected screen
40) **WO2006026743** Enhanced light diffusing sheet
41) **WO2006031545** Enhanced LCD backlight
42) **WO2006020583** Imaging material with improved contrast
43) **WO2006017585** Multi-region light scattering element
44) **CN1573448** Switchable display/mirror method and apparatus
45) **KR20040104427** Switchable display/mirror method and apparatus including switchable mirror with display operation mode and mirror operation mode
46) **WO2003038509** Reflective liquid crystal display with improved contrast
47) **WO2003038517** Compact projection system and associated device
48) **AT195189** Device for forming and detecting fingerprint images with valley and ridge structure

49) **JPH09509490** Device for forming and detecting fingerprint images with valley and ridge structure
50) **AU1925595** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same
51) **CA2183567** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same
52) **WO199522804** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same

Publications and Presentations

1) "LED Technology," LED Lighting Panel Discussion at Heartland Angel's "LEDs: What are they and why are they important" Chicago, IL, (2010)
2) "Challenges and opportunities for light management optics in LED lighting systems," LEDs 2008 Conference, San Diego, CA, (2008)
3) "Optically efficient displays and solid-state lighting systems using anisotropic polymer films," SID, New England Chapter, Dec. (2006)
4) "Novel high brightness LED backlight design and optimization," Mark Chu, Zane Coleman, Kurt Henrickson, Terry Yeo, Americas Display Engineering and Applications Conference, Atlanta, GA (2006)
5) "Head-mounted displays for visual communication," Zane Coleman, George Valliath, Motorola Hermes, internal conference (2000)
6) "LCD glare avoidance using a surface relief diffractive optical element," Zane Coleman, George Valliath, Motorola Publication via www.IP.com
7) "Display optical enhancement films," Zane Coleman, George Valliath, Robert Akins, Kevin Jelley" Motorola Hermes, internal conference (1999)
8) "Design of hologram for brightness enhancement in color LCDs," G.T. Valliath, Z.A. Coleman, J.L. Schindler, R. Polak, R.B. Akins, K.W. Jelley, Society for Information Display '98, Conference Proceedings Vol. 29, p. 1139, Anaheim, CA (1998)
9) "Modern holographic recording and analysis techniques applied to edge-lit holograms and their applications," Ph.D. in Physics Thesis, Loughborough University, Loughborough, England (1997)
10) "Holographic optical element for compact fingerprint imaging system", M.H. Metz, N. J. Phillips, Z. A. Coleman, C. Flatow, Optical Security and Counterfeit Deterrence Techniques, SPIE Proceedings vol. 2660, San Jose, CA (1996)
11) "Holograms in the extreme edge illumination geometry", Zane A. Coleman, Michael H. Metz, Nicholas J. Phillips, Holographic Materials II, SPIE Proceedings vol. 2688, San Jose, CA (1996)
12) "The use of edge-lit holograms for compact fingerprint capture", M. Metz, C. Flatow, Z. Coleman, N.J. Phillips, CardTec SecureTec, April 10th, (1995)
13) "Links between holography and lithography," Phillips, Nicholas J.; Barnett, Christopher A.; Wang, Ce; Coleman, Zane A., Proc. SPIE Vol. 2333, p. 206-214, Fifth International Symposium on Display Holography, Tung H. Jeong; Ed. (1995)
14) "Dichromated gelatin--some heretical comments", N.J. Phillips, R. D. Rallison, C. A. Barnett, S. R. Schicker, Z. A. Coleman, Practical Holography VII:Imaging Materials, SPIE vol. 1914, pp 101-114 (1993)
15) "Novel methods for the creation of silver-free images in holography, using conventional silver halide emulsion", N.J. Phillips, Z.A. Coleman, C. Wang, Holographic Systems, Components, and Applications, IEE Conf. Publication No 379, Neuchatel, Switzerland (1993)
16) "Holograms in the edge-illuminated geometry-new materials developments", N.J. Phillips, C. Wang, Z. Coleman, Practical Holography VII:Imaging Materials, SPIE vol. 1914, pp 75-81 (1993)

Legal Consulting

Type of Matter:	Expert in Optics
Client:	Foley and Lardner LLP
Case Name:	USPTO Patent Interference 105,972
Services provided:	Two declarations, Two-day deposition
Date:	March 2104 – September 2015

Type of Matter:	Expert in Optics
Client:	Fried, Frank, Harris, Shriver & Jacobson
Case Name:	IPR2015-01044, Mercedes-Benz v. IDT LLC
Services provided:	One Declaration
Date:	April 2015 – June 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00831, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00832, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00834, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00835, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00843, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00855, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter: Expert in Optics
Client: Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name: IPR2015-00857, Toyota Motor Corp. v IDT LLC
Services provided: One Declaration, Consulting
Date: May 2014 – May 2015

Type of Matter: Expert in Optics
Client: Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name: IPR2015-00897, Toyota Motor Corp. v IDT LLC
Services provided: One Declaration, Consulting
Date: May 2014 – May 2015

Type of Matter: Expert in Optics
Client: Steptoe & Johnson LLP
Case Name: ITC 337-TA-805, ITRI v. LG Corp.
Services provided: Non-testifying consulting
Date: Dec. 2011 – May 2013

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TECHNICAL CONSUMER PRODUCTS, INC.,
NICOR INC.,
AMAX LIGHTING,
Petitioners,

v.

LIGHTING SCIENCE GROUP CORPORATION,
Patent Owner

IPR Trial No.: Unassigned

DECLARATION OF DR. ZANE COLEMAN IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,672,518

EXHIBIT 3
WIT: Coleman
DATE: 1-17-18
S. Rocca, CSR, RMR, CRR

LIST OF EXHIBITS

Exhibit	Description
Ex. 1001	U.S. Patent No. 8,672,518
Ex. 1002	Declaration of Dr. Zane Coleman in Support of Petition for *Inter Partes* Review of U.S. Patent No. 8,672,518 ("Coleman Decl.")
Ex. 1003	Provisional Application 61/248665 ('968 Patent)
Ex. 1004	Original Application 12/775310('968 Patent)
Ex. 1005	Original claims of Application 12/775310 ('968 Patent)
Ex. 1006	Office Action ('968 Patent)
Ex. 1007	Reply to Office Action ('968 Patent)
Ex. 1008	Notice of Allowance ('968 Patent)
Ex. 1009	Notice of Allowance ('518 Patent)
Ex. 1010	U.S. Patent No. 7,670,021 ("Chou")
Ex. 1011	U.S. Patent No. 7,828,465 ("Roberge")
Ex. 1012	Roberge Provisional Appl. No. 60/916,053
Ex. 1013	U.S. Patent No. 7,980,736 ("Soderman")
Ex. 1014	U.S. Patent No. 7,722,227 ("Zhang")
Ex. 1015	U.S. Patent No. 7,993,034 ("Wegner")
Ex. 1016	Silescent S100LP2 *Installation Instructions and Cut Sheet* ("Silescent")
Ex. 1017	Declaration of Daryl Soderman in Support of Petition for *Inter Partes* Review of U.S. Patent No. 8,201,968 ("Soderman Decl.")
Ex. 1018	Reply to Office Action – November 13, 2014 ('844 Patent)
Ex. 1019	U.S. Patent Application Publication No. 2002/0113244 ("Barnett")
Ex. 1020	International Patent Application No. WO 2010/004503A1 ("Van Elmpt")
Ex. 1021	U.S. Application No. 13/476,388 (the "'388 application")
Ex. 1022	U.S. Patent No. 8,201,968 ("'968 Patent)
Ex. 1023	Progress Lighting's *Guide to Green Lighting* ("Progress Lighting Catalog")
Ex. 1024	U.S. Provisional Patent Application Ser. No. 60/979,068 ("Zhang Provisional")

I, Dr. Zane Coleman, declare as follows:

1. I am over the age of 18 and am competent to make this declaration in support of the Petition for *Inter Partes* Review of Technical Consumer Products, Inc., Nicor Inc., and Amax Lighting (collectively, "Petitioners"). The information set forth here is from my own personal knowledge. If called to testify, I could and would provide testimony regarding the substance, content, and reasons and bases for these statements.

2. I have been retained as an expert witness by Petitioners to address issues concerning the validity of U.S. Patent No. 8,672,518 ("the '518 Patent") (Ex. 1001) for the above captioned *inter partes* review. I am being compensated for my time at a rate of $400 per hour.

3. I am familiar with the technology at issue (*i.e.* LED luminaires). I am also familiar with the level of skill of a person of ordinary skill in the art with respect to the technology at issue as of October 2009. In preparing this declaration, I reviewed the '518 Patent and considered each of the documents cited below in light of my knowledge of the technology at issue. I have also reviewed Dr. Jonathan Leeper's declaration in support of Generation Brands LLC's *inter partes* review petition against the '844 Patent, IPR No. IPR2016-01546, Paper No. 2 (Ex. 1002), and I agree with Dr. Leeper's opinion about the validity of the '844 Patent. When

forming my opinions, I considered the viewpoint of a person of ordinary skill in the art as of October 2009.

QUALIFICATIONS

4. In 1992, I received a Bachelor of Science degree in Applied Physics, including a Certificate in Optics from the Georgia Institute of Technology. I received my doctorate in Physics at the Loughborough University in the United Kingdom in 1997, focusing on applied rigorous coupled wave diffraction theory to model and analyze recorded edge-lit holograms and their applications as illuminators. My analysis included modeling and measuring optical and thermal properties of illumination systems including Light Emitting Diode (LED) illumination systems.

5. From 1993-1997, I worked as an Optical Engineer at ImEdge Technology Inc. While at ImEdge Technology I conducted research for a start-up company developing holographic illumination technology which included analyzing optical and thermal performance of different recording systems and materials for illumination systems including LED based illumination systems. During this time, I also invented new methods directed to recording edge-lit holograms and edge-lit devices for display and biometric applications; responsible for seven issued patents.

6. From 1997 to 2002, I worked as a Senior Physicist for Motorola Labs. I helped optically design and construct the world's first personal micro-projector

(US Patent 6,637,896). I also designed optical films for LCDs as well as 3 new optical film products with suppliers, including an optical film with 3M, which was shipped in over 100 million cellular phones. I also analyzed thermal and optical properties of products including developing new measurement techniques. During my time at Motorola, I was also responsible for 4 issued patents and 26 patent disclosures.

7. From 2003-2005, I served as the President of Phostech, where my roles included the optical design, analysis, and invention of new diffusing films, refractive and total internal reflection (TIR) films, optical lenses, projection screens and systems, LCD backlights, lightguides, illuminated signs, head-up displays, and light fixtures.

8. From 2005-2006, I was the Manager of Optical Engineering at Fusion Optix Inc. where I helped to develop and prototype micro-replicated, multi-functional optical films, components and lenses for displays and light fixtures through optical modeling, prototyping, analysis, and specification. I designed, installed, and managed the optical film, LED backlight, and light fixture characterization lab including optical, thermal, and environmental characterization. I consulted with the product development group and contributed to the optical design, thermal design, packaging, and accessories for LED light fixtures and other products.

9. From 2006-2009, I was the VP of Technology & Director of Technology at Fusion Optix Inc. In this role, I lead the research strategy and transfer of technology to product engineering in a fast-paced small company providing innovation in the display and LED lighting industries. I also oversaw the research and development of optical films, LED backlights, and LED light fixture projects. I also co-developed a Lightfair 2009 Innovation Award-winning light fixture.

10. In 2009, I rejoined Phostech as President and am presently responsible for optical consulting and patent strategy & drafting services.

11. As noted above, I am a named inventor on forty-nine issued patents and numerous pending patent applications related to the areas of optics, optical films, LED backlights, LED light fixtures, LED light bulbs, personal micro-projectors, projection screens, and other light emitting devices. I am also a registered patent agent at the U.S. Patent and Trademark Office (Reg. No. 65,754). My curriculum vitae includes a more detailed summary of my background and experience including issued patents and publications and is attached to this declaration.

REVIEW AND USE OF DOCUMENTS

12. In forming the opinions presented in this report, I have reviewed and relied upon the following documents:

- U.S. Patent No. 8,672,518
- U.S. Patent No. 7,722,227 ("Zhang")

- U.S. Patent No. 7,980,736 ("Soderman")
- Declaration of Daryl Soderman, dated July 15, 2016 ("Soderman Decl.")
- Silescent S100 LP2 Installation Instructions and Cut Sheet ("Silescent")
- U.S. Patent No. 7,993,034 ("Wegner")
- U.S. Patent Application Publication No. 2002/0113244 ("Barnett")
- International Patent Application No. WO 2010/004503A1 ("Van Elmpt")
- Progress Lighting's *Guide to Green Lighting* ("Progress Lighting Catalog")
- U.S. Provisional Patent Application Ser. No. 60/979,068 ("Zhang Provisional")
- U.S. Patent No. 8,201,968 ("'968 Patent")

LEGAL STANDARDS

13. I am not an attorney but I am a patent agent. I have prosecuted patents for others and am therefor both familiar and well informed in aspects of patent law, particularly novelty (35 U.S.C. §102), obviousness (35 U.S.C. §103) and enablement (35 U.S.C. §112). While I understand these aspects through my patent prosecution experience, I am writing this declaration based on my expertise in optical and LED

lighting technologies. For the purposes of this declaration, I have been informed about certain aspects of the law relevant to my opinions. My understanding of the law is as follows:

14. I have been informed that a patent's claims determine the scope of the invention. How those claims are construed is a matter of law that will ultimately be determined by the Board.

15. I have been informed that, for purposes of my opinions as to the validity of the claims of the '518 Patent, I am to give the claims the broadest reasonable interpretation in light of the specification.

16. I have been informed and understand that a patent claim can be invalid as anticipated if all of the limitations of a claim are disclosed in a single reference and are arranged in a similar manner. I understand that a reference does not have to use the same terminology as the claim. I understand that a reference can anticipate a claim even if the reference discloses additional functions or components not in the claim.

17. I have been informed and understand that a patent claim can also be invalid as being obvious to a person of ordinary skill in the art at the time the application was filed. I understand this to mean that even if all of the elements of a claim are not found in a single reference, the claim is still not patentable if the differences between the subject matter disclosed in the reference and what is claimed

would have been obvious to a person of ordinary skill in the art at the time the application was filed.

18. I have been informed and understand that the determination of whether a claim would have been obvious should be based on several factors, including, among others:

- The level of ordinary skill in the art at the time the application was filed;
- The scope and content of the prior art;
- What differences, if any, existed between the claim and the prior art;
- Objective indicia of nonobviousness, such as recognition of a problem or failure of others.

19. I have been informed and understand that the teachings of two or more references may be combined in the same way as disclosed in the claims, if such a combination would have been obvious to one having ordinary skill in the art. In determining whether a combination would have been obvious, it is appropriate to consider, among other factors:

- Whether the teachings of the prior art references disclose known concepts combined in familiar ways, and when combined, would yield predictable results;
- Whether a person of ordinary skill in the art could implement a predictable variation, and would see the benefit of doing so;

- Whether the claimed elements represent one of a limited number of known design choices, and a person of ordinary skill in the art would have a reasonable expectation of success;
- Whether a person of ordinary skill in the art would have recognized a reason to combine known elements in the manner described in the claim;
- Whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent;
- Whether the innovation applies a known technique that has been used to improve a similar device or method in a similar way.

20. I understand that one of ordinary skill in the art has ordinary creativity and is not an automaton.

21. I understand that in considering obviousness, it is important not to use the benefit of hindsight (*i.e.* having the benefit of knowing the claimed invention).

LEVEL OF ORDINARY SKILL

22. A person of ordinary skill in the field of LED luminaire design as of October, 2009, would have had at least a bachelor's degree in either mechanical engineering, electrical engineering, or physics and at least 3-4 years of experience designing light fixtures.

23. At the time of the patent, I was a person of ordinary skill in the art. I had a Ph.D. degree in Physics and, in 2009, had six years of experience designing light fixtures.

24. When I refer to a person of ordinary skill in the art elsewhere in this declaration, I am referring to a person of ordinary skill in the art as of October, 2009.[1] I understand this is sometimes referred to as the "time of the invention," although I do not believe the '518 Patent represents an actual invention.

I. OVERVIEW OF THE '518 PATENT

Technology

25. Lighting fixtures come in a variety of shapes and sizes. One option is a low-profile ceiling fixture. Low-profile fixtures generally sit close to the ceiling and do not protrude substantially into the room. Low-profile fixtures are commonly constructed of metal and glass in a wide variety of forms or trims, reflecting a wide variety of aesthetic choices.

[1] I understand that the claims of the '518 Patent may not be entitled to the priority date of October 5, 2009, and that the earliest applicable priority date may be May 21, 2012 or later. My opinion about the obviousness of the claims of the '518 Patent does not materially change under either timeframe.

26. Some low-profile lighting fixtures are illuminated by light emitting diodes ("LEDs"). LEDs produce heat. That heat must be dissipated. LED is commonly dissipated by means of a heat sink – one or more pieces of thermally conductive material (*e.g.* metal) that draws heat away from the LEDs and dissipate.

27. LED fixtures are provided both as new work LED fixtures and old work, retrofit installations. In retrofit applications, the most common source of power is the female Edison socket up in the can fixture.

The '518 Patent

28. The '518 Patent generally concerns heat dissipation in a low-profile LED lighting fixture. '518 Patent at Abstract, 1:20-27. The luminaire of the '518 Patent generally includes an LED, a heat spreader, a heat sink, and an optic for focusing or diffusing light into the illuminated area. *Id.* at 1:47-53. The LED generates heat; the heat spreader transfers the heat to a heat sink; and the heat sink dissipates the heat into the air. *Id.* at 1:62-2:1. The fixture's outer trim functions as a heat sink, keeping the fixture cool with a low-profile.

29. The '518 Patent specifically pertains to a luminaire and accessory kit combination. *Id.* at 2:42-43. Here, the luminaire includes a heat spreader, heat sink, LED light source, power supply, a power supply, and an electrical power supply line. *Id.* at 2:43-48. And the accessory kit includes one or two pre-wired jumpers

configured to electrically engage with the plug-in connector of the electrical supply line. *Id.* at 2:48-59. Independent claim 1 is illustrative:

> 1. A luminaire and accessory kit in combination, the combination comprising:
> a luminaire, comprising:
> a heat spreader; a heat sink disposed in thermal communication with the heat spreader; a light source comprising a plurality of light emitting diodes (LEDs) disposed in thermal communication with the heat spreader; a power supply electrically connected to the light source;
> an electrical supply line having a first end connected to the power supply, and a second end connected to a plug-in connector; and, an optic disposed in optical communication with the LEDs; and
> an accessory kit, comprising:
> at least one of: a first pre-wired jumper comprising a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an Edison base electrically connected at the other end; and, a second pre-wired jumper comprising a pair of insulated electrical wires having a second plug-in connector electrically connected at one end and cut wire ends at the other end;
> wherein the plug-in connector of the first pre-wired jumper and the second pre-wired jumper are each configured to electrically engage with the plug-in connector of the electrical supply line.

Id. at Claim 1. Figures 11 and 12 of the '518 Patent illustrate an embodiment of the luminaire:

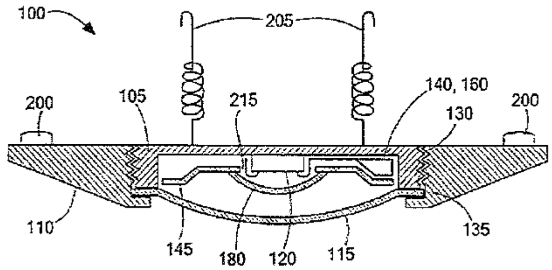


FIG. 12

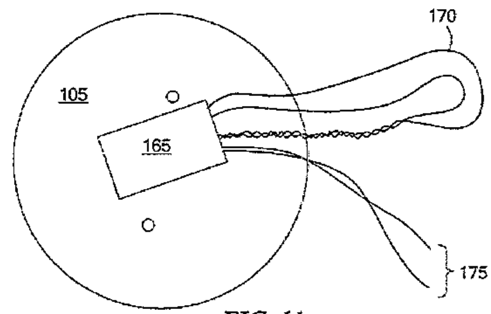


FIG. 11

Id. at Figs. 11, 12. As shown in Figure 12, the LED light source 120 is in thermal communication with the heat spreader 105. The heat spreader 105 transfers heat to heat sink 110. An outer optic 115 spans the heat spreader 105. *See generally id.* at 5:37-44. Figure 11 shows a power conditioner 165 mounted on the top of the heat spreader 105 to supply voltage to the LEDs 120. The power conditioner 165 is configured to fit at least partially within the interior space of a nominally sized light can fixture or nominally sized junction box.[2]

Figure 31 illustrates an embodiment of the accessory kit:

[2] Figure 12 shows the alternative embodiment of placing the power conditioner 140 or 160 on the underside of the heat spreader.

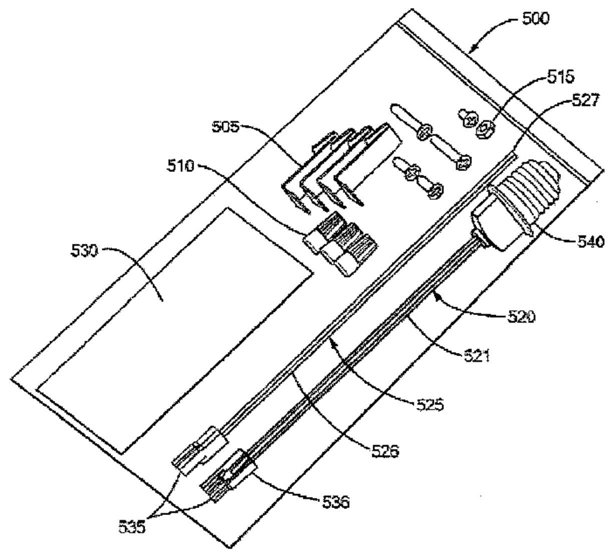


FIG. 31

As shown in Figure 31, the wire pair 521 of the first pre-wired jumper 520 electronically connects with the Edison base 540. *Id.* at 11:1-5. Here, the pre-connected Edison base simplifies installation in a can-type light fixture that already has an Edison screw receptacle pre-wired in place. *Id.* at 11:16-19. Whereas, in a J-box retrofit arrangement, open wire ends 527 of second pre-wired jumper 525 are pigtailed on to twist-on wire connectors 510, and appropriately sized hardware 515 may be used to secure the luminaire to the J-box via pre-formed mounting holes. *Id.* at 11:19-24. Further, the accessory kit may contain springs 505 to secure the luminaire and to deflect and slidably engage with an interior surface of a can-type light fixture. *Id.* at 11:27-30, 60-65.

II. OVERVIEW OF THE PRIOR ART

30. As set forth below, several prior art references accomplish exactly the same goal in exactly the same manner as the '518 Patent: dissipating heat from a low-profile LED fixture by using the fixture's own trim or periphery as a heat sink.

A. Overview of Soderman

31. U.S. Pat. No. 7,980,736 ("*Soderman*") (Ex. 1013), which issued on July 19, 2011 upon an application filed November 13, 2007, likewise discloses a low-profile ceiling fixture that dissipates heat to the surrounding air via a ring-shaped trim. Soderman at Figs. 1, 5. An illustration of the Soderman fixture is as follows:

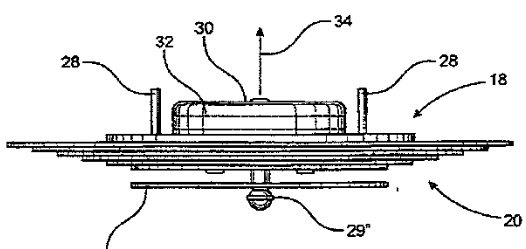


FIG. 1

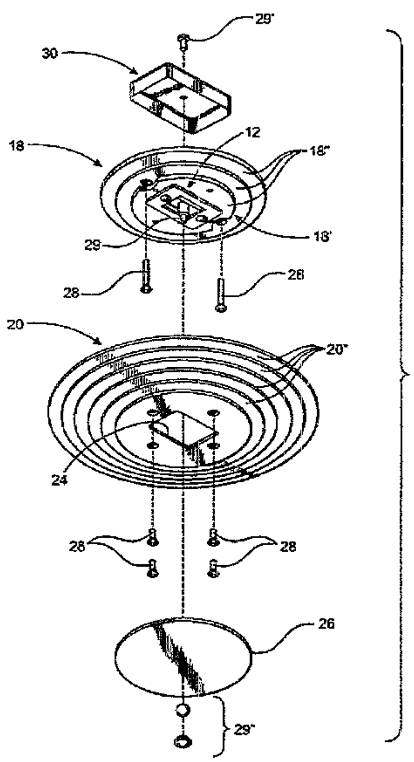


FIG. 5

Soderman at Figs. 1 and 5.

32. Soderman dissipates LED heat as follows: The LEDs 14 in the illumination assembly 12 are attached to the lower surface of a mounting assembly 18. *Id.* at 3:5-22, 6:14-17, 6:38-45, 8:5-10, Figs. 1, 5, 6. Heat generated by the LEDs spreads through the mounting assembly out to a surrounding cover 20.*Id.* at 7:36-41. The cover is ring-shaped; it is round with a hole through the middle. *Id.* at Fig. 5 (20), 7:43-46. It is made of thermally conductive material. *Id.* at 6:49-59, 7:11-24. The cover dissipates the heat into the surrounding air. *Id.* at 6:38-45, 7:37-41.

B. Overview of Zhang

33. U.S. Pat. No. 7,722,227 ("Zhang") (Ex. 1014), which issued on May 25, 2010 upon an application filed on October 10, 2008 claiming priority to provisional application 60/979068, filed on October 10, 2007, likewise discloses a low-profile ceiling fixture that dissipates heat to the surrounding air via a ring-shaped trim. Zhang at 1. An illustration of Zhang is as follows:

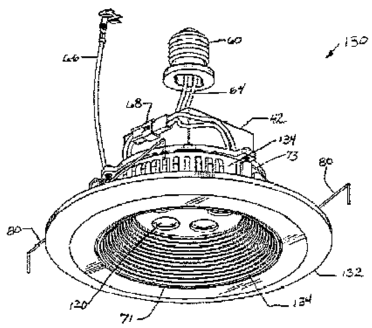


FIG. 10

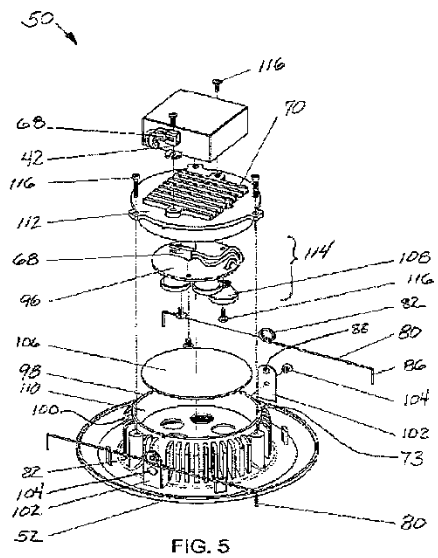


FIG. 5

Zhang at Figs. 5 and 10.

34. Zhang dissipates heat as follows. The LEDs and a driver are mounted onto a thermally-conductive "trim cup" (112) at the top of the fixture. *Id.* at 8:10-12, 9:44-48. The trim cup spreads the LED-generated heat to a peripherally surrounding baffle/heat sink/trim combination (98, 100, 52). *Id.* 7:63- 8:1, 9:37-47, Fig. 5. The baffle/heat sink/trim combination is shaped like a top hat. The trim portion of the top hat is ring-shaped. *Id.* at Fig 5 (item 52). The trim portion dissipates the heat into the air. *Id.* at 7:9-13, 7:31-34.

C. Overview of Wegner

35. U.S. Patent No. 7,993,034 ("Wegner") (Ex. 1015), filed on September 22, 2008, discloses an LED luminaire with an Edison base adaptor for mounting the

luminaire into an existing recessed can light fixture. Wegner at Fig. 14-16. An illustration of Wegner is as follows:

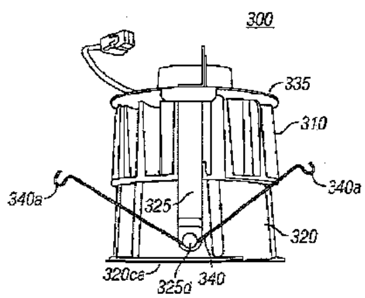


FIG. 6

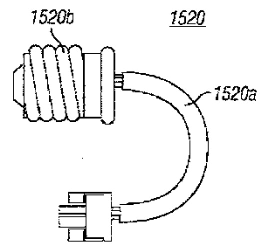


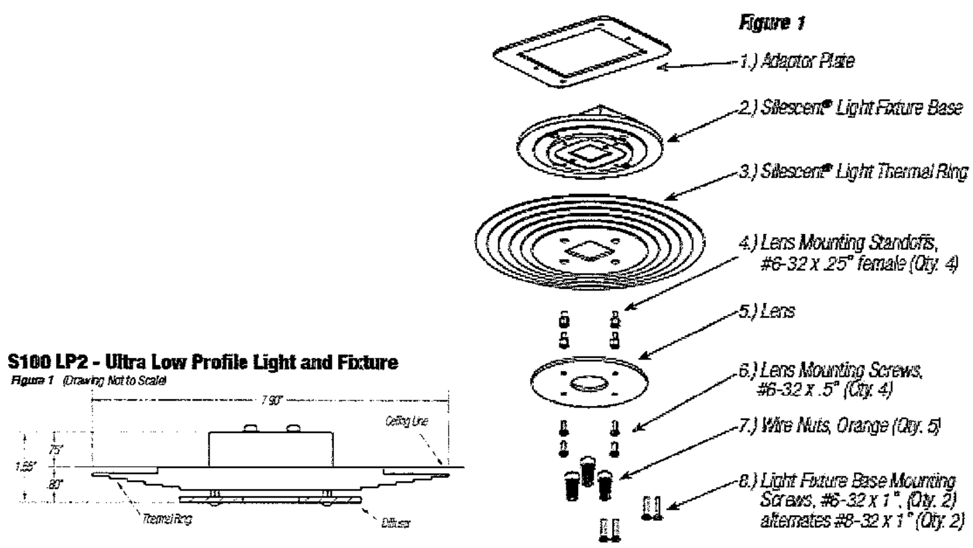
FIG. 16

Wegner at 10 (Fig. 15 and 16).

36. For purposes of the Petition, the relevant portion of Wegner is the adaptor kit 1520 comprising a plug-in connector 1520c at one end and a screw-in Edison plug 1520b at the other end. *Id.* 10:46-60. The plug-in connector 1520c connects to a corresponding connector on the Wegner fixture, and the Edison plug 1520b screws into the existing light socket. *Id.* at 10:40-44; *see also* Fig. 14.

D. Overview of Silescent S100 LP2

37. The Silescent S100 LP2 Installation Instructions and Cut Sheet (Ex. 1016) (collectively "Silescent"), publicly distributed on or before June 2009, likewise discloses a low-profile ceiling fixture that dissipates heat to the surrounding air via a ring-shaped trim. *See* Decl. of Daryl Soderman in Support of Petition for IPR of U.S Pat. No. 8,201,968 ("Soderman Decl.") ¶3 (Ex. 1017). Illustrations of Silescent are as follows:



Silescent at 2 (Fig. 1) and 3 (Fig. 1).

38. Silescent is substantially identical to Soderman's preferred embodiment because Silescent is a commercial embodiment of Soderman. Soderman Decl. at ¶6 (Mr. Soderman is the co-founder of Silescent Corp.). The Silescent product literature adds two details that are implied but not expressly disclosed in the Soderman patent. First, Silescent includes actual dimensions: 0.8" (H) by 7.9" (W), a ratio of 0.101. *Id.* at 2. Second, Silescent discloses an AC/DC power conditioner that fits into "Any UL Approved Junction Box." *Id.* at 4, Figs. 3, 5.

E. Barnett

39. U.S. Patent Application Publication No. 2002/0113244 (Ex. 1019), published on August 22, 2002, discloses an LED package made up of an anode, a cathode, an LED die, a lens, and a viscous or silicone material to fill the cavity

defined by the lens, the cathode, and the anode. Barnett at Abstract. An illustration of Barnett is as follows:

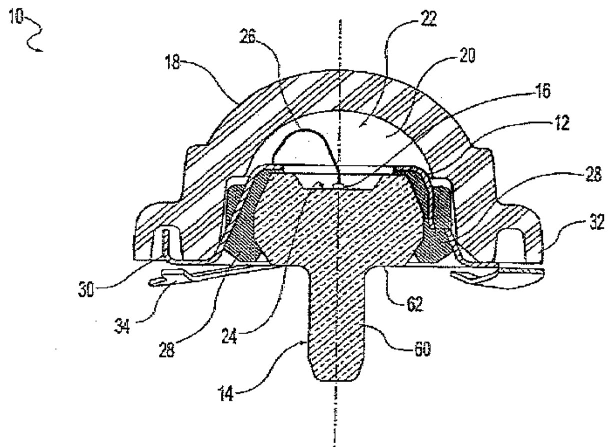


Fig. 1A

Id. at Fig. 1A. For the purposes of this Petition, the relevant portion of Barnett is the mounting mechanism to mechanically couple the LED package to the anode: a "socket, *bayonet*, or screwing like fashion." *Id.* at Abstract (emphasis added).

F. Van Elmpt

40. International Patent Publication No. WO 2010/004503A1 (Ex. 1020), published on January 14, 2010,[3] generally discloses a light output device comprising a heat sink, a substrate containing a light emitting element, and an optic. Van Elmpt at Abstract. An illustration of Van Elmpt is as follows:

[3] *Supra* note 1.

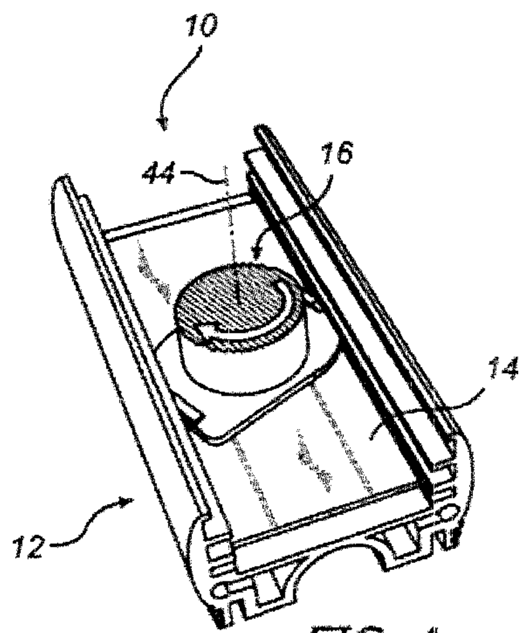


FIG. 4a

Id. at Ex. 1020. Most pertinently, Van Elmpt discloses that the optic is mounted to the heat sink via a bayonet type mechanism. *Id.* at Abstract; p.2, ll.4-18; Figs. 3A, 4A.

III. SUMMARY OF SPECIFIC GROUNDS FOR PETITION

Ground	Reference(s)	Basis	Claims
1	Rendered Obvious by Soderman in light of Wegner	§103	1, 3, 6-8, 11, 12, 14
2	Rendered Obvious by Soderman in light of Wegner and Silescent	§103	4, 5, 13
3	Rendered Obvious by Soderman in light of Barnett and/or Van Elmpt	§103	10
4	Rendered Obvious by Zhang in light of Wegner	§103	1, 3, 5-8, 11, 12, 14
5	Rendered Obvious by Zhang in light of Wegner and Silescent	§103	4, 13
6	Rendered Obvious by Zhang in light of Barnett and/or Van Elmpt	§103	10

IV. GROUND 1: CLAIMS 1, 3, 6-8, 11, 12, AND 14 ARE RENDERED OBVIOUS BY SODERMAN IN LIGHT OF WEGNER

41. While Soderman itself does not include every single element in claims 1, 3, 6-8, 11, 12, and 14 arranged as in the claims, Soderman combined with Wegner does. The combination would have been obvious to a person of ordinary skill in the art.

Claim 1

1. *"a heat spreader; a heat sink disposed in thermal communication with the heat spreader"*

42. Soderman discloses a luminaire comprising a heat spreader and a heat sink. With respect to the heat spreader, Soderman teaches that the "[LED] illumination assembly 12" transfers heat to "mounting assembly 18." Soderman at 6:22-31, Fig. 5; *see also id.* at 7:36-38 ("[T]he heat being removed from the illumination assembly 12 is transferred there from, through the mounting assembly 18."). "The mounting assembly 18 may be formed from a metallic or other material which facilitates the conductivity or transfer of heat." *Id.* at 6:34-36. "Such confronting engagement between the illumination assembly 12 and the mounting assembly 18 ... facilitates the transfer and dissipation of heat." *Id.* at 6:39-44, *see also id.* at Fig. 5(18). Mounting assembly 18 is thus a heat spreader, transferring heat away from the LED illumination assembly 12. *Id.* at Fig. 3.

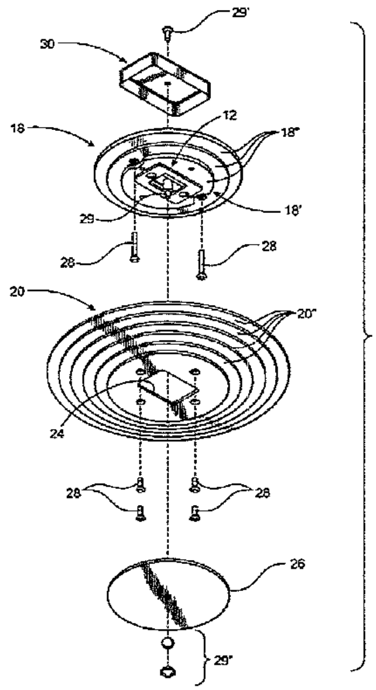


FIG. 5

43. With respect to the "heat sink," Soderman discloses a "cover structure 20" made of a "heat conductive material" that conducts heat from the heat spreader out to the air. *Id.* at 6:53, Fig. 5 (20), Fig 6 (20). Soderman states: "As such, heat is transferred from the illumination assembly 12 through the mounting assembly 18 and to the cover structure 20 for eventual dissipation to the surrounding area." *Id.* at 8:31-34, 7:36-41 (similar).

44. Soderman's ring-shaped heat sink is in thermal communication with an outer periphery of the heat spreader. *See id.* at Fig. 3 (showing the heat sink/cover 20 disposed around the outside of heat spreader/assembly 18).

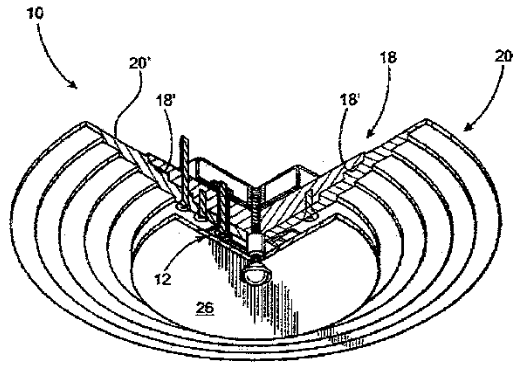


FIG. 3

Id. at Fig. 3. Soderman further discloses the coupling at the outer periphery of the mounting assembly (*i.e.* the boundary between the mounting assembly and cover). The heat sink/cover is "disposed in substantially continuous confronting engagement" around the mounting assembly." *Id.* at 6:64-65; s*ee also id.* at 7:4 (cover "mating" with corresponding assembly surfaces). As explained above, the cover is made of thermally conductive material, *id.* at 6:53, and draws heat from the mounting assembly (*i.e.* heat spreader). *Id.* at 8:31-34; *accord id.* at 7:36-41. It is therefore in thermal communication with the outer periphery of the heat spreader.

2. *"a light source comprising a plurality of light emitting diodes (LEDs) disposed in thermal communication with the heat spreader"*

45. Soderman discloses LEDs disposed in thermal communication with the heat spreader. Soderman states: "an illumination assembly generally indicated as 12 comprising one or more light emitting diodes 14." *Id.* at 6:14-17. These LEDs are mounted on the heat spreader/mounting assembly 18, *see* Fig. 5 (12), in "heat

transferring relation" to the heat spreader. *Id.* at 8:26-28; *see also id.* at Fig. 5 (12), Fig. 6 (12, 14).

3. *"a power supply electrically connected to the light source; an electrical supply line having a first end connected to the power supply, and a second end connected to a plug-in connector"*

46. Soderman discloses "an appropriate source of electrical energy." *E.g.*, *Id.* at 8:53-55. Figure 1 of Soderman represents such a source as labeled with the number 34 in Figure 1:

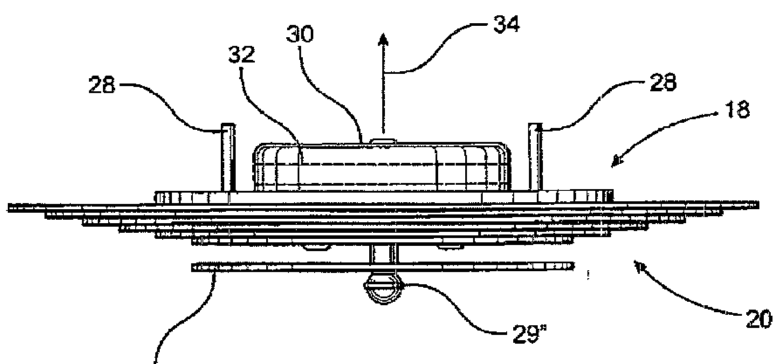


FIG. 1

Id. at Figure 1.

47. Next, Soderman discloses "conductors [that] interconnect the one or more connectors 42 with the source of electrical energy 34." *Id.* at 9:8-10, Figure 7.

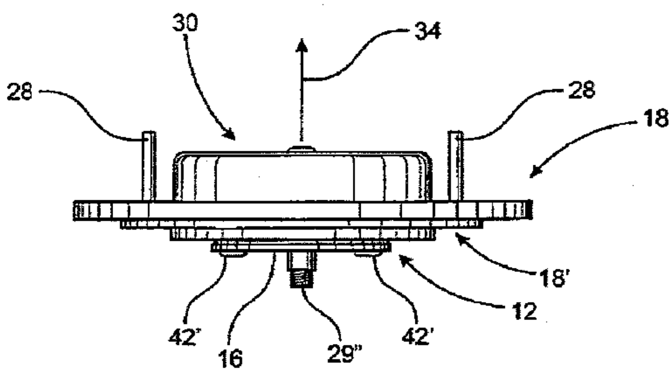


FIG. 7

Id. at Figure 7. Soderman further elaborates that "the specific wiring configurations which serve to interconnect the source of electrical energy 34 and the conductive material connectors 42 may take many forms and is therefore not shown, for purposes of clarity." *Id.* at 9:10-14, Figure 7.

4. ***"an optic disposed in optical communication with the LEDs"***

48. Soderman discloses an optic in optical communication with the LEDs. *See id.* at Fig. 3 (26). Soderman discloses "a light shield 26 which may be formed of a transparent and/or translucent material," *id.* at 7:54-61, affixed to a bolt, 29", *see* Fig. 6 (29"), Fig. 7 (29"), which is in optical communication with the LEDs.

5. ***"pre-wired jumper comprising a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an Edison base electrically connected at the other***

opposing end . . . configured to electrically engage with the plug-in connector of the electrical supply line"[4]

49. Although Soderman does not disclose an accessory kit, it would have been obvious to a POSITA to include one. Soderman already notes the need for power to operate the LEDs. *See id.* at 9:2-8 (electrical current flows from power source to LEDs). And in retrofit applications, the most common source of power is the female Edison socket up in the can fixture. A POSITA would therefore be motivated to place a male Edison base on the electrical interconnection (*i.e.* wires) 34 emanating from the top of Soderman fixture 10 in order to engage and couple with that source of power (*i.e.* the existing female Edison socket in the can). *Id.* This way, Soderman could more easily be deployed in both new (box) *and* retrofit (can) environments. *Id.* A POSITA would have been further motivated to add a connector between the Edison base and the fixture so that device could be easily installed into the existing can socket; only the jumper would need to be screwed/turned. *Id.*

Indeed, this is exactly what is shown in Wegner:

[4] In the interest of readability, we have not reproduced the entire claim element. *See* '518 Patent at Claim 1.

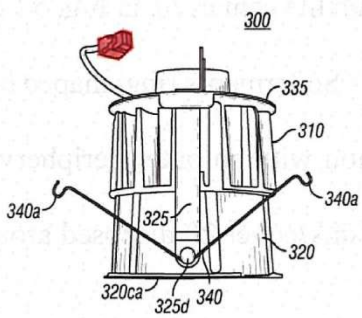


FIG. 6

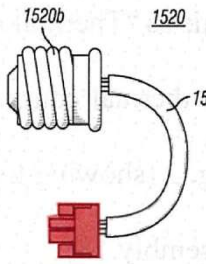


FIG. 16

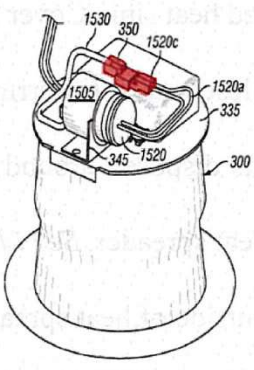


FIG. 15

Wegner at Figs. 6, 15, and 16 (highlighting added). Wegner teaches an adaptor kit 1520 comprising a plug-in connector 1520c at one end and a screw-in Edison plug 1520b at the other end. *Id.* at 10:46-60. The plug-in connector 1520c connects to a corresponding connector on the Wegner fixture, and the Edison plug 1520b screws into the existing light socket. *Id.* at 10:40-44; *see also* Fig. 14. Employing the accessory kit shown in Wegner would have yielded the predictable result of an adjustable height, more-easily-installed version of Soderman suitable for retrofit installation into existing cans.

50. Thus, Claim 1 of the '518 Patent is rendered obvious over Soderman in light of Wegner.

Claim 3

51. Dependent Claim 3 is further limited by "the heat sink is substantially ring-shaped, and is disposed around and coupled to an outer periphery of the heat spreader." '518 Patent at Claim 3. As discussed above, Soderman teaches a ring-

shaped heat sink. Cover 20 is round with a hole through the center. *Id.* at Fig. 5 (20); *cf.* Silescent at 2 (referring to this as "Thermal Ring").[5] Soderman's ring-shaped heat sink is disposed around and in thermal communication with an outer periphery of the heat spreader. *See id.* at Fig. 3 (showing the heat sink/cover 20 disposed around the outside of heat spreader/assembly 18).

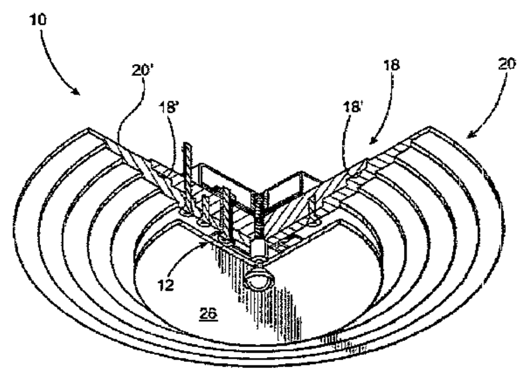


FIG. 3

[5] Silescent describes the commercial embodiment of Soderman. Soderman Decl. ¶6 (Mr. Soderman is the co-founder of Silescent Corp). *Compare* Soderman at Fig. 5 and 6:60-7:1 (referring to "cover 20") *with* Silescent at 2 (noting "Thermal Ring" options); Silescent at Fig. 5 (corresponding component called the "Light Fixture Ring").

Soderman at Fig. 3. This heat sink is disposed around the perimeter of the mounting assembly 18, specifically around the vertical risers 18'. Fig. 5 (18').[6] Soderman further discloses the coupling at the outer periphery of the mounting assembly (*i.e.* the boundary between the mounting assembly and cover). The heat sink/cover is "disposed in substantially continuous confronting engagement" around the mounting assembly." *Id.* at 6:64-65; s*ee also id.* at 7:4 (cover "mating" with corresponding assembly surfaces).[7] The heat sink is mechanically coupled to the

[6] The figures distinguish between the vertical perimeter 18' of each disc comprising the mounting assembly 18, on the one hand, and the flat surface 18" constituting the perimeter of each disc, on the other. *See* Fig. 5 (showing both the 18' vertical surface and the 18" horizontal surface), Fig. 6 (same). Under the broadest reasonable interpretation, either surface constitutes a perimeter of the mounting assembly. We focus on the vertical surface 18' for simplicity's sake. *Cf. also* '518 Patent at Fig. 12 (likewise showing the heat sink disposed around *and* overlapping the heat spreader).

[7] Notably, the overlap between the horizontal surfaces of the mounting assembly and the cover does not prevent Soderman from meeting the "disposed around" element. The '518 Patent uses the term to describe a heat sink that overlaps a portion of the heat spreader. *See* '518 patent at Fig. 12 (lower-most portion of inner periphery of heat sink 110 overlaps outer periphery of heat sink 105). Requiring that the heat

mounting assembly via a series of connectors. *Id.* at Fig. 5 (28), 8:1-5 (discussing connectors). As explained above, the cover is made of thermally conductive material, *id.* at 6:53, and draws heat from the mounting assembly (*i.e.* heat spreader). *Id.* at 8:31-34; *accord id.* at 7:36-41. It is therefore in thermal communication with the outer periphery of the heat spreader.

52. Thus, Claim 3 of the '518 Patent is rendered obvious over Soderman in light of Wegner.

Claim 6

53. Dependent Claim 6 is further limited by "the LEDs are disposed on the heat spreader, the heat spreader being configured to dissipate heat from the LEDs." '518 Patent at Claim 6. For dependent claim 6, Soderman discloses LEDs disposed on, and in thermal communication with, the heat spreader. Soderman states: "an illumination assembly generally indicated as 12 comprising one or more light emitting diodes 14." Soderman at 6:14-17. These LEDs are mounted on the heat spreader/mounting assembly 18, *see* Fig. 5 (12), in "heat transferring relation" to the heat spreader. *Id.* at 8:26-28; *see also id.* at Fig. 5 (12), Fig. 6 (12, 14). The heat

sink and heat spreader not overlap to any degree would read out one of the preferred embodiments of claim 1. Such a reading of the claim is "rarely, if ever, correct." *MBO Labs., Inc. v. Becton, Dickinson & Co.*, 474 F.3d 1323, 1333 (Fed. Cir. 2007).

sink (*i.e.* cover) then draws the LED heat away from the heat spreader. *Id.* at 8:31-34, 7:36-41.

Claim 7

54. Dependent Claim 7 is further limited by "the accessory kit further comprises a set of springs, each spring having a first portion configured to securely engage with the luminaire, and a second portion configured to deflect and slidably engage with an interior surface of a can-type light fixture." '518 Patent at Claim 7. Although Soderman does not disclose springs to secure a luminaire, it would have been obvious to a POSITA to include them in the accessory kit in light of Wegner. Wegner generally teaches that "[a] typical recessed light fixture includes hanger bars fastened to a spaced-apart ceiling support joists." Wegner at 1:44-46. Wegner also teaches that "[a] plaster frame extends between the hanger bars and includes an aperture configured to receive a lamp housing or 'can' fixture." *Id.* at 1:46-48.

55. Wegner further discloses that "one or more screws, nails, snaps, clips, pins, and/or other fastening devices known to a person of ordinary skill in the art" could be used to couple a bracket to the heat sink of a luminaire. *Id.* at 9:27-30. As a more specific embodiment, Wegner discloses torsion springs that are inserted inside slots in the can of a light fixture. *Id.* at 9:22-27.

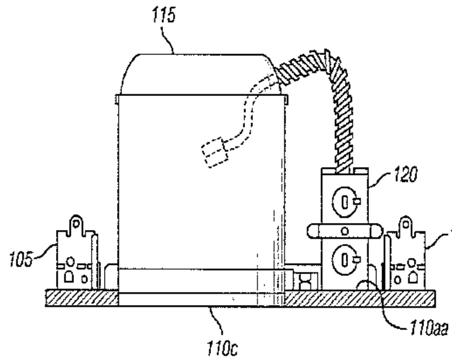


FIG. 2

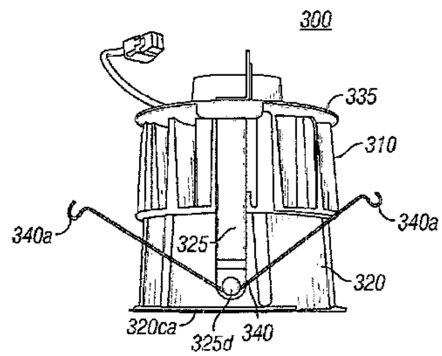


FIG. 6

Id. at Figs. 2, 6. As shown in Figures 2 and 6, torsion springs 340 are inserted inside corresponding slots in the can 115 of the fixture via bracket ends 340a. *Id.* at 9:35-37, Figures 2 & 6. Moreover, Wegner also teaches that the LED module 300 is installed by squeezing the bracket ends 340a together, sliding the module into the can, and then releasing the bracket ends 340a such that they enter the slots. *Id.* at 9:37-41, 10:61-67. A person of ordinary skill in the art would have been motivated to include the springs because they are a very common method for installing fixtures into cans because they provide a quick and easy (tool-less) way to insert the light fixture into the can that provides support and allows for easy removal.

Claim 8

56. Dependent claim 8 is further limited by "each spring of the set of springs is formed from flat stock spring steel." '518 Patent at Claim 8. While Soderman and Wegner do not disclose springs made of "flat stock spring steel," a person of ordinary skill in the art would know that flat stock spring steel is a

commonly used material to make such springs. A person of ordinary skill in the art, therefore, would be motivated to use springs formed of flat stock spring steel. *Id.* Furthermore, as exemplified by the Progress Lighting Catalog, LED lighting retrofit fixtures were known to use similar flat steel springs:

See Progress Lighting Catalog at p.63. The steel springs shown in the figures above are comparable to the formed springs 505 made of "flat stock spring steel" that are taught in the '518 Patent:

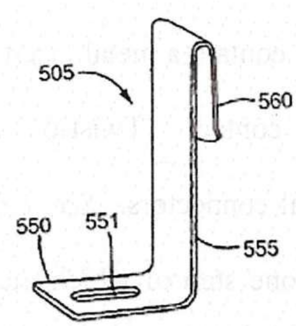


FIG. 32

'518 Patent at Fig. 32; *see also id.* at 11:26-37.

Claim 11

57. Dependent claim 11 further limits the luminaire of claim 1 by "the optic is securely retained relative to at least one of the heat spreader and the heat sink." '518 Patent at claim 11. Soderman discloses an optic securely retained relative to the heat sink. Soderman at Fig. 3 (26). Soderman discloses "a light shield 26 which may be formed of a transparent and/or translucent material," which is itself bolted to the heat spreader 18. *Id.* at 7:54-61, affixed to a bolt, 29", *see* Fig. 6 (29"), Fig. 7 (29").

Claim 12

58. Dependent claim 12 further limits the accessory kit of claim 1 by "at least one twist-on wire connector." '518 Patent at Claim 12. According to the '518 Patent, the twist-on wire connectors are used to pigtail the wire ends of the second pre-wired jumper to pre-existing wire ends in the junction box. *Id.* at 11:19-22. Twist-on wire connectors contain a metal insert to maintain electrical continuity in the twisted wire-to-wire contact. Twist-on wire connectors are an extremely common type of electrical connectors. *See, e.g.*, Silescent at Fig. 1 (teaching the installation of a fixture, one step of which includes connecting protruding wires using wire nuts). While Wegner does not expressly disclose twist-on wire connectors, it generally discloses the use of connectors to connect the various modules of the fixture. Wegner at 10:46-50, 11:8-19. A POSA, therefore, would be

motivated to implement twist-on wire connectors based on general knowledge and common practice in the art as well as the disclosures in Wegner.

Claim 14

59. Dependent Claim 14 further limits the luminaire of Claim 1 by "a reflector disposed in optical communication with the LEDs and the optic such that light emitted from the LEDs is reflected by the reflector toward the optic." '518 Patent at Claim 14. While Soderman does not disclose a reflector, Wegner discloses the limitation: "A reflector housing [that] can be mounted substantially around the LED package." Wegner at 2:41-42. Wegner also states that the "[T]he reflector housing can be configured to receive a reflector…" *Id.* at 2:43-45. Wegner further discloses that "reflector can be composed of any material for reflecting, refracting, transmitting, or diffusing light from the LED package." *Id.* at 2:48-50. Wegner also discloses that the reflector can have different configurations such as "a cross-sectional profile of the reflector [having] a substantially bell-shaped geometry that includes a smooth curve comprising an inflection point." *Id.* at 2:52-56. Next, Wegner discloses "[a]n optic coupler [that] can be mounted to the reflector housing, for covering electrical connections at the substrate of the LED package and/or for guiding or reflecting light emitted by the LED package." *Id.* at 2:62-65. Wegner further explains that "the optic coupler can include a member with a central channel that is aligned with one or more of the LEDs of the LED package such that the

channel guides light emitted by the LEDs while portions of the member around the channel cover the electrical connections at the substrate of the LED package." *Id.* at 2:65-3:3. A person of ordinary skill in the art would have been motivated to include the reflector because wide angle light from the LED would otherwise be significantly absorbed by the housing between the LED and the optic. Also, the reflector can focus the light from the LED into more narrow angles (spot illumination) as opposed to wide angles (flood illumination) for the light fixture.

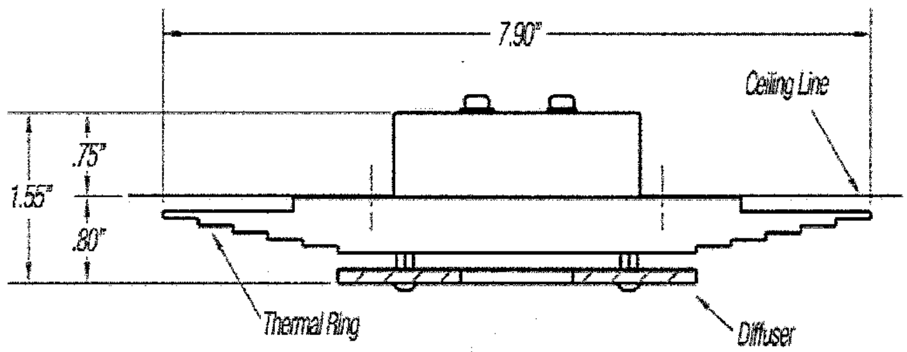
60. Thus, it would have been obvious to modify Soderman in light of Wegner to arrive at the subject matter covered in Claims 1, 3, 6-8, 11, 12, and 14.

V. GROUND 2: CLAIMS 4, 5, AND 13 ARE RENDERED OBVIOUS BY SODERMAN IN LIGHT OF WEGNER AND SILESCENT

Claim 4

61. Dependent claim 4 is further limited by "the heat spreader, the heat sink and the optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25." '518 Patent at Claim 4. While Soderman and Wegner do not expressly disclose the dimensions of the heat spreader, the heat sink and the outer optic, it would have been obvious to a POSITA to implement Soderman and Wegner using the dimensions disclosed in Silescent (as indeed occurred at the time) since Silescent is a commercial embodiment of Soderman. Soderman Decl. at ¶6. Silescent discloses a height

(including mounting assembly, cover, and light shield) of 0.80 inches and a diameter of 7.90 inches:



Silescent at Fig. 1. The H/D ratio is thus 0.101. *Id.* It would have been obvious to a POSITA to use these dimensions to implement Soderman and Wegner, yielding the predictable result of a low-profile fixture with a H/D ratio less than 0.25.

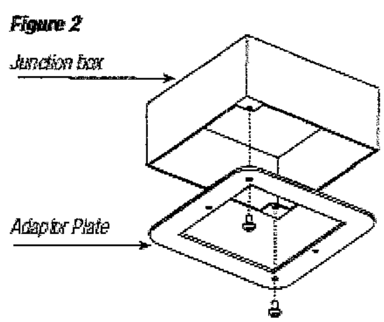
Claim 5

62. Dependent claim 5 is further limited by "the heat spreader, the heat sink and the optic, in combination, are so dimensioned as to cover: an opening defined by a nominally sized four-inch can light fixture; and, an opening defined by a nominally sized four-inch electrical junction box." '518 Patent at Claim 5. While Soderman does not expressly disclose the dimensions of the heat spreader, the heat sink and the outer optic, it would have been obvious to a POSITA to implement Soderman using the dimensions disclosed in Silescent (as indeed occurred at the time) since Silescent is a commercial embodiment of Soderman. Soderman Decl. at

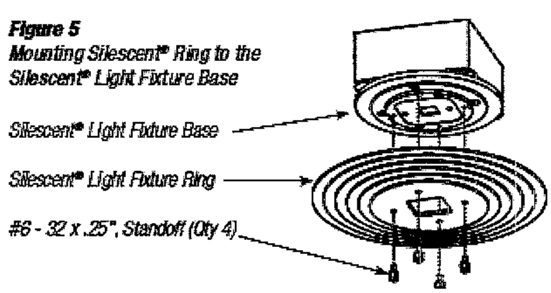
¶6. Silescent discloses a diameter of 7.90 inches. Silescent at Fig. 1. Implementing Silescent with a 7.90" diameter would have yielded the predictable result of covering a 4-inch box or a 4-inch can.

Claim 13

63. Dependent Claim 13 further limits the accessory kit of claim 1 by "at least one fastener configured to secure the luminaire to an electrical junction box." '518 Patent at Claim 13. Silescent teaches this limitation. Specifically, Figure 2 shows the use of fasteners to secure an adaptor plate to a junction box:



Silescent at Fig. 2. And Figure 5 shows the use of fasteners to secure the light fixture base and ring to the junction box:



Id. at Fig. 5. A POSITA would be motivated, at least based on Silescent's teaching, to include in the accessory kit a fastener to secure the luminaire to the junction box. Use of fasteners is one of the commonest means to mechanically secure components of a light fixture assembly, as taught in Silescent, *see also* Soderman at 8:1-7, Fig. (29, 29', 29")), and a POSITA would be motivated to choose it as one from among a number of finite, available options in the art for mechanical securement.

VI. GROUND 3: CLAIM 10 IS RENDERED OBVIOUS BY SODERMAN IN LIGHT OF BARNETT AND/OR VAN ELMPT

64. Dependent Claim 10 is further limited by the following:

> the heat spreader and the heat sink in combination define a base, wherein the base comprises engagement openings, wherein the optic comprises engagement tabs, wherein the optic is securely retained by the base by inserting respective ones of the engagement tabs into respective ones of the engagement openings and rotating the optic relative to a cylindrical axis of the base such that a portion of each engagement tab is securely retained by respective portions of the base.

'518 Patent at Claim 10. Claim 10 discloses a common bayonet style fastening mechanism to retain the optic to the heat sink. While Soderman does not disclose this limitation, Barnett does:

> The lens 18 further comprises protrusions 32, which may be lens feet, that allow the LED package 10 to be removeably secured in a coupling device 36 of the mounting device 54 in a socket like fashion, where the feet 32 are biased against the coupling device 36 via flexible extensions 34 extending from a peripheral portion of the anode 12.

Barnett at [0037].

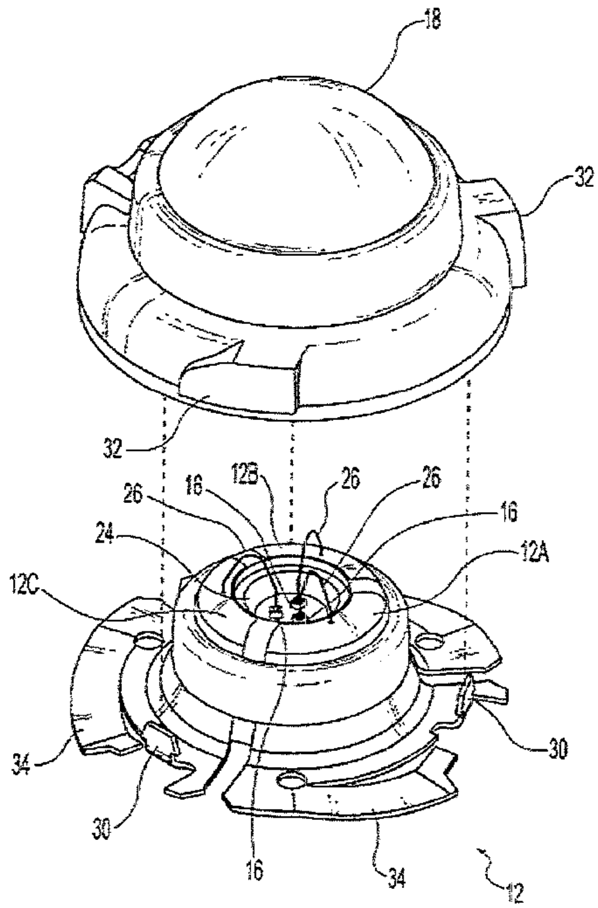


Fig. 7

Id. at Fig. 7. The protrusions 32 (engagement tabs) of Barnett are inserted into openings (engagement openings) in the anode[8] 12 and rotated under the flexible extensions 34 of the anode 12. The engagement openings in the anode 12 are formed

[8] The anode is a heat spreader that transfers heat to the liquid crystal polymer 28 to provide heat sinking. *See* Barnett at [0047].

by folding a portion of the metal anode (corresponding to the coupling devices 30) upward as shown in Fig. 4. *Id.* at Fig. 4. The rotation is about a central axis of the lens and the anode 12 due to the locations of the feet and the extensions along the circumference of the optic and the anode, respectively. A POSITA would be motivated, at least based on Barnett's teaching, to incorporate the claimed arrangement of engagement tabs and openings (also known as a bayonet-type coupling system) to secure the optic to the heat spreader/heat sink combination. The bayonet style of fastening has tabs on the perimeter of the side of the optic facing the LED. Thus, when a bayonet style of fastening is used, the attachment mechanism (such as the protruding cap 29'' of the attachment assembly of Soderman) on the outer side of the optic (away from the LED) could be made invisible, and the outer side of the optic (light shield 26 in Soderman) is uniform and has more surface area for optical functionality. Furthermore, by using openings in the heat spreader or heat sink and protrusions in the optic (bayonet style fastening mechanism), the optic can provide pressure against the LED package, circuit board, or heat spreader for it to be in close thermal contact and increase thermal coupling. Also, by adding the bayonet style of fastening of Barnett in the light fixture of Soderman, portions of the attachment assembly 29'' are not needed. In summary, a POSITA would be motivated to use the bayonet style fastening mechanism of Barnett to eliminate visibility of the attachment mechanism, make the optic (light shield) more uniform with more area for optical functionality, increase thermal coupling, and eliminate loose components.

65. Alternatively, Van Elmpt discloses a collimating optical component 16 with a cylindrical outer body portion 30 and a base plate 36 facing the base portion 18 of the heat sink 12. Van Elmpt at 4:3-9, Fig. 4a.

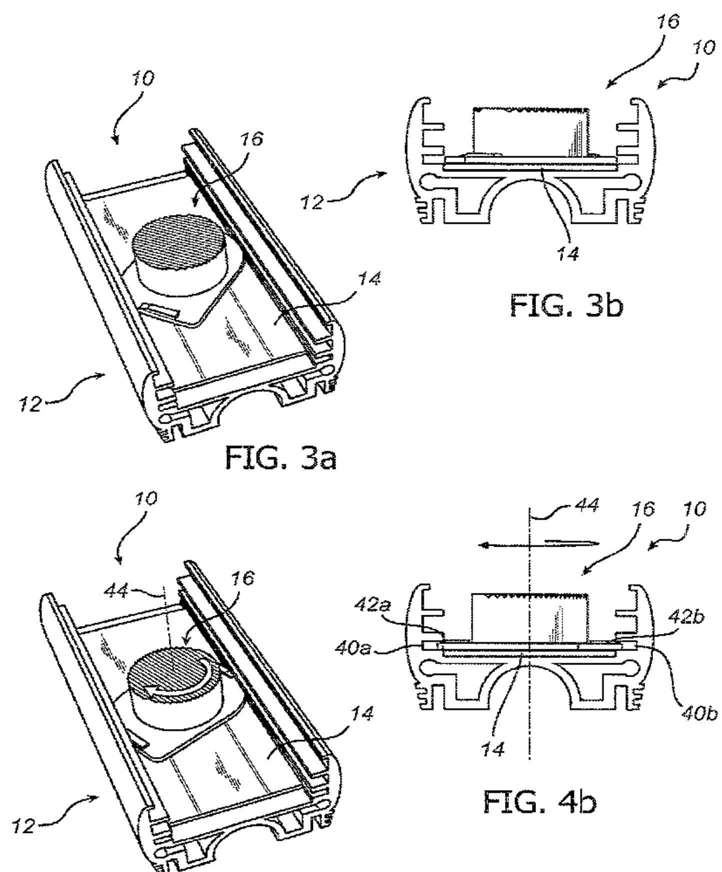


FIG. 3a

FIG. 3b

FIG. 4a

FIG. 4b

Id. at Figs. 3a, 3b, 4a, 4b. The optical component 16 is "introduced, e.g. from above, into the space between the wall portions 20a, 22b of the heat sink." *Id.* at 5:18-19. The protruding portions of the base plate (engagement tabs) are inserted through this space (engagement opening) and also through the openings 22a, 22b of the heat sink 12. When the optical component 16 is rotated around a central axis 44 of the optical component 16, portions of the "base plate 36 are received in the grooves 22a, 22b, whereby the optical element 16 is locked in the heat sink 12." *Id.* at 2:12-15, 5:23-24, 5:27:32, Fig. 4a.

66. As discussed above regarding claim 1, Soderman includes light shield 26 (optic) in optical communication with the LEDs that are disposed in thermal communication with the heat spreader/heat sink. A POSITA would have been motivated to use the bayonet-style fastening mechanism disclosed in Van Elmpt to secure the optic to the heat sink because such an arrangement "ensures thermal contact" and can be "advantageously carried out without having to use flexible elements, or screws, glue or other additional components." *Id.* at p.2, ll.8-10. As discussed above for Barnett, a POSITA would be motivated to use the bayonet style fastening mechanism of Van Elmpt to eliminate visibility of the attachment mechanism, make the optic (light shield) more uniform with more area for optical functionality, and eliminate loose components.

67. Thus, Claim 10 is obvious over Soderman in light of Barnett and/or Van Elmpt.

VII. GROUND 4: CLAIMS 1, 3, 5-8, 11, 12, AND 14 ARE RENDERED OBVIOUS BY ZHANG IN LIGHT OF WEGNER

While Zhang itself does not include every single element in claims 1, 3, 5-8, 11, 12, and 14 arranged as in the claims, Zhang combined with Wegner does.

Claim 1

1. ***"a heat spreader; a heat sink disposed in thermal communication with the heat spreader"***

68. Zhang discloses a heat spreader and a heat sink. With respect to the heat spreader, Zhang teaches that the LEDs (which are mounted on a printed circuit board) are located on the bottom of trim cup 112. Zhang at 9:46-48; Fig. 5 (LED PCB 96, trim cup 112). The trim cup is made of thermally conductive material. *Id.* at 8:37-38 ("single piece of cast aluminum"), 9:44-48 (trim cup made of "single piece of … thermally conductive material"). "[T]rim cup 72 is attached to the frustoconical shaped baffle 54 to effect heat transfer from the LED trim cup to the baffle drawing heat away from the LED trim cup…." *Id.* at 12:43-48. Trim cup 72 is, therefore, a heat spreader as recited in the '518 Patent. *Id.* at 12:43-48.

69. With regard to the heat sink, Zhang discloses a "trim unit" comprising a trim ring 52, a baffle 54 with a "low profile" heat sink 56. *Id.* at 3:6-18, 4:23-39. *See also id.* at Figs. 1 (trim unit 38), 1A (same), 3 (identifying the baffle, heat sink and trim ring as portions of fixture frame). "[T]he trim ring 52 and integrated baffle and heat sink 54 are formed as a single piece of cast aluminum." *Id.* at 8:34-36, *see also id.* at 8:58-61 ("baffle, integrated heat sink and trim ring … are formed of …

thermally conductive metal."). *cf. id.* at 7:3 ("the trim unit [38] *includes* a trim ring 44") (emphasis added).

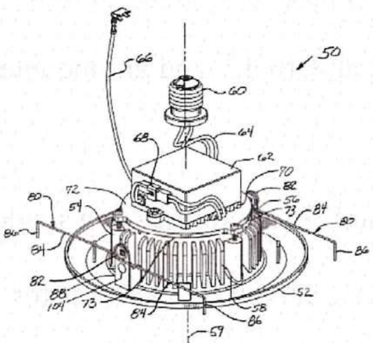


FIG. 3

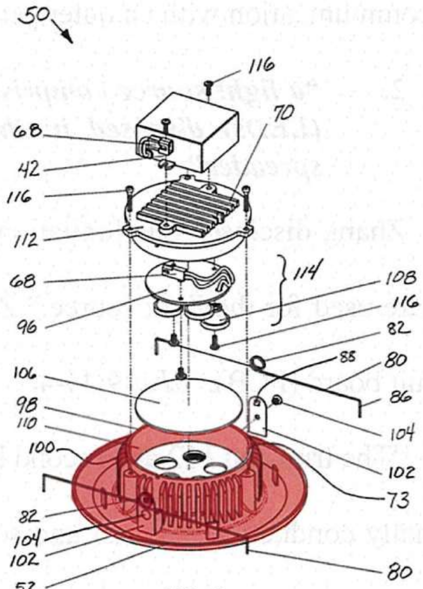


FIG. 5

Id. at Figs. 3 and 5 (highlighting added). The heat sink and baffle are "used to draw heat from the light sources 57 mounted within the baffle." *Id.* at 7:65-8:1; *see also id.* at Fig. 3 (54, 56). The trim ring portion, in turn, "draw[s] heat away from the trim unit 38 and conduct[s] it to the room 47 for dissipation." *Id.* at 7:8-13. Thus, the integrated trim unit (consisting of trim ring 52, baffle 54, and heat sink 56 portions) dissipates LED heat into the room. *See id.* While its constituent portions are given separate labels, the integrated aluminum "trim unit" is a "heat sink" as recited in the '518 Patent.

70. The interior perimeter of the baffle cavity (*i.e.* the upper portion of the integrated trim unit) surrounds the exterior perimeter of the bottom of the trim cup

on which the LEDs are mounted. *See id.* at Fig. 5 (96, 110, 112). The baffle draws heat away from the trim cup. *Id.* at 7:65-8:1. The heat sink (*i.e.* trim unit) is therefore in thermal communication with an outer periphery of the heat spreader.

2. *"a light source comprising a plurality of light emitting diodes (LEDs) disposed in thermal communication with the heat spreader"*

71. Zhang discloses this limitation. A "plurality of light emitting diodes (LEDs) 57 are used for the light source," Zhang at 8:10-12, and are mounted on a printed circuit board (PCB). *Id* at 9:44-48.

72. "The trim cup 112 and second heat sink 70 are formed as a single piece of … thermally conductive material and serve as a mounting platform for the … LED printed circuit board 96 and the LEDs." *Id.* at 9:44-48. The trim cup transfers heat from the LEDs to the baffle. *Id.* at 12:43-48. The heat then flows from the baffle down to the trim ring, where it is dissipated into the room. *Id.* at 7:8-13.

3. *"a power supply electrically connected to the light source; an electrical supply line having a first end connected to the power supply, and a second end connected to a plug-in connector"*

73. Again, Zhang discloses this limitation. "A light socket adapter 60 [may be used] to provide power for light source operation, although other means may also be used." Zhang at 8:22-24. "A drive unit 62 is wired 64 to the adapter and processes the received electrical energy for use by the light sources 57." Zhang at 8:24-26.

Figures 2 and 3, below are taken from Zhang and provide a bottom and top perspective of the trim unit 50.

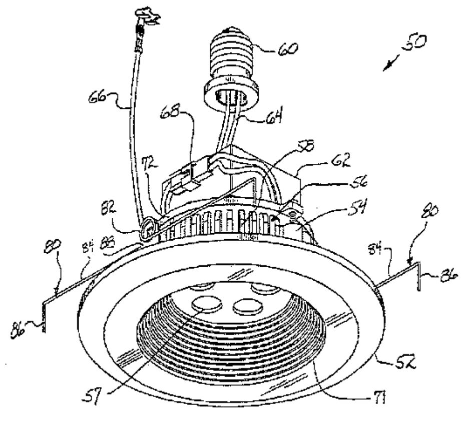


FIG. 2

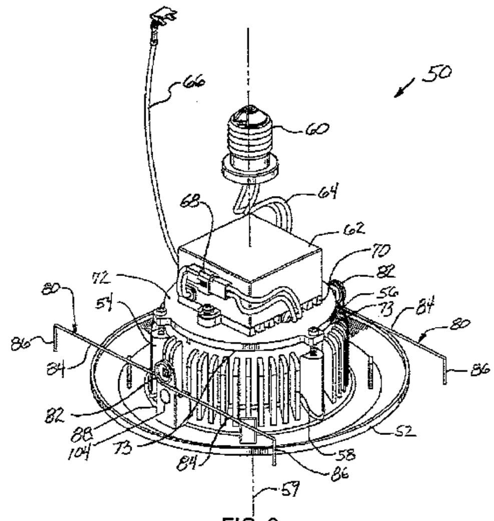


FIG. 3

Zhang at Figs. 2, 3.

4. ***"an optic disposed in optical communication with the LEDs"***

74. Zhang discloses this limitation. "A tempered glass plate 106" is "disposed in the cavity of the baffle 98 below the LED light sources …" Zhang at 9:41-44. This glass plate 106, "in optical communication with the LEDs," passes the LED light into the room. *Id.* at 9:41-44, Fig. 5 (glass plate 106, LED lens 108), Fig. 8 (LEDs 120). Zhang also discloses that lenses 108 (optic) are located over the LEDs and over the printed circuit board. *Id.* at 12:4-7, 9:43-44. A person of ordinary skill in the art would understand that various other plates, such as plastic diffusing lenses could be substituted for the "glass plate" in order to achieve different aesthetic properties (to achieve a diffuse area light source as opposed to bright spot light

sources, for example) or smoothing or making the light output more uniform through the use of a diffuse lens or cover.

75. Wegner also teaches that a reflector housing is configured to receive a reflector (optic) "composed of a material for reflecting, refracting, transmitting, or diffusing light emitted by the LED package 305. The term 'reflector' is used herein to refer to any material configured to serve as an optic in a light fixture, including any material configured to reflect, refract, transmit, or diffuse light." Wegner at 8:33-39. Thus, the term "reflector" as used by Wegner also encompasses traditional lenses or covers that refract or diffuse light.

5. *"pre-wired jumper comprising a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an Edison base electrically connected at the other opposing end . . . configured to electrically engage with the plug-in connector of the electrical supply line"*[9]

76. It would have been obvious to a person of ordinary skill in the art to modify Zhang such that it included an accessory kit comprised of a "pre-wired jumper comprising a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an Edison base electrically connected at the other opposing end" to electrically connect the fixture to an Edison

[9] In the interest of readability, we have not reproduced the entire claim element. *See* '518 Patent at claim 1.

socket. *See* '518 Patent at Claim 1. Indeed, Zhang nearly includes the entire kit already. Zhang would require only one modification: inserting a connector set somewhere along the line 64 connecting the fixture 50 to Edison base 60.[10]

77. Zhang already discloses an Edison adaptor connected to a power conditioner via an electrical supply line. "Power is provided to the LED lights directly from a light socket adaptor 60 through the wires 64." *Id.* 9:11-12; *accord id.* at 8:22-26. The wires 64 connect to the driver (*i.e.* power conditioner) via a connector 68. *Id.* at Fig. 3 (wires 64, driver 62, adaptor 60, connector 68).

[10] A jump wire, or jumper, refers to a short electrical wire used to connect electrical components. A jumper typically consists of insulated wires with a connector on each end. The connectors vary depending on what is being connected. In lighting fixtures, jumpers are used to connect a fixture to the power source.

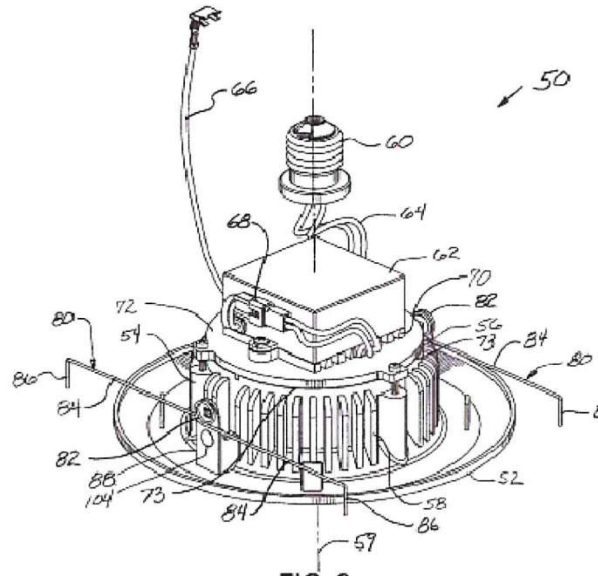


FIG. 3

Id. at Fig. 3. The existing combination of wires 64 and Edison base 60 could be turned into an "accessory kit" by inserting a male/female connector pair along the path of wires 64. Wegner explicitly teaches this:

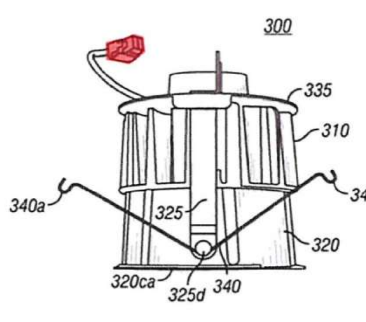


FIG. 6

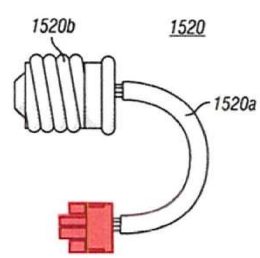


FIG. 16

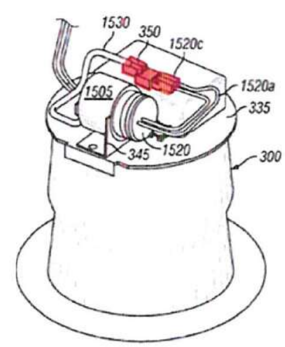


FIG. 15

Wegner at Figs. 6, 15, and 16 (highlighting added). Wegner teaches an adaptor kit 1520 comprising a plug-in connector 1520c at one end and a screw-in Edison plug 1520b at the other end. *Id.* at 10:46-60. A person of ordinary skill in the art would have understood that the wires 1520a are insulated. The Edison adaptor is meant to be installed in an electrical circuit by a human hand. Leaving bare wires would invite a dangerous shock. Bare wires would also lead to a risk of a short-circuit once the circuit is energized. Furthermore, a person of ordinary skill in the art would understand that the plug connector is also sometimes called a quick connect. It allows electrical components to be connected quickly and easily by detachably connecting electrical wiring via small plastic clips. The connector is configured to engage in a plug-in connector on an electrical supply line. Wegner at Fig. 15 (plug connectors 350); *id.* at 10:46-50 ("the person can plug one or more quick-connect or plug connectors 350 from the driver 315 into the Edison base adaptor 1520").

78. In short, a person of ordinary skill in the art would have understood that including a connector such as that disclosed in Wegner on wire 64 (*i.e.* making it an Edison jumper) would have made Zhang's non-detachable Edison base 60 detachable, and thus easier to install. Using an Edison jumper (as opposed to a hardwired Edison adaptor) would allow a person installing the fixture to screw in the Edison adapter without having to hold the entire fixture. The installer could just screw in the adaptor and, once that is in place, the fixture can be connected via the plug-in connectors and then secured in place itself. Such a combination would be desirable and obvious.

79. Thus, Claim 1 of the '518 Patent is obvious over Zhang in light of Wegner.

Claim 3

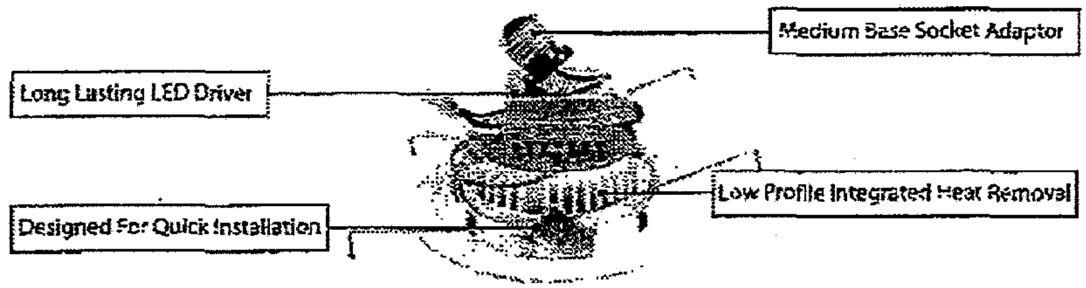
80. Dependent claim 3 is limited by "the heat sink is substantially ring-shaped, and is disposed around and coupled to an outer periphery of the heat spreader." '518 Patent at Claim 3. Zhang discloses the limitation. The perimeter of the trim unit in Zhang is circular. Zhang at Fig. 3 (52, 54, 56). There is a hole in the middle. *Id.* at Fig. 2 (recess into which light sources 57 mounted). It is *substantially* ring-shaped.

81. The interior perimeter of the baffle cavity (*i.e.* the upper portion of the integrated trim unit) surrounds the exterior perimeter of the bottom of the trim cup on which the LEDs are mounted. *See id.* at Fig. 5 (96, 110, 112). The baffle draws heat away from the trim cup. *Id.* at 7:65-8:1. The heat sink (*i.e.* trim unit) is therefore coupled to an outer periphery of the heat spreader.

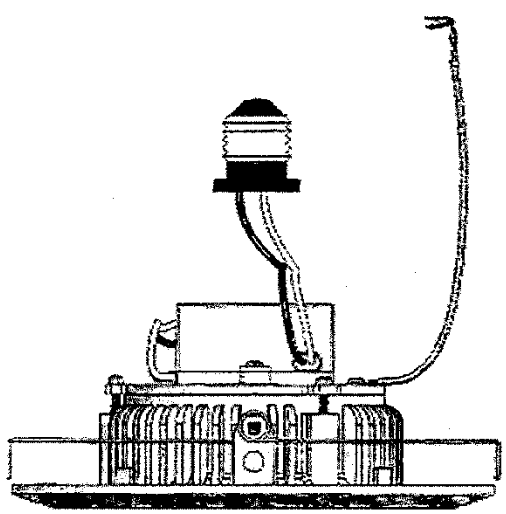
Claim 5

82. Dependent claim 5 is further limited by "the heat spreader, the heat sink and the optic, in combination, are so dimensioned as to cover: an opening defined by a nominally sized four-inch can light fixture; and, an opening defined by a nominally sized four-inch electrical junction box." '518 Patent at Claim 5. While Zhang does not expressly disclose dimensions, the Zhang provisional application,

which is incorporated by reference into the non-provisional specification, Zhang at 1:7-11, provides explicit reference that the fixture could be a 6" LED Shower Trim and come in 4" Trim or 6" trim for 4" or 6" recessed housings as shown below.



SKU#	DESCRIPTIONS	WHITE	BRUSHED NICKEL
901-093	4" GIMBAL TRIM	√	
770-582	4" GIMBAL TRIM		√
772-756	6" GIMBAL TRIM	√	
772-743	6" SHOWER TRIM	√	



6" LED SHOWER TRIM

Zhang Provisional at pp. 17, 19, 20.

83. Furthermore, it would have been obvious to a POSITA to implement Zhang so as to cover a four-inch can or four-inch junction box. Zhang already teaches covering the ceiling opening: "torsion springs 80 … pull[] and hold[] the trim unit up in the housing with the trim ring 44 held against the outer side of 46 of the surface 30." Zhang at 7:46-50; *see also id.* at Fig. 1A (trim ring 44 covering the opening 32), 6:64-67. A POSITA would understand, as noted above, the Zhang could be scaled (if necessary) to fit into and thus cover a range of sizes, including 4-inch junction box or 4-inch can. As to motivation, 4-inch cans and 4-inch junction boxes were widely used and scaling Zhang would allow a POSITA to serve more of the market for lighting fixtures.

Claim 6

84. Dependent claim 6 is further limited by "the LEDs are disposed on the heat spreader, the heat spreader being configured to dissipate heat from the LEDs." '518 Patent at Claim 6. Zhang discloses this limitation. A "plurality of light emitting diodes (LEDs) 57 are used for the light source," Zhang at 8:10-12, and are mounted on a printed circuit board (PCB). *Id* at 9:44-48. "The trim cup 112 and second heat sink 70 are formed as a single piece of … thermally conductive material and serve as a mounting platform for the … LED printed circuit board 96 and the LEDs." *Id.* at 9:44-48. As discussed above in the context of Claim 1, the "trim cup" of Zhang

is the heat spreader. Further, the trim cup transfers heat to the baffle. *Id.* at 12:43-48. The heat then flows from the baffle down to the trim ring, where it is dissipated into the room. *Id.* at 7:8-13.

Claim 7

85. Dependent claim 7 is further limited by "the accessory kit further comprises a set of springs, each spring having a first portion configured to securely engage with the luminaire, and a second portion configured to deflect and slidably engage with an interior surface of a can-type light fixture." '518 Patent at Claim 7. Zhang generally discloses torsion springs to securely engage a luminaire: "[T]orsion springs 80 are fit into openings in the housing in an interlocking manner resulting in the force of the spring pulling and holding the trim unit up in the housing with the trim ring 44 held against the outer side 46 of the surface." Zhang at 7:46-50. Wegner also generally teaches that "[a] typical recessed light fixture includes hanger bars fastened to a spaced-apart ceiling support joists." Wegner at 1:44-46. Wegner also teaches that "[a] plaster frame extends between the hanger bars and includes an aperture configured to receive a lamp housing or 'can' fixture." *Id.* at 1:46-48.

86. Wegner further discloses that "one or more screws, nails, snaps, clips, pins, and/or other fastening devices known to a person of ordinary skill in the art" could be used to couple a bracket to the heat sink of a luminaire. *Id.* at 9:27-30. As

a more specific embodiment, Wegner discloses torsion springs that are inserted inside slots in the can of a light fixture. *Id.* at 9:22-27.

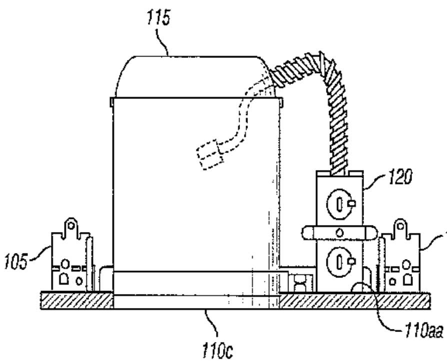


FIG. 2

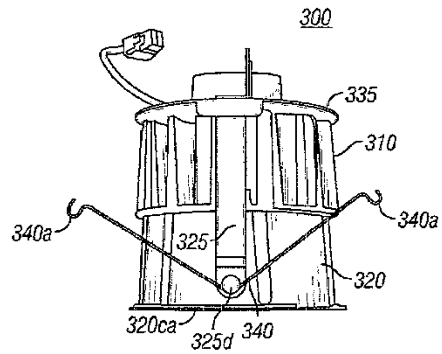


FIG. 6

Id. at Figs. 2, 6. As shown in Figures 2 and 6, torsion springs 340 are inserted inside corresponding slots in the can 115 of the fixture via bracket ends 340a. *Id.* at 9:35-37, Figs. 2, 6. Moreover, Wegner also teaches that the LED module 300 is installed by squeezing the bracket ends 340a together, sliding the module into the can, and then releasing the bracket ends 340a such that they enter the slots. *Id.* at 9:37-41, 10:61-67. A person of ordinary skill in the art would have been motivated to include the springs because they are a very common method for installing fixtures into cans because they provide a quick and easy (tool-less) way to insert the light fixture into the can that provides support and allows for easy removal.

Claim 8

87. Dependent claim 8 is further limited by "each spring of the set of springs is formed from flat stock spring steel." '518 Patent at Claim 8. While Zhang

and Wegner do not disclose springs made of "flat stock spring steel," a person of ordinary skill in the art would know that flat stock spring steel is a commonly used material to make such springs. A person of ordinary skill in the art, therefore, would be motivated to use springs formed of flat stock spring steel. *Id.* Furthermore, as exemplified by the Progress Lighting Catalog, LED lighting retrofit fixtures were known to use similar flat steel springs:

See Progress Lighting Catalog at p.63. The steel springs shown in the figures above are comparable to the formed springs 505 made of "flat stock spring steel" that are taught in the '518 Patent.

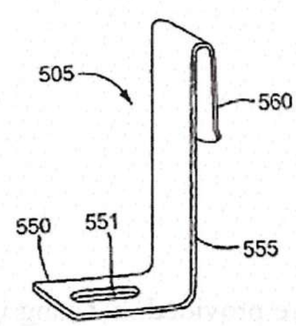


FIG. 32

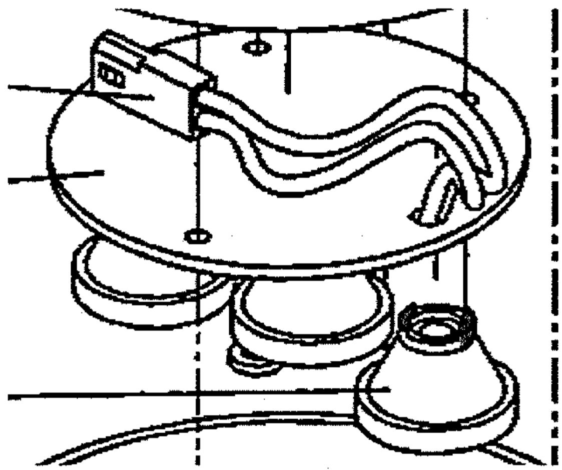
'518 Patent at Fig. 32; *see also id.* at 11:26-37.

Claim 11

88. Dependent claim 11 further limits the luminaire of claim 1 by "the optic is securely retained relative to at least one of the heat spreader and the heat sink." '518 Patent at Claim 11. Zhang discloses an outer optic secured relative to the heat sink or heat spreader. As discussed with regard to claim 1, the tempered glass plate 106 located below the LEDs is an outer optic. Zhang at 9:41-44; Fig. 5 (glass plate 106); The glass plate rests on the divider within the baffle cavity. *Id.* at Fig. 5 (cavity 110). When the fixture is fully assembled, the glass plate is secured in a fixed position relative to the trim cup, *i.e.*, heat spreader. *See id.*

89. As discussed above for Claim 1, the lenses 108 are located over the LEDs and circuit board. *Id.* at 12:4-7. The lenses contain attachment tabs to snap into an optics mount on the circuit board such as is commonly done with lenses over LEDs. The tabs (equivalent to those in Zhang Fig. 5(108)) are shown highlighted in red in a portion of a figure from Zhang Provisional:[11]

[11] The portion of the figure provided in Zhang Provisional is shown here for better clarity.



Zhang Provisional at 10 (highlights added).

90. The lenses 108 are secured to the circuit board 106 and the circuit board 106 is attached ("securely retained") to the trim cup (heat spreader) 112 via screws 116. *Id.* at 5:27-28 Fig. 5 *Id.* at 9:31-32 (similar).

Claim 12

91. Dependent claim 12 is further limits the accessory kit of claim 1 by "at least one twist-on wire connector." '518 Patent at Claim 12. According to the '518 Patent, the twist-on wire connectors are used to pigtail the wire ends of the second pre-wired jumper to pre-existing wire ends in the junction box. *Id.* at 11:19-22. Twist-on wire connectors contain a metal insert to maintain electrical continuity in the twisted wire-to-wire contact. Twist-on wire connectors are an extremely common type of electrical connectors. While Wegner does not expressly disclose twist-on wire connectors, it generally discloses the use of connectors to connect the various modules of the fixture. Wegner at 10:46-50, 11:8-19. A POSA, therefore,

would be motivated to implement twist-on wire connectors based on general knowledge and common practice in the art as well as the disclosures in Wegner.

Claim 14

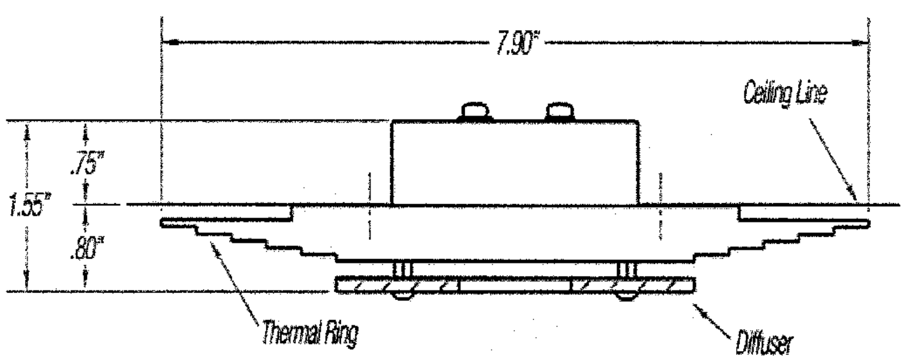
92. Dependent claim 14 is further limited by "a reflector disposed in optical communication with the LEDs and the optic such that light emitted from the LEDs is reflected by the reflector toward the optic." '518 Patent at Claim 14. Wegner discloses this limitation: "A reflector housing [that] can be mounted substantially around the LED package." Wegner at 2:41-42. Wegner further discloses that "reflector can be composed of any material for reflecting, refracting, transmitting, or diffusing light from the LED package." *Id.* at 2:48-50. Wegner also discloses that the reflector can have different configurations such as "a cross-sectional profile of the reflector [having] a substantially bell-shaped geometry that includes a smooth curve comprising an inflection point." *Id.* at 2:52-56. Next, Wegner discloses "[a]n optic coupler [that] can be mounted to the reflector housing, for covering electrical connections at the substrate of the LED package and/or for guiding or reflecting light emitted by the LED package." *Id.* at 2:62-65. Wegner further explains that "the optic coupler can include a member with a central channel that is aligned with one or more of the LEDs of the LED package such that the channel guides light emitted by the LEDs while portions of the member around the channel cover the electrical connections at the substrate of the LED package." *Id.* at 2:65-3:3.

93. It would have been obvious to modify Zhang to include a reflector such as the one disclosed in Wegner. A person of ordinary skill in the art would have been motivated to include the reflector because wide angle light from the LED would otherwise be significantly absorbed by the housing. Also, the reflector can focus the light from the LED into more narrow angles (spot illumination) as opposed to wide angles (flood illumination) for the light fixture.

VIII. GROUND 5: CLAIMS 4 AND 13 ARE RENDERED OBVIOUS BY ZHANG IN LIGHT OF WEGNER AND SILESCENT

Claim 4

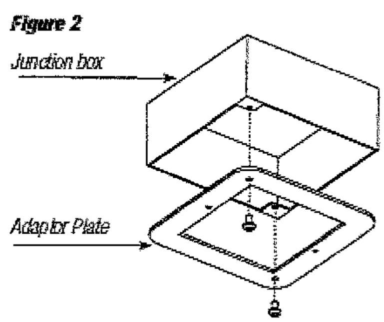
94. While Zhang and Wegner do not expressly disclose the dimensions of the heat spreader, the heat sink and the outer optic, it would have been obvious to a POSITA to implement Zhang and Wegner using the dimensions disclosed in Silescent. Silescent is a commercial embodiment of Soderman. Soderman Decl. at ¶6. Silescent discloses a height (including mounting assembly, cover, and light shield) of 0.80 inches and a diameter of 7.90 inches:



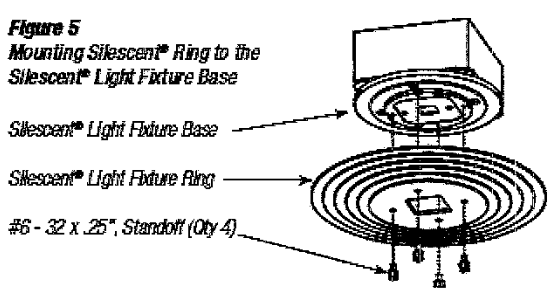
Silescent at Fig. 1. The H/D ratio is thus 0.101. *Id.* It would have been obvious to a POSITA to use these dimensions to implement Zhang and Wegner, yielding the predictable result of a low-profile fixture with a H/D ratio less than 0.25.

Claim 13

95. Dependent Claim 13 further limits the accessory kit of claim 1 by "at least one fastener configured to secure the luminaire to an electrical junction box." '518 Patent at Claim 13. Silescent teaches this limitation. Specifically, Figure 2 shows the use of fasteners to secure an adaptor plate to a junction box:



Silescent at Fig. 2. And Figure 5 shows the use of fasteners to secure the light fixture base and ring to the junction box:



Id. at Fig. 5. A POSITA would be motivated, at least based on Silescent's teaching, to include in the accessory kit a fastener to secure the luminaire to the junction box. Use of fasteners is one of the commonest means to mechanically secure components of a light fixture assembly, as taught in Silescent, *see also* Soderman at 8:1-7 and Fig. 5 (29, 29', 29''), and a POSITA would be motivated to choose it as one from among a number of finite, available options in the art for mechanical securement.

IX. GROUND 6: CLAIM 10 IS RENDERED OBVIOUS BY ZHANG IN LIGHT OF BARNETT AND/OR VAN ELMPT

96. Dependent Claim 10 is further limited by the following:

> the heat spreader and the heat sink in combination define a base, wherein the base comprises engagement openings, wherein the optic comprises engagement tabs, wherein the optic is securely retained by the base by inserting respective ones of the engagement tabs into respective ones of the engagement openings and rotating the optic relative to a cylindrical axis of the base such that a portion of each engagement tab is securely retained by respective portions of the base.

'518 Patent at Claim 10. Claim 10 discloses a common bayonet style fastening mechanism to retain the optic to the heat sink. While Zhang does not disclose this limitation, Barnett does:

> The lens 18 further comprises protrusions 32, which may be lens feet, that allow the LED package 10 to be removeably secured in a coupling device 36 of the mounting device 54 in a socket like fashion, where the feet 32 are biased against the coupling device 36 via flexible extensions 34 extending from a peripheral portion of the anode 12.

Barnett at [0037].

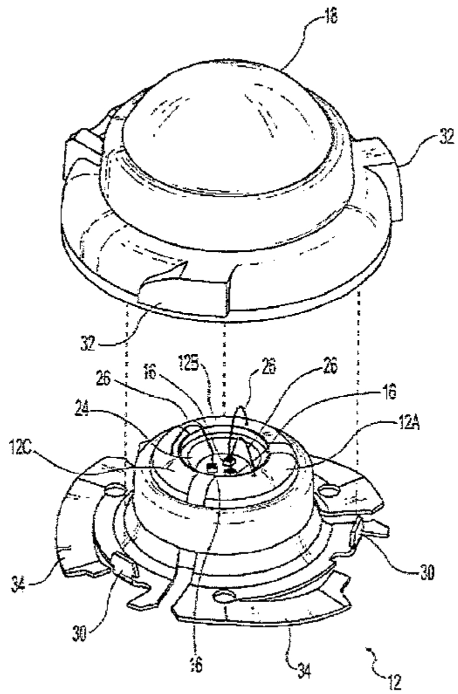


Fig. 7

Id. at Fig. 7. The protrusions 32 (engagement tabs) of Barnett are inserted into openings (engagement openings) in the anode[12] 12 and rotated under the flexible extensions 34 of the anode 12. The engagement openings in the anode 12 are formed by folding a portion of the metal anode (corresponding to the coupling devices 30) upward as shown in Fig. 4. *Id.* at Fig. 4. The rotation is about a central axis of the lens and the anode 12 due to the locations of the feet and the extensions along the

[12] The anode is a heat spreader that transfers heat to the liquid crystal polymer 28 to provide heat sinking. *See* Barnett at [0047].

circumference of the optic and the anode, respectively. A POSITA would be motivated, at least based on Barnett's teaching, to incorporate the claimed arrangement of engagement tabs and openings (also known as a bayonet-type coupling system) to secure the optic to the heat spreader/heat sink combination. Furthermore, by using openings in the heat spreader or heat sink and protrusions in the optic (bayonet style fastening mechanism), the optic can provide pressure against the LED package, circuit board, or heat spreader for it to be in close thermal contact and increase thermal coupling.

97. As discussed above for claim 1, Zhang includes lenses 108 (optic) over the LEDs on the printed circuit board. It would have been obvious to a POSITA to use the LED package of Barnett in order to utilize the high power LED of Barnett for high light output for a luminaire where the LED package includes a bayonet type fastener for retaining the optic to a heat spreader.

98. Alternatively, Van Elmpt discloses a collimating optical component 16 with a cylindrical outer body portion 30 and a base plate 36 facing the base portion 18 of the heat sink 12. Van Elmpt at 4:3-9, Fig. 4a.

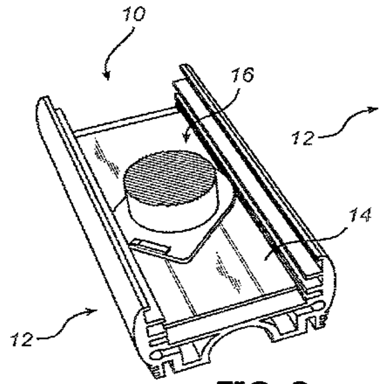


FIG. 3a

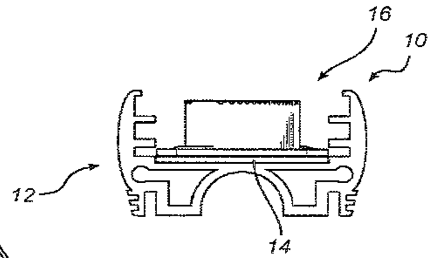


FIG. 3b

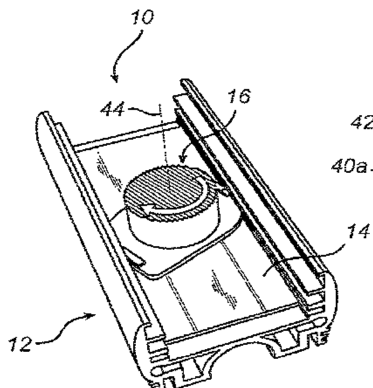


FIG. 4a

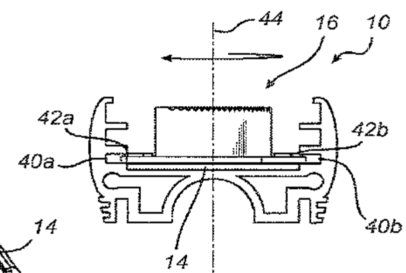


FIG. 4b

Id. at Figs. 3a, 3b, 4a, 4b. The optical component 16 is "introduced, e.g. from above, into the space between the wall portions 20a, 22b of the heat sink." *Id.* at 5:18-19. The protruding portions of the base plate (engagement tabs) are inserted through this space (engagement opening) and also through the openings 22a, 22b of the heat sink 12. When the optical component 16 is rotated around a central axis 44 of the optical component 16, portions of the "base plate 36 are received in the grooves 22a, 22b, whereby the optical element 16 is locked in the heat sink 12." *Id.* at 5:23-24, 5:27:32, 2:12-15, Fig. 4a.

99. As discussed above regarding claim 1, Zhang includes lenses 108 (optic) over the LEDs on the printed circuit board. It would have been obvious to a POSITA to use the optical element of Van Elmpt in a bayonet-style fastening mechanism to secure the optic to the heat sink. Van Elmpt teaches that bayonet-style fastening also "applies a pressure or force to the PCB 14… such that the PCB 14 is pressed against the heat sink 12, thereby fixating the PCB 14 to the heat sink 12 and establishing a desired level of thermal contact between the PCB 14 and the heat sink 12." *Id.* at 4:22-26. A POSITA would be motivated to utilize the bayonet method of fastening disclosed in Van Elmpt to fixate the circuit board 96 to the trim cup 112 (heat spreader) of Zhang, obviating the need for screws 116 since the bayonet style fastening mechanism for the optic could also fixate the circuit board to the trim cup. Thus, a POSITA would be motivated to employ the bayonet-type fastening mechanism to maintain thermal contact and to avoid using other types of fastening mechanisms.

100. Thus, Claim 10 is obvious over Zhang in light of Barnett and/or Van Elmpt.

X. CONCLUSION

101. The prior art references teach exactly the same goal, in the same manner, as the '518 Patent: (i) dissipating heat from a low-profile LED fixture by using the fixture's own trim or periphery as a heat sink; and (ii) adding an accessory

kit to the fixture to create a version of the luminaire that is easily installed in both new and retrofit environments. They place ancillary components in exactly the same places. The '518 patent claims nothing new.

Signed under the penalty of perjury this 17th day of April, 2017.

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ATTACHMENT

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OPTICAL TECHNOLOGY EXPERT

PROFILE
- Optical technology, lighting, and display expert
- Inventor on 49 issued patents, Inventor on 30+ pending patent applications
- Expertise and analytical skills for optical and physical product analysis
- USPTO Registered Patent Agent

EMPLOYMENT

Phostech **President** *2009 – Present*
- Optical consulting
- Patent strategy & drafting services
- Expert declaration and deposition in Morgan Solar, Inc. v. Banyan Energy Inc., USPTO PTAB Interference No. 105,972
- Submitted declarations for 9 USPTO *Inter partes* reviews related to backlights
- Non-testifying expert ITRI v. LG Corp., ITC CASE 337-TA-805 (consultant for Steptoe & Johnson on behalf of defendants) on backlight technology
- Invented backlights, flexible lightguide technology, waveguide configurations, LED bulbs based on waveguides, LED light fixture configurations, concentrating solar collection systems, and other illumination devices

Fusion Optix Inc. **VP Technology & Dir. of Technology** *2006-2009*

Led the research strategy and transfer of technology to product engineering in a fast-paced small company providing innovation in the display and LED lighting industries
- Developed technology roadmaps, intellectual property strategy, & competitive benchmarking
- Invented more than 35 unique, patentable products and drafted & prosecuted 60+ patent applications
- Managed and researched optical films, display backlights, LED light fixture, and LED light bulb projects
- Co-developed the optical system of a Lightfair 2009 Innovation Award-winning LED light fixture

Manager, Optical Engineering *2005-2006*
- Developed and prototyped micro-replicated, multi-functional optical films for displays and light fixtures through optical modeling, prototyping, optical and thermal analysis, and specification
- Designed and managed optical film, LED backlight, and light fixture optical and thermal characterization lab
- Led polymer based optical film research including production and optical characterization

Phostech **President** *2003-2005*
- Optical design & analysis of diffusing films, refractive-TIR films, displays, LCD backlights, lightguides, illuminated signs and light fixtures
- Invented new optical films, light fixtures, projection screens, backlights and displays

Motorola Labs **Senior Physicist** *1997-2002*
- Optically designed & constructed world's first personal micro-projector (US Patent 6,637,896)
- Designed reflection and transmission micro-structured optical films for display backlights and illumination
- Designed and developed 3 new optical film products with suppliers, including an optical film with 3M which was shipped in over 100 million cellular phones
- Analyzed thermal and optical properties of products including developing new measurement techniques
- 4 issued Patents, 26 patent disclosures

ImEdge Technology Inc. **Optical Engineer** *1993-1997*
- Co-invented new methods for recording edge-lit lightguide based holograms and edge-lit devices for display illumination and biometric applications (7 issued patents)
- Modeled, recorded, and performed optical and thermal analysis of optical components and systems

EDUCATION

Ph.D. in Physics, Loughborough University (UK) 1997
Applied rigorous coupled wave diffraction theory to model and analyze recorded edge-lit holograms
BSc. in Applied Physics, Certificate in Optics, Georgia Institute of Technology 1992

Issued Patents

1) 9,566,751 Methods of forming film-based lightguides
2) 9,557,473 Reflective spatial light modulator display with stacked lightguides and method
3) 9,523,807 Device comprising a film-based lightguide and component with angled teeth
4) 9,110,200 Illumination device comprising a film-based lightguide
5) 9,103,956 Light emitting device with optical redundancy
6) 9,028,123 Display illumination device with a film-based lightguide having stacked incident surfaces
7) 8,958,698 Versatile remote control device and system
8) 8,950,902 Light emitting device with light mixing within a film
9) 8,917,962 Method of manufacturing a light input coupler and lightguide
10) 8,905,610 Light emitting device comprising a lightguide film
11) CA2702600 Light emitting devices and applications thereof
12) CA2702690 Light emitting devices and applications thereof
13) CA2702685 Light emitting devices and applications thereof
14) 8,794,812 Light emitting devices and applications thereof
15) 8,783,898 Light emitting devices and applications thereof
16) 8,761,565 Arcuate lightguide and light emitting device comprising the same
17) 8,721,152 Light emitting devices and applications thereof
18) 8,619,363 Light redirecting element comprising a forward diffracting region and a scattering region
19) 8,434,909 Light emitting display with light mixing within a film
20) 8,430,548 Enhanced light fixture with volumetric scattering
21) 8,408,775 Light recycling directional control element and light emitting device using the same
22) 8,249,408 Method of manufacturing an optical composite
23) 8,233,803 Versatile remote control device and system
24) 8,231,256 Light fixture comprising a multi-functional non-imaging optical component
25) 8,177,408 Light filtering directional control element and light fixture incorporating the same
26) 8,033,706 Lightguide comprising a low refractive index region
27) 8,033,674 Optical components and light emitting devices comprising asymmetric scattering domains
28) 7,991,257 Method of manufacturing an optical composite
29) 7,914,192 Enhanced light diffusing sheet
30) 7,784,954 Polarization sensitive light homogenizer
31) 7,758,227 Light fixture with curved light scattering region comprising ellipsoidal domains
32) 7,722,224 Illuminating device incorporating a high clarity scattering layer
33) 7,542,635 Dual illumination anisotropic light emitting device
34) 7,453,636 High contrast optical path corrected screen
35) 7,453,635 Imaging material with improved contrast
36) 7,431,489 Enhanced light fixture
37) 7,408,707 Multi-region light scattering element
38) 7,278,775 Enhanced LCD backlight
39) 7,015,893 Photoluminescent electrophoretic display
40) 6,861,788 Switchable display/mirror method and apparatus
41) 6,637,896 Compact projection system and associated device
42) 6,636,285 Reflective liquid crystal display with improved contrast
43) 6,151,142 Grazing incidence holograms and system and method for producing the same
44) 6,061,463 Holographic fingerprint device
45) 5,986,746 Topographical object detection system
46) 5,974,162 Device for forming and detecting fingerprint images with valley and ridge structure
47) 5,822,089 Grazing incidence holograms and system and method for producing the same
48) 5,710,645 Grazing incidence holograms and system and method for producing the same
49) EP0749610 Compact device for producing an image of the topological surface

US Patent Application Publications

1) **20170045669 Light emitting device comprising a film-based lightguide and reduced cladding layer at the input surface**
2) **20150253487 Reflective display comprising a frontlight with extraction features and a light redirecting optical element**
3) **20150219834 Display with a film-based lightguide and light redirecting optical element**
4) **20150078035 Device comprising a film-based lightguide and component with angled teeth**
5) **20140360578 Solar energy system including a lightguide film**
6) **20140063853 Film-based lightguide including a wrapped stack of input couplers and light emitting device including the same**
7) **20140056028 Light emitting device with adjustable light output profile**
8) **20140049983 Light emitting device comprising a lightguide film and aligned coupling lightguides**
9) **20130314942 Packaging comprising a lightguide**
10) **20130250618 Light emitting device with light mixing within a film**
11) **20130208508 Light emitting device with optical redundancy**
12) **20130155723 Replaceable lightguide film display**
13) **20120294620 Versatile remote control device and system**
14) **20120288283 Versatile remote control device and system**
15) **20120287674 Illumination device comprising oriented coupling lightguides**
16) **20120082461 Versatile remote control device and system**
17) **20110286222 Method of manufacturing an optical composite**
18) **20110277361 Sign comprising a film-based lightguide**
19) **20110273906 Front illumination device comprising a film-based lightguide**
20) **20110255303 Illumination device comprising a film-based lightguide**
21) **20110227487 Light emitting display with light mixing within a film**
22) **20110013420 Light emitting devices and applications thereof**
23) **20100321953 Light emitting devices and applications thereof**
24) **20100321952 Light emitting devices and applications thereof**
25) **20080094854 Dual illumination anisotropic light emitting device**
26) **20080043490** Enhanced Light Guide
27) **20070201246 Enhanced Light Diffusing Sheet**
28) **20060290253 Enhanced Diffusing Plates, Films and Backlights**
29) **20060227546 Enhanced light fixture**
30) **20060215958 Enhanced electroluminescent sign**
31) **20060066945 High contrast optical path corrected screen**
32) **20060056166 Enhanced LCD backlight**
33) **20060056022 Imaging material with improved contrast**
34) **20060056021 Multi-region light scattering element**
35) **20050259302 Holographic light panels and flat panel display systems and method and apparatus for making same**
36) **20040245902 Switchable display/mirror method and apparatus**
37) **20040151491 Apparatus and method concerning a passive multi-indicia visual position indicator**
38) **20040150613 Photoluminescent electrophoretic display**
39) **20030081184 Compact projection system and associated device**
40) **20030081154 Reflective liquid crystal display with improved contrast**
41) **20030020975 Holographic light panels and flat panel display systems and method and apparatus for making same**
42) **20020001110 Holographic light panels and flat panel display systems and method and apparatus for making same**

International Patent Application Publications

1) **JP2013525955** Illumination device comprising a film-based lightguide
2) **JP2013525836** Sign comprising a film-based lightguide
3) **JP2013530412** Front illumination device comprising a film-based lightguide
4) **AU2012225244** Light emitting device with adjustable light output profile
5) **CA2829388** Light emitting device with adjustable light output profile
6) **EP2683980** Light emitting device with adjustable light output profile
7) **KR20130096155** Illumination device comprising a film-based lightguide
8) **MX2012012033** Illumination device comprising a film-based lightguide
9) **MX2012012035** Sign comprising a film-based lightguide
10) **MX2012012034** Front illumination device comprising a film-based lightguide
11) **CN103038568** Front illumination device comprising a film-based lightguide
12) **CN103038567** Illumination device comprising a film-based lightguide
13) **WO2012158460** Solar energy system including a lightguide film
14) **KR20130096155** Illumination device comprising a film-based lightguide
15) **KR20130055598** Front illumination device comprising a film-based lightguide
16) **KR20130054263** Sign comprising a film-based lightguide
17) **EP2558775** Illumination device comprising a film-based lightguide
18) **EP2558893** Sign comprising a film-based lightguide
19) **EP2558776** Front illumination device comprising a film-based lightguide
20) **CN102918435** Sign comprising a film-based lightguide
21) **GB2492398** Manufacturing an optical composite using inverted light collimating surface features
22) **WO2012122511** Light emitting device with adjustable light output profile
23) **WO2012088315** Packaging comprising a lightguide
24) **WO2012068543** Light emitting device comprising a lightguide film and aligned coupling lightguides
25) **WO2012044972** Versatile remote control device, system, and method
26) **WO2012016047** Light emitting device with optical redundancy
27) **CA2796515** Sign comprising a film-based lightguide
28) **CA2796518** Illumination device comprising a film-based lightguide
29) **CA2796519** Illumination device comprising a film-based lightguide
30) **WO2011130715** Illumination device comprising a film-based lightguide
31) **WO2011130718** Front illumination device comprising a film-based lightguide
32) **WO2011130720** Sign comprising a film-based lightguide
33) **CA2702600** Light emitting devices and applications thereof
34) **CA2702685** Light emitting devices and applications thereof
35) **CA2702690** Light emitting devices and applications thereof
36) **WO2007002317** Enhanced diffusing plates, films and backlights
37) **WO2006055872** Enhanced light fixture
38) **WO2006055873** Enhanced electroluminescent sign
39) **WO2006032002** High contrast optical path corrected screen
40) **WO2006026743** Enhanced light diffusing sheet
41) **WO2006031545** Enhanced LCD backlight
42) **WO2006020583** Imaging material with improved contrast
43) **WO2006017585** Multi-region light scattering element
44) **CN1573448** Switchable display/mirror method and apparatus
45) **KR20040104427** Switchable display/mirror method and apparatus including switchable mirror with display operation mode and mirror operation mode
46) **WO2003038509** Reflective liquid crystal display with improved contrast
47) **WO2003038517** Compact projection system and associated device
48) **AT195189** Device for forming and detecting fingerprint images with valley and ridge structure

49) **JPH09509490** Device for forming and detecting fingerprint images with valley and ridge structure
50) **AU1925595** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same
51) **CA2183567** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same
52) **WO199522804** Method of producing and detecting high-contrast images of the surface topography of objects and a compact system for carrying out the same

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2) "Challenges and opportunities for light management optics in LED lighting systems," LEDs 2008 Conference, San Diego, CA, (2008)
3) "Optically efficient displays and solid-state lighting systems using anisotropic polymer films," SID, New England Chapter, Dec. (2006)
4) "Novel high brightness LED backlight design and optimization," Mark Chu, Zane Coleman, Kurt Henrickson, Terry Yeo, Americas Display Engineering and Applications Conference, Atlanta, GA (2006)
5) "Head-mounted displays for visual communication," Zane Coleman, George Valliath, Motorola Hermes, internal conference (2000)
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7) "Display optical enhancement films," Zane Coleman, George Valliath, Robert Akins, Kevin Jelley" Motorola Hermes, internal conference (1999)
8) "Design of hologram for brightness enhancement in color LCDs," G.T. Valliath, Z.A. Coleman, J.L. Schindler, R. Polak, R.B. Akins, K.W. Jelley, Society for Information Display '98, Conference Proceedings Vol. 29, p. 1139, Anaheim, CA (1998)
9) "Modern holographic recording and analysis techniques applied to edge-lit holograms and their applications," Ph.D. in Physics Thesis, Loughborough University, Loughborough, England (1997)
10) "Holographic optical element for compact fingerprint imaging system", M.H. Metz, N. J. Phillips, Z. A. Coleman, C. Flatow, Optical Security and Counterfeit Deterrence Techniques, SPIE Proceedings vol. 2660, San Jose, CA (1996)
11) "Holograms in the extreme edge illumination geometry", Zane A. Coleman, Michael H. Metz, Nicholas J. Phillips, Holographic Materials II, SPIE Proceedings vol. 2688, San Jose, CA (1996)
12) "The use of edge-lit holograms for compact fingerprint capture", M. Metz, C. Flatow, Z. Coleman, N.J. Phillips, CardTec SecureTec, April 10th, (1995)
13) "Links between holography and lithography," Phillips, Nicholas J.; Barnett, Christopher A.; Wang, Ce; Coleman, Zane A., Proc. SPIE Vol. 2333, p. 206-214, Fifth International Symposium on Display Holography, Tung H. Jeong; Ed. (1995)
14) "Dichromated gelatin--some heretical comments", N.J. Phillips, R. D. Rallison, C. A. Barnett, S. R. Schicker, Z. A. Coleman, Practical Holography VII:Imaging Materials, SPIE vol. 1914, pp 101-114 (1993)
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16) "Holograms in the edge-illuminated geometry-new materials developments", N.J. Phillips, C. Wang, Z. Coleman, Practical Holography VII:Imaging Materials, SPIE vol. 1914, pp 75-81 (1993)

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Client: Foley and Lardner LLP
Case Name: USPTO Patent Interference 105,972
Services provided: Two declarations, Two-day deposition
Date: March 2104 – September 2015

Type of Matter: Expert in Optics
Client: Fried, Frank, Harris, Shriver & Jacobson
Case Name: IPR2015-01044, Mercedes-Benz v. IDT LLC
Services provided: One Declaration
Date: April 2015 – June 2015

Type of Matter: Expert in Optics
Client: Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name: IPR2015-00831, Toyota Motor Corp. v IDT LLC
Services provided: One Declaration, Consulting
Date: May 2014 – May 2015

Type of Matter: Expert in Optics
Client: Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name: IPR2015-00832, Toyota Motor Corp. v IDT LLC
Services provided: One Declaration, Consulting
Date: May 2014 – May 2015

Type of Matter: Expert in Optics
Client: Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name: IPR2015-00834, Toyota Motor Corp. v IDT LLC
Services provided: One Declaration, Consulting
Date: May 2014 – May 2015

Type of Matter: Expert in Optics
Client: Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name: IPR2015-00835, Toyota Motor Corp. v IDT LLC
Services provided: One Declaration, Consulting
Date: May 2014 – May 2015

Type of Matter: Expert in Optics
Client: Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name: IPR2015-00843, Toyota Motor Corp. v IDT LLC
Services provided: One Declaration, Consulting
Date: May 2014 – May 2015

Type of Matter: Expert in Optics
Client: Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name: IPR2015-00855, Toyota Motor Corp. v IDT LLC
Services provided: One Declaration, Consulting
Date: May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00857, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Finnegan, Henderson, Farabow, Garrett & Dunner LLP
Case Name:	IPR2015-00897, Toyota Motor Corp. v IDT LLC
Services provided:	One Declaration, Consulting
Date:	May 2014 – May 2015

Type of Matter:	Expert in Optics
Client:	Steptoe & Johnson LLP
Case Name:	ITC 337-TA-805, ITRI v. LG Corp.
Services provided:	Non-testifying consulting
Date:	Dec. 2011 – May 2013

US008201968B2

(12) United States Patent
Maxik et al.

(10) **Patent No.: US 8,201,968 B2**
(45) **Date of Patent: Jun. 19, 2012**

(54) **LOW PROFILE LIGHT**

(75) Inventors: **Fredric S. Maxik**, Indialantic, FL (US); **Raymond A. Reynolds**, Satellite Beach, FL (US); **Addy S. Widjaja**, Palm Bay, FL (US); **Mark Penley Boomgaarden**, Indian Harbour Beach, FL (US); **Robert Rafael Soler**, Cocoa Beach, FL (US); **James L. Schellack**, Cocoa Beach, FL (US)

(73) Assignee: **Lighting Science Group Corporation**, Satellite Beach, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 98 days.

(21) Appl. No.: **12/775,310**

(22) Filed: **May 6, 2010**

(65) **Prior Publication Data**

US 2011/0080727 A1 Apr. 7, 2011

Related U.S. Application Data

(60) Provisional application No. 61/248,665, filed on Oct. 5, 2009.

(51) **Int. Cl.**
F21V 1/00 (2006.01)
F21V 29/00 (2006.01)

(52) **U.S. Cl.** **362/235**; 362/294; 362/147; 362/373

(58) **Field of Classification Search** 362/147, 362/148, 149, 150, 404, 294, 373, 547, 365
See application file for complete search history.

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2009/0141506 A1* 6/2009 Lan et al. 362/351

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WO 2008137732 A1 11/2008

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EP International Search Report for Application No. 10174449.8; Dated Dec. 14, 2010.

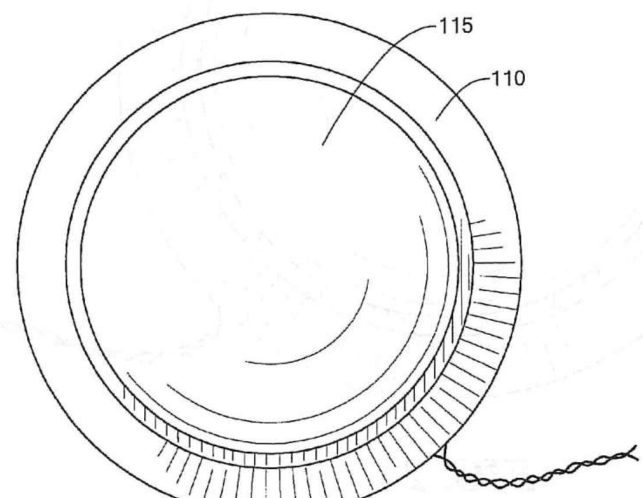
* cited by examiner

Primary Examiner — Ali Alavi
(74) *Attorney, Agent, or Firm* — Cantor Colburn LLP

(57) **ABSTRACT**

A luminaire includes a heat spreader and a heat sink thermally coupled to and disposed diametrically outboard of the heat spreader, an outer optic securely retained relative to at least one of the heat spreader and the heat sink, and a light source disposed in thermal communication with the heat spreader, the light source having a plurality of light emitting diodes (LEDs). The heat spreader, the heat sink and the outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25. The combination defined by the heat spreader, the heat sink and the outer optic, is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

23 Claims, 13 Drawing Sheets



PETITIONERS, Ex. 1001

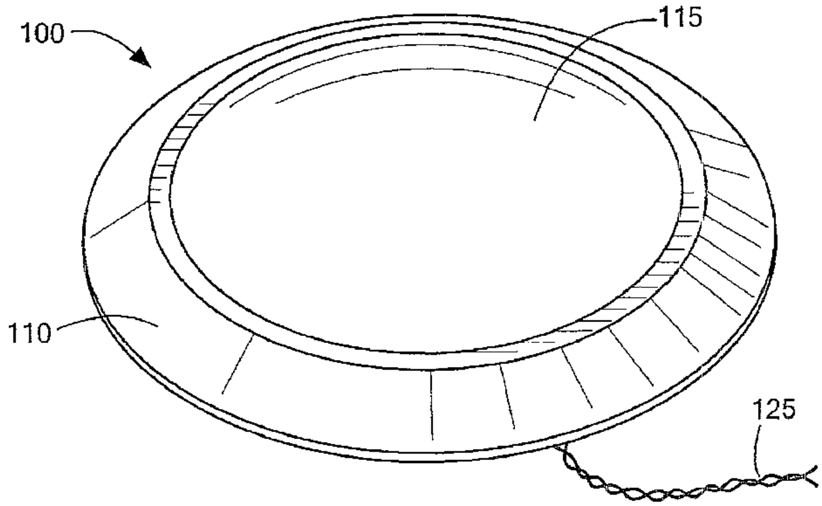


FIG. 1

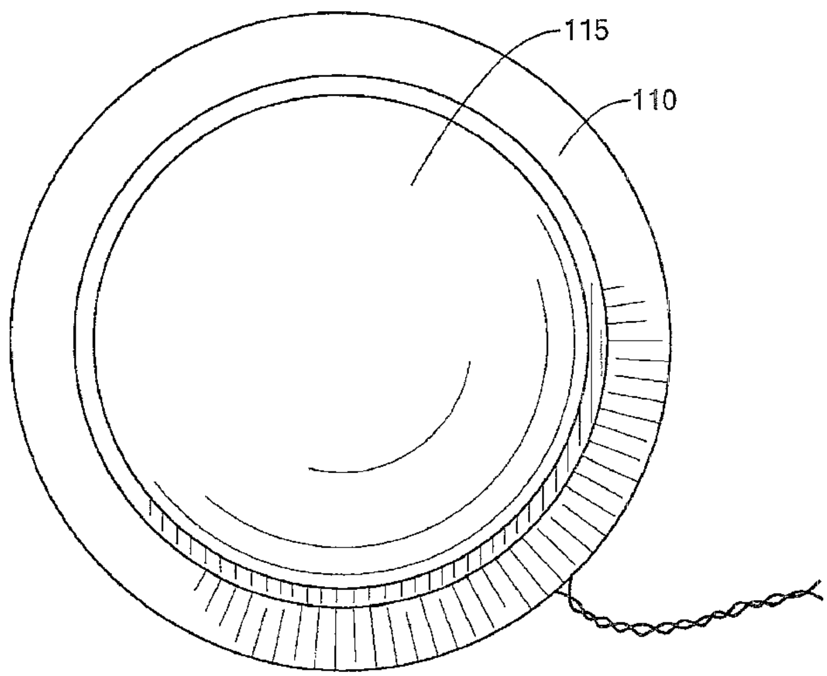


FIG. 2

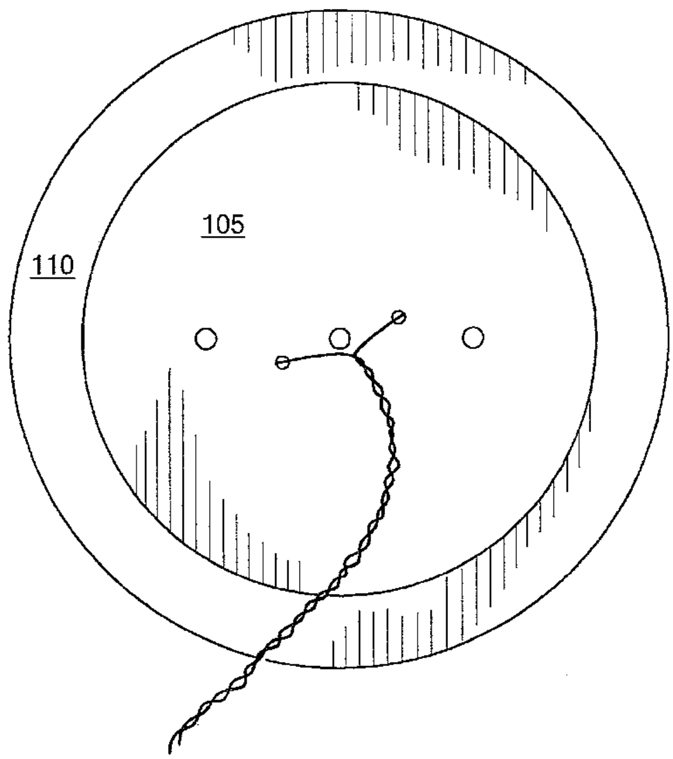


FIG. 3

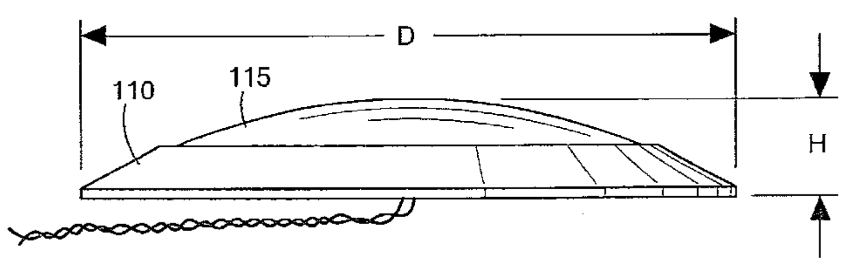


FIG. 4

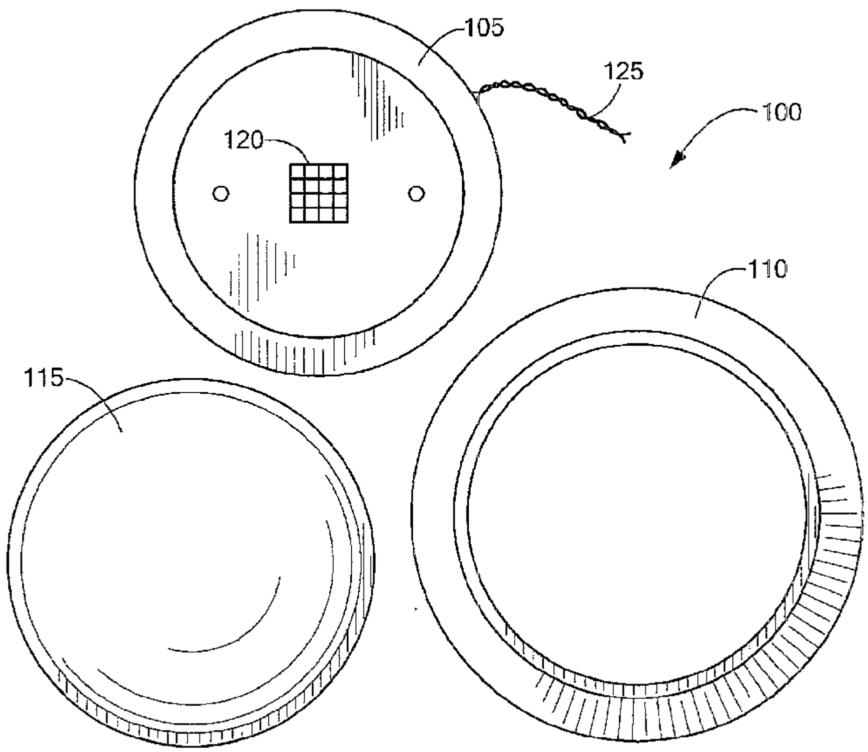


FIG. 5

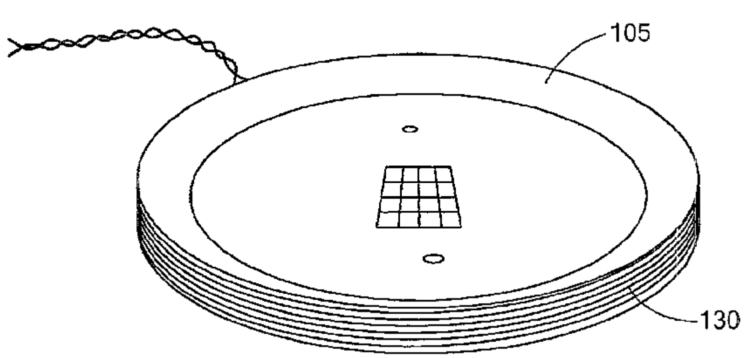


FIG. 6

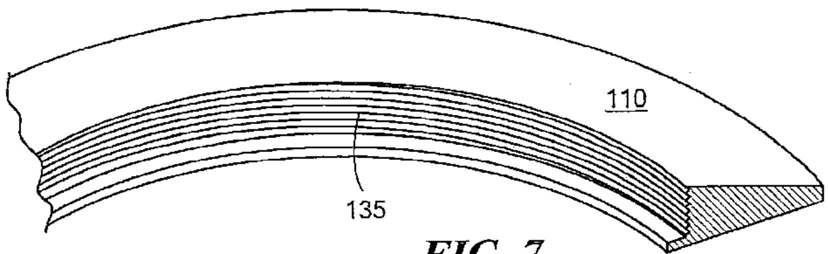


FIG. 7

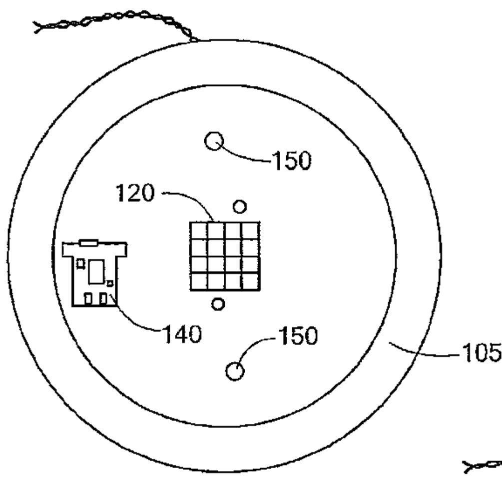


FIG. 8

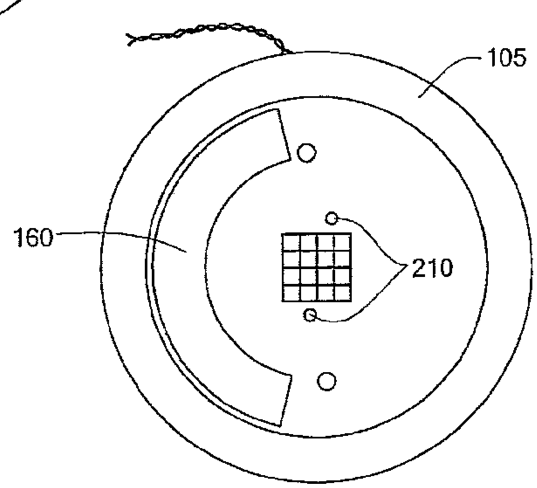


FIG. 9

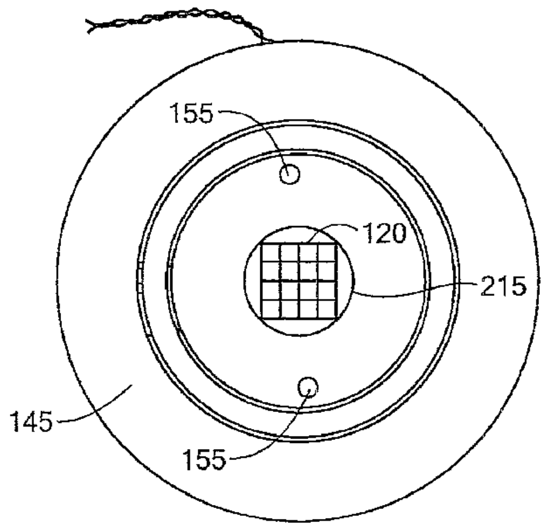


FIG. 10

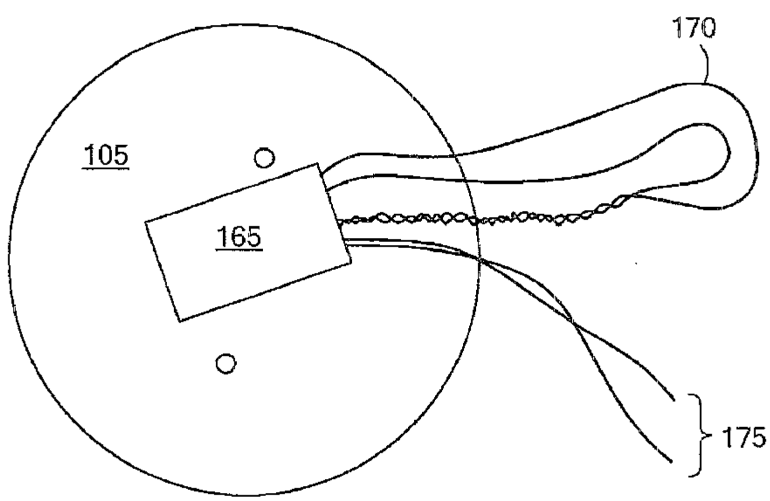


FIG. 11

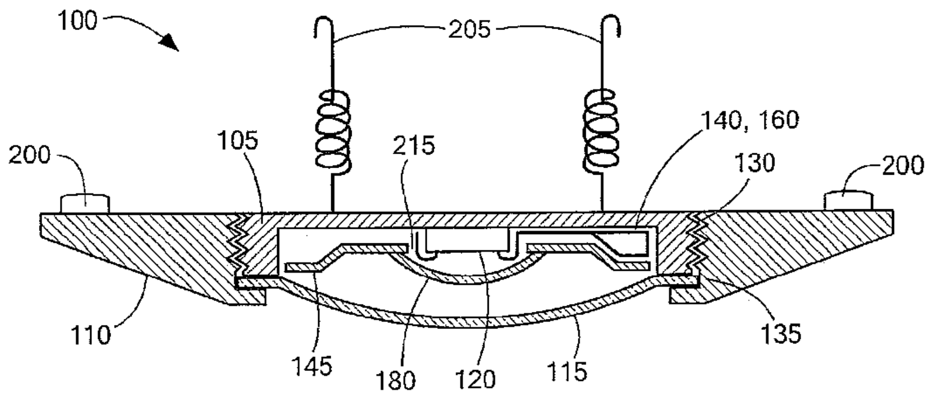

100
205
140, 160
105
215
130
200
200
110
135
145
180
120
115

FIG. 12

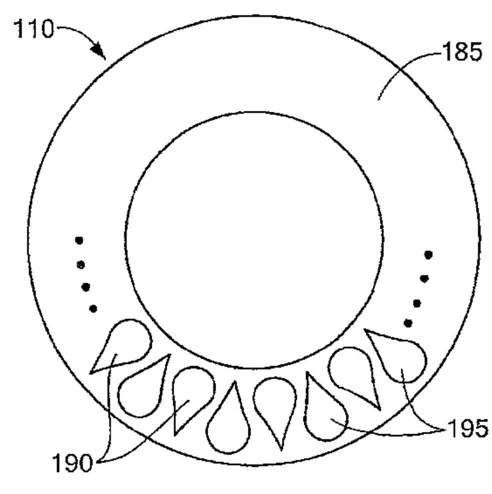

110
185
190
195

FIG. 13

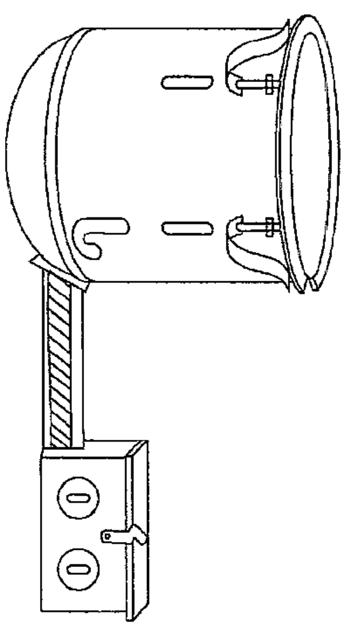


FIG. 14

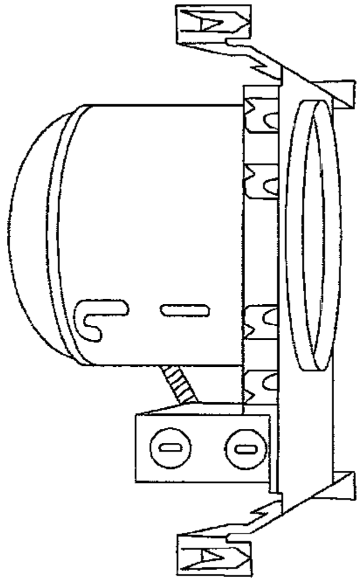


FIG. 15

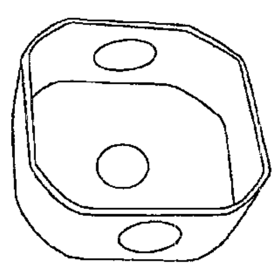


FIG. 16

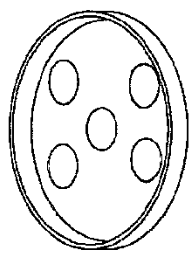


FIG. 17

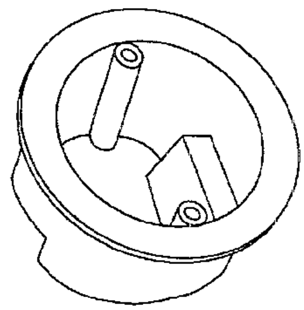


FIG. 18

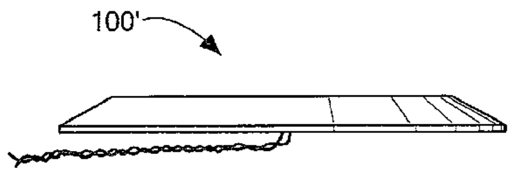


FIG. 19

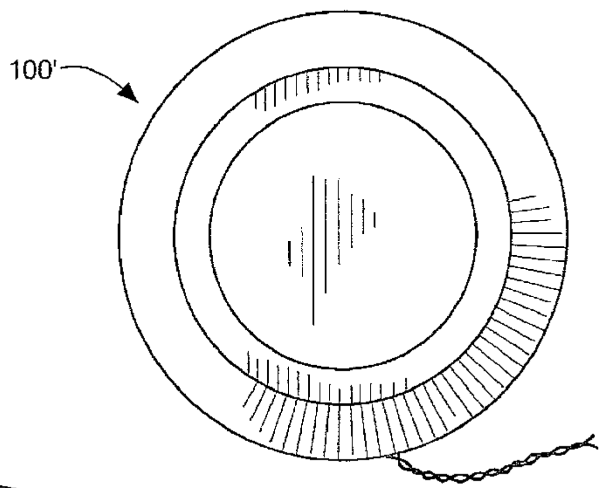


FIG. 20

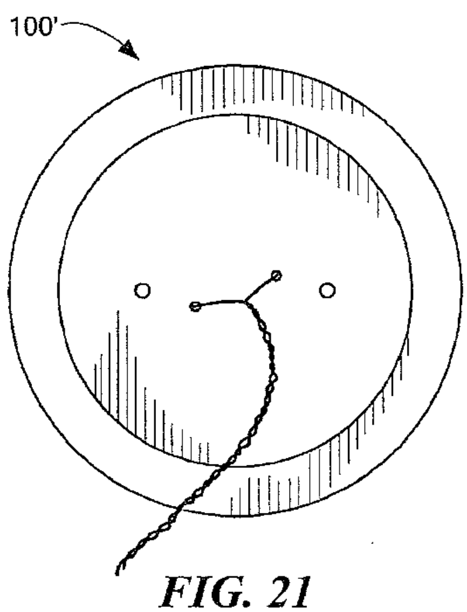


FIG. 21

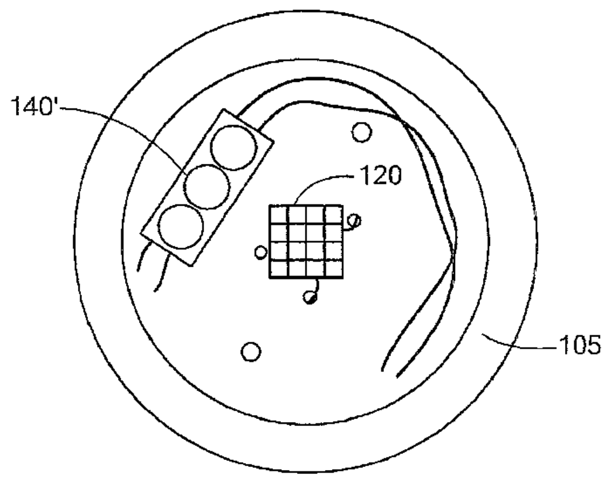


FIG. 22

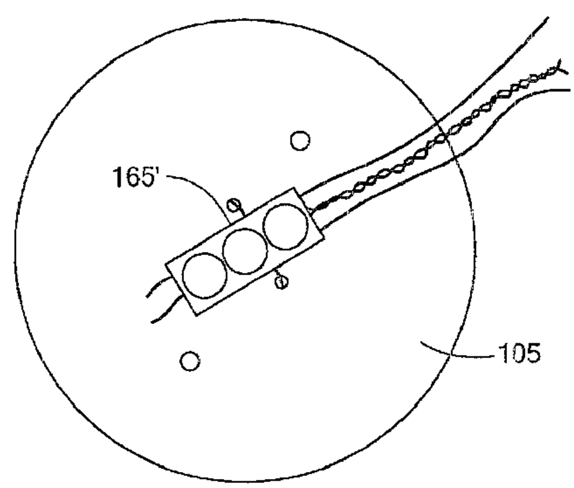


FIG. 23

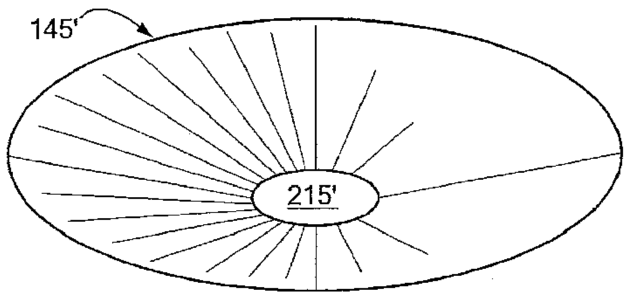


FIG. 24

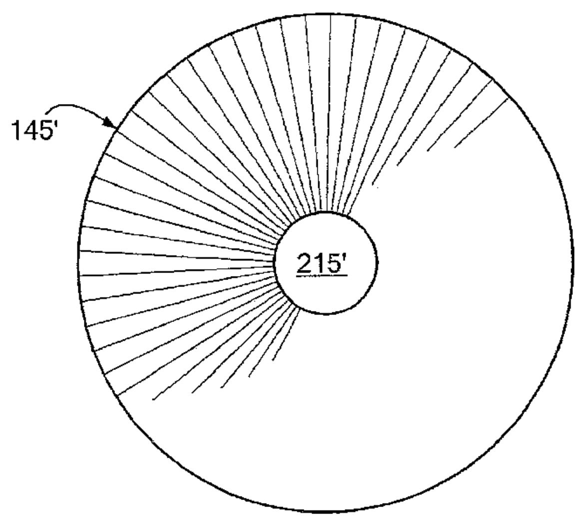


FIG. 25

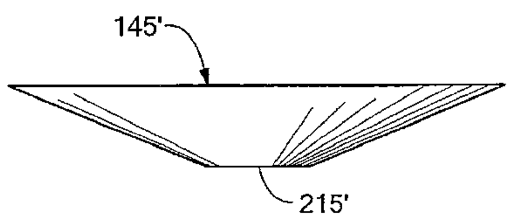


FIG. 26

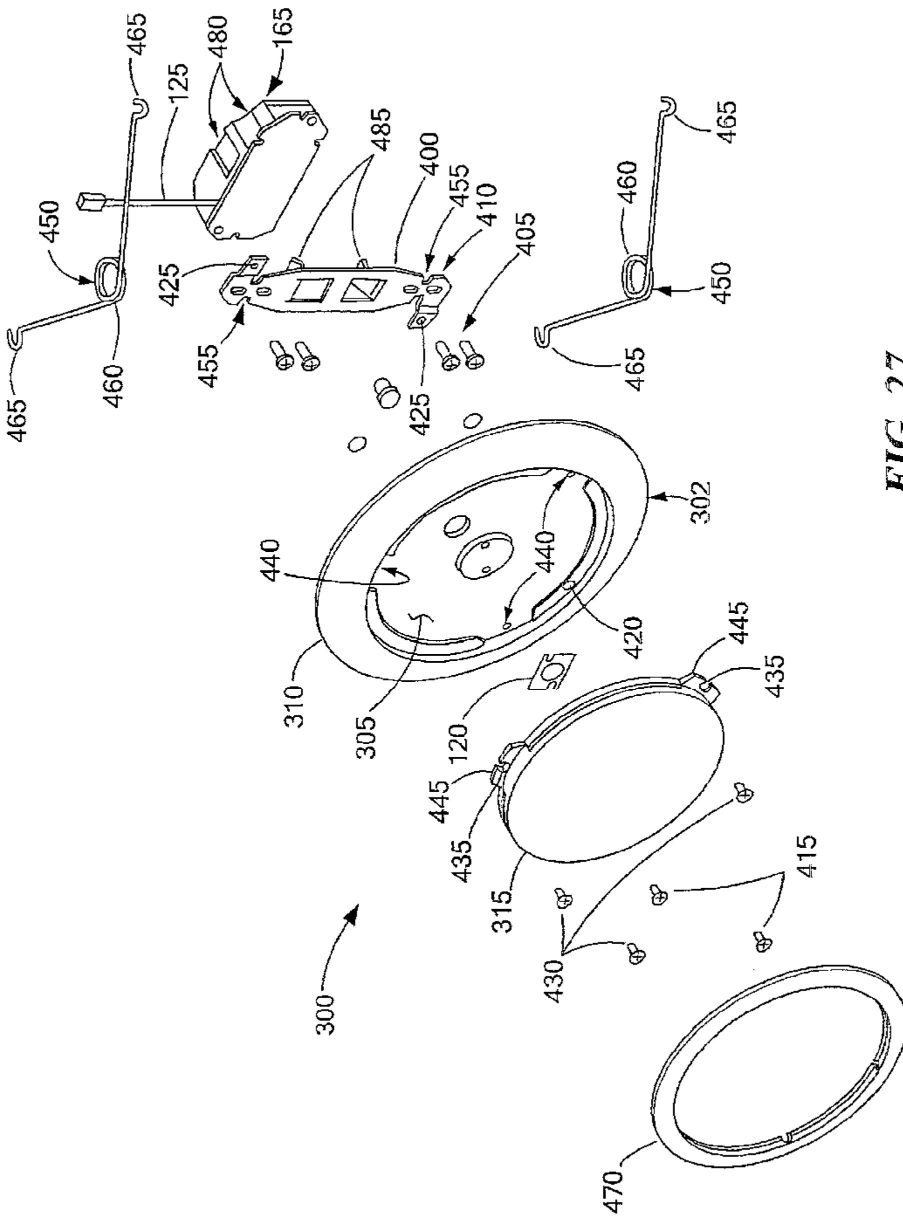

465
125
480
165
485
400
455
410
405
450
425
460
465
455
425
302
440
440
420
310
305
120
445
435
315
415
430
300
470

FIG. 27

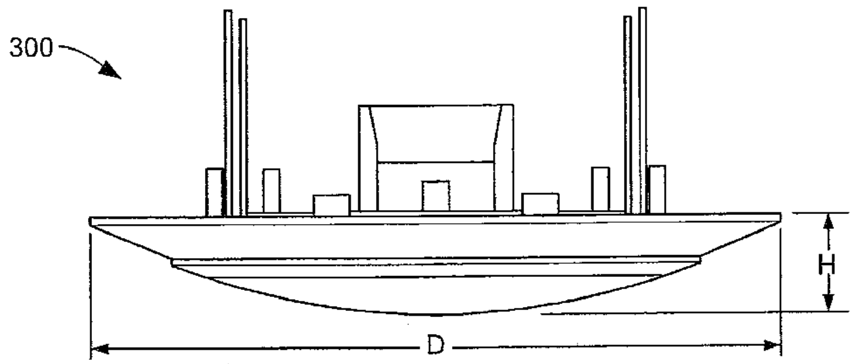


FIG. 28

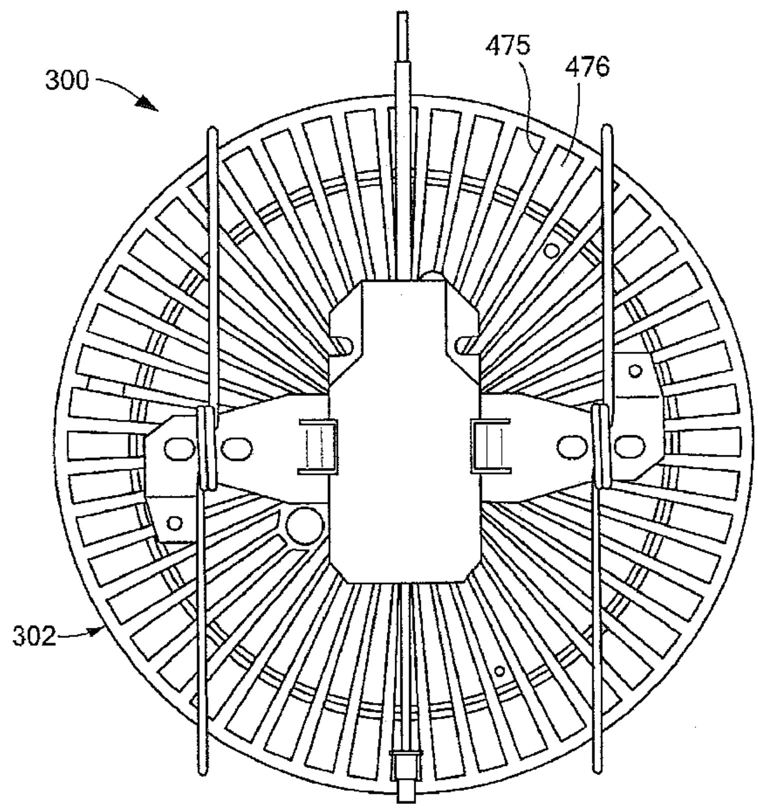


FIG. 29

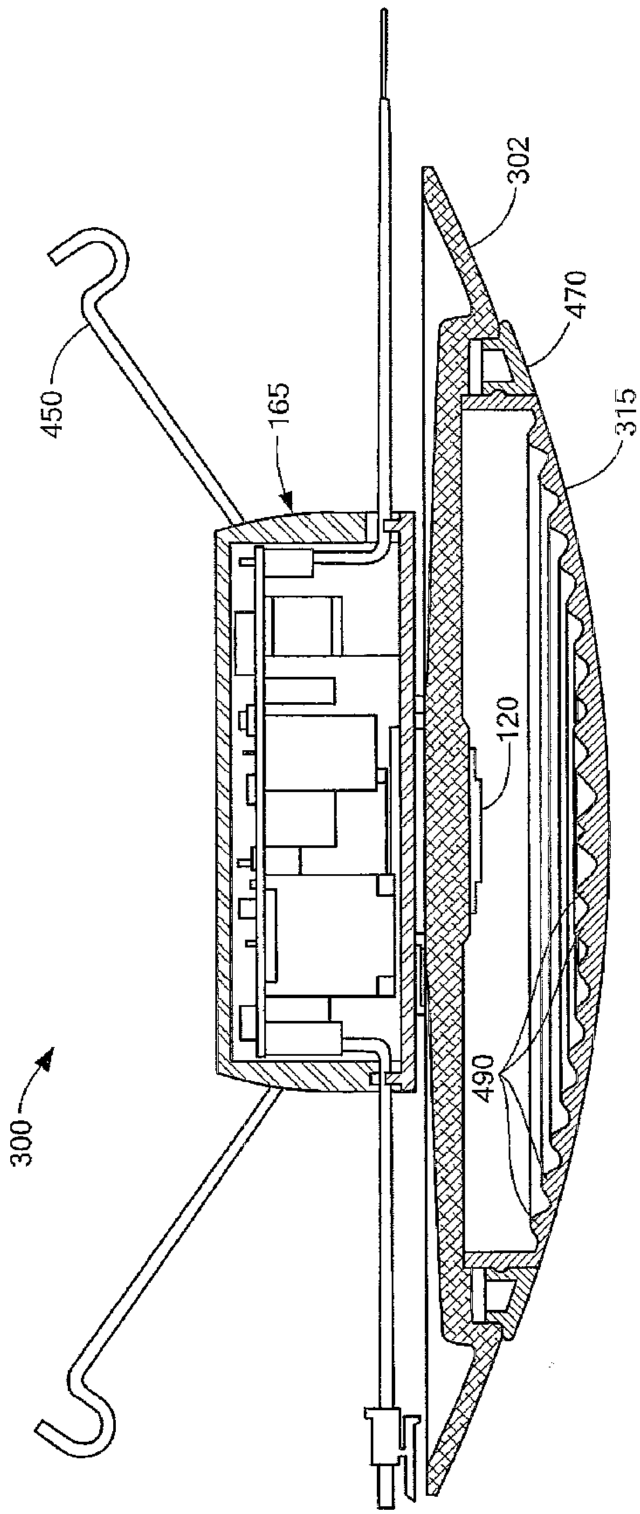


FIG. 30

LOW PROFILE LIGHT

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application Ser. No. 61/248,665, filed Oct. 5, 2009, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

The present disclosure relates generally to lighting, particularly to low profile lighting, and more particularly to low profile downlighting for retrofit applications.

Light fixtures come in many shapes and sizes, with some being configured for new work installations while others are configured for old work installations. New work installations are not limited to as many constraints as old work installations, which must take into account the type of electrical fixture/enclosure or junction box existing behind a ceiling or wall panel material. With recessed ceiling lighting, sheet metal can-type light fixtures are typically used, while surface-mounted ceiling and wall lighting typically use metal or plastic junction boxes of a variety of sizes and depths. With the advent of LED (light emitting diode) lighting, there is a great need to not only provide new work LED light fixtures, but to also provide LED light fixtures that are suitable for old work applications, thereby enabling retrofit installations. One way of providing old work LED lighting is to configure an LED luminaire in such a manner as to utilize the volume of space available within an existing fixture (can-type fixture or junction box). However, such configurations typically result in unique designs for each type and size of fixture. Accordingly, there is a need in the art for an LED lighting apparatus that overcomes these drawbacks.

This background information is provided to reveal information believed by the applicant to be of possible relevance to the present invention. No admission is necessarily intended, nor should be construed, that any of the preceding information constitutes prior art against the present invention.

BRIEF DESCRIPTION OF THE INVENTION

An embodiment of the invention includes a luminaire having a heat spreader and a heat sink thermally coupled to and disposed diametrically outboard of the heat spreader, an outer optic securely retained relative to at least one of the heat spreader and the heat sink, and a light source disposed in thermal communication with the heat spreader, the light source having a plurality of light emitting diodes (LEDs). The heat spreader, the heat sink and the outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25. The combination defined by the heat spreader, the heat sink and the outer optic, is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a heat spreader and a heat sink thermally coupled to and disposed diametrically outboard of the heat spreader. An outer optic is securely retained relative to at least one of the heat spreader and the heat sink. A light source is disposed in thermal communication with the heat spreader, the light source having a plurality of light emitting diodes (LEDs). A power conditioner is disposed in electrical communication with the light source, the power conditioner being configured to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs, the power conditioner being so dimensioned as to fit within at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a heat spreader, a heat sink thermally coupled to and disposed diametrically outboard of the heat spreader, an outer optic securely retained relative to at least one of the heat spreader and the heat sink, a light source disposed in thermal communication with the heat spreader, and an electrical supply line disposed in electrical communication with the light source. The heat spreader, heat sink and outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25. The defined combination is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a housing with a light unit and a trim unit. The light unit includes a light source, and the trim unit is mechanically separable from the light unit. A means for mechanically separating the trim unit from the light unit provides a thermal conduction path therebetween. The light unit has sufficient thermal mass to spread heat generated by the light source to the means for mechanically separating, and the trim unit has sufficient thermal mass to serve as a heat sink to dissipate heat generated by the light source.

An embodiment of the invention includes a luminaire for retrofit connection to an installed light fixture having a concealed in-use housing. The luminaire includes a housing having a light unit and a trim unit, the light unit having a light source, and the trim unit being mechanically separable from the light unit. The trim unit defines a heat sinking thermal management element, configured to dissipate heat generated by the light source, that is completely 100% external of the concealed in-use housing of the installed light fixture.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the exemplary drawings wherein like elements are numbered alike in the accompanying Figures, abbreviated in each illustration as "Fig.":

FIG. 1 depicts an isometric top view of a luminaire in accordance with an embodiment of the invention;

FIG. 2 depicts a top view of the luminaire of FIG. 1;

FIG. 3 depicts a bottom view of the luminaire of FIG. 1;

FIG. 4 depicts a side view of the luminaire of FIG. 1;

FIG. 5 depicts a top view of a heat spreader assembly, a heat sink, and an outer optic in accordance with an embodiment of the invention;

FIG. 6 depicts an isometric view of the heat spreader of FIG. 5;

FIG. 7 depicts a partial isometric view of the heat sink of FIG. 5;

FIG. 8 depicts a top view of an alternative heat spreader assembly in accordance with an embodiment of the invention;

FIG. 9 depicts a top view of another alternative heat spreader assembly in accordance with an embodiment of the invention;

FIG. 10 depicts a top view of yet another alternative heat spreader assembly in accordance with an embodiment of the invention;

FIG. 11 depicts a bottom view of a heat spreader having a power conditioner in accordance with an embodiment of the invention;

FIG. **12** depicts a section view of a luminaire in accordance with an embodiment of the invention;

FIG. **13** depicts a bottom view of a heat sink having recesses in accordance with an embodiment of the invention;

FIGS. **14-18** depict isometric views of existing electrical can-type light fixtures and electrical junction boxes for use in accordance with an embodiment of the invention;

FIGS. **19-21** depict a side view, top view and bottom view, respectively, of a luminaire similar but alternative to that of FIGS. **2-4**, in accordance with an embodiment of the invention;

FIGS. **22-23** depict top and bottom views, respectively, of a heat spreader having an alternative power conditioner in accordance with an embodiment of the invention;

FIG. **24-26** depict in isometric, top and side views, respectively, an alternative reflector to that depicted in FIGS. **10** and **12**;

FIG. **27** depicts an exploded assembly view of an alternative luminaire in accordance with an embodiment of the invention;

FIG. **28** depicts a side view of the luminaire of FIG. **27**;

FIG. **29** depicts a back view of the luminaire of FIG. **27**; and

FIG. **30** depicts a cross section view of the luminaire of FIG. **27**, and more particularly depicts a cross section view of the outer optic used in accordance with an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Although the following detailed description contains many specifics for the purposes of illustration, anyone of ordinary skill in the art will appreciate that many variations and alterations to the following details are within the scope of the invention. Accordingly, the following preferred embodiments of the invention are set forth without any loss of generality to, and without imposing limitations upon, the claimed invention.

An embodiment of the invention, as shown and described by the various figures and accompanying text, provides a low profile downlight, more generally referred to as a luminaire, having an LED light source disposed on a heat spreader, which in turn is thermally coupled to a heat sink that also serves as the trim plate of the luminaire. The luminaire is configured and dimensioned for retrofit installation on standard can-type light fixtures used for recessed ceiling lighting, and on standard ceiling or wall junction boxes (J-boxes) used for ceiling or wall mounted lighting. The luminaire is also suitable for new work installation.

While embodiments of the invention described and illustrated herein depict an example luminaire for use as a downlight when disposed upon a ceiling, it will be appreciated that embodiments of the invention also encompass other lighting applications, such as a wall sconce for example.

While embodiments of the invention described and illustrated herein depict example power conditioners having visually defined sizes, it will be appreciated that embodiments of the invention also encompass other power conditioners having other sizes as long as the power conditioners fall within the ambit of the invention disclosed herein.

Referring to FIGS. **1-26** collectively, a luminaire **100** includes a heat spreader **105**, a heat sink **110** thermally coupled to and disposed diametrically outboard of the heat spreader, an outer optic **115** securely retained relative to at least one of the heat spreader **105** and the heat sink **110**, a light source **120** disposed in thermal communication with the heat spreader **105**, and an electrical supply line **125** disposed in electrical communication with the light source **120**. To provide for a low profile luminaire **100**, the combination of the heat spreader **105**, heat sink **110** and outer optic **115**, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25. In an example embodiment, height H is 1.5-inches, and outside dimension D is a diameter of 7-inches. Other dimensions for H and D are contemplated such that the combination of the heat spreader **105**, heat sink **110** and outer optic **115**, are configured and sized so as to; (i) cover an opening defined by an industry standard can-type light fixture having nominal sizes from three-inches to six-inches (see FIGS. **14** and **15** for example); and, (ii) cover an opening defined by an industry standard electrical junction box having nominal sizes from three-inches to six-inches (see FIGS. **16** and **17** for example). Since can-type light fixtures and ceiling/wall mount junction boxes are designed for placement behind a ceiling or wall material, an example luminaire has the back surface of the heat spreader **105** substantially planar with the back surface of the heat sink **110**, thereby permitting the luminaire **100** to sit substantially flush on the surface of the ceiling/wall material. Alternatively, small standoffs **200** (see FIG. **12** for example) may be used to promote air movement around the luminaire **100** for improved heat transfer to ambient, which will be discussed further below. Securement of the luminaire **100** to a junction box may be accomplished by using suitable fasteners through appropriately spaced holes **150** (see FIG. **8** for example), and securement of the luminaire **100** to a can-type fixture may be accomplished by using extension springs **205** fastened at one end to the heat spreader **105** (see FIG. **12** for example) and then hooked at the other end onto an interior detail of the can-type fixture.

In an embodiment, the light source **120** includes a plurality of light emitting diodes (LEDs) (also herein referred to as an LED chip package), which is represented by the "checkered box" in FIGS. **5**, **6** and **8-10**. In application, the LED chip package generates heat at the junction of each LED die. To dissipate this heat, the LED chip package is disposed in suitable thermal communication with the heat spreader **105**, which in an embodiment is made using aluminum, and the heat spreader is disposed in suitable thermal communication with the heat sink **110**, which in an embodiment is also made using aluminum. To provide for suitable heat transfer from the heat spreader **105** to the heat sink **110**, an embodiment employs a plurality of interconnecting threads **130**, **135**, which when tightened provide suitable surface area for heat transfer thereacross.

Embodiments of luminaire **100** may be powered by DC voltage, while other embodiments may be powered by AC voltage. In a DC-powered embodiment, the electrical supply lines **125**, which receive DC voltage from a DC supply, are directly connected to the plurality of LEDs **120**. Holes **210** (see FIG. **9** for example) in the heat spreader **105** permit passage of the supply lines **125** from the back side of the heat spreader **105** to the front side. In an AC-powered embodiment, a suitable power conditioner **140**, **160**, **165** (see FIGS. **8**, **9** and **11** for example) is used.

In an embodiment, and with reference to FIG. **8**, power conditioner **140** is disposed on the heat spreader **105** on a same side of the heat spreader as the plurality of LEDs **120**. In an embodiment, the power conditioner **140** is an electronic circuit board having electronic components configured to receive AC voltage from the electrical supply line **125** and to deliver DC voltage to the plurality of LEDs through appropriate electrical connections on either the front side or the back side of the heat spreader **105**, with holes through the heat spreader or insulated electrical traces across the surface of the heat spreader being used as appropriate for the purposes.

In an alternative embodiment, and with reference to FIG. **9**, an arc-shaped electronic-circuit-board-mounted power conditioner **160** may be used in place of the localized power conditioner **140** illustrated in FIG. **8**, thereby utilizing a larger available area of the heat spreader **105** without detracting from the lighting efficiency of luminaire **100**.

In a further embodiment, and with reference to FIG. **11**, a block-type power conditioner **165** (electronics contained within a housing) may be used on the back surface of the heat spreader **105**, where the block-type power conditioner **165** is configured and sized to fit within the interior space of an industry-standard nominally sized can-type light fixture or an industry-standard nominally sized wall/ceiling junction box. Electrical connections between the power conditioner **165** and the LEDs **120** are made via wires **170**, which may be contained within the can fixture or junction box, or may be self-contained within the power conditioner housing. Electrical wires **175** receive AC voltage via electrical connections within the can fixture or junction box.

Referring now to FIGS. **8-10** and **12**, an embodiment includes a reflector **145** disposed on the heat spreader **105** so as to cover the power conditioner **140**, **160**, while permitting the plurality of LEDs **120** to be visible (i.e., uncovered) through an aperture **215** of the reflector **145**. Mounting holes **155** in the reflector **145** align with mounting holes **150** in the heat spreader **105** for the purpose discussed above. The reflector **145** provides a reflective covering that hides power conditioner **140**, **160** from view when viewed from the outer optic side of luminaire **100**, while efficiently reflecting light from the LEDs **120** toward the outer optic **115**. FIG. **12** illustrates a section view through luminaire **100**, showing a stepped configuration of the reflector **145**, with the power conditioner **140**, **160** hidden inside a pocket (i.e., between the reflector **145** and the heat spreader **105**), and with the LEDs **120** visible through the aperture **215**. In an embodiment, the outer optic is made using a glass-bead-impregnated-plastic material. In an embodiment the outer optic **115** is made of a suitable material to mask the presence of a pixilated light source **120** disposed at the center of the luminaire. In an embodiment, the half angle power of the luminaire, where the light intensity of the light source when viewed at the outer optic drops to 50% of its maximum intensity, is evident within a central diameter of the outer optic that is equal to or greater than 50% of the outer diameter of the outer optic.

While FIG. **10** includes a reflector **145**, it will be appreciated that not all embodiments of the invention disclosed herein may employ a reflector **145**, and that when a reflector **145** is employed it may be used for certain optical preferences or to mask the electronics of the power conditioner **140**, **160**. The reflective surface of the reflector **145** may be white, reflective polished metal, or metal film over plastic, for example, and may have surface detail for certain optical effects, such as color mixing or controlling light distribution and/or focusing for example.

Referring to FIG. **12**, an embodiment includes an inner optic **180** disposed over the plurality of LEDs **120**. Employing an inner optic **180** not only provides protection to the LEDs **120** during installation of the luminaire **100** to a can fixture or junction box, but also offers another means of color-mixing and/or diffusing and/or color-temperature-adjusting the light output from the LEDs **120**. In alternative embodiments, the inner optic **180** may be a standalone element, or integrally formed with the reflector **145**. In an embodiment, the LEDs **120** are encapsulated in a phosphor of a type suitable to produce a color temperature output of 2700 deg-Kelvin. Other LEDs with or without phosphor encapsulation may be used to produce other color temperatures as desired.

Referring to FIG. **13**, a back surface **185** of the heat sink **110** includes a first plurality of recesses **190** oriented in a first direction, and a second plurality of recesses **195** oriented in a second opposing direction, each recess of the first plurality and the second plurality having a shape that promotes localized air movement within the respective recess due at least in part to localized air temperature gradients and resulting localized air pressure gradients. Without being held to any particular theory, it is contemplated that a teardrop-shaped recess **190**, **195** each having a narrow end and an opposing broad end will generate localized air temperatures in the narrow end that are higher than localized air temperatures in the associated broad end, due to the difference of proximity of the surrounding "heated" walls of the associated recess. It is contemplated that the presence of such air temperature gradients, with resulting air pressure gradients, within a given recess **190**, **195** will cause localized air movement within the associated recess, which in turn will enhance the overall heat transfer of the thermal system (the thermal system being the luminaire **100** as a whole). By alternating the orientation of the recesses **190**, **195**, such that the first plurality of recesses **190** and the second plurality of recesses **195** are disposed in an alternating fashion around the circumference of the back **185** of the heat sink **110**, it is contemplated that further enhancements in heat transfer will be achieved, either by the packing density of recesses achievable by nesting one recess **190** adjacent the other **195**, or by alternating the direction vectors of the localized air temperature/pressure gradients to enhance overall air movement. In an embodiment, the first plurality of recesses **190** have a first depth into the back surface of the heat sink, and the second plurality of recesses **195** have a second depth into the back surface of the heat sink, the first depth being different from the second depth, which is contemplated to further enhance heat transfer.

FIGS. **14-18** illustrate typical industry standard can-type light fixtures for recessed lighting (FIGS. **14-15**), and typical industry standard electrical junction boxes for ceiling or wall mounted lighting (FIGS. **16-18**). Embodiments of the invention are configured and sized for use with such fixtures of FIGS. **14-18**.

FIGS. **19-21** illustrate an alternative luminaire **100'** having a different form factor (flat top, flat outer optic, smaller appearance) as compared to luminaire **100** of FIGS. **1-4**.

FIGS. **22-23** illustrate alternative electronic power conditioners **140'**, **165'** having a different form factor as compared to power conditioners **140**, **165** of FIGS. **8** and **11**, respectively. All alternative embodiments disclosed herein, either explicitly, implicitly or equivalently, are considered within the scope of the invention.

FIGS. **24-26** illustrate an alternative reflector **145'** to that illustrated in FIGS. **10** and **12**, with FIG. **24** depicting an isometric view, FIG. **25** depicting a top view, and FIG. **26** depicting a side view of alternative reflector **145'**. As illustrated, reflector **145'** is conically-shaped with a centrally disposed aperture **215'** for receiving the LED package **120**. The cone of reflector **145'** has a shallow form factor so as to fit in the low profile luminaire **100**, **100'**. Similar to reflector **145**, the reflective surface of the reflector **145'** may be white, reflective polished metal, or metal film over plastic, for example, and may have surface detail for certain optical effects, such as color mixing or controlling light distribution and/or focusing for example. As discussed herein with respect to reflector **145**, alternative reflector **145'** may or may not be employed as required to obtain the desired optical effects.

From the foregoing, it will be appreciated that embodiments of the invention also include a luminaire **100** with a housing (collectively referred to by reference numerals **105**, **110** and **115**) having a light unit (collectively referred to by reference numerals **105** and **115**) and a trim unit **110**, the light unit including a light source **120**, the trim unit being mechanically separable from the light unit, a means for mechanically separating **130**, **135** the trim unit from the light unit providing a thermal conduction path therebetween, the light unit having sufficient thermal mass to spread heat generated by the light source to the means for mechanically separating, the trim unit having sufficient thermal mass to serve as a heat sink to dissipate heat generated by the light source.

From the foregoing, it will also be appreciated that embodiments of the invention further include a luminaire **100** for retrofit connection to an installed light fixture having a concealed in-use housing (see FIGS. **14-18** for example), the luminaire including a housing **105**, **110**, **115** having a light unit **105**, **115** and a trim unit **110**, the light unit comprising a light source **120**, the trim unit being mechanically separable from the light unit, the trim unit defining a heat sinking thermal management element configured to dissipate heat generated by the light source that is completely 100% external of the concealed in-use housing of the installed light fixture. As used herein, the term "concealed in-use housing" refers to a housing that is hidden behind a ceiling or a wall panel once the luminaire of the invention has been installed thereon.

Reference is now made to FIG. **27**, which depicts an exploded assembly view of an alternative luminaire **300** to that depicted in FIGS. **1-12**. Similar to luminaire **100** (where like elements are numbered alike, and similar elements are named alike but numbered differently), luminaire **300** includes a heat spreader **305** integrally formed with a heat sink **310** disposed diametrically outboard of the heat spreader **305** (the heat spreader **305** and heat sink **310** are collectively herein referred to as base **302**), an outer optic **315** securely retained relative to at least one of the heat spreader **305** and the heat sink **310**, a light source (LED) **120** disposed in thermal communication with the heat spreader **305**, and an electrical supply line **125** disposed in electrical communication with the light source **120**. The integrally formed heat spreader **305** and heat sink **310** provides for improved heat flow from the LED **120** to the heat sink **310** as the heat flow path therebetween is continuous and uninterrupted as compared to the luminaire **100** discussed above.

To provide for a low profile luminaire **300**, the combination of the heat spreader **305**, heat sink **310** and outer optic **315**, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25 (best seen by reference to FIG. **28**). In an example embodiment, height H is 1.5-inches, and outside dimension D is a diameter of 7-inches. Other dimensions for H and D are contemplated such that the combination of the heat spreader **305**, heat sink **310** and outer optic **315**, are so configured and dimensioned as to; (i) cover an opening defined by an industry standard can-type light fixture having nominal sizes from three-inches to six-inches (see FIGS. **14** and **15** for example); and, (ii) cover an opening defined by an industry standard electrical junction box having nominal sizes from three-inches to six-inches (see FIGS. **16** and **17** for example). Since can-type light fixtures and ceiling/wall mount junction boxes are designed for placement behind a ceiling or wall material, an example luminaire **300** has the back surface of the heat spreader **305** substantially planar with the back surface of the heat sink **310**, thereby permitting the luminaire **300** to sit substantially flush on the surface of the ceiling/wall material.

Alternatively, small standoffs **200** (see FIG. **12** in combination with FIG. **27** for example) may be used to promote air movement around the luminaire **300** for improved heat transfer to ambient, as discussed above.

Securement of the luminaire **300** to a junction box (see FIGS. **16-18** for example) may be accomplished by using a bracket **400** and suitable fasteners **405** (four illustrated) through appropriately spaced holes **410** (four illustrated) in the bracket **400**. Securement of the base **302** to the bracket **400** is accomplished using suitable fasteners **415** (two illustrated) through appropriately spaced holes **420** (two used, diametrically opposing each other, but only one visible) in the base **302**, and threaded holes **425** (two illustrated) in the bracket **400**. Securement of the optic **315** to the base **302** is accomplished using suitable fasteners **430** (three illustrated) through appropriately spaced holes **435** (three used, spaced 120 degrees apart, but only two illustrated) in tabs **445** of the optic **315**, and threaded holes **440** (three used, spaced 120 degrees apart, but only two illustrated) in the base **302**. A trim ring **470** circumferentially snap-fits over the optic **315** to hide the retaining fasteners **430**, the holes **435** and the tabs **445**. The snap-fit arrangement of the trim ring **470** relative to the optic **315** is such that the trim ring **470** can be removed in a pop-off manner for maintenance or other purposes.

Securement of the luminaire **300** to a can-type fixture (see FIGS. **14-15** for example) may be accomplished by using two torsion springs **450** each loosely coupled to the bracket **400** at a pair of notches **455** by placing the circular portion **460** of each torsion spring **450** over the pairs of notches **455**, and then engaging the hook ends **465** of the torsion spring **450** with suitable detents in the can-type fixture (known detent features of can-type light fixtures are depicted in FIGS. **14-15**). In an embodiment, the circular portion **460** of each torsion spring **450** and the distance between each notch of a respective pair of notches **455** are so dimensioned as to permit the torsion springs **450** to lay flat (that is, parallel with the back side of luminaire **300**) during shipping, and to be appropriately rotated for engagement with a can-type fixture during installation (as illustrated in FIGS. **27-30**).

A power conditioner **165** similar to that discussed above in connection with FIG. **11** receives AC power from electrical connections within the junction box or can-type fixture, and provides conditioned DC power to the light source (LED) **120**. While illustrative details of the electrical connections between the power conditioner **165** and the light source (LED) **120** are not specifically shown in FIG. **27**, one skilled in the art will readily understand how to provide such suitable connections when considering all that is disclosed herein in combination with information known to one skilled in the art. The housing of power conditioner **165** includes recesses **480** (one on each side, only one illustrated) that engage with tabs **485** of the bracket **400** to securely hold the power conditioner **165** in a snap-fit or frictional-fit engagement relative to the bracket **400**.

Reference is now made to FIGS. **28** and **29**, which depict a side view and a back view, respectively, of the luminaire **300**. As discussed above in reference to FIG. **28**, an overall height H and an overall outside dimension D is such that the ratio of H/D is equal to or less than 0.25. The back view depicted in FIG. **29** is comparable with the back view depicted in FIGS. **3**, **11** and **13**, but with a primary difference that can be seen in the configuration of the heat sinking fins. In FIGS. **3**, **11** and **13**, the back surface **185** of the heat sink **110** includes a first plurality of recesses **190** oriented in a first direction, and a second plurality of recesses **195** oriented in a second opposing direction, with each recess of the first plurality and the second plurality having a shape that promotes localized air movement within the respective recess due at least in part to localized air temperature gradients and resulting localized air pressure gradients. Such recesses **190**, **195** were employed at least in part due to the radial dimension of the heat sink **110**, which is ring-like in shape. In FIG. **29**, and as discussed above, the heat sink **310** is integrally formed with the heat spreader **305** to form the base **302**. With such an integrally formed base arrangement, radially oriented heat sink fins **475** are integrally formed over a substantial portion of the back surface of the base **302**, which provide for greater heat transfer than is available by the recesses **190**, **195** having a more limited radial dimension that is limited by the configuration of the heat sink **110**. Heat sink fins **475** alternate with adjacently disposed and radially oriented recesses **476** to form a star pattern about the center of the back side of luminaire **300**. Such a star pattern provides a plurality of air flow channels on the back side of the base **302** for efficiently distributing and dissipating heat generated by the light source (LED) **120** disposed on the front side of the heat spreader **305** of the base **302**.

In an embodiment, and with reference now to FIG. **30**, the outer optic **315** forms a blondel-type lens having a plurality of concentric circular flutes/ridges **490** formed and disposed on the inside surface of the outer optic **315**. With such a lens, the exact location of the light source **120** within the luminaire **300** is masked from the perspective of an observer standing a distance away from the luminaire **300**, thereby providing for a more uniform distribution of light. Such a lens may also be suitable for outer optic **115**. In an embodiment, the lens material used for outer optic **115**, **315** may be frosted. Example materials considered suitable for use in outer optic **115**, **315** include, but are not limited to, ACRYLITE® Acrylic Sheet Material available from CYRO Industries, and Acrylite Plus® also available from CYRO Industries.

Example materials considered suitable for use in reflector **145**, **145'** include, but are not limited to, MAKROLON® 2405, 2407 and 2456 available from Bayer Material Science, and MAKROLON® 6265 also available from Bayer Material Science.

While certain combinations of elements have been described herein, it will be appreciated that these certain combinations are for illustration purposes only and that any combination of any of the elements disclosed herein may be employed in accordance with an embodiment of the invention. Any and all such combinations are contemplated herein and are considered within the scope of the invention disclosed.

While embodiments of the invention have been described employing aluminum as a suitable heat transfer material for the heat spreader and heat sink, it will be appreciated that the scope of the invention is not so limited, and that the invention also applies to other suitable heat transfer materials, such as copper and copper alloys, or composites impregnated with heat transfer particulates, for example, such as plastic impregnated with carbon, copper, aluminum or other suitable heat transfer material, for example.

The particular and innovative arrangement of elements disclosed herein and all in accordance with an embodiment of the invention affords numerous not insignificant technical advantages in addition to providing an entirely novel and attractive visual appearance.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best or only mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

What is claimed is:

1. A luminaire, comprising:

a heat spreader and a heat sink thermally coupled to the heat spreader, the heat sink being substantially ring-shaped and being disposed around and coupled to an outer periphery of the heat spreader;

an outer optic securely retained relative to at least one of the heat spreader and the heat sink; and

a light source disposed in thermal communication with the heat spreader, the light source comprising a plurality of light emitting diodes (LEDs) that are disposed on the heat spreader such that the heat spreader dissipates heat from the LEDs;

wherein the heat spreader, the heat sink and the outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25;

wherein the combination defined by the heat spreader, the heat sink and the outer optic, is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

2. The luminaire of claim **1**, wherein:

the heat spreader and the heat sink are integrally formed such that a heat flow path from the light source through the heat spreader to the heat sink is continuous and uninterrupted.

3. The luminaire of claim **2**, wherein the integrally formed heat spreader and heat sink form a base, the base having a back surface with radially oriented recesses therein.

4. The luminaire of claim **2**, wherein the heat spreader and the heat sink are integrally formed to define a base, wherein a back side of the base comprises a plurality of heat sink fins and air flow channels configured and disposed to transport heat generated by the light source away from the light source.

5. The luminaire of claim **1**, wherein:

the heat spreader comprises mounting holes suitably spaced apart to receive mounting fasteners to secure the heat spreader to an electrical junction box.

6. The luminaire of claim **1**, further comprising:

a phosphor disposed over the plurality of LEDs comprising material to produce a color temperature output of 2700 deg-Kelvin.

7. The luminaire of claim **1**, further comprising:

a mounting bracket; and

a power conditioner, the power conditioner being configured and disposed to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs;

wherein the power conditioner is supported by the mounting bracket on one side thereof, and the heat spreader and heat sink are supported by the mounting bracket on another opposing side thereof; and

wherein the mounting bracket comprises mounting holes disposed to secure the luminaire to an electrical junction box.

8. The luminaire of claim 7, further comprising:

at least one torsion spring configured and disposed so as to secure the luminaire to a can light fixture.

9. The luminaire of claim 1, further comprising:

a trim ring;

wherein the outer optic is securely retained relative to at least one of the heat spreader and the heat sink via fasteners; and

wherein the trim ring snap-fits onto the outer optic in such a manner as to cover the fasteners securely retaining the outer optic.

10. The luminaire of claim 1, wherein a back surface of the heat spreader is substantially planar with a back surface of the heat sink.

11. The luminaire of claim 1, further comprising:

an inner optic disposed over the plurality of LEDs.

12. The luminaire of claim 11, wherein:

the inner optic is integrally formed with the reflector.

13. The luminaire of claim 11, wherein:

the inner optic comprises a color mixing diffuser.

14. The luminaire of claim 1, wherein at least some of the LEDs are connected to a circuit board, the circuit board being disposed substantially flat on the heat spreader inside a recessed portion of the heat sink.

15. The luminaire of claim 1, further comprising:

a power conditioner mechanically supported by the heat spreader, the power conditioner being configured and disposed to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs.

16. The luminaire of claim 15, wherein:

the power conditioner is disposed on a same side of the heat spreader as the plurality of LEDs.

17. The luminaire of claim 15, further comprising:

a reflector disposed on the heat spreader, the reflector having an aperture in which the plurality of LEDs are disposed.

18. The luminaire of claim 17, wherein:

the heat spreader comprises mounting holes and the reflector comprises mounting holes suitably spaced apart to receive mounting fasteners to secure the heat spreader to an electrical junction box.

19. The luminaire of claim 15, wherein:

the power conditioner is disposed on an opposite side of the heat spreader as the plurality of LEDs, the power conditioner being so dimensioned as to fit within: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box.

20. A luminaire, comprising:

a heat spreader and a ring-shaped heat sink thermally coupled to and disposed diametrically outboard of the heat spreader;

an outer optic securely retained relative to at least one of the heat spreader and the heat sink;

a light source disposed in thermal communication with the heat spreader, the light source comprising a plurality of light emitting diodes (LEDs) that are disposed on the heat spreader such that the heat spreader dissipates heat from the LEDs;

the heat spreader, the heat sink and the outer optic define a combination having an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25; and

a power conditioner disposed in electrical communication with the light source, the power conditioner being configured to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs, the power conditioner being so dimensioned as to fit within at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box.

21. The luminaire of claim 20, wherein:

the power conditioner is so dimensioned as to fit completely within at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box.

22. The luminaire of claim 21, wherein:

the defined combination is so dimensioned as to cover a circular opening defined by at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box.

23. The luminaire of claim 20, wherein:

the heat sink forms a trim plate that is disposed completely external of the can light fixture or the electrical junction box.

* * * * *

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(54) **LOW PROFILE LIGHT AND ACCESSORY KIT FOR THE SAME**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(58) **Field of Classification Search**
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See application file for complete search history.

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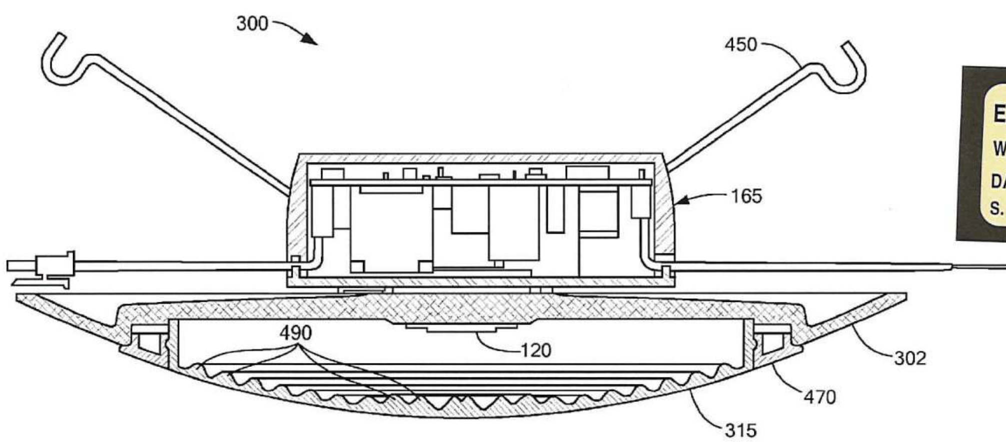
(57) **ABSTRACT**

A luminaire includes a heat spreader, a heat sink, a light source and an outer optic. The heat sink is substantially ring-shaped and is disposed around and in thermal communication with an outer periphery of the heat spreader. The light source is disposed in thermal communication with the heat spreader, the light source having a plurality of light emitting diodes (LEDs) that are disposed in thermal communication with the heat spreader. The outer optic is disposed in optical communication with the plurality of LEDs. The heat spreader, the heat sink and the outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

24 Claims, 17 Drawing Sheets



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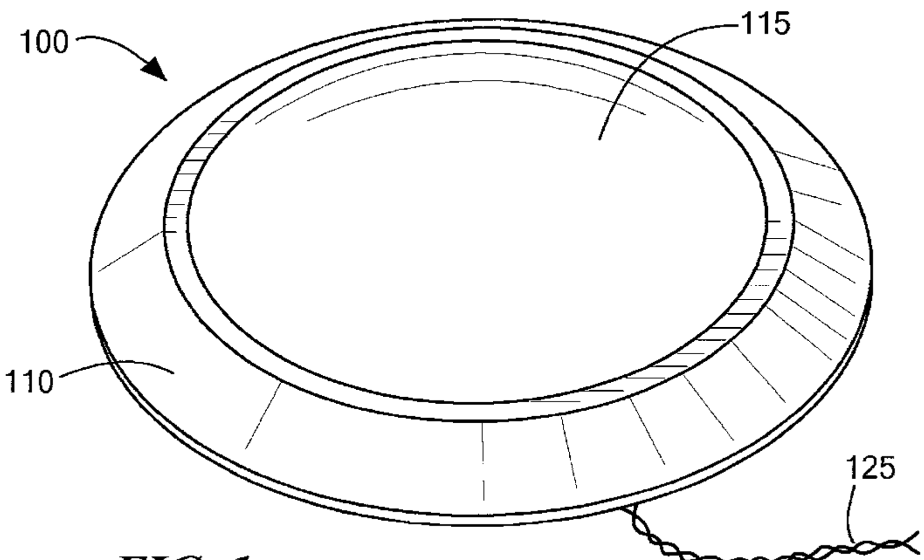

FIG. 1

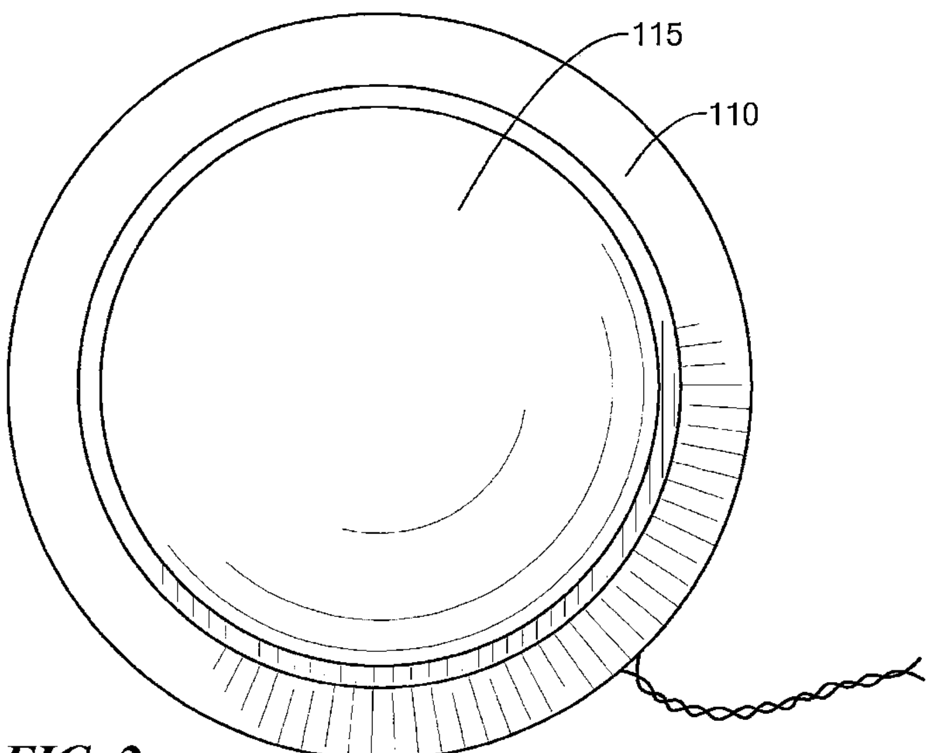

FIG. 2

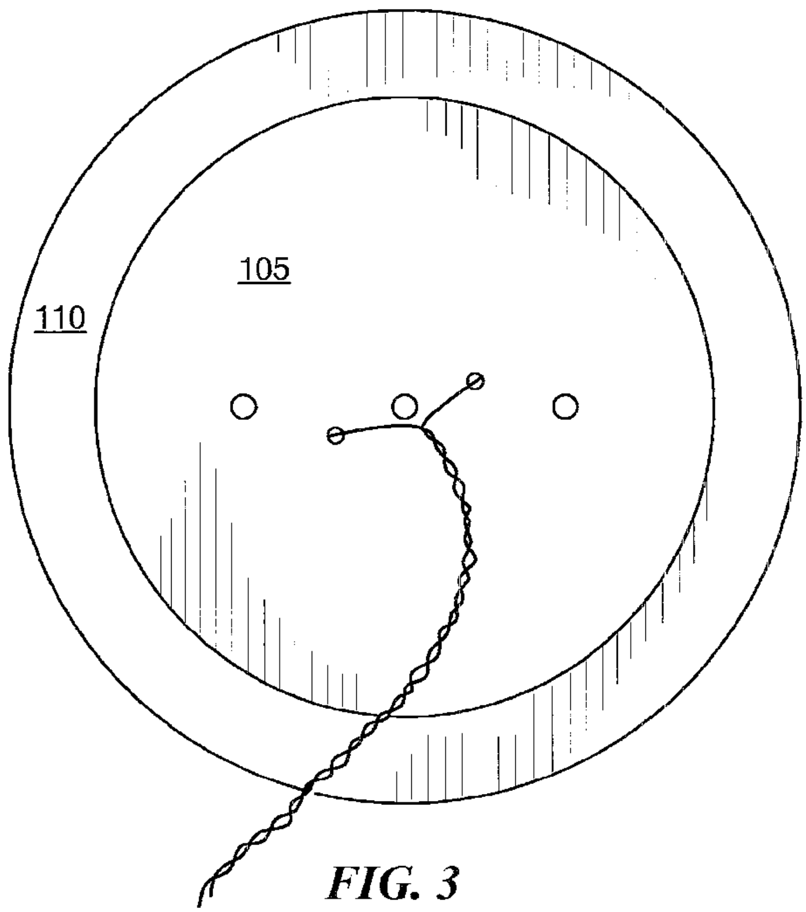

FIG. 3

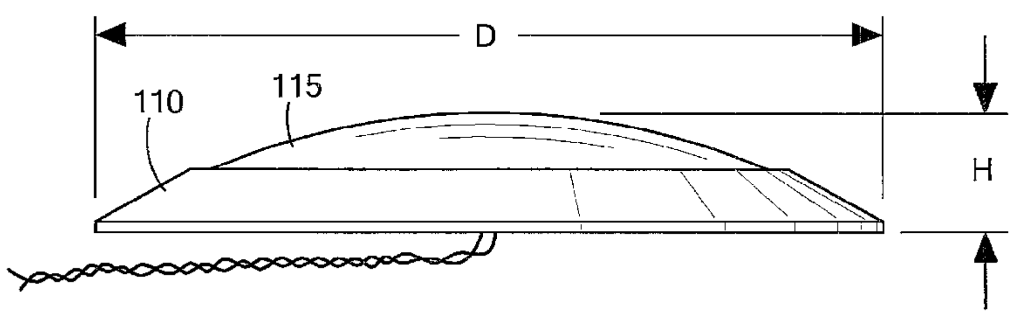

FIG. 4

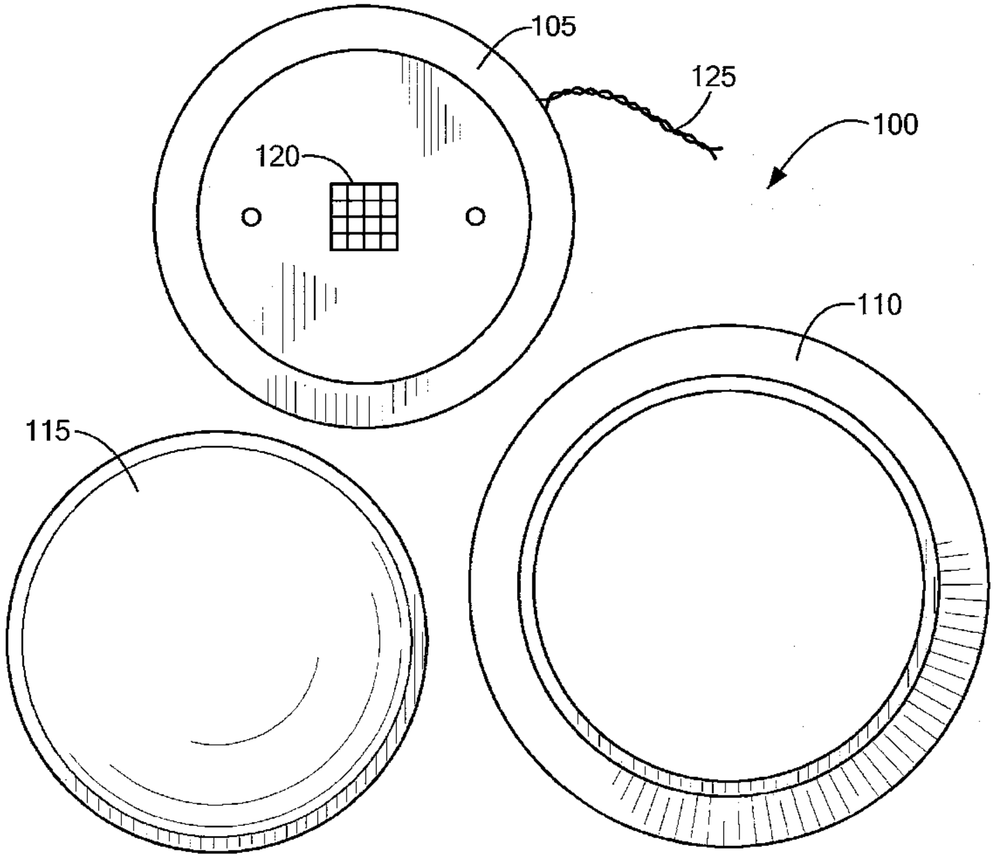

FIG. 5

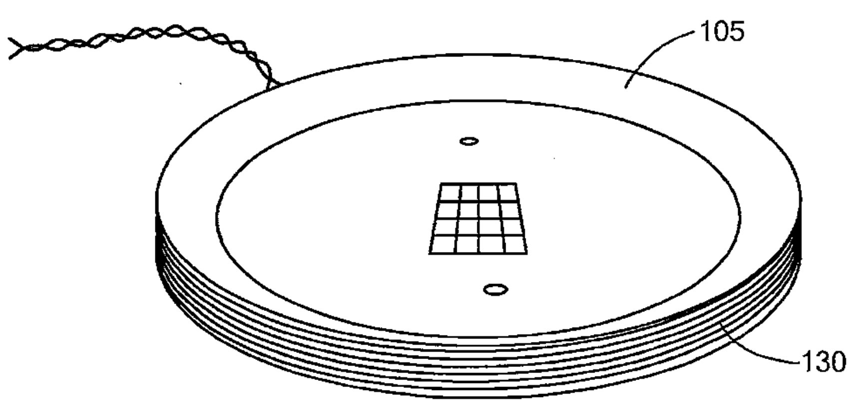

FIG. 6

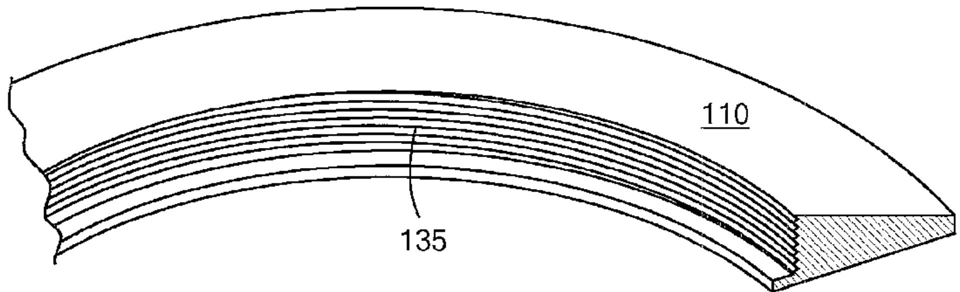

FIG. 7

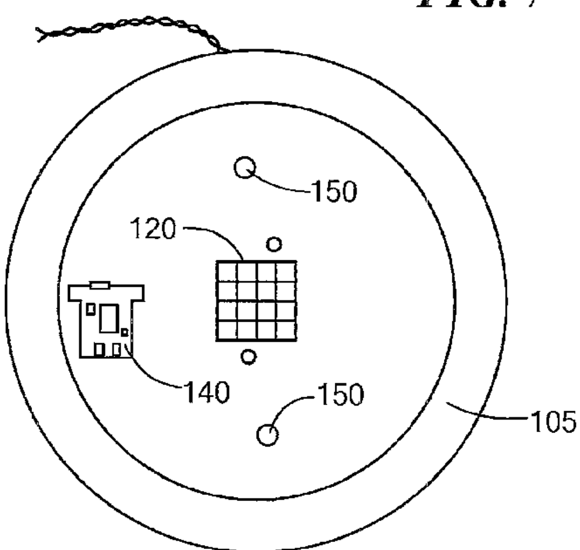

FIG. 8

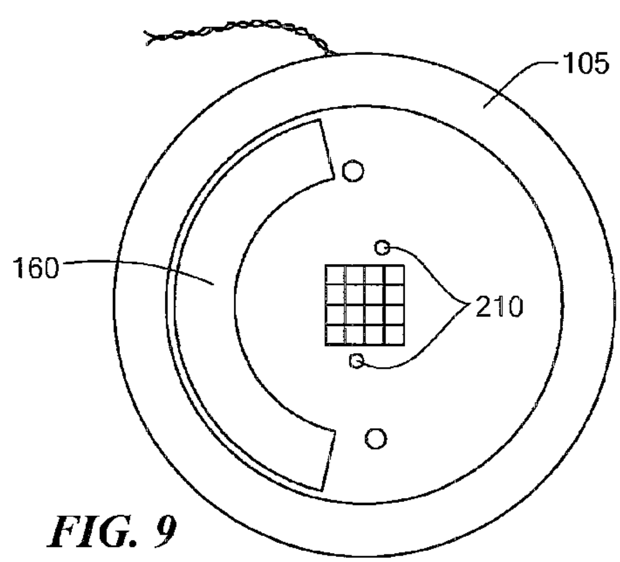

FIG. 9

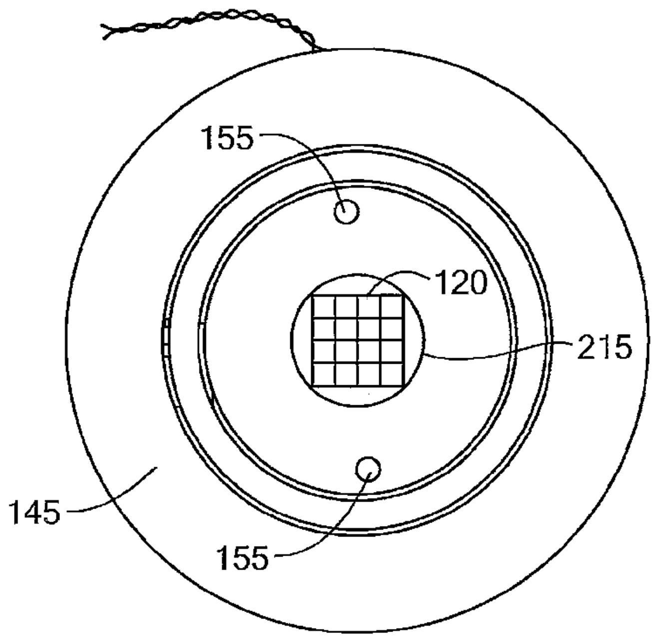

FIG. 10

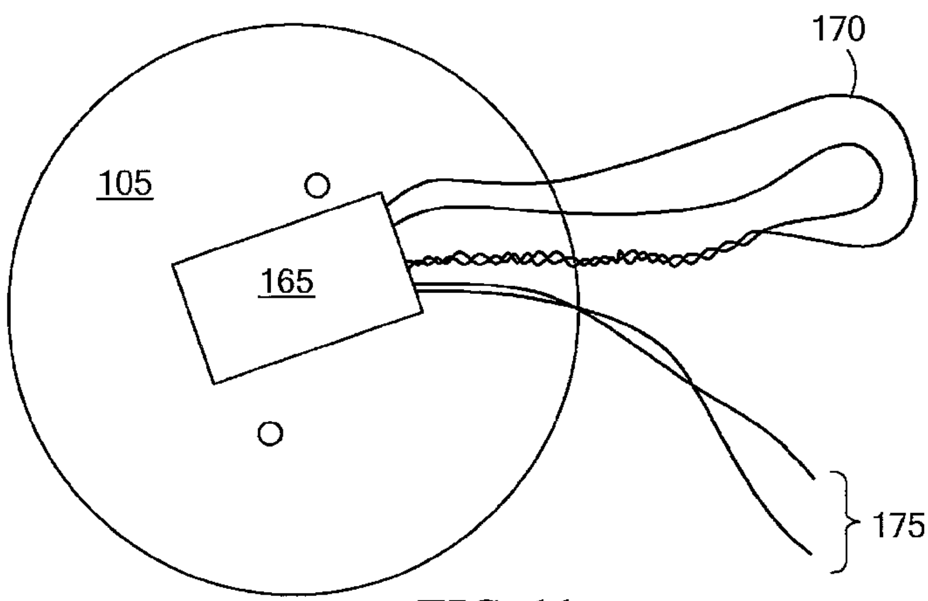

FIG. 11

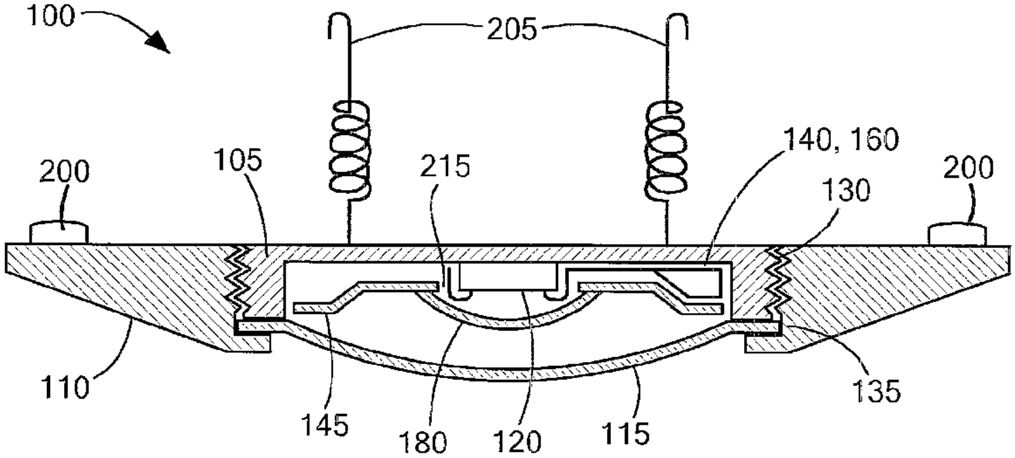
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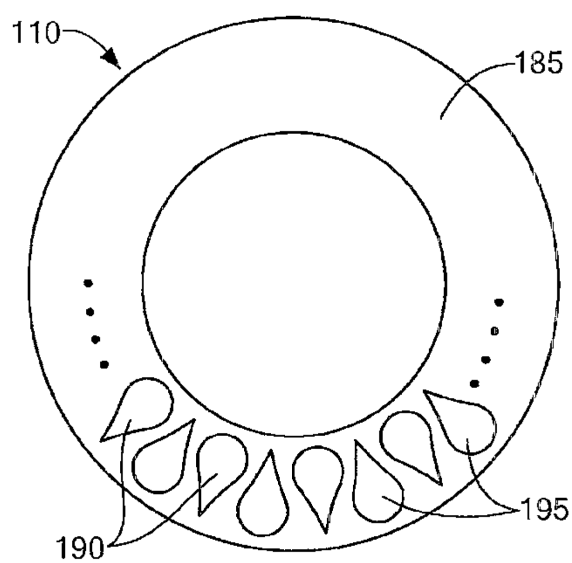
FIG. 12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195
190

FIG. 13

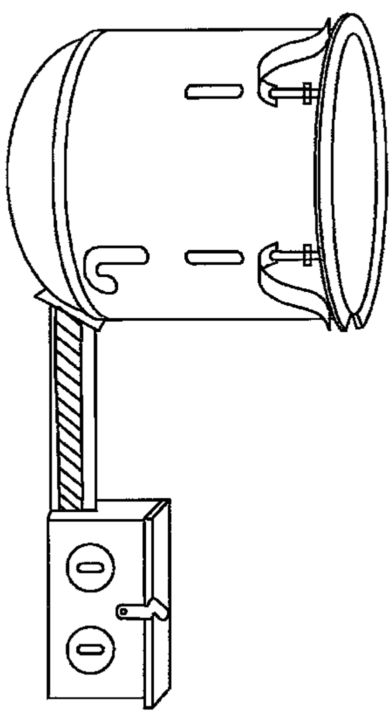

FIG. 14

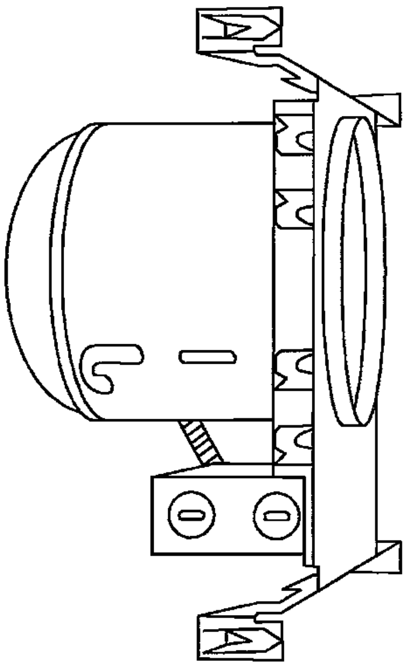

FIG. 15

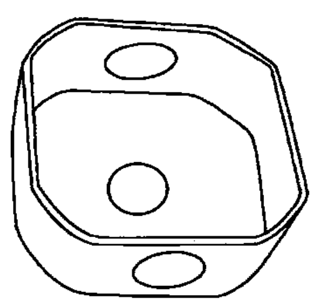

FIG. 16

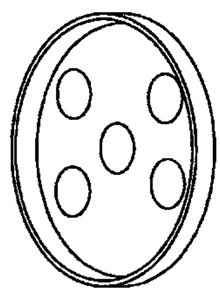

FIG. 17

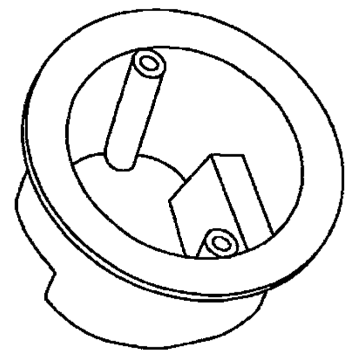

FIG. 18

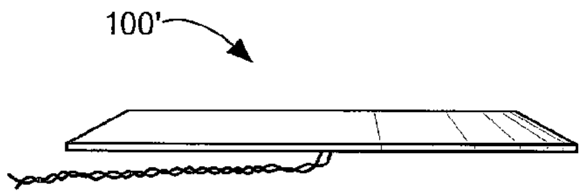

FIG. 19

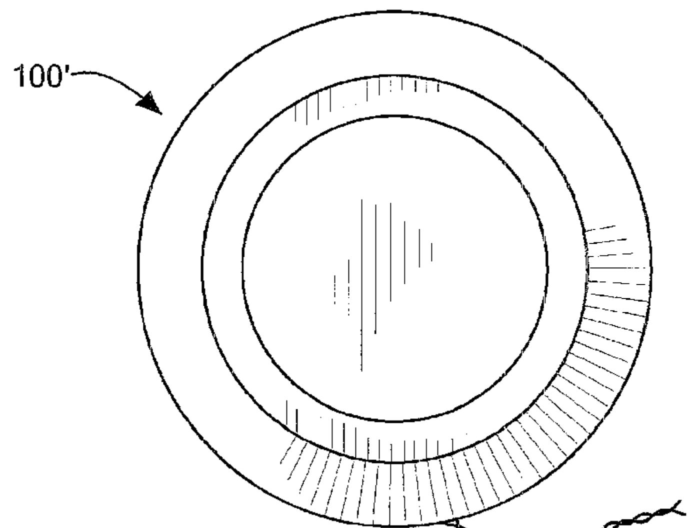

FIG. 20

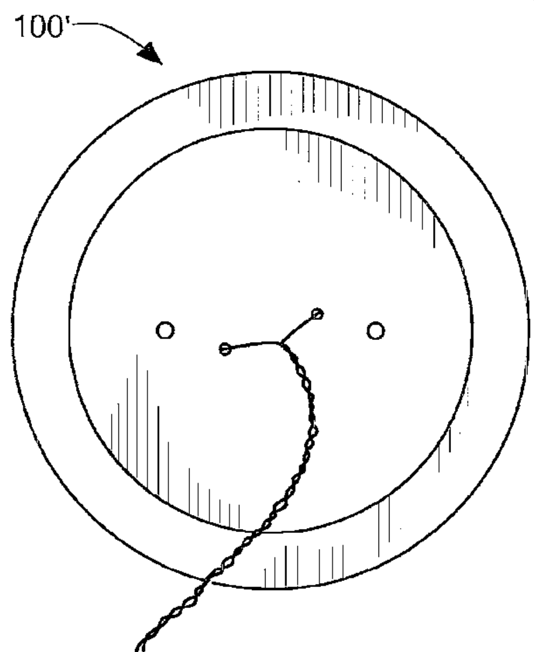

FIG. 21

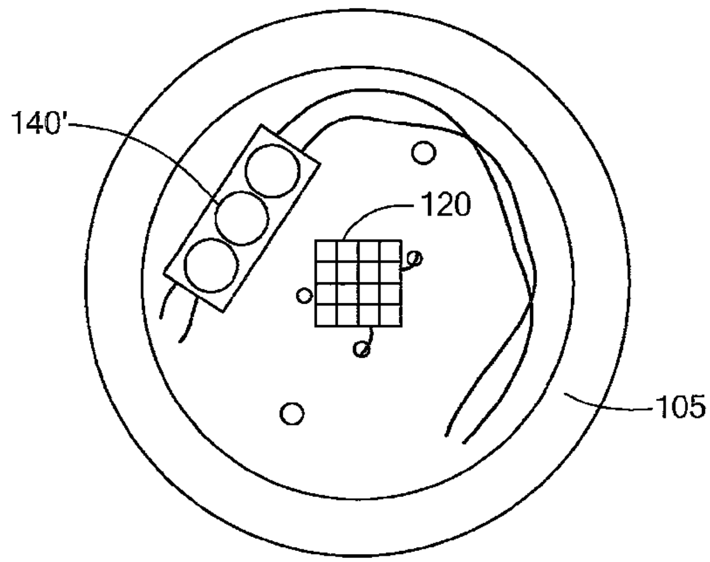

FIG. 22

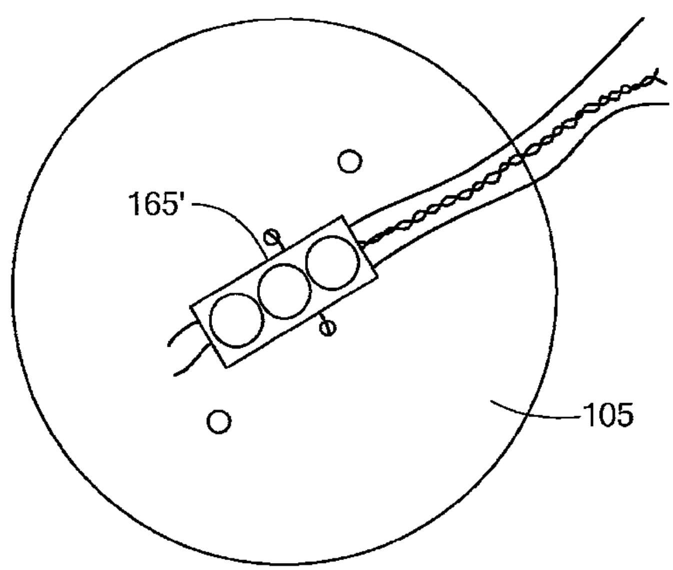

FIG. 23

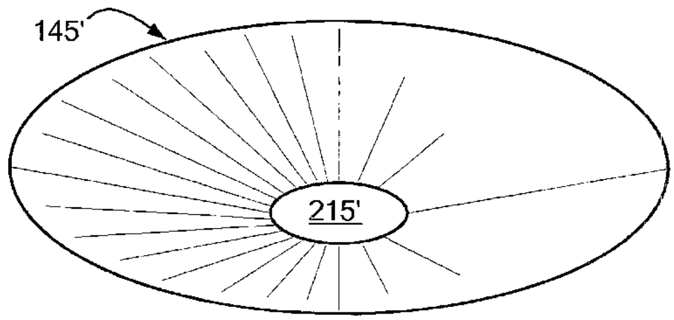

FIG. 24

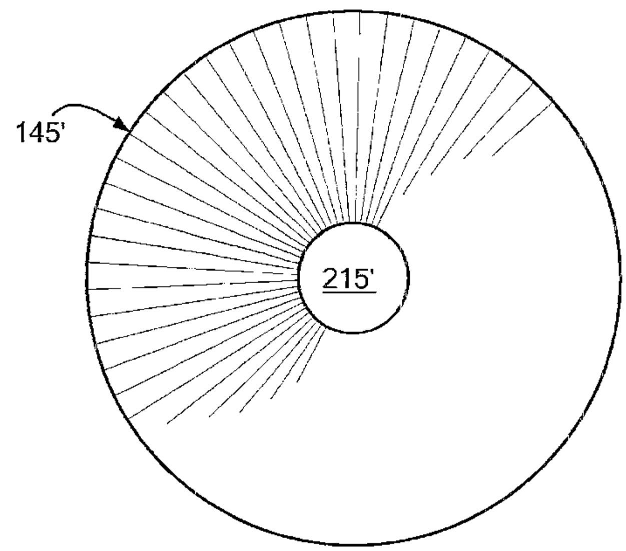

FIG. 25

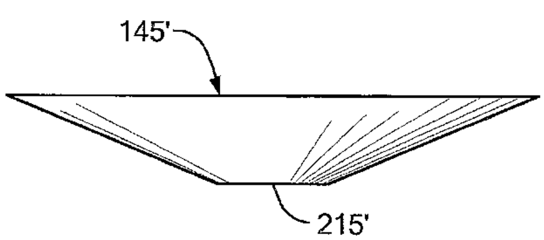

FIG. 26

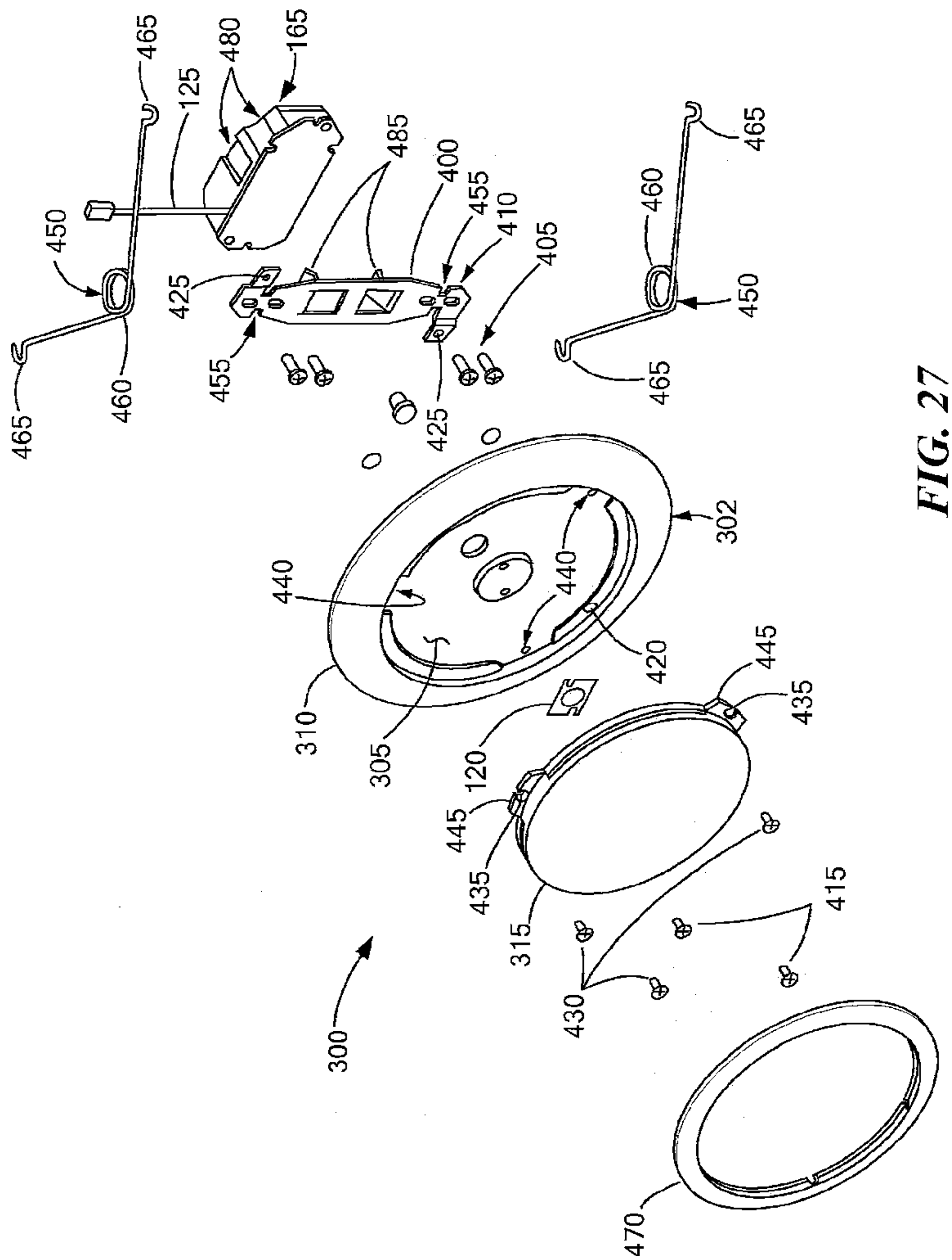
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FIG. 27

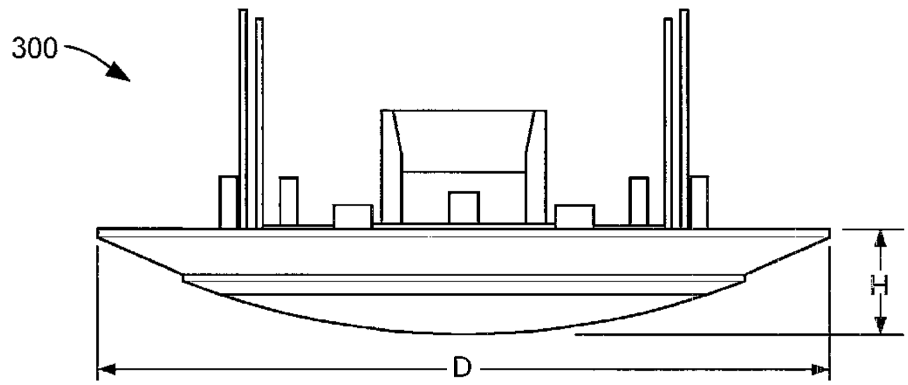

FIG. 28

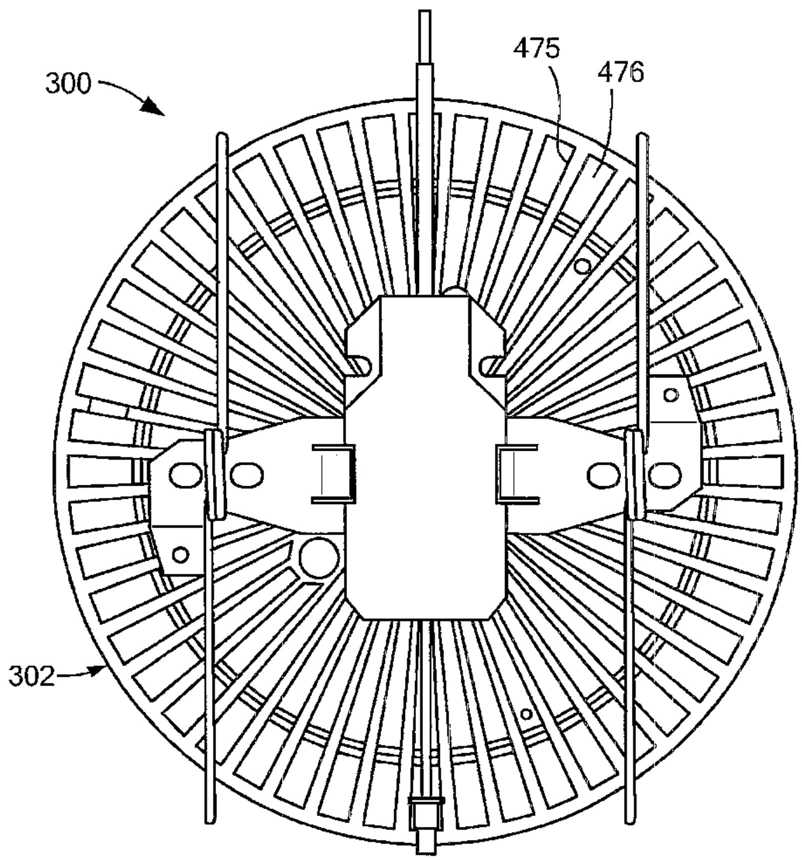

FIG. 29

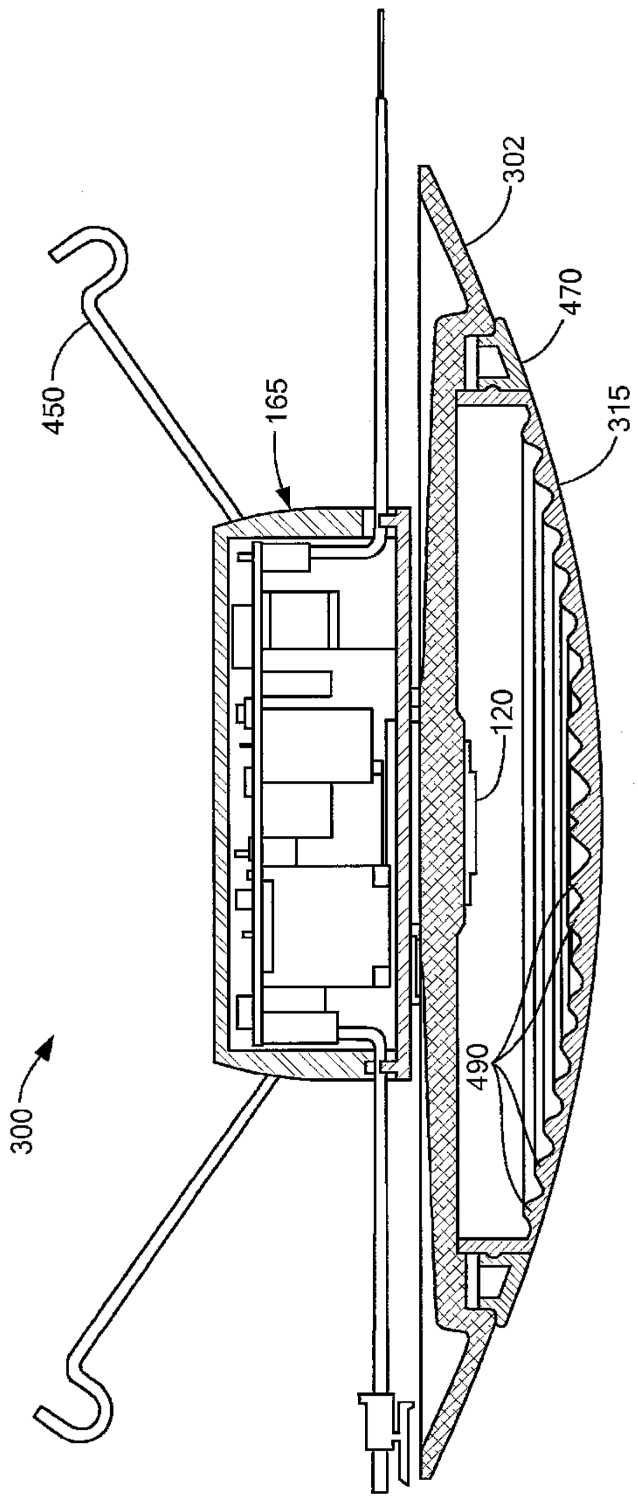

FIG. 30

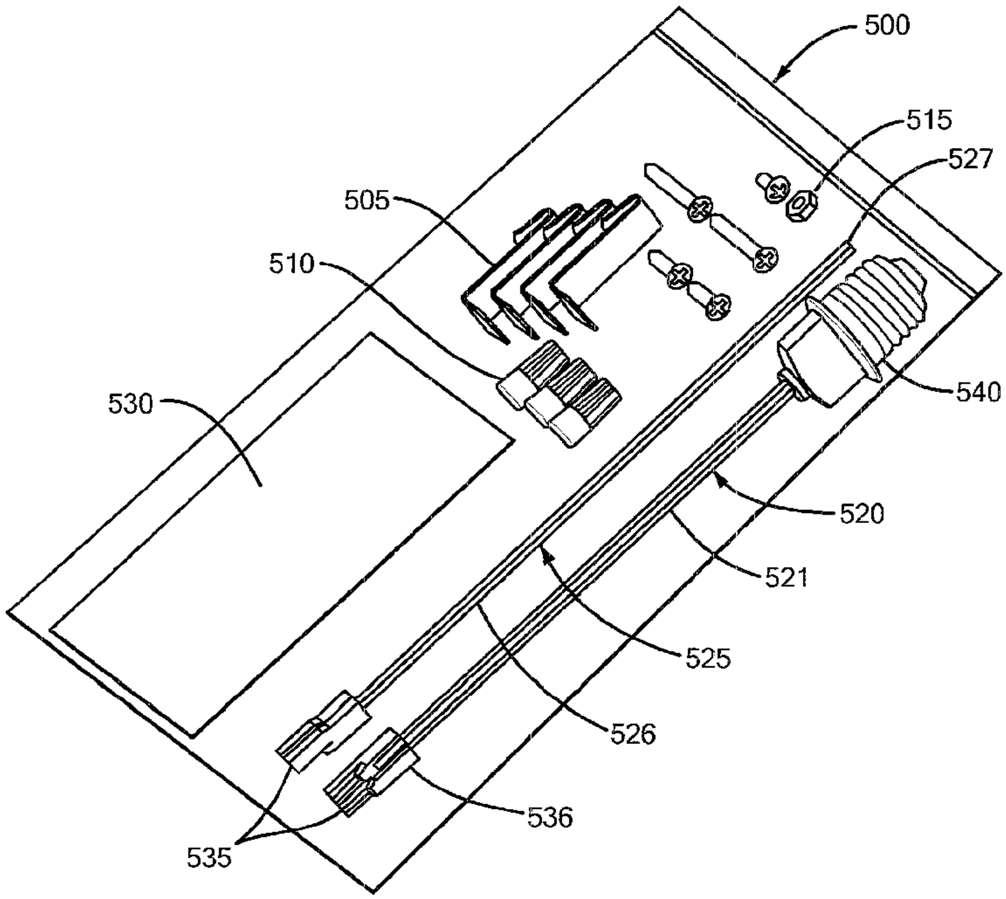
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FIG. 31

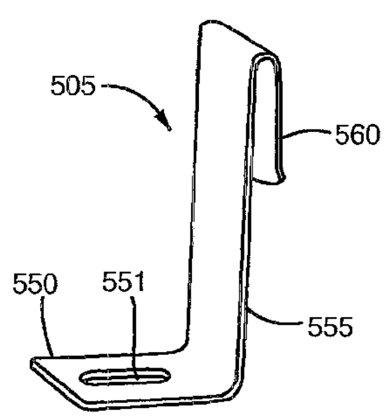
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FIG. 32

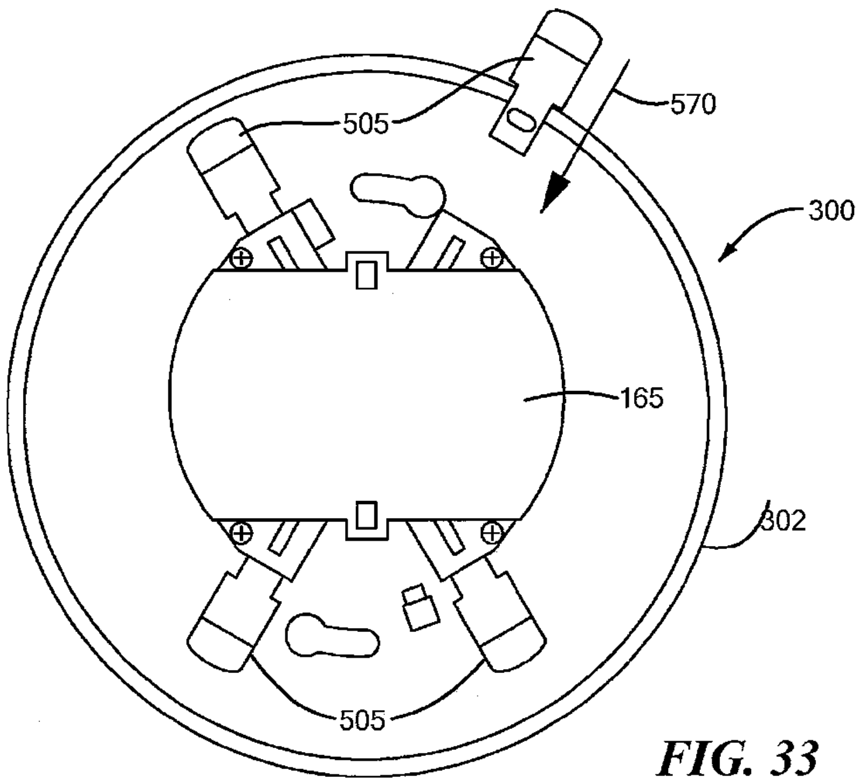

FIG. 33

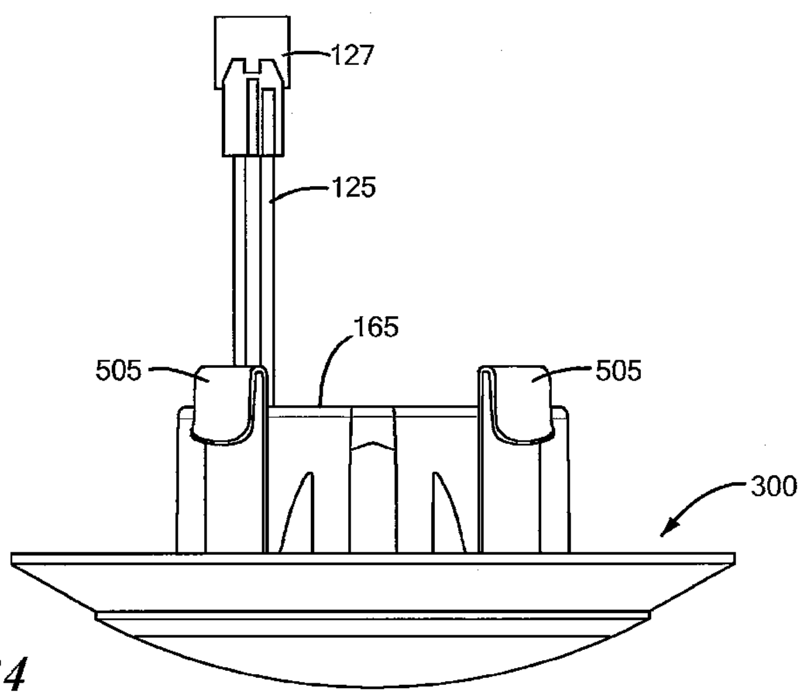

FIG. 34

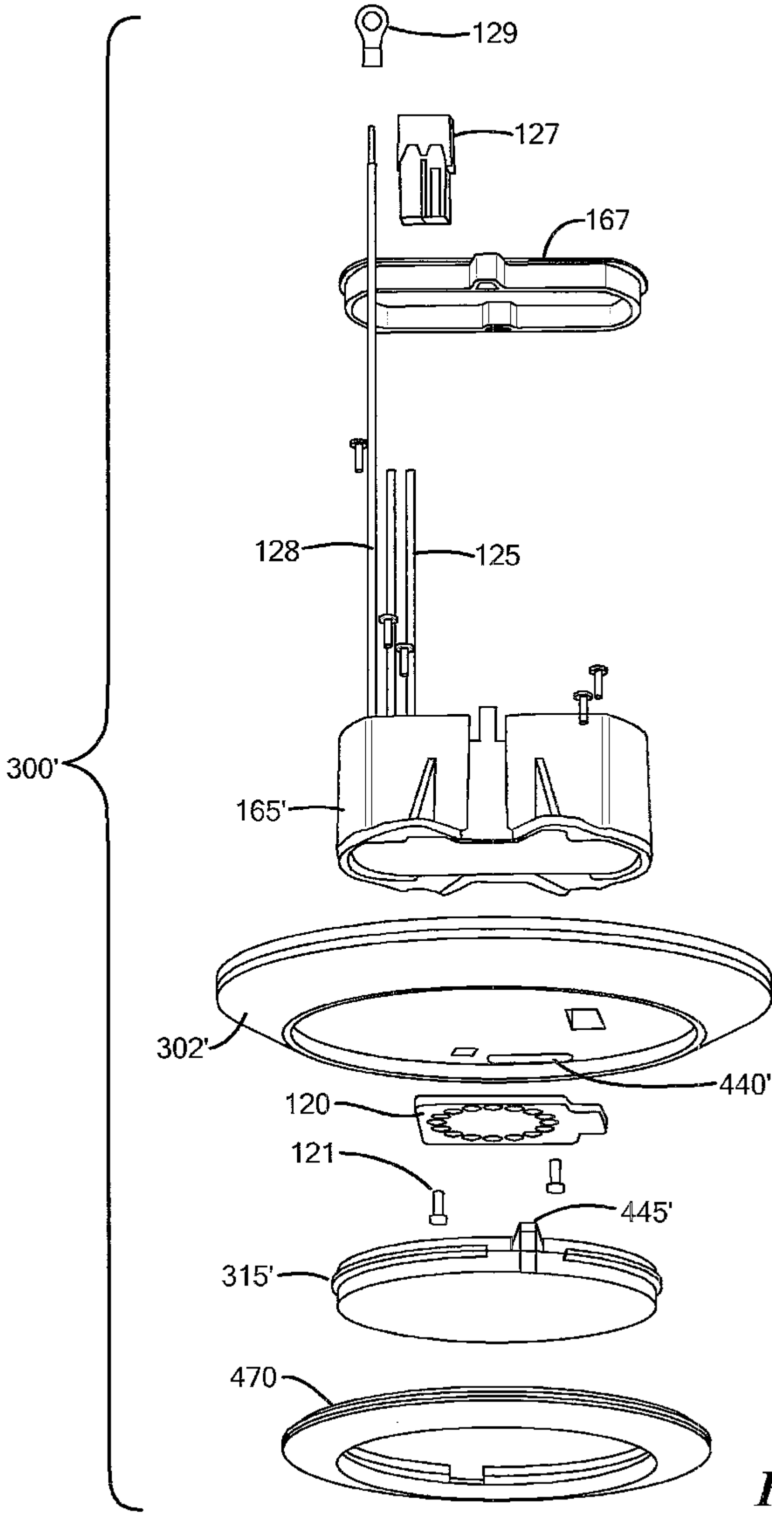

FIG. 35

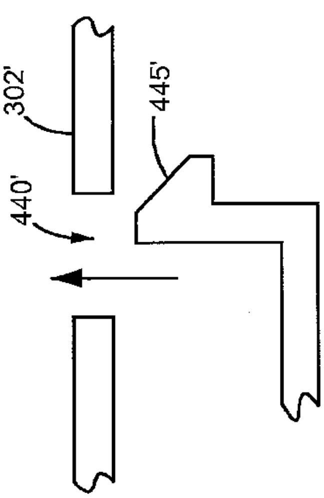

FIG. 36A

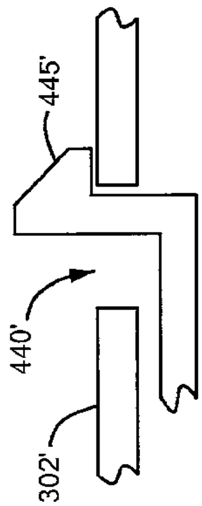

FIG. 36B

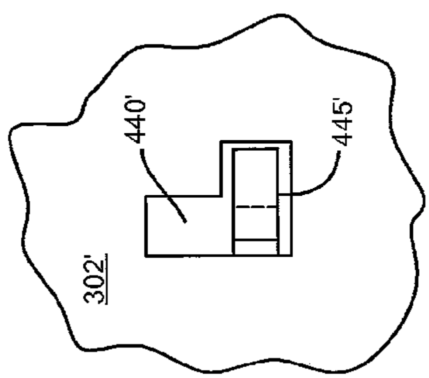

FIG. 37A

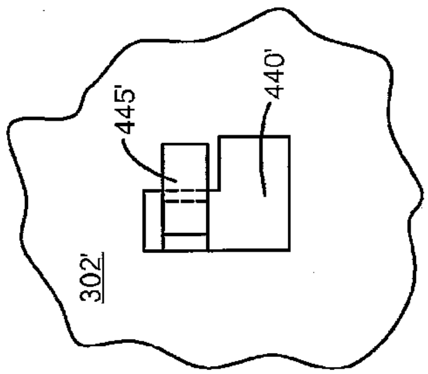

FIG. 37B

LOW PROFILE LIGHT AND ACCESSORY KIT FOR THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 13/476,388, filed May 21, 2012, which is a continuation-in-part of U.S. application Ser. No. 12/775,310, filed May 6, 2010, now U.S. Pat. No. 8,201,968, which claims the benefit of U.S. Provisional Application Ser. No. 61/248,665, filed Oct. 5, 2009, all of which are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

The present disclosure relates generally to lighting, particularly to low profile lighting, and more particularly to low profile downlighting for retrofit applications.

Light fixtures come in many shapes and sizes, with some being configured for new work installations while others are configured for old work installations. New work installations are not limited to as many constraints as old work installations, which must take into account the type of electrical fixture/enclosure or junction box existing behind a ceiling or wall panel material. With recessed ceiling lighting, sheet metal can-type light fixtures are typically used, while surface-mounted ceiling and wall lighting typically use metal or plastic junction boxes of a variety of sizes and depths. With the advent of LED (light emitting diode) lighting, there is a great need to not only provide new work LED light fixtures, but to also provide LED light fixtures that are suitable for old work applications, thereby enabling retrofit installations. One way of providing old work LED lighting is to configure an LED luminaire in such a manner as to utilize the volume of space available within an existing fixture (can-type fixture or junction box). However, such configurations typically result in unique designs for each type and size of fixture. Accordingly, there is a need in the art for an LED lighting apparatus that overcomes these drawbacks.

This background information is provided to reveal information believed by the applicant to be of possible relevance to the present invention. No admission is necessarily intended, nor should be construed, that any of the preceding information constitutes prior art against the present invention.

BRIEF DESCRIPTION OF THE INVENTION

An embodiment of the invention includes a luminaire having a heat spreader, a heat sink, a light source and an outer optic. The heat sink is substantially ring-shaped and is disposed around and in thermal communication with an outer periphery of the heat spreader. The light source is disposed in thermal communication with the heat spreader, the light source having a plurality of light emitting diodes (LEDs) that are disposed in thermal communication with the heat spreader such that the heat spreader facilitates transfer of heat from the LEDs to the heat sink. The outer optic is disposed in optical communication with the plurality of LEDs. The heat spreader, the heat sink and the outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a heat spreader, a heat sink, a light source, an outer optic,

and a power conditioner. The heat sink is substantially ring-shaped and is disposed around and in thermal communication with an outer periphery of the heat spreader. The light source is disposed in thermal communication with the heat spreader, the light source having a plurality of light emitting diodes (LEDs) that are disposed in thermal communication with the heat spreader such that the heat spreader facilitates transfer of heat from the LEDs to the heat sink. The outer optic is disposed in optical communication with the plurality of LEDs. The power conditioner is disposed and configured to receive AC voltage from an electrical supply and to provide DC voltage for the plurality of LEDs.

An embodiment of the invention includes a luminaire having a heat spreader, a heat sink a light source, an outer optic, and a power conditioner. The heat sink is substantially ring-shaped and is disposed around and in thermal communication with an outer periphery of the heat spreader. The light source is disposed in thermal communication with the heat spreader, the light source having a plurality of light emitting diodes (LEDs) that are disposed in thermal communication with the heat spreader such that the heat spreader facilitates transfer of heat from the LEDs to the heat sink. The outer optic is disposed in optical communication with the plurality of LEDs. The power conditioner is disposed and configured to receive AC voltage from an electrical supply and to provide DC voltage for the plurality of LEDs. The LEDs are disposed on one side of the heat spreader and the power conditioner is disposed on another opposing side of the heat spreader. The power conditioner is configured and sized to fit at least partially within an interior space of: a nominally sized can light fixture; and, a nominally sized electrical junction box. The heat spreader, the heat sink and the outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a heat spreader and a heat sink thermally coupled to and disposed diametrically outboard of the heat spreader, an outer optic securely retained relative to at least one of the heat spreader and the heat sink, and a light source disposed in thermal communication with the heat spreader, the light source having a plurality of light emitting diodes (LEDs). The heat spreader, the heat sink and the outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25. The combination defined by the heat spreader, the heat sink and the outer optic, is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a heat spreader and a heat sink thermally coupled to and disposed diametrically outboard of the heat spreader. An outer optic is securely retained relative to at least one of the heat spreader and the heat sink. A light source is disposed in thermal communication with the heat spreader, the light source having a plurality of light emitting diodes (LEDs). A power conditioner is disposed in electrical communication with the light source, the power conditioner being configured to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs, the power conditioner being so dimensioned as to fit within at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a heat spreader, a heat sink thermally coupled to and disposed diametrically outboard of the heat spreader, an outer optic securely retained relative to at least one of the heat spreader and the heat sink, a light source disposed in thermal communication with the heat spreader, and an electrical supply line disposed in electrical communication with the light source. The heat spreader, heat sink and outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25. The defined combination is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a housing with a light unit and a trim unit. The light unit includes a light source, and the trim unit is mechanically separable from the light unit. A means for mechanically separating the trim unit from the light unit provides a thermal conduction path therebetween. The light unit has sufficient thermal mass to spread heat generated by the light source to the means for mechanically separating, and the trim unit has sufficient thermal mass to serve as a heat sink to dissipate heat generated by the light source.

An embodiment of the invention includes a luminaire for retrofit connection to an installed light fixture having a concealed in-use housing. The luminaire includes a housing having a light unit and a trim unit, the light unit having a light source, and the trim unit being mechanically separable from the light unit. The trim unit defines a heat sinking thermal management element, configured to dissipate heat generated by the light source, that is completely 100% external of the concealed in-use housing of the installed light fixture.

An embodiment of the invention includes a luminaire and accessory kit combination. The luminaire includes a heat spreader; a heat sink; an LED light source; a power supply; an electrical supply line having a first end connected to the power supply, and a second end connected to a plug-in connector; and, an optic securely retained relative to the heat spreader or heat sink. The accessory kit includes a first pre-wired jumper including a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an Edison base electrically connected at the other end; and/or, a second pre-wired jumper including a pair of insulated electrical wires having a second plug-in connector electrically connected at one end and unconnected wire ends at the other end. The plug-in connector of the first pre-wired jumper and the second pre-wired jumper are each configured to electrically engage with the plug-in connector of the electrical supply line.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the exemplary drawings wherein like elements are numbered alike in the accompanying Figures, abbreviated in each illustration as "Fig.":

FIG. **1** depicts an isometric top view of a luminaire in accordance with an embodiment of the invention;

FIG. **2** depicts a top view of the luminaire of FIG. **1**;

FIG. **3** depicts a bottom view of the luminaire of FIG. **1**;

FIG. **4** depicts a side view of the luminaire of FIG. **1**;

FIG. **5** depicts a top view of a heat spreader assembly, a heat sink, and an outer optic in accordance with an embodiment of the invention;

FIG. **6** depicts an isometric view of the heat spreader of FIG. **5**;

FIG. **7** depicts a partial isometric view of the heat sink of FIG. **5**;

FIG. **8** depicts a top view of an alternative heat spreader assembly in accordance with an embodiment of the invention;

FIG. **9** depicts a top view of another alternative heat spreader assembly in accordance with an embodiment of the invention;

FIG. **10** depicts a top view of yet another alternative heat spreader assembly in accordance with an embodiment of the invention;

FIG. **11** depicts a bottom view of a heat spreader having a power conditioner in accordance with an embodiment of the invention;

FIG. **12** depicts a section view of a luminaire in accordance with an embodiment of the invention;

FIG. **13** depicts a bottom view of a heat sink having recesses in accordance with an embodiment of the invention;

FIGS. **14-18** depict isometric views of existing electrical can-type light fixtures and electrical junction boxes for use in accordance with an embodiment of the invention;

FIGS. **19-21** depict a side view, top view and bottom view, respectively, of a luminaire similar but alternative to that of FIGS. **2-4**, in accordance with an embodiment of the invention;

FIGS. **22-23** depict top and bottom views, respectively, of a heat spreader having an alternative power conditioner in accordance with an embodiment of the invention;

FIG. **24-26** depict in isometric, top and side views, respectively, an alternative reflector to that depicted in FIGS. **10** and **12**;

FIG. **27** depicts an exploded assembly view of an alternative luminaire in accordance with an embodiment of the invention;

FIG. **28** depicts a side view of the luminaire of FIG. **27**;

FIG. **29** depicts a back view of the luminaire of FIG. **27**;

FIG. **30** depicts a cross section view of the luminaire of FIG. **27**, and more particularly depicts a cross section view of the outer optic used in accordance with an embodiment of the invention;

FIG. **31** depicts an accessory kit in accordance with an embodiment of the invention;

FIG. **32** depicts a formed spring included in the accessory kit of FIG. **31**;

FIG. **33** depicts a top-down view of a luminaire similar to that depicted in FIG. **27**, and illustrative of an assembly of a formed spring of FIG. **32** onto the luminaire;

FIG. **34** depicts a side view of the luminaire of FIG. **33**;

FIG. **35** depicts an exploded assembly view of the luminaire of FIGS. **33** and **34**;

FIGS. **36A** and **36B** are side view depictions of a first position (not engaged) and a second position (engaged), respectively, of an engagement tab of an optic snap-fitting into an engagement opening of a base, where both the optic and the base are part of the luminaire of FIG. **35**; and

FIGS. **37A** and **37B** are plan view depictions of an alternative arrangement to that depicted in FIGS. **36A** and **36B**, respectively, and more specifically are depictions of a first position (not engaged) and a second position (engaged), respectively, of an engagement tab of an optic rotationally-fitting into an engagement opening of a base, where both the optic and the base are part of the luminaire of FIG. **35**.

DETAILED DESCRIPTION OF THE INVENTION

Although the following detailed description contains many specifics for the purposes of illustration, anyone of ordinary skill in the art will appreciate that many variations and alterations to the following details are within the scope of the invention. Accordingly, the following preferred embodiments of the invention are set forth without any loss of generality to, and without imposing limitations upon, the claimed invention.

An embodiment of the invention, as shown and described by the various figures and accompanying text, provides a low profile downlight, more generally referred to as a luminaire, having an LED light source disposed on a heat spreader, which in turn is thermally coupled to a heat sink that also serves as the trim plate of the luminaire. The luminaire is configured and dimensioned for retrofit installation on standard can-type light fixtures used for recessed ceiling lighting, and on standard ceiling or wall junction boxes (J-boxes) used for ceiling or wall mounted lighting. The luminaire is also suitable for new work installation. Retrofit installation of the luminaire is accomplished utilizing an accessory kit that includes a pre-wired electrical jumper and mounting hardware. For installations involving a can-type fixture, the pre-wired jumper includes a plug-in connector electrically connected to an Edison base via flexible insulated wires For installations involving a J-box, the pre-wired jumper includes a plug-in connector electrically connected to flexible insulated wires that may or may not be pre-stripped, or partially pre-stripped, on the opposing end.

While embodiments of the invention described and illustrated herein depict an example luminaire for use as a downlight when disposed upon a ceiling, it will be appreciated that embodiments of the invention also encompass other lighting applications, such as a wall sconce for example.

While embodiments of the invention described and illustrated herein depict example power conditioners having visually defined sizes, it will be appreciated that embodiments of the invention also encompass other power conditioners having other sizes as long as the power conditioners fall within the ambit of the invention disclosed herein.

Referring to FIGS. **1-26** collectively, a luminaire **100** includes a heat spreader **105**, a heat sink **110** thermally coupled to and disposed diametrically outboard of the heat spreader, an outer optic **115** securely retained relative to at least one of the heat spreader **105** and the heat sink **110**, a light source **120** disposed in thermal communication with the heat spreader **105**, and an electrical supply line **125** disposed in electrical communication with the light source **120**. To provide for a low profile luminaire **100**, the combination of the heat spreader **105**, heat sink **110** and outer optic **115**, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25. In an example embodiment, height H is 1.5-inches, and outside dimension D is a diameter of 7-inches. Other dimensions for H and D are contemplated such that the combination of the heat spreader **105**, heat sink **110** and outer optic **115**, are configured and sized so as to; (i) cover an opening defined by an industry standard can-type light fixture having nominal sizes from three-inches to six-inches, such as a four-inch can or a six-inch can for example (see FIGS. **14** and **15** for example); and, (ii) cover an opening defined by an industry standard electrical junction box having nominal sizes from three-inches to six-inches, such as a four-inch J-box or a six-inch J-box for example (see FIGS. **16** and **17** for example). Since can-type light fixtures and ceiling/wall mount junction boxes are designed for placement behind a ceiling or wall material, an example luminaire has the back surface of the heat spreader **105** substantially planar with the back surface of the heat sink **110**, thereby permitting the luminaire **100** to sit substantially flush on the surface of the ceiling/wall material. Alternatively, small standoffs **200** (see FIG. **12** for example) may be used to promote air movement around the luminaire **100** for improved heat transfer to ambient air, which will be discussed further below. Securement of the luminaire **100** to a junction box may be accomplished by using suitable fasteners through appropriately spaced holes **150** (see FIG. **8** for example), and securement of the luminaire **100** to a can-type fixture may be accomplished by using extension springs **205** fastened at one end to the heat spreader **105** (see FIG. **12** for example) and then hooked at the other end onto an interior detail of the can-type fixture.

In an embodiment, the light source **120** includes a plurality of light emitting diodes (LEDs) (also herein referred to as an LED chip package), which is represented by the "checkered box" in FIGS. **5**, **6** and **8-10**. In application, the LED chip package generates heat at the junction of each LED die. To dissipate this heat, the LED chip package is disposed in suitable thermal communication with the heat spreader **105**, which in an embodiment is made using aluminum, and the heat spreader is disposed in suitable thermal communication with the heat sink **110**, which in an embodiment is also made using aluminum. To provide for suitable heat transfer from the heat spreader **105** to the heat sink **110**, an embodiment employs a plurality of interconnecting threads **130**, **135**, which when tightened provide suitable surface area for heat transfer thereacross.

Embodiments of luminaire **100** may be powered by DC voltage, while other embodiments may be powered by AC voltage. In a DC-powered embodiment, the electrical supply lines **125**, which receive DC voltage from a DC supply, are directly connected to the plurality of LEDs **120**. Holes **210** (see FIG. **9** for example) in the heat spreader **105** permit passage of the supply lines **125** from the back side of the heat spreader **105** to the front side. In an AC-powered embodiment, a suitable power conditioner **140**, **160**, **165** (see FIGS. **8**, **9** and **11** for example) is used.

In an embodiment, and with reference to FIG. **8**, power conditioner **140** is disposed on the heat spreader **105** on a same side of the heat spreader as the plurality of LEDs **120**. In an embodiment, the power conditioner **140** is an electronic circuit board having electronic components configured to receive AC voltage from the electrical supply line **125** and to deliver DC voltage to the plurality of LEDs through appropriate electrical connections on either the front side or the back side of the heat spreader **105**, with holes through the heat spreader or insulated electrical traces across the surface of the heat spreader being used as appropriate for the purposes.

In an alternative embodiment, and with reference to FIG. **9**, an arc-shaped electronic-circuit-board-mounted power conditioner **160** may be used in place of the localized power conditioner **140** illustrated in FIG. **8**, thereby utilizing a larger available area of the heat spreader **105** without detracting from the lighting efficiency of luminaire **100**.

In a further embodiment, and with reference to FIG. **11**, a block-type power conditioner **165** (electronics contained within a housing) may be used on the back surface of the heat spreader **105**, where the block-type power conditioner **165** is configured and sized to fit within the interior space of an industry-standard nominally sized can-type light fixture or an industry-standard nominally sized wall/ceiling junction box. Electrical connections between the power conditioner **165** and the LEDs **120** are made via wires **170**, which may be contained within the can fixture or junction box, or may be self-contained within the power conditioner housing. Electrical wires **175** receive AC voltage via electrical connections within the can fixture or junction box.

Referring now to FIGS. **8-10** and **12**, an embodiment includes a reflector **145** disposed on the heat spreader **105** so as to cover the power conditioner **140**, **160**, while permitting the plurality of LEDs **120** to be visible (i.e., uncovered) through an aperture **215** of the reflector **145**. Mounting holes **155** in the reflector **145** align with mounting holes **150** in the heat spreader **105** for the purpose discussed above. The reflector **145** provides a reflective covering that hides power conditioner **140**, **160** from view when viewed from the outer optic side of luminaire **100**, while efficiently reflecting light from the LEDs **120** toward the outer optic **115**. FIG. **12** illustrates a section view through luminaire **100**, showing a stepped configuration of the reflector **145**, with the power conditioner **140**, **160** hidden inside a pocket (i.e., between the reflector **145** and the heat spreader **105**), and with the LEDs **120** visible through the aperture **215**. In an embodiment, the outer optic is made using a glass-bead-impregnated-plastic material. In an embodiment the outer optic **115** is made of a suitable material to mask the presence of a pixilated light source **120** disposed at the center of the luminaire. In an embodiment, the half angle power of the luminaire, where the light intensity of the light source when viewed at the outer optic drops to 50% of its maximum intensity, is evident within a central diameter of the outer optic that is equal to or greater than 50% of the outer diameter of the outer optic.

While FIG. **10** includes a reflector **145**, it will be appreciated that not all embodiments of the invention disclosed herein may employ a reflector **145**, and that when a reflector **145** is employed it may be used for certain optical preferences or to mask the electronics of the power conditioner **140**, **160**. The reflective surface of the reflector **145** may be white, reflective polished metal, or metal film over plastic, for example, and may have surface detail for certain optical effects, such as color mixing or controlling light distribution and/or focusing for example.

Referring to FIG. **12**, an embodiment includes an inner optic **180** disposed over the plurality of LEDs **120**. Employing an inner optic **180** not only provides protection to the LEDs **120** during installation of the luminaire **100** to a can fixture or junction box, but also offers another means of color-mixing and/or diffusing and/or color-temperature-adjusting the light output from the LEDs **120**. In alternative embodiments, the inner optic **180** may be a standalone element, or integrally formed with the reflector **145**. In an embodiment, the LEDs **120** are encapsulated in a phosphor of a type suitable to produce a color temperature output of 2700 deg-Kelvin. Other LEDs with or without phosphor encapsulation may be used to produce other color temperatures as desired.

Referring to FIG. **13**, a back surface **185** of an embodiment of the heat sink **110** includes a first plurality of recesses **190** oriented in a first direction, and a second plurality of recesses **195** oriented in a second opposing direction, each recess of the first plurality and the second plurality having a shape that promotes localized air movement within the respective recess due at least in part to localized air temperature gradients and resulting localized air pressure gradients. Without being held to any particular theory, it is contemplated that a teardrop-shaped recess **190**, **195** each having a narrow end and an opposing broad end will generate localized air temperatures in the narrow end that are higher than localized air temperatures in the associated broad end, due to the difference of proximity of the surrounding "heated" walls of the associated recess. It is contemplated that the presence of such air temperature gradients, with resulting air pressure gradients, within a given recess **190**, **195** will cause localized air movement within the associated recess, which in turn will enhance the overall heat transfer of the thermal system (the thermal system being the luminaire **100** as a whole). By alternating the orientation of the recesses **190**, **195**, such that the first plurality of recesses **190** and the second plurality of recesses **195** are disposed in an alternating fashion around the circumference of the back **185** of the heat sink **110**, it is contemplated that further enhancements in heat transfer will be achieved, either by the packing density of recesses achievable by nesting one recess **190** adjacent the other **195**, or by alternating the direction vectors of the localized air temperature/pressure gradients to enhance overall air movement. In an embodiment, the first plurality of recesses **190** have a first depth into the back surface of the heat sink, and the second plurality of recesses **195** have a second depth into the back surface of the heat sink, the first depth being different from the second depth, which is contemplated to further enhance heat transfer.

FIGS. **14-18** illustrate typical industry standard can-type light fixtures for recessed lighting (FIGS. **14-15**), and typical industry standard electrical junction boxes for ceiling or wall mounted lighting (FIGS. **16-18**). Embodiments of the invention are configured and sized for use with such fixtures of FIGS. **14-18**.

FIGS. **19-21** illustrate an alternative luminaire **100'** having a different form factor (flat top, flat outer optic, smaller appearance) as compared to luminaire **100** of FIGS. **1-4**.

FIGS. **22-23** illustrate alternative electronic power conditioners **140'**, **165'** having a different form factor as compared to power conditioners **140**, **165** of FIGS. **8** and **11**, respectively. All alternative embodiments disclosed herein, either explicitly, implicitly or equivalently, are considered within the scope of the invention.

FIGS. **24-26** illustrate an alternative reflector **145'** to that illustrated in FIGS. **10** and **12**, with FIG. **24** depicting an isometric view, FIG. **25** depicting a top view, and FIG. **26** depicting a side view of alternative reflector **145'**. As illustrated, reflector **145'** is conically-shaped with a centrally disposed aperture **215'** for receiving the LED package **120**. The cone of reflector **145'** has a shallow form factor so as to fit in the low profile luminaire **100**, **100'**. Similar to reflector **145**, the reflective surface of the reflector **145'** may be white, reflective polished metal, or metal film over plastic, for example, and may have surface detail for certain optical effects, such as color mixing or controlling light distribution and/or focusing for example. As discussed herein with respect to reflector **145**, alternative reflector **145'** may or may not be employed as required to obtain the desired optical effects.

From the foregoing, it will be appreciated that embodiments of the invention also include a luminaire **100** with a housing (collectively referred to by reference numerals **105**, **110** and **115**) having a light unit (collectively referred to by reference numerals **105** and **115**) and a trim unit **110**, the light unit including a light source **120**, the trim unit being mechanically separable from the light unit, a means for mechanically separating **130**, **135** the trim unit from the light unit providing a thermal conduction path therebetween, the light unit having sufficient thermal mass to spread heat generated by the light source to the means for mechanically separating, the trim unit having sufficient thermal mass to serve as a heat sink to dissipate heat generated by the light source.

From the foregoing, it will also be appreciated that embodiments of the invention further include a luminaire **100** for retrofit connection to an installed light fixture having a concealed in-use housing (see FIGS. **14-18** for example), the luminaire including a housing **105**, **110**, **115** having a light unit **105**, **115** and a trim unit **110**, the light unit comprising a light source **120**, the trim unit being mechanically separable from the light unit, the trim unit defining a heat sinking thermal management element configured to dissipate heat generated by the light source that is completely 100% external of the concealed in-use housing of the installed light fixture. As used herein, the term "concealed in-use housing" refers to a housing that is hidden behind a ceiling or a wall panel once the luminaire of the invention has been installed thereon.

Reference is now made to FIG. 27, which depicts an exploded assembly view of an alternative luminaire 300 to that depicted in FIGS. 1-12. Similar to luminaire 100 (where like elements are numbered alike, and similar elements are named alike but numbered differently), luminaire 300 includes a heat spreader 305 integrally formed with a heat sink 310 disposed diametrically outboard of the heat spreader 305 (the heat spreader 305 and heat sink 310 are collectively herein referred to as base 302), an outer optic 315 securely retained relative to at least one of the heat spreader 305 and the heat sink 310, a light source (LED) 120 disposed in thermal communication with the heat spreader 305, and an electrical supply line 125 disposed in electrical communication with the light source 120. The integrally formed heat spreader 305 and heat sink 310 provides for improved heat flow from the LED 120 to the heat sink 310 as the heat flow path therebetween is continuous and uninterrupted as compared to the luminaire 100 discussed above.

To provide for a low profile luminaire 300, the combination of the heat spreader 305, heat sink 310 and outer optic 315, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25 (best seen by reference to FIG. 28). In an example embodiment, height H is 1.5-inches, and outside dimension D is a diameter of 7-inches. Other dimensions for H and D are contemplated such that the combination of the heat spreader 305, heat sink 310 and outer optic 315, are so configured and dimensioned as to; (i) cover an opening defined by an industry standard can-type light fixture having nominal sizes from three-inches to six-inches, such as a four-inch can or a six-inch can for example (see FIGS. 14 and 15 for example); and, (ii) cover an opening defined by an industry standard electrical junction box having nominal sizes from three-inches to six-inches, such as a four-inch J-box or a six-inch J-box for example (see FIGS. 16 and 17 for example). Since can-type light fixtures and ceiling/wall mount junction boxes are designed for placement behind a ceiling or wall material, an example luminaire 300 has the back surface of the heat spreader 305 substantially planar with the back surface of the heat sink 310, thereby permitting the luminaire 300 to sit substantially flush on the surface of the ceiling/wall material. Alternatively, small standoffs 200 (see FIG. 12 in combination with FIG. 27 for example) may be used to promote air movement around the luminaire 300 for improved heat transfer to ambient, as discussed above.

Securement of the luminaire 300 to a junction box (see FIGS. 16-18 for example) may be accomplished by using a bracket 400 and suitable fasteners 405 (four illustrated) through appropriately spaced holes 410 (four illustrated) in the bracket 400. Securement of the base 302 to the bracket 400 is accomplished using suitable fasteners 415 (two illustrated) through appropriately spaced holes 420 (two used, diametrically opposing each other, but only one visible) in the base 302, and threaded holes 425 (two illustrated) in the bracket 400. Securement of the optic 315 to the base 302 is accomplished using suitable fasteners 430 (three illustrated) through appropriately spaced holes 435 (three used, spaced 120 degrees apart, but only two illustrated) in tabs 445 of the optic 315, and threaded holes 440 (three used, spaced 120 degrees apart, but only two illustrated) in the base 302. A trim ring 470 circumferentially snap-fits over the optic 315 to hide the retaining fasteners 430, the holes 435 and the tabs 445.

The snap-fit arrangement of the trim ring 470 relative to the optic 315 is such that the trim ring 470 can be removed in a pop-off manner for maintenance or other purposes. In an embodiment, securement of the optic 315 to the base 302 is accomplished using an insert-and-rotate action, where legs are integrally formed with, or molded onto, the optic 315 in place of the tabs 445, and where engagement openings are integrally formed with the base 302 in place of the holes 440. In another embodiment, securement of the optic 315 to the base 302 is accomplished using a snap-fit arrangement, where snap-fits legs are integrally formed with, or molded onto, the optic 315 in place of the tabs 445, and where snap-fit receptors are integrally formed with the base 302 in place of the holes 440.

In an embodiment, securement of the luminaire 300 to a junction box (see FIGS. 16-18 for example) may be accomplished without using a bracket 400. That is, the luminaire 300 may be directly secured to a junction box using appropriate size and length hardware that passes through appropriately sized and placed holes in the base 302 to engage with the preformed standard securement holes formed in the J-box.

Securement of the luminaire 300 to a can-type fixture (see FIGS. 14-15 for example) may be accomplished by using two torsion springs 450 each loosely coupled to the bracket 400 at a pair of notches 455 by placing the circular portion 460 of each torsion spring 450 over the pairs of notches 455, and then engaging the hook ends 465 of the torsion spring 450 with suitable detents in the can-type fixture (known detent features of can-type light fixtures are depicted in FIGS. 14-15). In an embodiment, the circular portion 460 of each torsion spring 450 and the distance between each notch of a respective pair of notches 455 are so dimensioned as to permit the torsion springs 450 to lay flat (that is, parallel with the back side of luminaire 300) during shipping, and to be appropriately rotated for engagement with a can-type fixture during installation (as illustrated in FIGS. 27-30).

A power conditioner 165 similar to that discussed above in connection with FIG. 11 receives AC power from electrical connections within the junction box or can-type fixture, and provides conditioned DC power to the light source (LED) 120. While illustrative details of the electrical connections between the power conditioner 165 and the light source (LED) 120 are not specifically shown in FIG. 27, one skilled in the art will readily understand how to provide such suitable connections when considering all that is disclosed herein in combination with information known to one skilled in the art. The housing of power conditioner 165 includes recesses 480 (one on each side, only one illustrated) that engage with tabs 485 of the bracket 400 to securely hold the power conditioner 165 in a snap-fit or frictional-fit engagement relative to the bracket 400.

Reference is now made to FIGS. 28 and 29, which depict a side view and a back view, respectively, of the luminaire 300. As discussed above in reference to FIG. 28, an overall height H and an overall outside dimension D is such that the ratio of H/D is equal to or less than 0.25. The back view depicted in FIG. 29 is comparable with the back view depicted in FIGS. 3, 11 and 13, but with a primary difference that can be seen in the configuration of the heat sinking fins. In FIGS. 3, 11 and 13, the back surface 185 of the heat sink 110 includes a first plurality of recesses 190 oriented in a first direction, and a second plurality of recesses 195 oriented in a second opposing direction, with each recess of the first plurality and the second plurality having a shape that promotes localized air movement within the respective recess due at least in part to localized air temperature gradients and resulting localized air pressure gradients. Such recesses 190, 195 were employed at least in part due to the radial dimension of the heat sink **110**, which is ring-like in shape. In FIG. **29**, and as discussed above, the heat sink **310** is integrally formed with the heat spreader **305** to form the base **302**. With such an integrally formed base arrangement, radially oriented heat sink fins **475** are integrally formed over a substantial portion of the back surface of the base **302**, which provide for greater heat transfer than is available by the recesses **190**, **195** having a more limited radial dimension that is limited by the configuration of the heat sink **110**. Heat sink fins **475** alternate with adjacently disposed and radially oriented recesses **476** to form a star pattern about the center of the back side of luminaire **300**. Such a star pattern provides a plurality of air flow channels on the back side of the base **302** for efficiently distributing and dissipating heat generated by the light source (LED) **120** disposed on the front side of the heat spreader **305** of the base **302**.

While heat sink **110** has herein been described having recesses **190**, **195**, and base **302** has herein been described having heat sink fins **475** and recesses **476**, for efficiently distributing and dissipating heat generated by the light source (LED) **120**, it will be appreciated that not all heat sinks will require fins and recesses depending on the power requirements of the luminaire, the power efficiency of the luminaire, the heat generated by the luminaire, and the heat transfer characteristics of the luminaire. As such, the scope of the invention is not limited to the inclusion of such fins and recesses, but also includes heat sinks that are absent fins and recesses but structured appropriately for distributing and dissipating heat generated by the light source.

In an embodiment, and with reference now to FIG. **30**, the outer optic **315** forms a blondel-type lens having a plurality of concentric circular flutes/ridges **490** formed and disposed on the inside surface of the outer optic **315**. With such a lens, the exact location of the light source **120** within the luminaire **300** is masked from the perspective of an observer standing a distance away from the luminaire **300**, thereby providing for a more uniform distribution of light. Such a lens may also be suitable for outer optic **115**. In an embodiment, the lens material used for outer optic **115**, **315** may be frosted. Example materials considered suitable for use in outer optic **115**, **315** include, but are not limited to, ACRYLITE® Acrylic Sheet Material available from CYRO Industries, and Acrylite Plus® also available from CYRO Industries.

Example materials considered suitable for use in reflector **145**, **145'** include, but are not limited to, MAKROLON® 2405, 2407 and 2456 available from Bayer Material Science, and MAKROLON® 6265 also available from Bayer Material Science.

With reference now to FIG. **31**, an accessory kit **500** is depicted having a set of formed springs **505**, a set of twist-on wire connectors **510**, a set of fasteners **515**, a first pre-wired jumper **520**, a second pre-wired jumper **525**, and a set of installation instructions **530**. Each of the first and second pre-wired jumpers **520**, **525** include a pair of flexible wires (hot/black and neutral/white wires) **521**, **526**, and a plug-in male connector **535**. The first pre-wired jumper **520** has an Edison base **540** mechanically and electrically connected to the end of the wire-pair **521** opposite that of the male connector **535**. The wire-pair **521** and Edison base **540** are electrically connected with the proper polarity in a manner known in the art (hot wire electrically connected to the tip of the Edison base, neutral wire electrically connected to the screw threads of the Edison base). The second pre-wired jumper **525** has open wire ends **527** at the end of the wire-pair **526** opposite that of the male connector **535**. Each male connector **535** is electrically connected to the respective wire-pair **521**, **526** in a polarity-correct manner, where an interlock feature **536** on each male connector **535** prevents a reverse polarity connection when the plug-in male connector **535** is connected to a plug-in female connector **127** (see FIG. **34**), discussed further below. In a typical installation, the first pre-wired jumper **525** is used when the luminaire **300** is to be installed in a can-type light fixture, and the second pre-wired jumper **525** is used when the luminaire **300** is to be installed in a J-box. The pre-connected Edison base serves to simplify installation in a can-type light fixture that already has an Edison screw receptacle pre-wired in place. In a J-box retrofit arrangement, the twist-on wire connectors **510** are used to pigtail wire ends **527** of the second pre-wired jumper **525** to pre-existing wire ends in the J-box. In a J-box arrangement, the luminaire **300** may be directly secured to the J-box pre-formed mounting holes using appropriately sized hardware **515**.

As mentioned above, securement of the luminaire **300** to a junction box may be accomplished by directly securing the luminaire **300** to a junction box using hardware **515**. However, it is contemplated that the luminaire **300** may also be secured to a junction box using the plurality of formed springs **505**, absent a mounting bracket **400**, by attaching the springs **505** to the luminaire **300** in a manner described below, and pushing the luminaire **300** onto the J-box such that the springs deflect inward to provide a friction fit with an interior side surface of the J-box. Installation of a luminaire **300** with springs **505** onto a can-type light fixture is discussed below. In an embodiment, the formed springs **505** are formed from flat stock spring steel, best seen by referring to FIG. **32**, where each spring **505** has a first portion forming an anchor portion **550**, and a second portion forming both a flexible leg portion **555** and a flexible finger portion **560**. With reference to FIGS. **33** and **34**, each spring **505** is mechanically fixed to the luminaire **300** by pushing the spring **505** in the direction of arrow **570** such that the anchor portion **550** fits snugly with respect to the luminaire **300**, and more particularly fits snugly in a friction fit manner between the power conditioner **165** and the base **302**. Either the power conditioner **165** or the base **302** may have recesses appropriately sized to receive the springs **505**. A projection **551** on the anchor portion **550** of each spring **505** may be used to enhance the friction fit.

FIG. **34** depicts a luminaire **300** with the set of springs **505** installed, and with the electrical supply line **125** having a first end electrically connected to, and extending outward from, the power supply **165**, and having a second end, a free end or open end, electrically connected to a female plug-in connector **127** in a polarity-correct orientation. During installation into a can-type light fixture, the Edison base **540** of the first pre-wired jumper **520** is first screwed into the existing Edison screw receptacle of the can-type fixture, leaving the plug-in male connector **535** hanging out of the light fixture. The male and female connectors **535**, **127** are then connected, and the luminaire **300** then pushed into and attached to the can-type light fixture such that the second portion of the springs **505** deflect slightly inward and slidably engage with an interior surface of the can-type light fixture to form a friction fit assembly inside the can-type light fixture. While an embodiment has been herein described having male and female connectors **535**, **127** disposed in a particular manner and in relation to specific parts, it will be appreciated that the male and female connectors **535**, **127** may be interchangeable with their respective parts, or may be replaced with another type of connector, without detracting from the scoped of the invention. As such, it will also be appreciated that the two different connectors **535**, **127** may more generally be described as connectors that are configured such that one connector can electrically engage with the other connector to provide a suitable electrical connection for the purpose disclosed herein.

FIG. 35 depicts an exploded assembly view of another embodiment of a luminaire 300' similar to that of luminaire 300 depicted in FIG. 27, but absent the mounting bracket 400. In the embodiment of FIG. 35, the luminaire 300' includes a trim ring 470, an optic 315' having diametrically opposing engagement tabs 445' (only one illustrated), a light source 120, fasteners 121 for securing the light source 120 to a base 302', which has integrally formed and diametrically opposed engagement openings 440' (only one illustrated) configured to receive the engagement tabs 445' such that the optic 315' is secured to the base 302' by inserting the tabs 445' into the openings 440' and rotating the optic 315' relative to a cylindrical axis of the base 302' in an insert-and-rotate action from a first position to a second position such that a portion of each engagement tab 445' is securely retained by respective portions of the base 302' (best seen by referring to FIG. 36A, illustrating the tabs/openings in the first unsecured position, and FIG. 36B, illustrating the tabs/openings in the second secured position), a power source 165', an electrical supply line 125, a ground wire 128, a top 167, a female plug-in connector 127, and a ground eyelet 129. The electrical supply line 125, such as insulated two-conductor wire for example, and the ground wire 128, which may be a green color-coded insulated single-conductor wire for example, pass through holes (not illustrated) in the top 167, and subsequently have the female plug-in connector 127 and ground eyelet 129, respectfully, electrically attached thereto during factory assembly. The luminaire 300' is secured to the can-type light fixture by means of the springs 505, as depicted in FIGS. 32-34. In an alternative embodiment, the optic 315' is securely retained by the base 302' via a snap-fit engagement between the optic 315' and the base 302' created by the engagement tabs 445' snapping into engagement with a wall thickness of the base 302' as the engagement tabs 445' are pushed through the engagement openings 440' of the base 302', which is best seen with reference to FIG. 37A (illustrating the tabs/openings in a first unsecured position) and FIG. 37B (illustrating the tabs/openings in a second secured position). The ground wire 128 of the luminaire 300' may be electrically connected to the can of the can-type light fixtures using eyelet 129 and mounting hardware (short screw and washer) 515 of the accessory kit 500, or may be electrically connected to the pre-existing ground wire in the J-box by clipping off the eyelet and stripping back the wire insulation, depending of the type of installation at hand.

While certain combinations of elements have been described herein, it will be appreciated that these certain combinations are for illustration purposes only and that any combination of any of the elements disclosed herein may be employed in accordance with an embodiment of the invention. Any and all such combinations are contemplated herein and are considered within the scope of the invention disclosed.

While embodiments of the invention have been described employing aluminum as a suitable heat transfer material for the heat spreader and heat sink, it will be appreciated that the scope of the invention is not so limited, and that the invention also applies to other suitable heat transfer materials, such as copper and copper alloys, or composites impregnated with heat transfer particulates, for example, such as plastic impregnated with carbon, copper, aluminum or other suitable heat transfer material, for example.

The particular and innovative arrangement of elements disclosed herein and all in accordance with an embodiment of the invention affords numerous not insignificant technical advantages in addition to providing an entirely novel and attractive visual appearance.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best or only mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

What is claimed is:

1. A luminaire, comprising:

a heat spreader and a heat sink, the heat sink being substantially ring-shaped and being disposed around and in thermal communication with an outer periphery of the heat spreader;

a light source disposed in thermal communication with the heat spreader, the light source comprising a plurality of light emitting diodes (LEDs) that are disposed in thermal communication with the heat spreader such that the heat spreader facilitates transfer of heat from the LEDs to the heat sink;

an outer optic disposed in optical communication with the plurality of LEDs; and

a power conditioner disposed and configured to receive AC voltage from an electrical supply and to provide DC voltage for the plurality of LEDs;

wherein the power conditioner is disposed, configured and sized to fit at least partially within an interior space of: a nominally sized can light fixture; and, a nominally sized electrical junction box.

2. The luminaire of claim 1, wherein:

the heat spreader, the heat sink and the outer optic, in combination, have an overall outside dimension D so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

3. The luminaire of claim 2, wherein:

the heat spreader, the heat sink and the outer optic, in combination, further have an overall height H such that the ratio of H/D is equal to or less than 0.25.

4. The luminaire of claim 3, wherein:

the overall height H is equal to or less than 1.5 inches.

5. The luminaire of claim 3, wherein:

the overall outside dimension D is equal to or greater than 7 inches.

6. The luminaire of claim 1, wherein:

the heat spreader comprises a first plurality of threads, and the heat sink comprises a second plurality of threads that are interconnected with the first plurality of threads.

7. The luminaire of claim 1, wherein:

the heat spreader and the heat sink are integrally formed such that a heat flow path through the heat spreader to the heat sink is continuous an uninterrupted.

8. The luminaire of claim 1, wherein:

the LEDs are disposed on one side of the heat spreader and the power conditioner is disposed on another opposing side of the heat spreader.

9. The luminaire of claim 1, wherein:

the power conditioner is configured and sized to fit completely within an interior space of a nominally sized can light fixture; and, a nominally sized electrical junction box.

10. The luminaire of claim 1, further comprising:

an inner optic disposed over the plurality of LEDs between the plurality of LEDs and the outer optic.

11. The luminaire of claim 1, further comprising:

a reflector fixedly disposed in optical communication with the plurality of LEDs to reflect incident light from the plurality of LEDs to the outer optic.

12. The luminaire of claim 1, wherein:

the heat sink forms a trim plate that is disposed completely external of the can light fixture or the electrical junction box.

13. The luminaire of claim 1, wherein:

the plurality of LEDs is in the form of an LED chip package.

14. The luminaire of claim 1, wherein:

the heat sink is disposed in direct thermal communication with the heat spreader.

15. The luminaire of claim 13, wherein:

the LED chip package is disposed in direct thermal communication with the heat spreader.

16. The luminaire of claim 1, wherein:

the outer optic is securely retained relative to at least one of the heat spreader and the heat sink.

17. The luminaire of claim 1, further comprising:

an electrical supply line having a first end electrically connected to the power conditioner, and a second end electrically connected to a plug-in connector; and

an accessory kit, comprising:

at least one of: a first pre-wired jumper comprising a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an Edison base electrically connected at the other opposing end; and, a second pre-wired jumper comprising a pair of insulated electrical wires having a second plug-in connector electrically connected at one end and cut wire ends at the other opposing end;

wherein the plug-in connector of the first pre-wired jumper and the second pre-wired jumper are each configured to electrically engage with the plug-in connector of the electrical supply line.

18. The luminaire of claim 17, wherein:

the accessory kit comprises both the first pre-wired jumper and the second pre-wired jumper.

19. The luminaire of claim 17, wherein the accessory kit further comprises:

at least one twist-on wire connector.

20. The luminaire of claim 1, wherein:

the heat spreader comprises mounting holes suitably spaced apart to receive mounting fasteners to secure the heat spreader to an electrical junction box.

21. The luminaire of claim 1, wherein:

the nominally sized can light fixture is a nominally sized four-inch can light fixture, and the nominally sized electrical junction box is a nominally sized four-inch electrical junction box.

22. The luminaire of claim 1, wherein:

the heat sink is disposed diametrically outboard of the heat spreader.

23. The luminaire of claim 1, wherein:

the heat sink also serves as a trim plate;

the combination of the trim plate and the outer optic have an overall height H;

the trim plate has an overall diameter D; and

the ratio of H/D is equal to or less than 0.25.

24. A luminaire, comprising:

a heat spreader and a heat sink, the heat sink being substantially ring-shaped and being disposed around and in thermal communication with an outer periphery of the heat spreader;

a light source disposed in thermal communication with the heat spreader, the light source comprising a plurality of light emitting diodes (LEDs) that are disposed in thermal communication with the heat spreader such that the heat spreader facilitates transfer of heat from the LEDs to the heat sink;

an outer optic disposed in optical communication with the plurality of LEDs;

a power conditioner disposed and configured to receive AC voltage from an electrical supply and to provide DC voltage for the plurality of LEDs;

wherein the power conditioner is disposed, configured and sized to fit at least partially within an interior space of: a nominally sized can light fixture; and, a nominally sized electrical junction box;

wherein the heat spreader, the heat sink and the outer optic, in combination, have an overall outside dimension D so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box; and

wherein the heat sink forms a trim plate that is disposed completely external of the can light fixture or the electrical junction box.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO.	: 8,967,844 B2
APPLICATION NO.	: 14/134884
DATED	: March 3, 2015
INVENTOR(S)	: Mark Penley Boomgaarden et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page, item (63), in column 1, in "Related U.S. Application Data", line 4, delete "8,672,518." and insert -- 8,201,968. --, therefor.

Signed and Sealed this
Ninth Day of February, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office

PETITIONERS, Ex. 1001

US008672518B2

(12) United States Patent
Boomgaarden et al.

(10) **Patent No.: US 8,672,518 B2**
(45) **Date of Patent: Mar. 18, 2014**

(54) **LOW PROFILE LIGHT AND ACCESSORY KIT FOR THE SAME**

(75) Inventors: **Mark Penley Boomgaarden**, Satellite Beach, FL (US); **Michael Balestracci**, Satellite Beach, FL (US); **Rick LeClair**, Melbourne, FL (US); **Wei Sun**, Indialantic, FL (US); **David Henderson**, Indialantic, FL (US); **Shane Sullivan**, Indialantic, FL (US)

(73) Assignee: **Lighting Science Group Corporation**, Satellite Beach, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 44 days.

(21) Appl. No.: **13/476,388**

(22) Filed: **May 21, 2012**

(65) **Prior Publication Data**

US 2012/0262921 A1 Oct. 18, 2012

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/775,310, filed on May 6, 2010, now Pat. No. 8,201,968.

(60) Provisional application No. 61/248,665, filed on Oct. 5, 2009.

(51) **Int. Cl.**
F21V 29/00 (2006.01)

(52) **U.S. Cl.**
USPC **362/294**; 362/147; 362/148; 362/365; 362/235; 362/249.02

(58) **Field of Classification Search**
USPC 362/147, 148, 150, 404, 294, 373, 365
See application file for complete search history.

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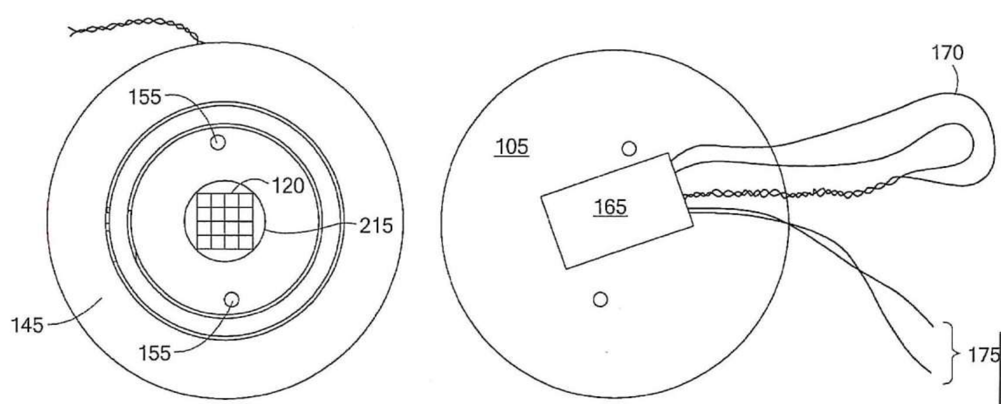
Primary Examiner — Ali Alavi
(74) *Attorney, Agent, or Firm* — Cantor Colburn LLP

(57) **ABSTRACT**

A luminaire includes a heat spreader; a heat sink; an LED light source; a power supply; an electrical supply line having a first end connected to the power supply, and a second end connected to a plug-in connector; and, an optic securely retained relative to the heat spreader or heat sink. An accessory kit includes a first pre-wired jumper including a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an Edison base electrically connected at the other end; and/or, a second pre-wired jumper including a pair of insulated electrical wires having a second plug-in connector electrically connected at one end and unconnected wire ends at the other end. The plug-in connector of the first pre-wired jumper and the second pre-wired jumper are each configured to electrically engage with the plug-in connector of the electrical supply line.

15 Claims, 17 Drawing Sheets



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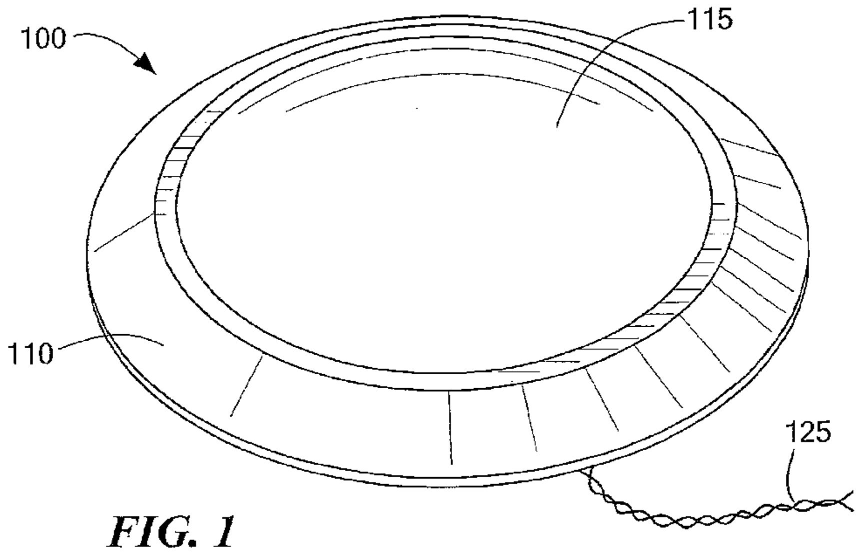


FIG. 1

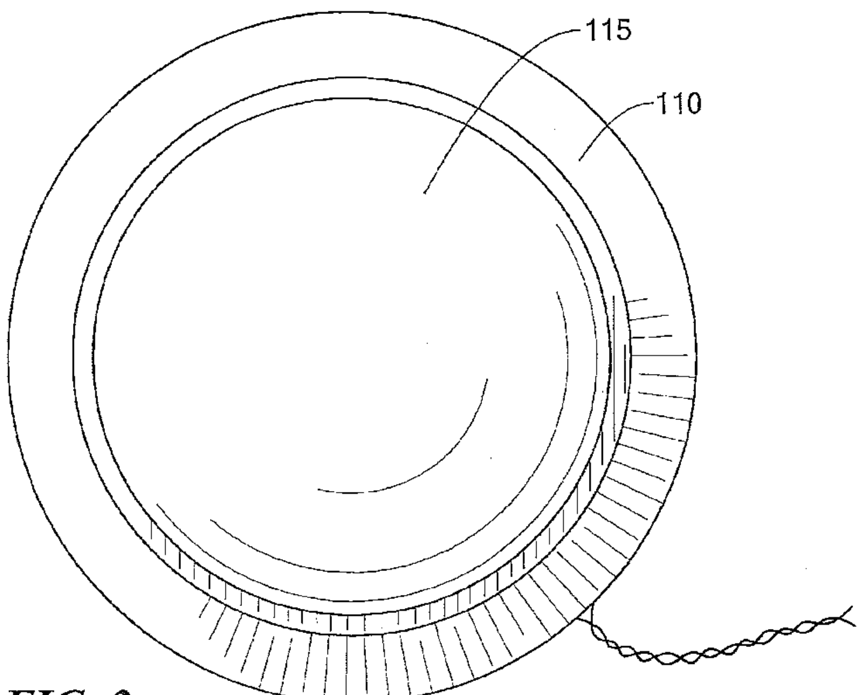


FIG. 2

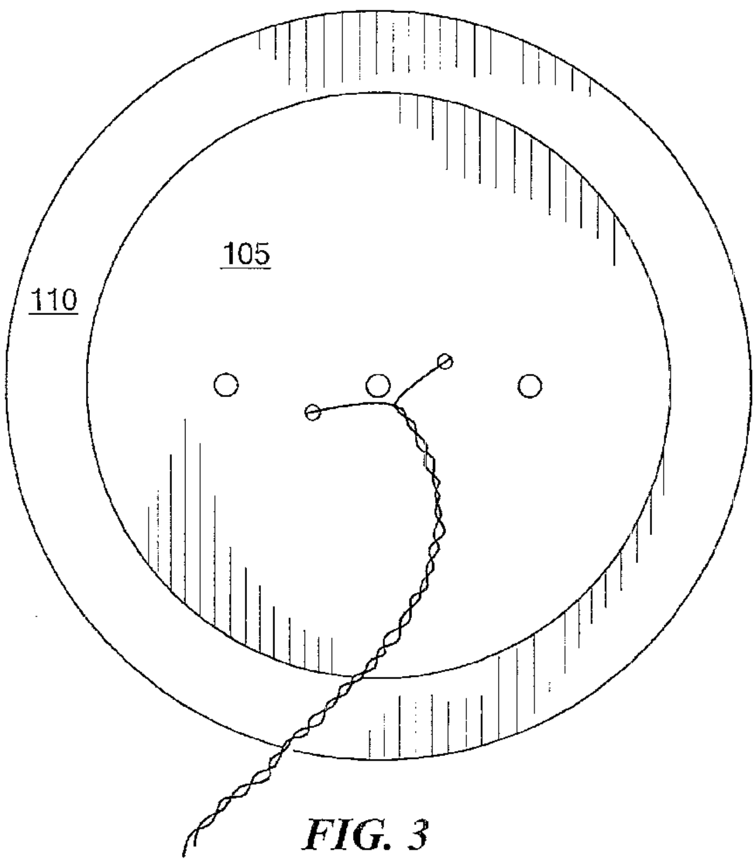


FIG. 3

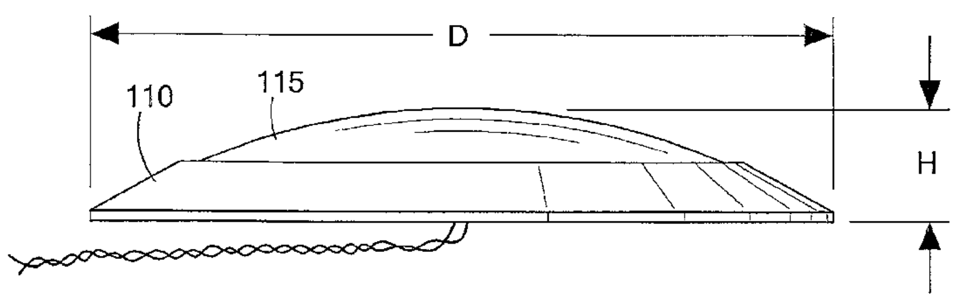
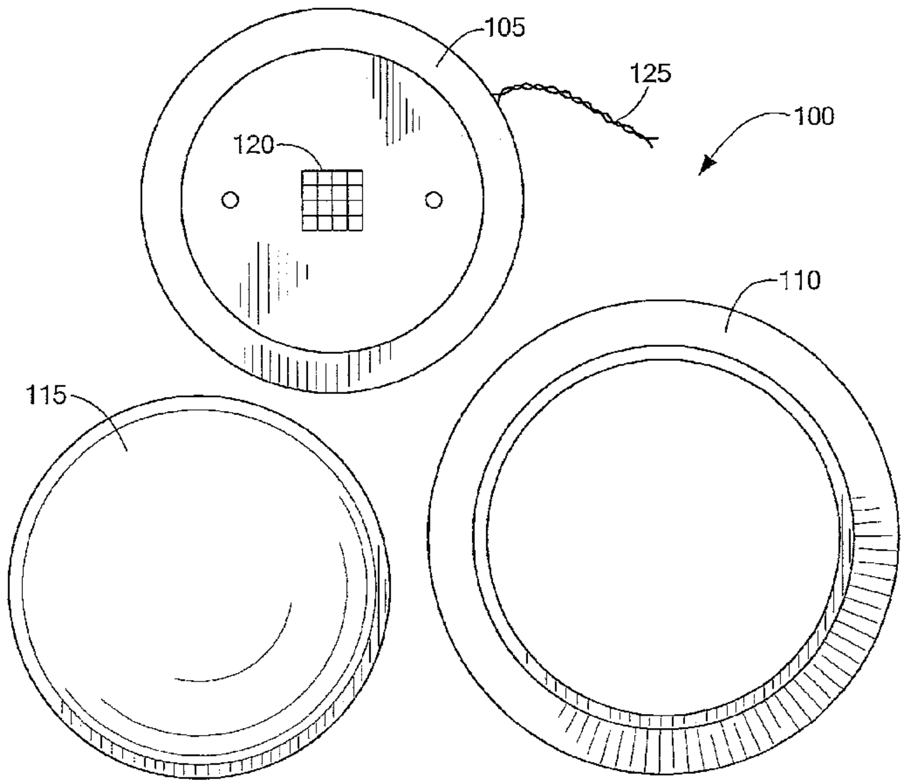


FIG. 4



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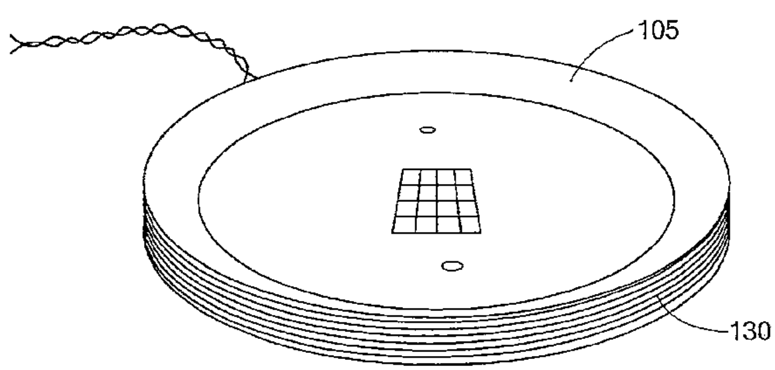

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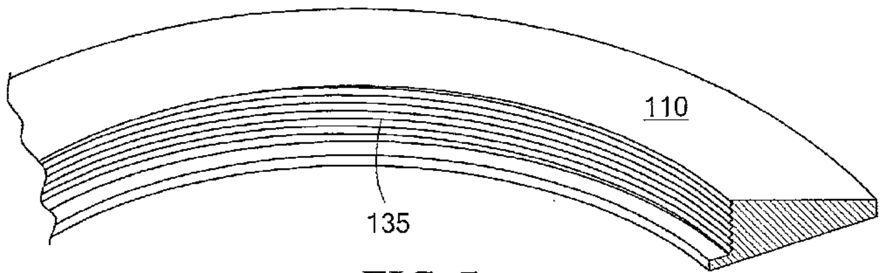

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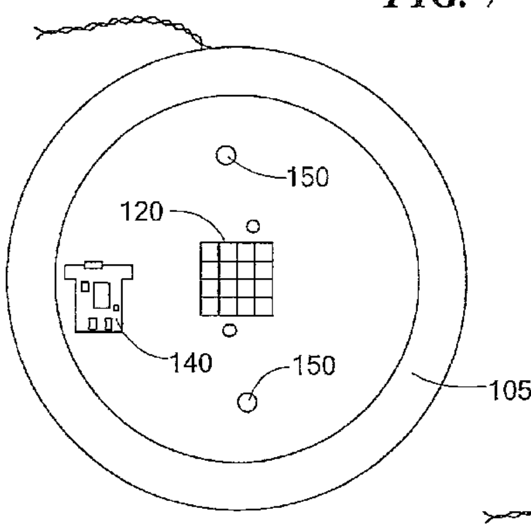

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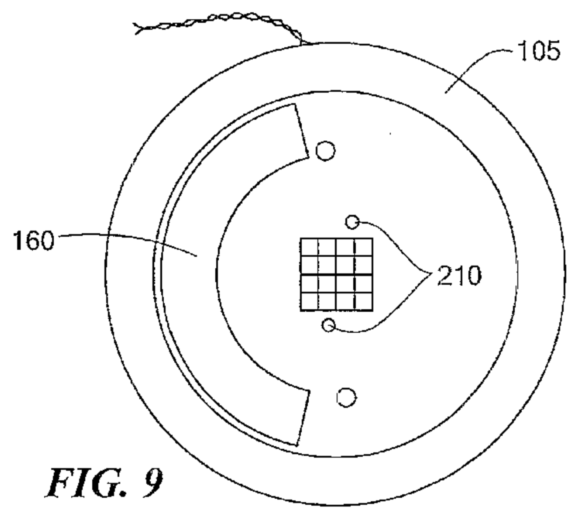

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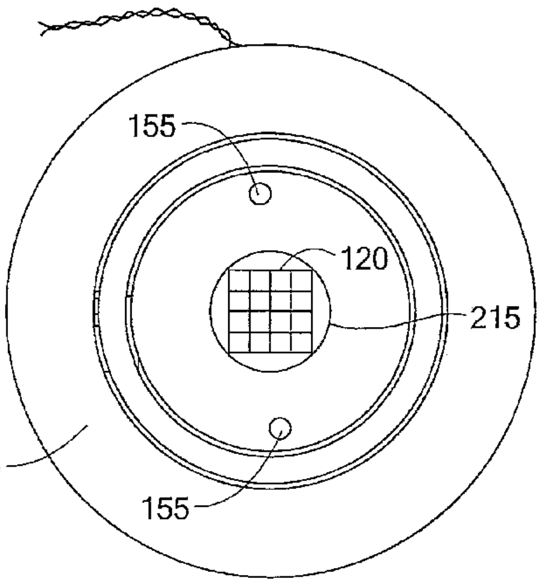

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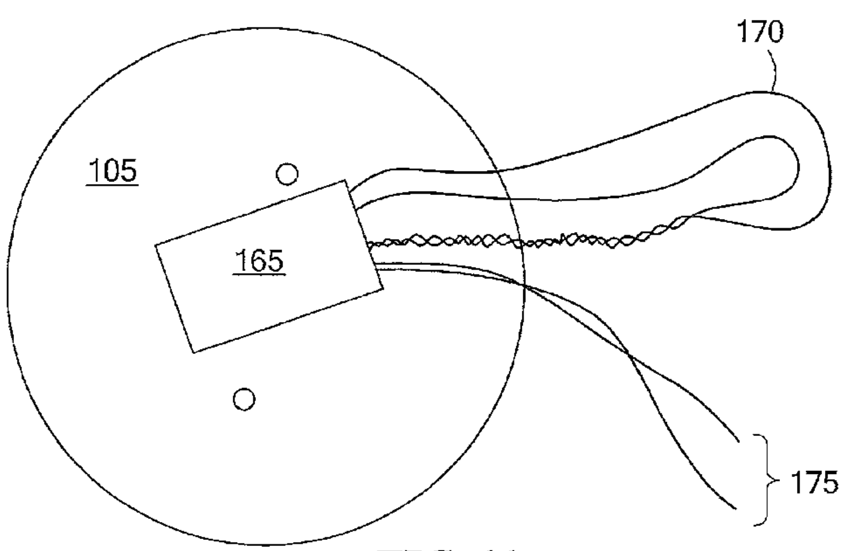

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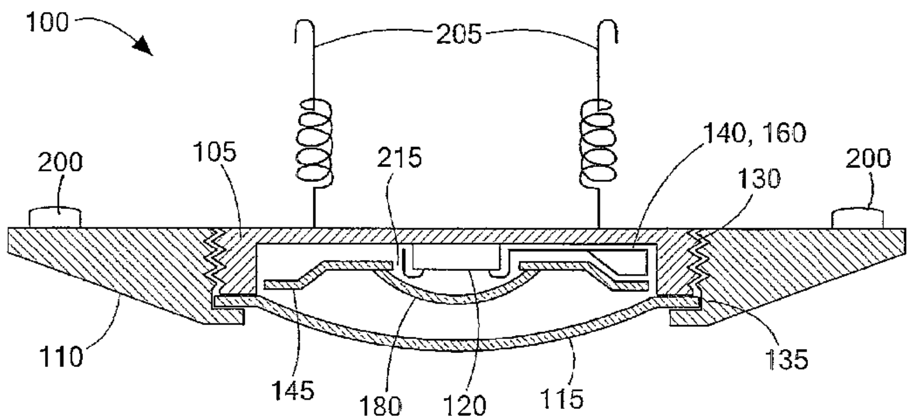
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FIG. 12

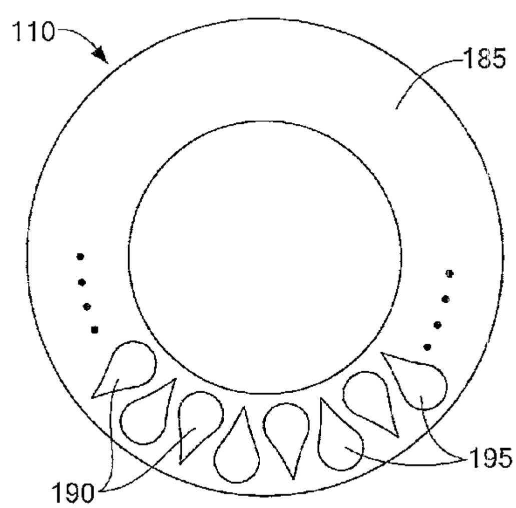
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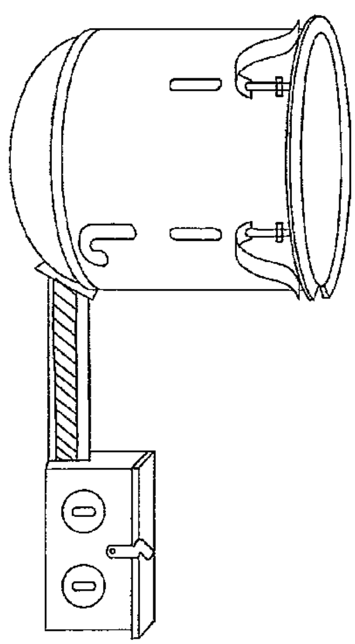
FIG. 13



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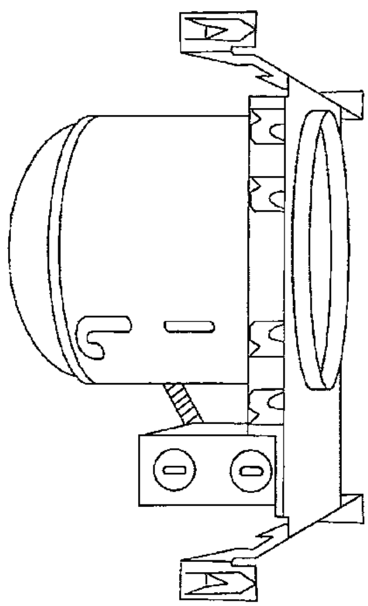

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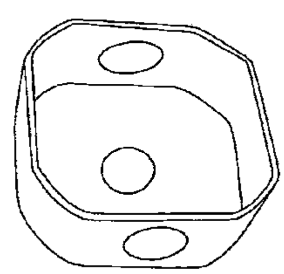

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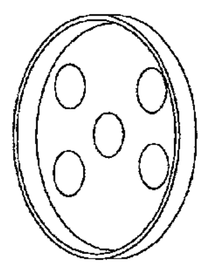


FIG. 17

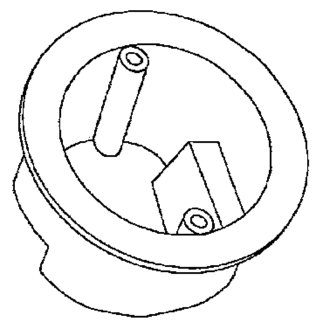


FIG. 18

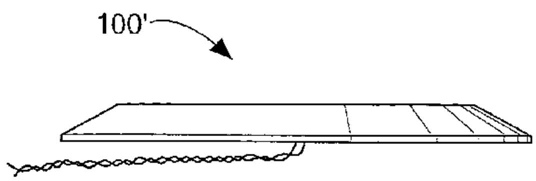


FIG. 19

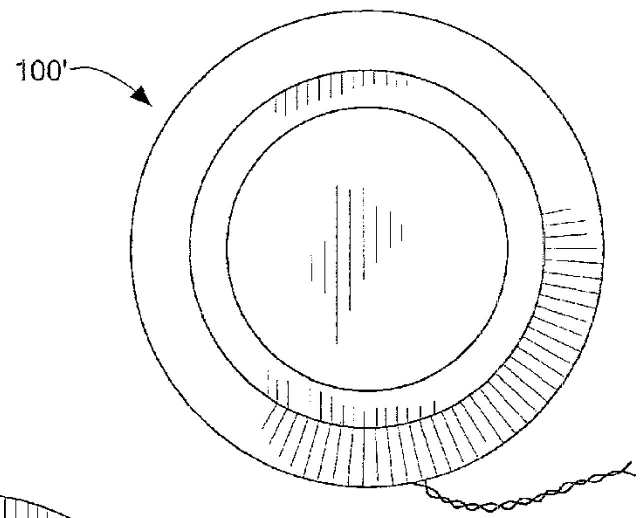


FIG. 20

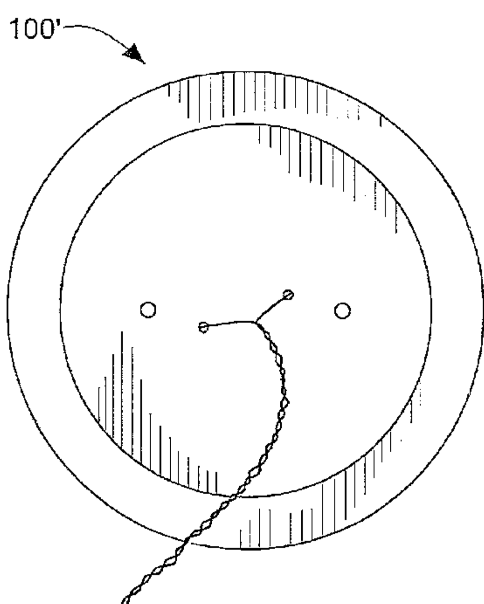


FIG. 21

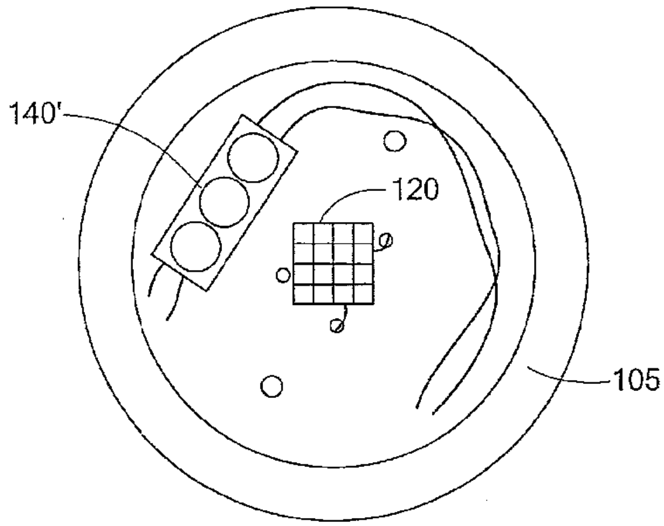
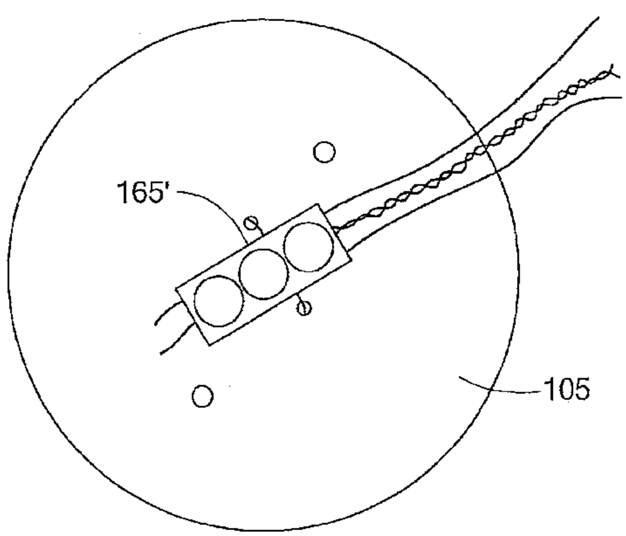


FIG. 22



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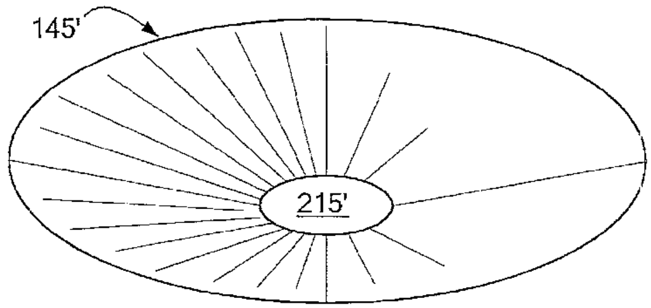
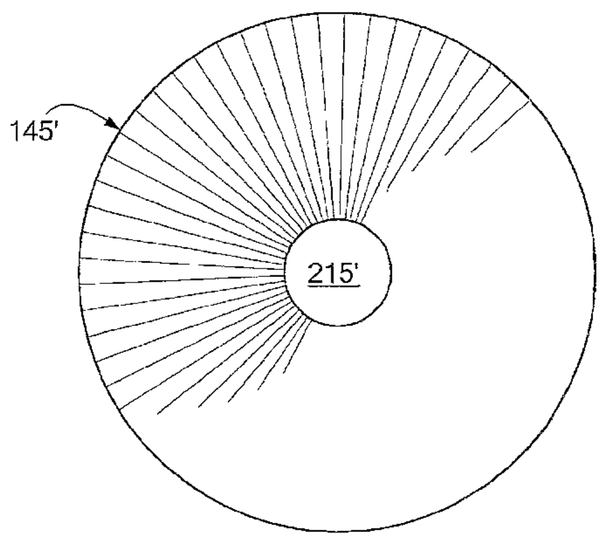


FIG. 24



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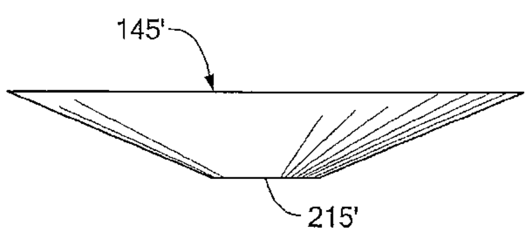

FIG. 26

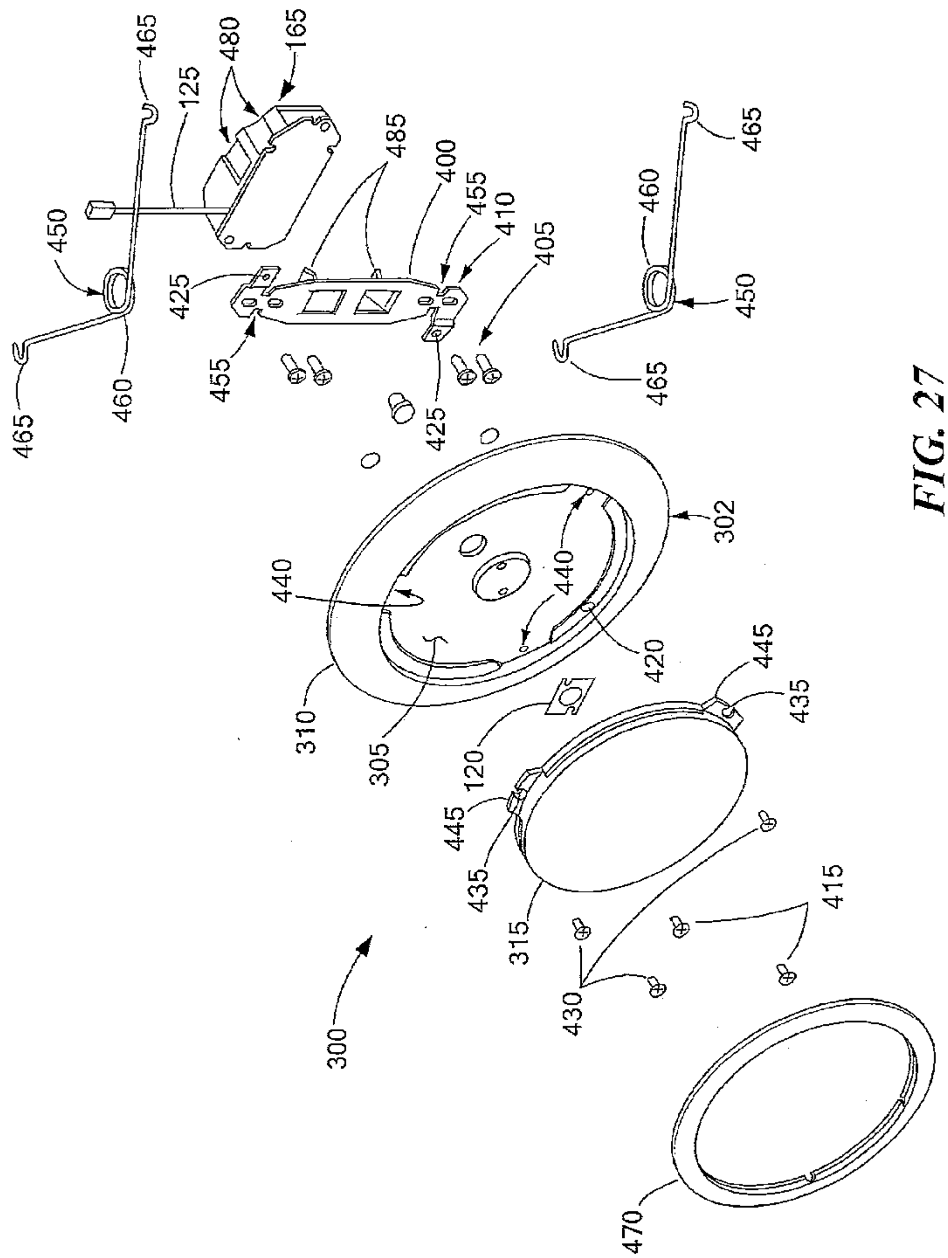
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FIG. 27

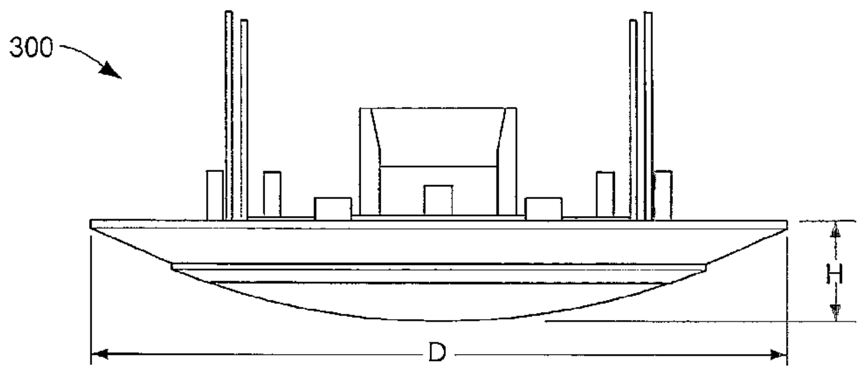
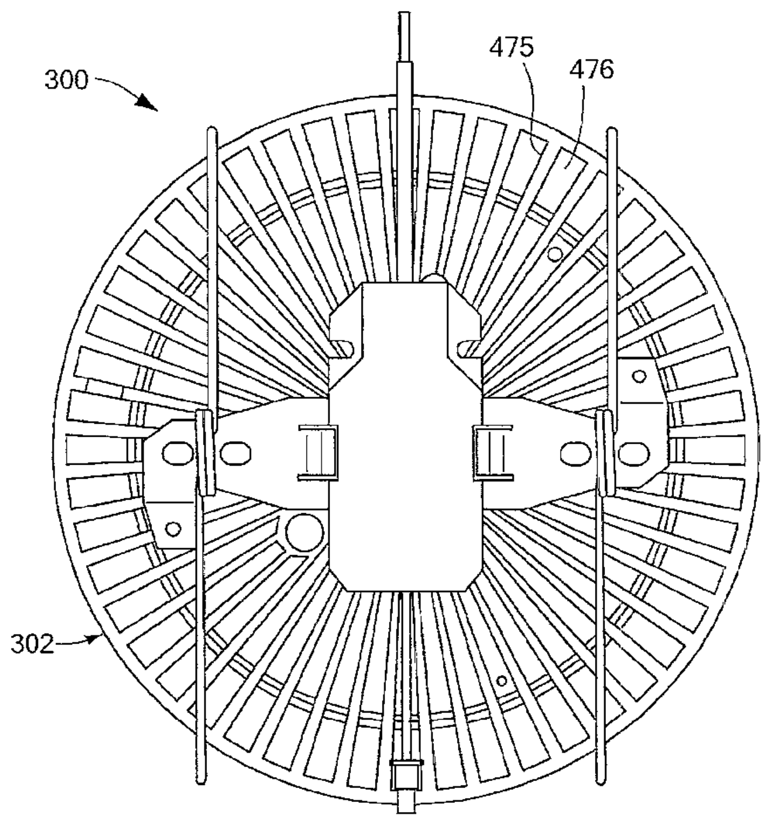


FIG. 28



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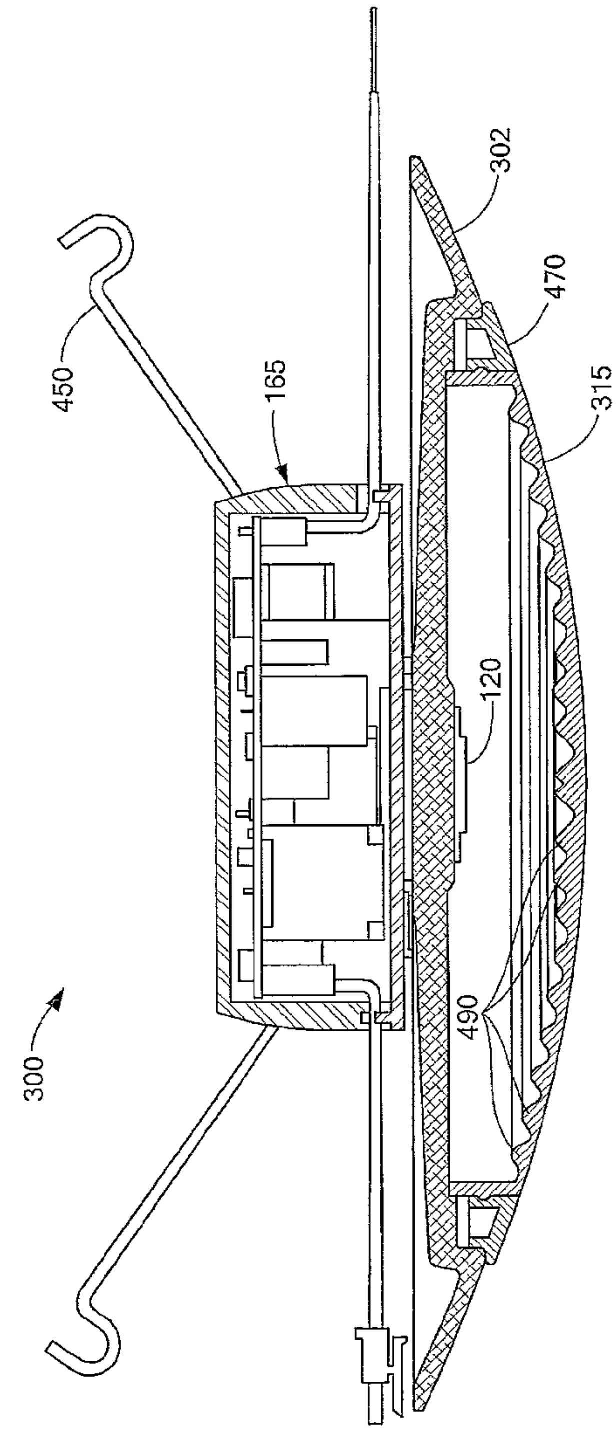

FIG. 30

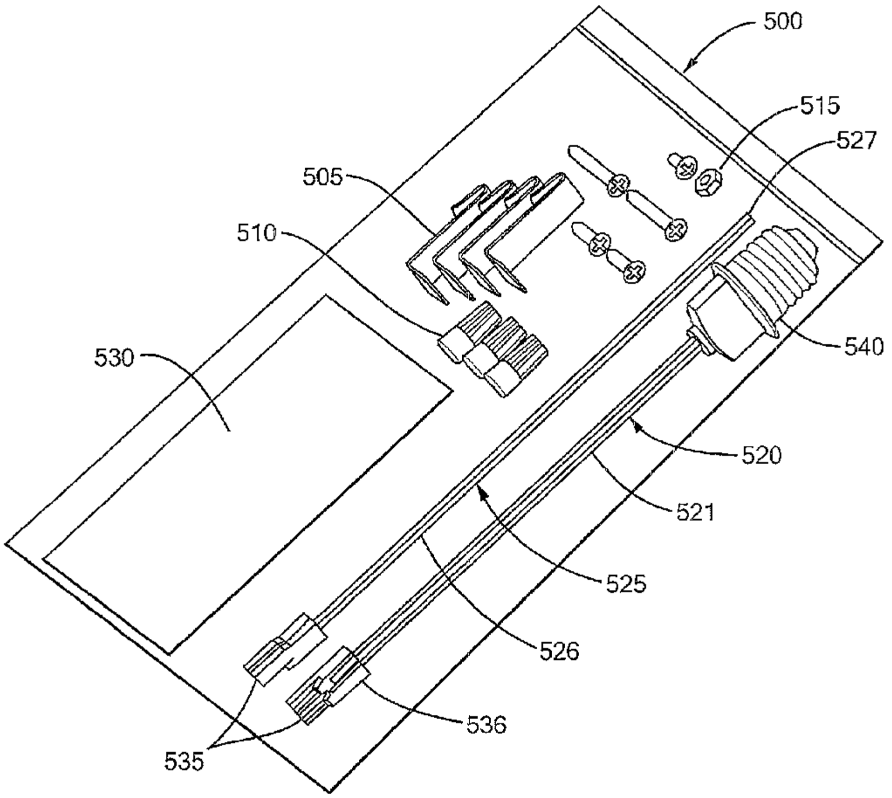
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FIG. 31

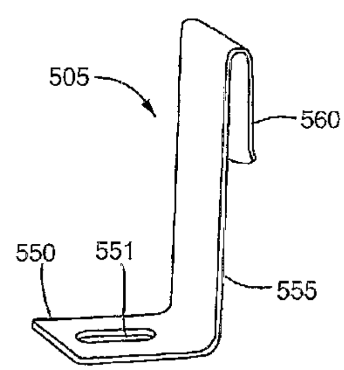
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FIG. 32

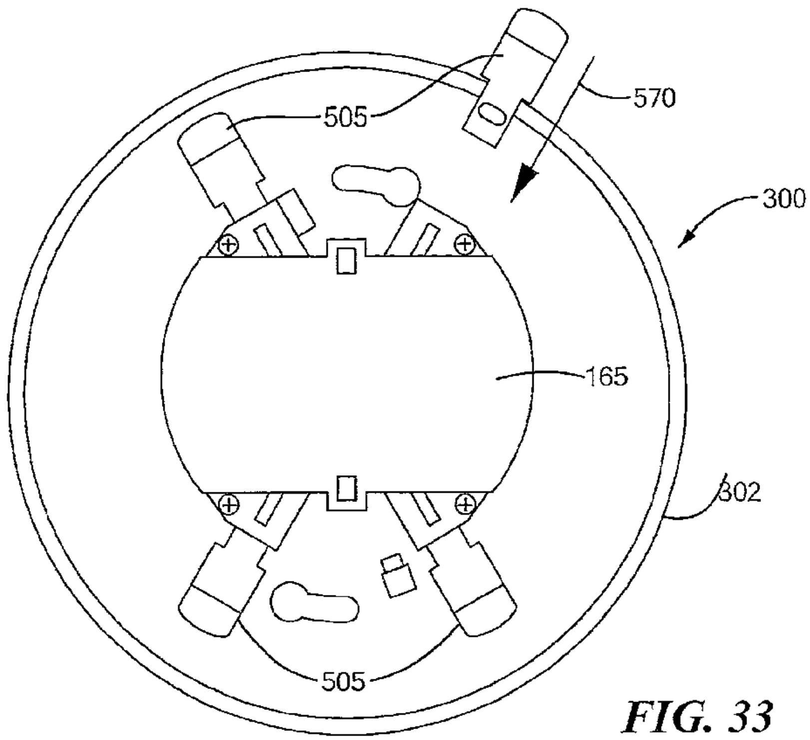

FIG. 33

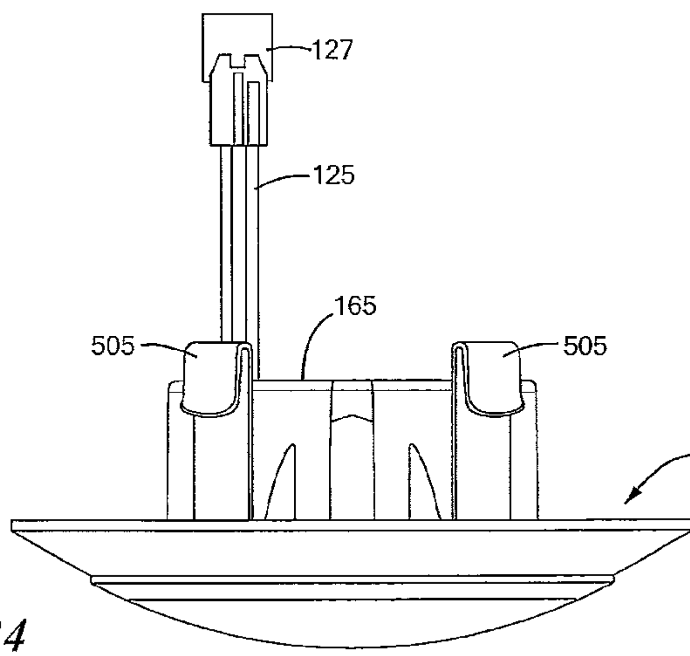

FIG. 34

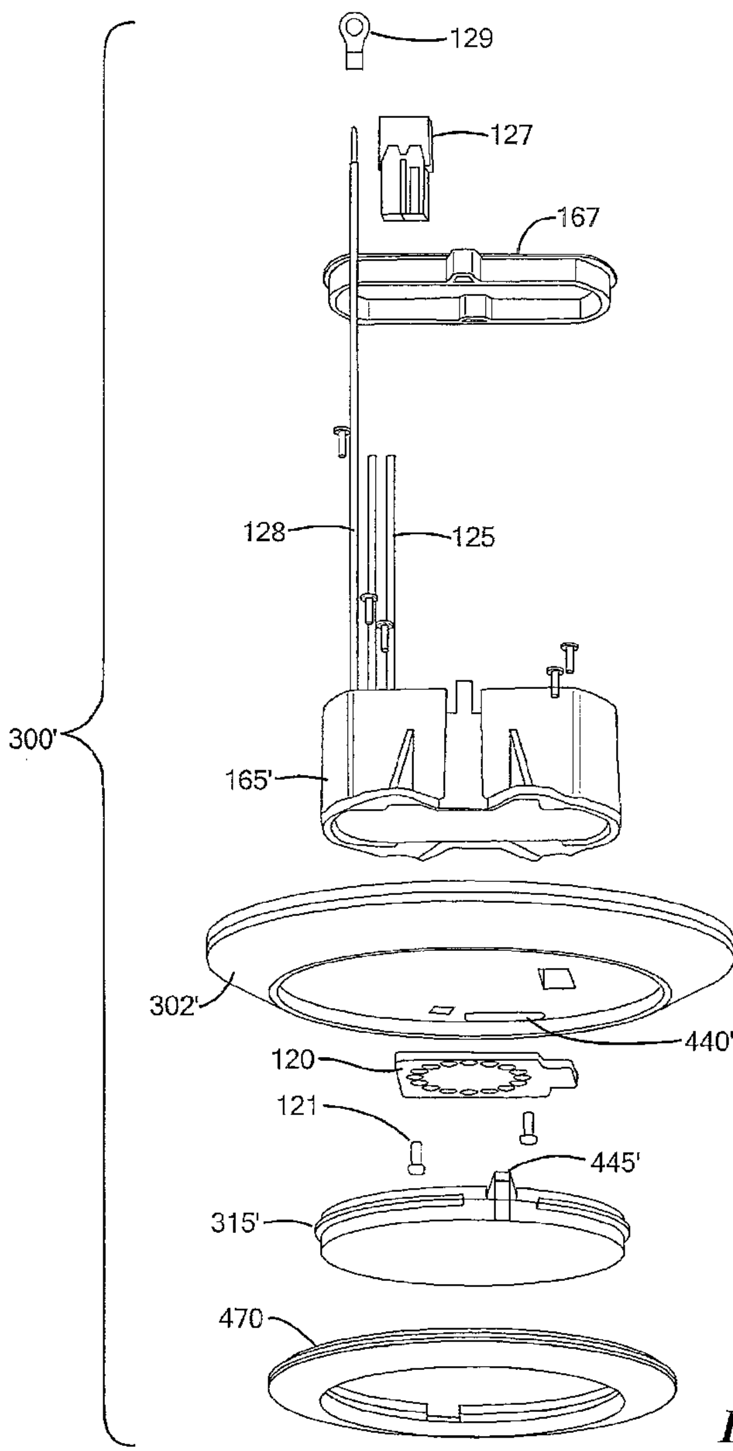

FIG. 35

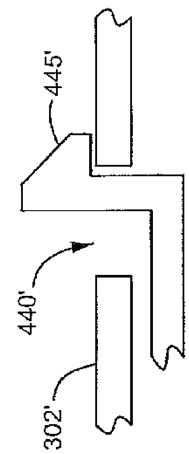

FIG. 36B

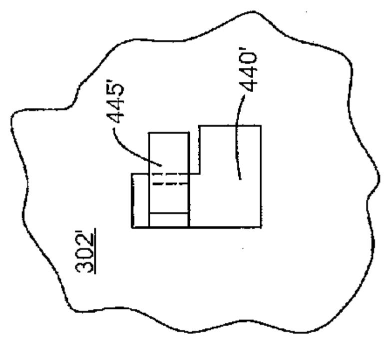

FIG. 37B

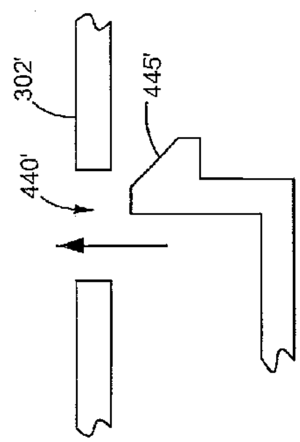

FIG. 36A

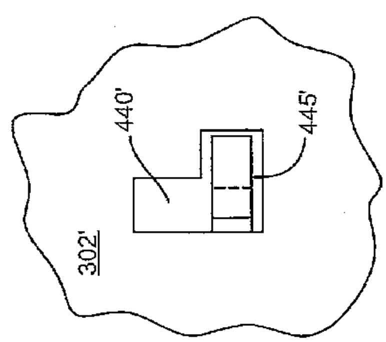

FIG. 37A

LOW PROFILE LIGHT AND ACCESSORY KIT FOR THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. application Ser. No. 12/775,310, filed May 6, 2010, which claims the benefit of U.S. Provisional Application Ser. No. 61/248,665, filed Oct. 5, 2009, both of which are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

The present disclosure relates generally to lighting, particularly to low profile lighting, and more particularly to low profile downlighting for retrofit applications.

Light fixtures come in many shapes and sizes, with some being configured for new work installations while others are configured for old work installations. New work installations are not limited to as many constraints as old work installations, which must take into account the type of electrical fixture/enclosure or junction box existing behind a ceiling or wall panel material. With recessed ceiling lighting, sheet metal can-type light fixtures are typically used, while surface-mounted ceiling and wall lighting typically use metal or plastic junction boxes of a variety of sizes and depths. With the advent of LED (light emitting diode) lighting, there is a great need to not only provide new work LED light fixtures, but to also provide LED light fixtures that are suitable for old work applications, thereby enabling retrofit installations. One way of providing old work LED lighting is to configure an LED luminaire in such a manner as to utilize the volume of space available within an existing fixture (can-type fixture or junction box). However, such configurations typically result in unique designs for each type and size of fixture. Accordingly, there is a need in the art for an LED lighting apparatus that overcomes these drawbacks.

This background information is provided to reveal information believed by the applicant to be of possible relevance to the present invention. No admission is necessarily intended, nor should be construed, that any of the preceding information constitutes prior art against the present invention.

BRIEF DESCRIPTION OF THE INVENTION

An embodiment of the invention includes a luminaire having a heat spreader and a heat sink thermally coupled to and disposed diametrically outboard of the heat spreader, an outer optic securely retained relative to at least one of the heat spreader and the heat sink, and a light source disposed in thermal communication with the heat spreader, the light source having a plurality of light emitting diodes (LEDs). The heat spreader, the heat sink and the outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25. The combination defined by the heat spreader, the heat sink and the outer optic, is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a heat spreader and a heat sink thermally coupled to and disposed diametrically outboard of the heat spreader. An outer optic is securely retained relative to at least one of the heat spreader and the heat sink. A light source is disposed in thermal communication with the heat spreader, the light

source having a plurality of light emitting diodes (LEDs). A power conditioner is disposed in electrical communication with the light source, the power conditioner being configured to receive AC voltage from an electrical supply line and to deliver DC voltage to the plurality of LEDs, the power conditioner being so dimensioned as to fit within at least one of: a nominally sized four-inch can light fixture; and, a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a heat spreader, a heat sink thermally coupled to and disposed diametrically outboard of the heat spreader, an outer optic securely retained relative to at least one of the heat spreader and the heat sink, a light source disposed in thermal communication with the heat spreader, and an electrical supply line disposed in electrical communication with the light source. The heat spreader, heat sink and outer optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25. The defined combination is so dimensioned as to: cover an opening defined by a nominally sized four-inch can light fixture; and, cover an opening defined by a nominally sized four-inch electrical junction box.

An embodiment of the invention includes a luminaire having a housing with a light unit and a trim unit. The light unit includes a light source, and the trim unit is mechanically separable from the light unit. A means for mechanically separating the trim unit from the light unit provides a thermal conduction path therebetween. The light unit has sufficient thermal mass to spread heat generated by the light source to the means for mechanically separating, and the trim unit has sufficient thermal mass to serve as a heat sink to dissipate heat generated by the light source.

An embodiment of the invention includes a luminaire for retrofit connection to an installed light fixture having a concealed in-use housing. The luminaire includes a housing having a light unit and a trim unit, the light unit having a light source, and the trim unit being mechanically separable from the light unit. The trim unit defines a heat sinking thermal management element, configured to dissipate heat generated by the light source, that is completely 100% external of the concealed in-use housing of the installed light fixture.

An embodiment of the invention includes a luminaire and accessory kit combination. The luminaire includes a heat spreader; a heat sink; an LED light source; a power supply; an electrical supply line having a first end connected to the power supply, and a second end connected to a plug-in connector; and, an optic securely retained relative to the heat spreader or heat sink. The accessory kit includes a first pre-wired jumper including a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an Edison base electrically connected at the other end; and/or, a second pre-wired jumper including a pair of insulated electrical wires having a second plug-in connector electrically connected at one end and unconnected wire ends at the other end. The plug-in connector of the first pre-wired jumper and the second pre-wired jumper are each configured to electrically engage with the plug-in connector of the electrical supply line.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the exemplary drawings wherein like elements are numbered alike in the accompanying Figures, abbreviated in each illustration as "Fig.":

FIG. **1** depicts an isometric top view of a luminaire in accordance with an embodiment of the invention;

FIG. **2** depicts a top view of the luminaire of FIG. **1**;

FIG. 3 depicts a bottom view of the luminaire of FIG. 1;

FIG. 4 depicts a side view of the luminaire of FIG. 1;

FIG. 5 depicts a top view of a heat spreader assembly, a heat sink, and an outer optic in accordance with an embodiment of the invention;

FIG. 6 depicts an isometric view of the heat spreader of FIG. 5;

FIG. 7 depicts a partial isometric view of the heat sink of FIG. 5;

FIG. 8 depicts a top view of an alternative heat spreader assembly in accordance with an embodiment of the invention;

FIG. 9 depicts a top view of another alternative heat spreader assembly in accordance with an embodiment of the invention;

FIG. 10 depicts a top view of yet another alternative heat spreader assembly in accordance with an embodiment of the invention;

FIG. 11 depicts a bottom view of a heat spreader having a power conditioner in accordance with an embodiment of the invention;

FIG. 12 depicts a section view of a luminaire in accordance with an embodiment of the invention;

FIG. 13 depicts a bottom view of a heat sink having recesses in accordance with an embodiment of the invention;

FIGS. 14-18 depict isometric views of existing electrical can-type light fixtures and electrical junction boxes for use in accordance with an embodiment of the invention;

FIGS. 19-21 depict a side view, top view and bottom view, respectively, of a luminaire similar but alternative to that of FIGS. 2-4, in accordance with an embodiment of the invention;

FIGS. 22-23 depict top and bottom views, respectively, of a heat spreader having an alternative power conditioner in accordance with an embodiment of the invention;

FIG. 24-26 depict in isometric, top and side views, respectively, an alternative reflector to that depicted in FIGS. 10 and 12;

FIG. 27 depicts an exploded assembly view of an alternative luminaire in accordance with an embodiment of the invention;

FIG. 28 depicts a side view of the luminaire of FIG. 27;

FIG. 29 depicts a back view of the luminaire of FIG. 27;

FIG. 30 depicts a cross section view of the luminaire of FIG. 27, and more particularly depicts a cross section view of the outer optic used in accordance with an embodiment of the invention;

FIG. 31 depicts an accessory kit in accordance with an embodiment of the invention;

FIG. 32 depicts a formed spring included in the accessory kit of FIG. 31;

FIG. 33 depicts a top-down view of a luminaire similar to that depicted in FIG. 27, and illustrative of an assembly of a formed spring of FIG. 32 onto the luminaire;

FIG. 34 depicts a side view of the luminaire of FIG. 33;

FIG. 35 depicts an exploded assembly view of the luminaire of FIGS. 33 and 34;

FIGS. 36A and 36B are side view depictions of a first position (not engaged) and a second position (engaged), respectively, of an engagement tab of an optic snap-fitting into an engagement opening of a base, where both the optic and the base are part of the luminaire of FIG. 35; and

FIGS. 37A and 37B are plan view depictions of an alternative arrangement to that depicted in FIGS. 36A and 36B, respectively, and more specifically are depictions of a first position (not engaged) and a second position (engaged), respectively, of an engagement tab of an optic rotationally-fitting into an engagement opening of a base, where both the optic and the base are part of the luminaire of FIG. 35.

DETAILED DESCRIPTION OF THE INVENTION

Although the following detailed description contains many specifics for the purposes of illustration, anyone of ordinary skill in the art will appreciate that many variations and alterations to the following details are within the scope of the invention. Accordingly, the following preferred embodiments of the invention are set forth without any loss of generality to, and without imposing limitations upon, the claimed invention.

An embodiment of the invention, as shown and described by the various figures and accompanying text, provides a low profile downlight, more generally referred to as a luminaire, having an LED light source disposed on a heat spreader, which in turn is thermally coupled to a heat sink that also serves as the trim plate of the luminaire. The luminaire is configured and dimensioned for retrofit installation on standard can-type light fixtures used for recessed ceiling lighting, and on standard ceiling or wall junction boxes (J-boxes) used for ceiling or wall mounted lighting. The luminaire is also suitable for new work installation. Retrofit installation of the luminaire is accomplished utilizing an accessory kit that includes a pre-wired electrical jumper and mounting hardware. For installations involving a can-type fixture, the pre-wired jumper includes a plug-in connector electrically connected to an Edison base via flexible insulated wires For installations involving a J-box, the pre-wired jumper includes a plug-in connector electrically connected to flexible insulated wires that may or may not be pre-stripped, or partially pre-stripped, on the opposing end.

While embodiments of the invention described and illustrated herein depict an example luminaire for use as a downlight when disposed upon a ceiling, it will be appreciated that embodiments of the invention also encompass other lighting applications, such as a wall sconce for example.

While embodiments of the invention described and illustrated herein depict example power conditioners having visually defined sizes, it will be appreciated that embodiments of the invention also encompass other power conditioners having other sizes as long as the power conditioners fall within the ambit of the invention disclosed herein.

Referring to FIGS. 1-26 collectively, a luminaire 100 includes a heat spreader 105, a heat sink 110 thermally coupled to and disposed diametrically outboard of the heat spreader, an outer optic 115 securely retained relative to at least one of the heat spreader 105 and the heat sink 110, a light source 120 disposed in thermal communication with the heat spreader 105, and an electrical supply line 125 disposed in electrical communication with the light source 120. To provide for a low profile luminaire 100, the combination of the heat spreader 105, heat sink 110 and outer optic 115, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25. In an example embodiment, height H is 1.5-inches, and outside dimension D is a diameter of 7-inches. Other dimensions for H and D are contemplated such that the combination of the heat spreader 105, heat sink 110 and outer optic 115, are configured and sized so as to; (i) cover an opening defined by an industry standard can-type light fixture having nominal sizes from three-inches to six-inches, such as a four-inch can or a six-inch can for example (see FIGS. 14 and 15 for example); and, (ii) cover an opening defined by an industry standard electrical junction box having nominal sizes from three-inches to six-inches, such as a four-inch J-box or a six-inch J-box for example (see FIGS. **16** and **17** for example). Since can-type light fixtures and ceiling/wall mount junction boxes are designed for placement behind a ceiling or wall material, an example luminaire has the back surface of the heat spreader **105** substantially planar with the back surface of the heat sink **110**, thereby permitting the luminaire **100** to sit substantially flush on the surface of the ceiling/wall material. Alternatively, small standoffs **200** (see FIG. **12** for example) may be used to promote air movement around the luminaire **100** for improved heat transfer to ambient air, which will be discussed further below. Securement of the luminaire **100** to a junction box may be accomplished by using suitable fasteners through appropriately spaced holes **150** (see FIG. **8** for example), and securement of the luminaire **100** to a can-type fixture may be accomplished by using extension springs **205** fastened at one end to the heat spreader **105** (see FIG. **12** for example) and then hooked at the other end onto an interior detail of the can-type fixture.

In an embodiment, the light source **120** includes a plurality of light emitting diodes (LEDs) (also herein referred to as an LED chip package), which is represented by the "checkered box" in FIGS. **5**, **6** and **8-10**. In application, the LED chip package generates heat at the junction of each LED die. To dissipate this heat, the LED chip package is disposed in suitable thermal communication with the heat spreader **105**, which in an embodiment is made using aluminum, and the heat spreader is disposed in suitable thermal communication with the heat sink **110**, which in an embodiment is also made using aluminum. To provide for suitable heat transfer from the heat spreader **105** to the heat sink **110**, an embodiment employs a plurality of interconnecting threads **130**, **135**, which when tightened provide suitable surface area for heat transfer thereacross.

Embodiments of luminaire **100** may be powered by DC voltage, while other embodiments may be powered by AC voltage. In a DC-powered embodiment, the electrical supply lines **125**, which receive DC voltage from a DC supply, are directly connected to the plurality of LEDs **120**. Holes **210** (see FIG. **9** for example) in the heat spreader **105** permit passage of the supply lines **125** from the back side of the heat spreader **105** to the front side. In an AC-powered embodiment, a suitable power conditioner **140**, **160**, **165** (see FIGS. **8**, **9** and **11** for example) is used.

In an embodiment, and with reference to FIG. **8**, power conditioner **140** is disposed on the heat spreader **105** on a same side of the heat spreader as the plurality of LEDs **120**. In an embodiment, the power conditioner **140** is an electronic circuit board having electronic components configured to receive AC voltage from the electrical supply line **125** and to deliver DC voltage to the plurality of LEDs through appropriate electrical connections on either the front side or the back side of the heat spreader **105**, with holes through the heat spreader or insulated electrical traces across the surface of the heat spreader being used as appropriate for the purposes.

In an alternative embodiment, and with reference to FIG. **9**, an arc-shaped electronic-circuit-board-mounted power conditioner **160** may be used in place of the localized power conditioner **140** illustrated in FIG. **8**, thereby utilizing a larger available area of the heat spreader **105** without detracting from the lighting efficiency of luminaire **100**.

In a further embodiment, and with reference to FIG. **11**, a block-type power conditioner **165** (electronics contained within a housing) may be used on the back surface of the heat spreader **105**, where the block-type power conditioner **165** is configured and sized to fit within the interior space of an industry-standard nominally sized can-type light fixture or an industry-standard nominally sized wall/ceiling junction box.

Electrical connections between the power conditioner **165** and the LEDs **120** are made via wires **170**, which may be contained within the can fixture or junction box, or may be self-contained within the power conditioner housing. Electrical wires **175** receive AC voltage via electrical connections within the can fixture or junction box.

Referring now to FIGS. **8-10** and **12**, an embodiment includes a reflector **145** disposed on the heat spreader **105** so as to cover the power conditioner **140**, **160**, while permitting the plurality of LEDs **120** to be visible (i.e., uncovered) through an aperture **215** of the reflector **145**. Mounting holes **155** in the reflector **145** align with mounting holes **150** in the heat spreader **105** for the purpose discussed above. The reflector **145** provides a reflective covering that hides power conditioner **140**, **160** from view when viewed from the outer optic side of luminaire **100**, while efficiently reflecting light from the LEDs **120** toward the outer optic **115**. FIG. **12** illustrates a section view through luminaire **100**, showing a stepped configuration of the reflector **145**, with the power conditioner **140**, **160** hidden inside a pocket (i.e., between the reflector **145** and the heat spreader **105**), and with the LEDs **120** visible through the aperture **215**. In an embodiment, the outer optic is made using a glass-bead-impregnated-plastic material. In an embodiment the outer optic **115** is made of a suitable material to mask the presence of a pixilated light source **120** disposed at the center of the luminaire. In an embodiment, the half angle power of the luminaire, where the light intensity of the light source when viewed at the outer optic drops to 50% of its maximum intensity, is evident within a central diameter of the outer optic that is equal to or greater than 50% of the outer diameter of the outer optic.

While FIG. **10** includes a reflector **145**, it will be appreciated that not all embodiments of the invention disclosed herein may employ a reflector **145**, and that when a reflector **145** is employed it may be used for certain optical preferences or to mask the electronics of the power conditioner **140**, **160**. The reflective surface of the reflector **145** may be white, reflective polished metal, or metal film over plastic, for example, and may have surface detail for certain optical effects, such as color mixing or controlling light distribution and/or focusing for example.

Referring to FIG. **12**, an embodiment includes an inner optic **180** disposed over the plurality of LEDs **120**. Employing an inner optic **180** not only provides protection to the LEDs **120** during installation of the luminaire **100** to a can fixture or junction box, but also offers another means of color-mixing and/or diffusing and/or color-temperature-adjusting the light output from the LEDs **120**. In alternative embodiments, the inner optic **180** may be a standalone element, or integrally formed with the reflector **145**. In an embodiment, the LEDs **120** are encapsulated in a phosphor of a type suitable to produce a color temperature output of 2700 deg-Kelvin. Other LEDs with or without phosphor encapsulation may be used to produce other color temperatures as desired.

Referring to FIG. **13**, a back surface **185** of an embodiment of the heat sink **110** includes a first plurality of recesses **190** oriented in a first direction, and a second plurality of recesses **195** oriented in a second opposing direction, each recess of the first plurality and the second plurality having a shape that promotes localized air movement within the respective recess due at least in part to localized air temperature gradients and resulting localized air pressure gradients. Without being held to any particular theory, it is contemplated that a teardrop-shaped recess **190**, **195** each having a narrow end and an opposing broad end will generate localized air temperatures in the narrow end that are higher than localized air temperatures in the associated broad end, due to the difference of proximity of the surrounding "heated" walls of the associated recess. It is contemplated that the presence of such air temperature gradients, with resulting air pressure gradients, within a given recess **190, 195** will cause localized air movement within the associated recess, which in turn will enhance the overall heat transfer of the thermal system (the thermal system being the luminaire **100** as a whole). By alternating the orientation of the recesses **190, 195**, such that the first plurality of recesses **190** and the second plurality of recesses **195** are disposed in an alternating fashion around the circumference of the back **185** of the heat sink **110**, it is contemplated that further enhancements in heat transfer will be achieved, either by the packing density of recesses achievable by nesting one recess **190** adjacent the other **195**, or by alternating the direction vectors of the localized air temperature/pressure gradients to enhance overall air movement. In an embodiment, the first plurality of recesses **190** have a first depth into the back surface of the heat sink, and the second plurality of recesses **195** have a second depth into the back surface of the heat sink, the first depth being different from the second depth, which is contemplated to further enhance heat transfer.

FIGS. **14-18** illustrate typical industry standard can-type light fixtures for recessed lighting (FIGS. **14-15**), and typical industry standard electrical junction boxes for ceiling or wall mounted lighting (FIGS. **16-18**). Embodiments of the invention are configured and sized for use with such fixtures of FIGS. **14-18**.

FIGS. **19-21** illustrate an alternative luminaire **100'** having a different form factor (flat top, flat outer optic, smaller appearance) as compared to luminaire **100** of FIGS. **1-4**.

FIGS. **22-23** illustrate alternative electronic power conditioners **140', 165'** having a different form factor as compared to power conditioners **140, 165** of FIGS. **8** and **11**, respectively. All alternative embodiments disclosed herein, either explicitly, implicitly or equivalently, are considered within the scope of the invention.

FIGS. **24-26** illustrate an alternative reflector **145'** to that illustrated in FIGS. **10** and **12**, with FIG. **24** depicting an isometric view, FIG. **25** depicting a top view, and FIG. **26** depicting a side view of alternative reflector **145'**. As illustrated, reflector **145'** is conically-shaped with a centrally disposed aperture **215'** for receiving the LED package **120**. The cone of reflector **145'** has a shallow form factor so as to fit in the low profile luminaire **100, 100'**. Similar to reflector **145**, the reflective surface of the reflector **145'** may be white, reflective polished metal, or metal film over plastic, for example, and may have surface detail for certain optical effects, such as color mixing or controlling light distribution and/or focusing for example. As discussed herein with respect to reflector **145**, alternative reflector **145'** may or may not be employed as required to obtain the desired optical effects.

From the foregoing, it will be appreciated that embodiments of the invention also include a luminaire **100** with a housing (collectively referred to by reference numerals **105, 110** and **115**) having a light unit (collectively referred to by reference numerals **105** and **115**) and a trim unit **110**, the light unit including a light source **120**, the trim unit being mechanically separable from the light unit, a means for mechanically separating **130, 135** the trim unit from the light unit providing a thermal conduction path therebetween, the light unit having sufficient thermal mass to spread heat generated by the light source to the means for mechanically separating, the trim unit having sufficient thermal mass to serve as a heat sink to dissipate heat generated by the light source.

From the foregoing, it will also be appreciated that embodiments of the invention further include a luminaire **100** for retrofit connection to an installed light fixture having a concealed in-use housing (see FIGS. **14-18** for example), the luminaire including a housing **105, 110, 115** having a light unit **105, 115** and a trim unit **110**, the light unit comprising a light source **120**, the trim unit being mechanically separable from the light unit, the trim unit defining a heat sinking thermal management element configured to dissipate heat generated by the light source that is completely 100% external of the concealed in-use housing of the installed light fixture. As used herein, the term "concealed in-use housing" refers to a housing that is hidden behind a ceiling or a wall panel once the luminaire of the invention has been installed thereon.

Reference is now made to FIG. **27**, which depicts an exploded assembly view of an alternative luminaire **300** to that depicted in FIGS. **1-12**. Similar to luminaire **100** (where like elements are numbered alike, and similar elements are named alike but numbered differently), luminaire **300** includes a heat spreader **305** integrally formed with a heat sink **310** disposed diametrically outboard of the heat spreader **305** (the heat spreader **305** and heat sink **310** are collectively herein referred to as base **302**), an outer optic **315** securely retained relative to at least one of the heat spreader **305** and the heat sink **310**, a light source (LED) **120** disposed in thermal communication with the heat spreader **305**, and an electrical supply line **125** disposed in electrical communication with the light source **120**. The integrally formed heat spreader **305** and heat sink **310** provides for improved heat flow from the LED **120** to the heat sink **310** as the heat flow path therebetween is continuous and uninterrupted as compared to the luminaire **100** discussed above.

To provide for a low profile luminaire **300**, the combination of the heat spreader **305**, heat sink **310** and outer optic **315**, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25 (best seen by reference to FIG. **28**). In an example embodiment, height H is 1.5-inches, and outside dimension D is a diameter of 7-inches. Other dimensions for H and D are contemplated such that the combination of the heat spreader **305**, heat sink **310** and outer optic **315**, are so configured and dimensioned as to; (i) cover an opening defined by an industry standard can-type light fixture having nominal sizes from three-inches to six-inches, such as a four-inch can or a six-inch can for example (see FIGS. **14** and **15** for example); and, (ii) cover an opening defined by an industry standard electrical junction box having nominal sizes from three-inches to six-inches, such as a four-inch J-box or a six-inch J-box for example (see FIGS. **16** and **17** for example). Since can-type light fixtures and ceiling/wall mount junction boxes are designed for placement behind a ceiling or wall material, an example luminaire **300** has the back surface of the heat spreader **305** substantially planar with the back surface of the heat sink **310**, thereby permitting the luminaire **300** to sit substantially flush on the surface of the ceiling/wall material. Alternatively, small standoffs **200** (see FIG. **12** in combination with FIG. **27** for example) may be used to promote air movement around the luminaire **300** for improved heat transfer to ambient, as discussed above.

Securement of the luminaire **300** to a junction box (see FIGS. **16-18** for example) may be accomplished by using a bracket **400** and suitable fasteners **405** (four illustrated) through appropriately spaced holes **410** (four illustrated) in the bracket **400**. Securement of the base **302** to the bracket **400** is accomplished using suitable fasteners **415** (two illustrated) through appropriately spaced holes **420** (two used, diametrically opposing each other, but only one visible) in the base **302**, and threaded holes **425** (two illustrated) in the bracket **400**. Securement of the optic **315** to the base **302** is accomplished using suitable fasteners **430** (three illustrated) through appropriately spaced holes **435** (three used, spaced 120 degrees apart, but only two illustrated) in tabs **445** of the optic **315**, and threaded holes **440** (three used, spaced 120 degrees apart, but only two illustrated) in the base **302**. A trim ring **470** circumferentially snap-fits over the optic **315** to hide the retaining fasteners **430**, the holes **435** and the tabs **445**. The snap-fit arrangement of the trim ring **470** relative to the optic **315** is such that the trim ring **470** can be removed in a pop-off manner for maintenance or other purposes. In an embodiment, securement of the optic **315** to the base **302** is accomplished using an insert-and-rotate action, where legs are integrally formed with, or molded onto, the optic **315** in place of the tabs **445**, and where engagement openings are integrally formed with the base **302** in place of the holes **440**. In another embodiment, securement of the optic **315** to the base **302** is accomplished using a snap-fit arrangement, where snap-fits legs are integrally formed with, or molded onto, the optic **315** in place of the tabs **445**, and where snap-fit receptors are integrally formed with the base **302** in place of the holes **440**.

In an embodiment, securement of the luminaire **300** to a junction box (see FIGS. **16-18** for example) may be accomplished without using a bracket **400**. That is, the luminaire **300** may be directly secured to a junction box using appropriate size and length hardware that passes through appropriately sized and placed holes in the base **302** to engage with the preformed standard securement holes formed in the J-box.

Securement of the luminaire **300** to a can-type fixture (see FIGS. **14-15** for example) may be accomplished by using two torsion springs **450** each loosely coupled to the bracket **400** at a pair of notches **455** by placing the circular portion **460** of each torsion spring **450** over the pairs of notches **455**, and then engaging the hook ends **465** of the torsion spring **450** with suitable detents in the can-type fixture (known detent features of can-type light fixtures are depicted in FIGS. **14-15**). In an embodiment, the circular portion **460** of each torsion spring **450** and the distance between each notch of a respective pair of notches **455** are so dimensioned as to permit the torsion springs **450** to lay flat (that is, parallel with the back side of luminaire **300**) during shipping, and to be appropriately rotated for engagement with a can-type fixture during installation (as illustrated in FIGS. **27-30**).

A power conditioner **165** similar to that discussed above in connection with FIG. **11** receives AC power from electrical connections within the junction box or can-type fixture, and provides conditioned DC power to the light source (LED) **120**. While illustrative details of the electrical connections between the power conditioner **165** and the light source (LED) **120** are not specifically shown in FIG. **27**, one skilled in the art will readily understand how to provide such suitable connections when considering all that is disclosed herein in combination with information known to one skilled in the art. The housing of power conditioner **165** includes recesses **480** (one on each side, only one illustrated) that engage with tabs **485** of the bracket **400** to securely hold the power conditioner **165** in a snap-fit or frictional-fit engagement relative to the bracket **400**.

Reference is now made to FIGS. **28** and **29**, which depict a side view and a back view, respectively, of the luminaire **300**. As discussed above in reference to FIG. **28**, an overall height H and an overall outside dimension D is such that the ratio of H/D is equal to or less than 0.25. The back view depicted in FIG. **29** is comparable with the back view depicted in FIGS. **3**, **11** and **13**, but with a primary difference that can be seen in the configuration of the heat sinking fins. In FIGS. **3**, **11** and **13**, the back surface **185** of the heat sink **110** includes a first plurality of recesses **190** oriented in a first direction, and a second plurality of recesses **195** oriented in a second opposing direction, with each recess of the first plurality and the second plurality having a shape that promotes localized air movement within the respective recess due at least in part to localized air temperature gradients and resulting localized air pressure gradients. Such recesses **190**, **195** were employed at least in part due to the radial dimension of the heat sink **110**, which is ring-like in shape. In FIG. **29**, and as discussed above, the heat sink **310** is integrally formed with the heat spreader **305** to form the base **302**. With such an integrally formed base arrangement, radially oriented heat sink fins **475** are integrally formed over a substantial portion of the back surface of the base **302**, which provide for greater heat transfer than is available by the recesses **190**, **195** having a more limited radial dimension that is limited by the configuration of the heat sink **110**. Heat sink fins **475** alternate with adjacently disposed and radially oriented recesses **476** to form a star pattern about the center of the back side of luminaire **300**. Such a star pattern provides a plurality of air flow channels on the back side of the base **302** for efficiently distributing and dissipating heat generated by the light source (LED) **120** disposed on the front side of the heat spreader **305** of the base **302**.

While heat sink **110** has herein been described having recesses **190**, **195**, and base **302** has herein been described having heat sink fins **475** and recesses **476**, for efficiently distributing and dissipating heat generated by the light source (LED) **120**, it will be appreciated that not all heat sinks will require fins and recesses depending on the power requirements of the luminaire, the power efficiency of the luminaire, the heat generated by the luminaire, and the heat transfer characteristics of the luminaire. As such, the scope of the invention is not limited to the inclusion of such fins and recesses, but also includes heat sinks that are absent fins and recesses but structured appropriately for distributing and dissipating heat generated by the light source.

In an embodiment, and with reference now to FIG. **30**, the outer optic **315** forms a blondel-type lens having a plurality of concentric circular flutes/ridges **490** formed and disposed on the inside surface of the outer optic **315**. With such a lens, the exact location of the light source **120** within the luminaire **300** is masked from the perspective of an observer standing a distance away from the luminaire **300**, thereby providing for a more uniform distribution of light. Such a lens may also be suitable for outer optic **115**. In an embodiment, the lens material used for outer optic **115**, **315** may be frosted. Example materials considered suitable for use in outer optic **115**, **315** include, but are not limited to, ACRYLITE® Acrylic Sheet Material available from CYRO Industries, and Acrylite Plus® also available from CYRO Industries.

Example materials considered suitable for use in reflector **145**, **145'** include, but are not limited to, MAKROLON® 2405, 2407 and 2456 available from Bayer Material Science, and MAKROLON® 6265 also available from Bayer Material Science.

With reference now to FIG. **31**, an accessory kit **500** is depicted having a set of formed springs **505**, a set of twist-on wire connectors **510**, a set of fasteners **515**, a first pre-wired jumper **520**, a second pre-wired jumper **525**, and a set of installation instructions **530**. Each of the first and second pre-wired jumpers **520**, **525** include a pair of flexible wires (hot/black and neutral/white wires) **521**, **526**, and a plug-in male connector **535**. The first pre-wired jumper **520** has an Edison base **540** mechanically and electrically connected to the end of the wire-pair **521** opposite that of the male connector 535. The wire-pair 521 and Edison base 540 are electrically connected with the proper polarity in a manner known in the art (hot wire electrically connected to the tip of the Edison base, neutral wire electrically connected to the screw threads of the Edison base). The second pre-wired jumper 525 has open wire ends 527 at the end of the wire-pair 526 opposite that of the male connector 535. Each male connector 535 is electrically connected to the respective wire-pair 521, 526 in a polarity-correct manner, where an interlock feature 536 on each male connector 535 prevents a reverse polarity connection when the plug-in male connector 535 is connected to a plug-in female connector 127 (see FIG. 34), discussed further below. In a typical installation, the first pre-wired jumper 525 is used when the luminaire 300 is to be installed in a can-type light fixture, and the second pre-wired jumper 525 is used when the luminaire 300 is to be installed in a J-box. The pre-connected Edison base serves to simplify installation in a can-type light fixture that already has an Edison screw receptacle pre-wired in place. In a J-box retrofit arrangement, the twist-on wire connectors 510 are used to pigtail wire ends 527 of the second pre-wired jumper 525 to pre-existing wire ends in the J-box. In a J-box arrangement, the luminaire 300 may be directly secured to the J-box pre-formed mounting holes using appropriately sized hardware 515.

As mentioned above, securement of the luminaire 300 to a junction box may be accomplished by directly securing the luminaire 300 to a junction box using hardware 515. However, it is contemplated that the luminaire 300 may also be secured to a junction box using the plurality of formed springs 505, absent a mounting bracket 400, by attaching the springs 505 to the luminaire 300 in a manner described below, and pushing the luminaire 300 onto the J-box such that the springs deflect inward to provide a friction fit with an interior side surface of the J-box. Installation of a luminaire 300 with springs 505 onto a can-type light fixture is discussed below. In an embodiment, the formed springs 505 are formed from flat stock spring steel, best seen by referring to FIG. 32, where each spring 505 has a first portion forming an anchor portion 550, and a second portion forming both a flexible leg portion 555 and a flexible finger portion 560. With reference to FIGS. 33 and 34, each spring 505 is mechanically fixed to the luminaire 300 by pushing the spring 505 in the direction of arrow 570 such that the anchor portion 550 fits snugly with respect to the luminaire 300, and more particularly fits snugly in a friction fit manner between the power conditioner 165 and the base 302. Either the power conditioner 165 or the base 302 may have recesses appropriately sized to receive the springs 505. A projection 551 on the anchor portion 550 of each spring 505 may be used to enhance the friction fit.

FIG. 34 depicts a luminaire 300 with the set of springs 505 installed, and with the electrical supply line 125 having a first end electrically connected to, and extending outward from, the power supply 165, and having a second end, a free end or open end, electrically connected to a female plug-in connector 127 in a polarity-correct orientation. During installation into a can-type light fixture, the Edison base 540 of the first pre-wired jumper 520 is first screwed into the existing Edison screw receptacle of the can-type fixture, leaving the plug-in male connector 535 hanging out of the light fixture. The male and female connectors 535, 127 are then connected, and the luminaire 300 then pushed into and attached to the can-type light fixture such that the second portion of the springs 505 deflect slightly inward and slidably engage with an interior surface of the can-type light fixture to form a friction fit assembly inside the can-type light fixture. While an embodiment has been herein described having male and female connectors 535, 127 disposed in a particular manner and in relation to specific parts, it will be appreciated that the male and female connectors 535, 127 may be interchangeable with their respective parts, or may be replaced with another type of connector, without detracting from the scoped of the invention. As such, it will also be appreciated that the two different connectors 535, 127 may more generally be described as connectors that are configured such that one connector can electrically engage with the other connector to provide a suitable electrical connection for the purpose disclosed herein.

FIG. 35 depicts an exploded assembly view of another embodiment of a luminaire 300' similar to that of luminaire 300 depicted in FIG. 27, but absent the mounting bracket 400. In the embodiment of FIG. 35, the luminaire 300' includes a trim ring 470, an optic 315' having diametrically opposing engagement tabs 445' (only one illustrated), a light source 120, fasteners 121 for securing the light source 120 to a base 302', which has integrally formed and diametrically opposed engagement openings 440' (only one illustrated) configured to receive the engagement tabs 445' such that the optic 315' is secured to the base 302' by inserting the tabs 445' into the openings 440' and rotating the optic 315' relative to a cylindrical axis of the base 302' in an insert-and-rotate action from a first position to a second position such that a portion of each engagement tab 445' is securely retained by respective portions of the base 302' (best seen by referring to FIG. 36A, illustrating the tabs/openings in the first unsecured position, and FIG. 36B, illustrating the tabs/openings in the second secured position), a power source 165', an electrical supply line 125, a ground wire 128, a top 167, a female plug-in connector 127, and a ground eyelet 129. The electrical supply line 125, such as insulated two-conductor wire for example, and the ground wire 128, which may be a green color-coded insulated single-conductor wire for example, pass through holes (not illustrated) in the top 167, and subsequently have the female plug-in connector 127 and ground eyelet 129, respectfully, electrically attached thereto during factory assembly. The luminaire 300' is secured to the can-type light fixture by means of the springs 505, as depicted in FIGS. 32-34. In an alternative embodiment, the optic 315' is securely retained by the base 302' via a snap-fit engagement between the optic 315' and the base 302' created by the engagement tabs 445' snapping into engagement with a wall thickness of the base 302' as the engagement tabs 445' are pushed through the engagement openings 440' of the base 302', which is best seen with reference to FIG. 37A (illustrating the tabs/openings in a first unsecured position) and FIG. 37B (illustrating the tabs/openings in a second secured position). The ground wire 128 of the luminaire 300' may be electrically connected to the can of the can-type light fixtures using eyelet 129 and mounting hardware (short screw and washer) 515 of the accessory kit 500, or may be electrically connected to the pre-existing ground wire in the J-box by clipping off the eyelet and stripping back the wire insulation, depending of the type of installation at hand.

While certain combinations of elements have been described herein, it will be appreciated that these certain combinations are for illustration purposes only and that any combination of any of the elements disclosed herein may be employed in accordance with an embodiment of the invention. Any and all such combinations are contemplated herein and are considered within the scope of the invention disclosed.

While embodiments of the invention have been described employing aluminum as a suitable heat transfer material for the heat spreader and heat sink, it will be appreciated that the scope of the invention is not so limited, and that the invention also applies to other suitable heat transfer materials, such as copper and copper alloys, or composites impregnated with heat transfer particulates, for example, such as plastic impregnated with carbon, copper, aluminum or other suitable heat transfer material, for example.

The particular and innovative arrangement of elements disclosed herein and all in accordance with an embodiment of the invention affords numerous not insignificant technical advantages in addition to providing an entirely novel and attractive visual appearance.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best or only mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

What is claimed is:

1. A luminaire and accessory kit in combination, the combination comprising:

a luminaire, comprising:

a heat spreader; a heat sink disposed in thermal communication with the heat spreader; a light source comprising a plurality of light emitting diodes (LEDs) disposed in thermal communication with the heat spreader; a power supply electrically connected to the light source; an electrical supply line having a first end connected to the power supply, and a second end connected to a plug-in connector; and, an optic disposed in optical communication with the LEDs; and

an accessory kit, comprising:

at least one of: a first pre-wired jumper comprising a pair of insulated electrical wires having a first plug-in connector electrically connected at one end and an Edison base electrically connected at the other end; and, a second pre-wired jumper comprising a pair of insulated electrical wires having a second plug-in connector electrically connected at one end and cut wire ends at the other end;

wherein the plug-in connector of the first pre-wired jumper and the second pre-wired jumper are each configured to electrically engage with the plug-in connector of the electrical supply line.

2. The combination of claim **1**, wherein the accessory kit includes both the first pre-wired jumper and the second pre-wired jumper.

3. The combination of claim **1**, wherein the heat sink is substantially ring-shaped, and is disposed around and coupled to an outer periphery of the heat spreader.

4. The combination of claim **1**, wherein the heat spreader, the heat sink and the optic, in combination, have an overall height H and an overall outside dimension D such that the ratio of H/D is equal to or less than 0.25.

5. The combination of claim **1**, wherein the heat spreader, the heat sink and the optic, in combination, are so dimensioned as to cover: an opening defined by a nominally sized four-inch can light fixture; and, an opening defined by a nominally sized four-inch electrical junction box.

6. The combination of claim **1**, wherein the LEDs are disposed on the heat spreader, the heat spreader being configured to dissipate heat from the LEDs.

7. The combination of claim **1**, wherein the accessory kit further comprises a set of springs, each spring having a first portion configured to securely engage with the luminaire, and a second portion configured to deflect and slidably engage with an interior surface of a can-type light fixture.

8. The combination of claim **7**, wherein each spring of the set of springs is formed from flat stock spring steel.

9. The combination of claim **1**, wherein the heat spreader and the heat sink in combination define a base, wherein the optic is securely retained by the base via a snap-fit engagement between the optic and the base.

10. The combination of claim **1**, wherein the heat spreader and the heat sink in combination define a base, wherein the base comprises engagement openings, wherein the optic comprises engagement tabs, wherein the optic is securely retained by the base by inserting respective ones of the engagement tabs into respective ones of the engagement openings and rotating the optic relative to a cylindrical axis of the base such that a portion of each engagement tab is securely retained by respective portions of the base.

11. The combination of claim **1**, wherein:

the optic is securely retained relative to at least one of the heat spreader and the heat sink.

12. The combination of claim **1**, wherein the accessory kit further comprises:

at least one twist-on wire connector.

13. The combination of claim **1**, wherein the accessory kit further comprises:

at least one fastener configured to secure the luminaire to an electrical junction box.

14. The combination of claim **1**, wherein the luminaire further comprises:

a reflector disposed in optical communication with the LEDs and the optic such that light emitted from the LEDs is reflected by the reflector toward the optic.

15. The combination of claim **14**, wherein the reflector overlies the power supply such that the power supply is hidden from view when viewed from an outer optic side of the luminaire.

* * * * *

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Chou

(10) **Patent No.: US 7,670,021 B2**
(45) **Date of Patent: Mar. 2, 2010**

(54) **METHOD AND APPARATUS FOR THERMALLY EFFECTIVE TRIM FOR LIGHT FIXTURE**

(75) Inventor: **Der Jeou Chou**, Mesa, AZ (US)

(73) Assignee: **Enertron, Inc.**, Tempe, AZ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1 day.

(21) Appl. No.: **12/123,960**

(22) Filed: **May 20, 2008**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**
F21V 29/00 (2006.01)

(52) **U.S. Cl.** **362/148**; 362/147; 362/404; 362/294

(58) **Field of Classification Search** 362/147, 362/148, 149, 150, 404, 294, 373, 547
See application file for complete search history.

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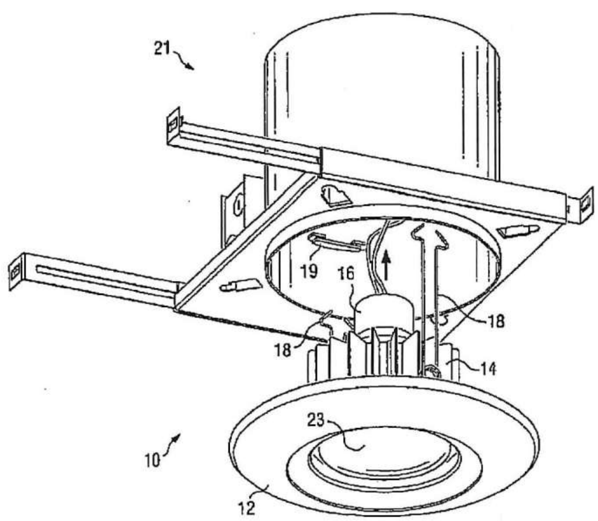
Primary Examiner—Laura Tso
(74) *Attorney, Agent, or Firm*—Robert D. Atkins

(57) **ABSTRACT**

A lighting assembly comprises a light fixture. The light fixture includes a trim formed by a stamping or die casting process. The trim has thermally conductive properties and includes a flange around a perimeter of the trim. The light fixture includes a light source mounted to a central portion of a front surface of the trim, and a heatsink formed by an extrusion or die casting process. The heatsink has thermally conductive properties and is mounted to a back surface of the trim. The light fixture includes an attachment mechanism connected to the light fixture. A recessed can housing mounted to a surface may be provided. The light fixture may be mounted to the recessed can housing by inserting the heatsink into the recessed can housing and engaging the attachment mechanism to an interior portion of the recessed can housing to brace the flange against the surface.

19 Claims, 11 Drawing Sheets



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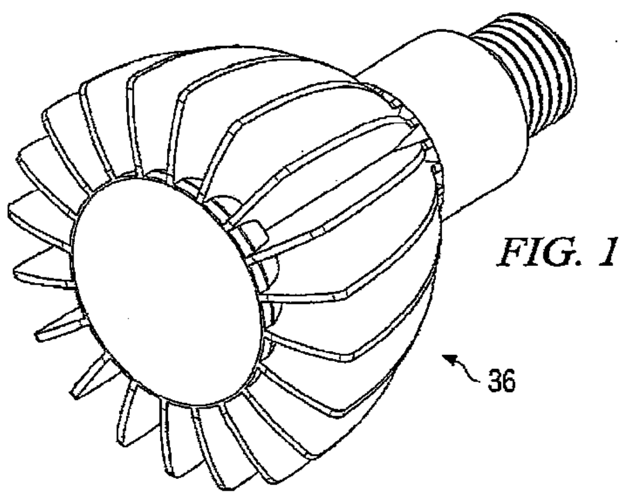

FIG. 1

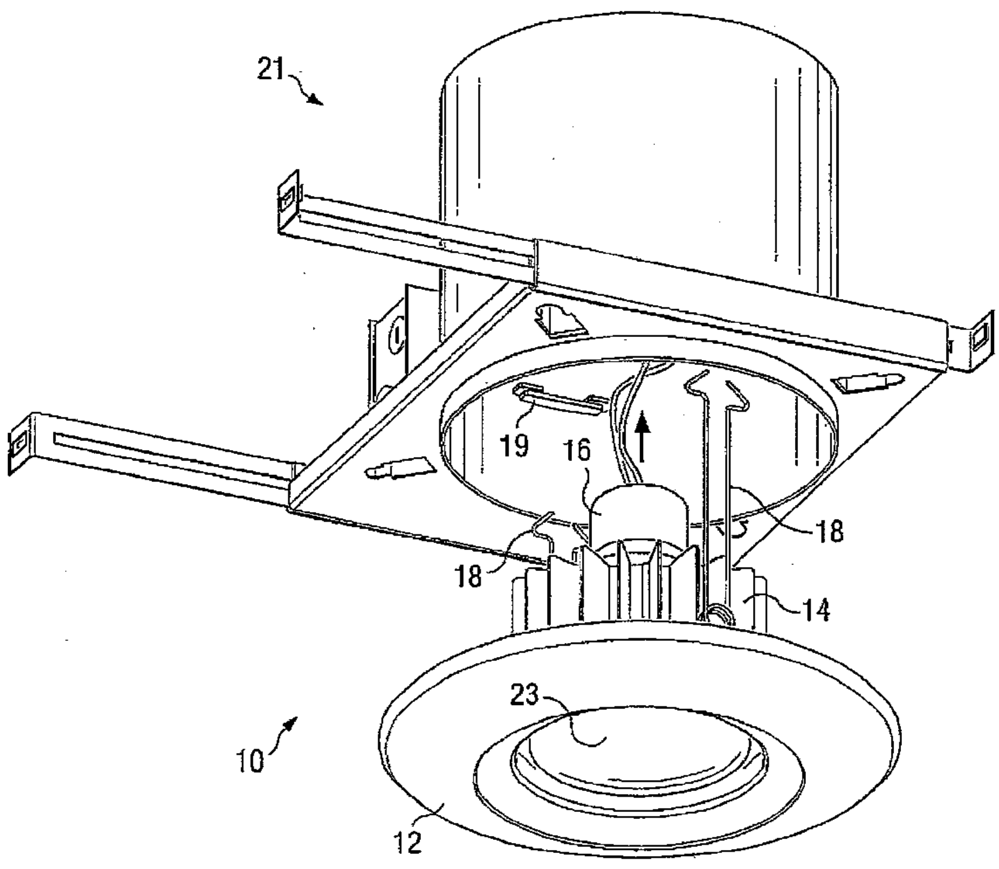

FIG. 3

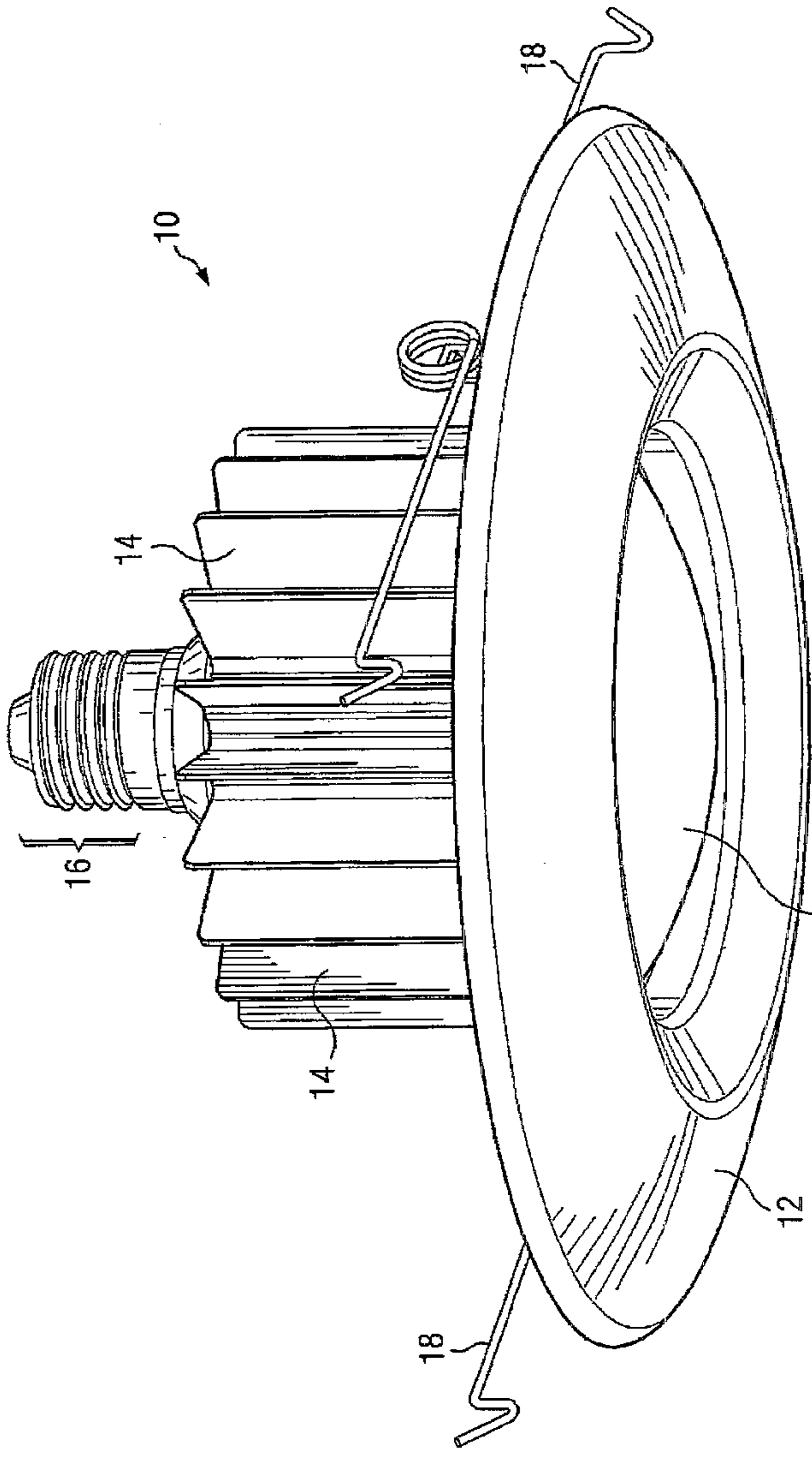

FIG. 2a

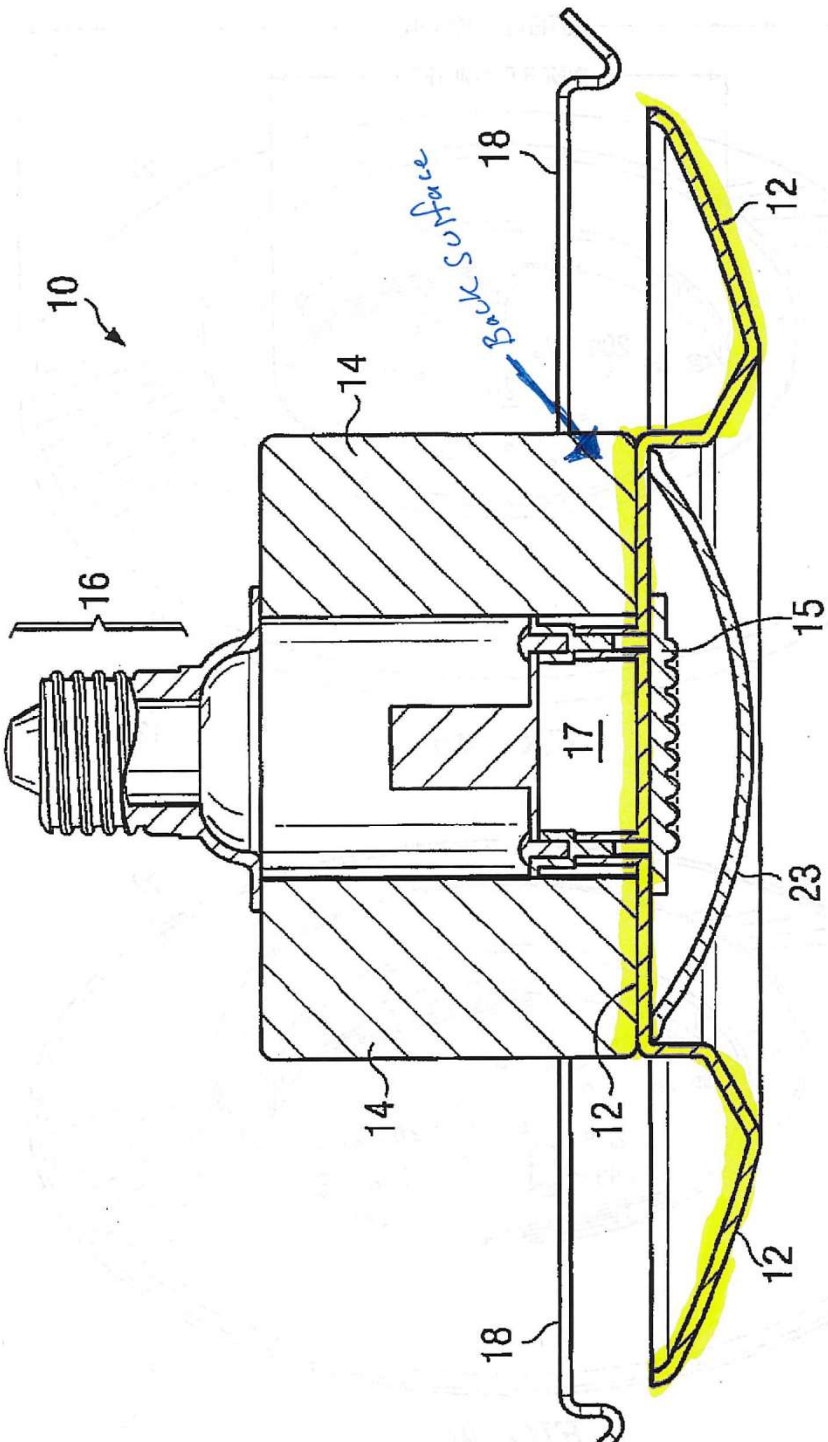

FIG. 2b

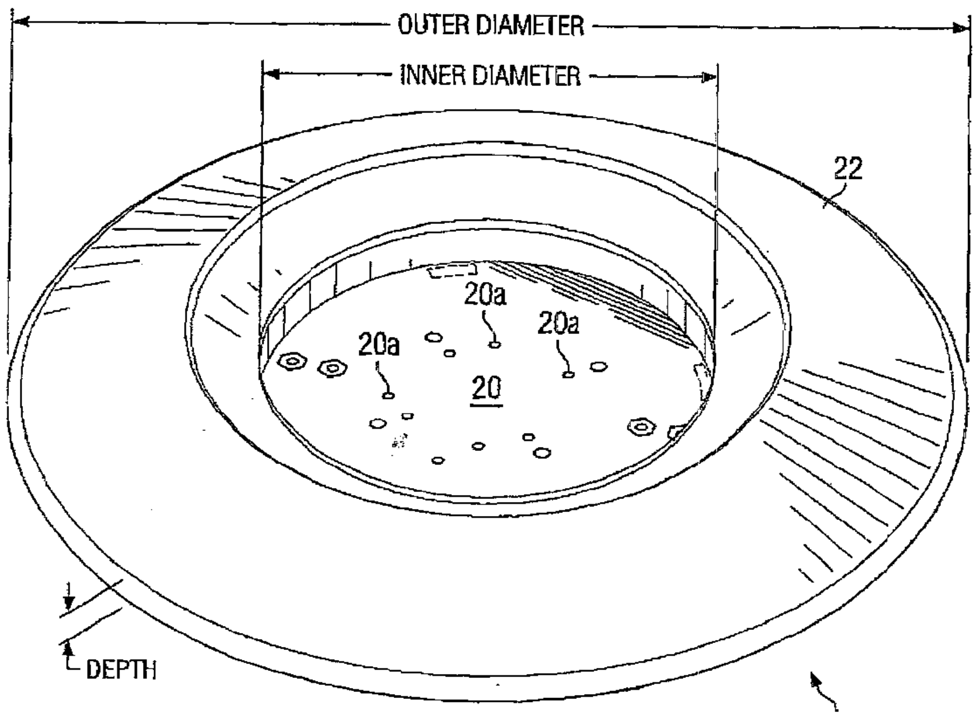
OUTER DIAMETER
INNER DIAMETER
22
20a
20a
20a
20
DEPTH
12

FIG. 4a

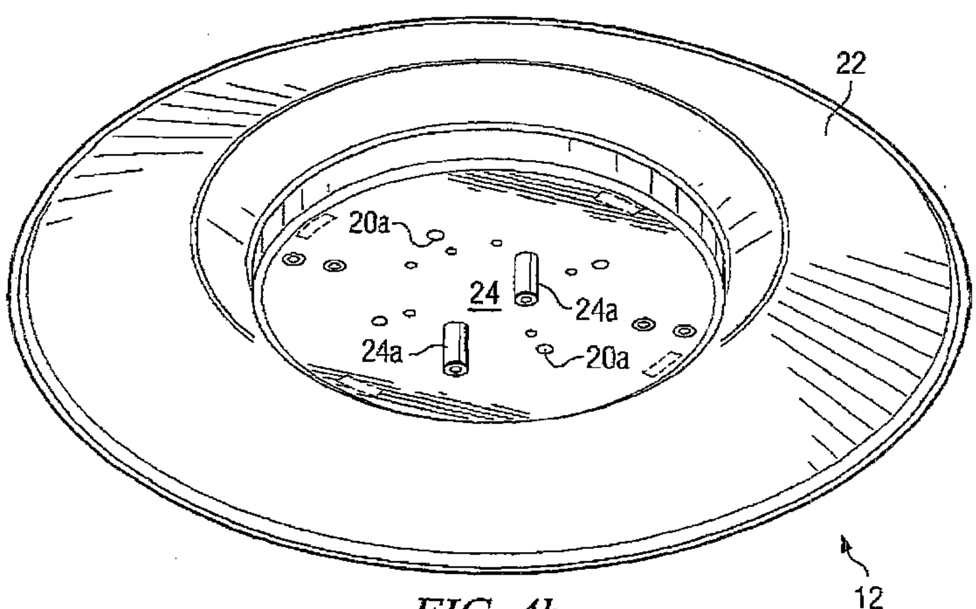
22
20a
24
24a
24a
20a
12

FIG. 4b

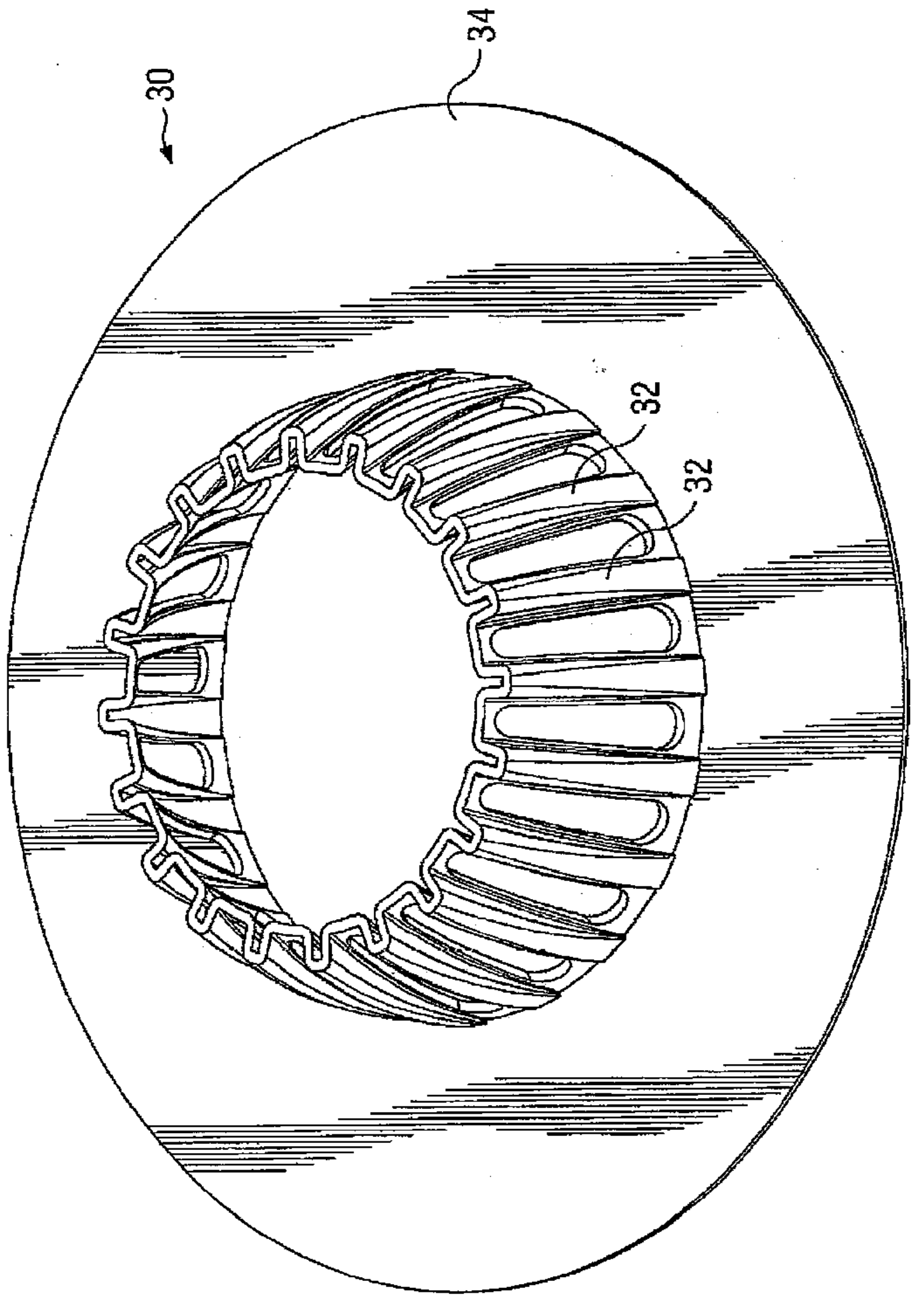

FIG. 5

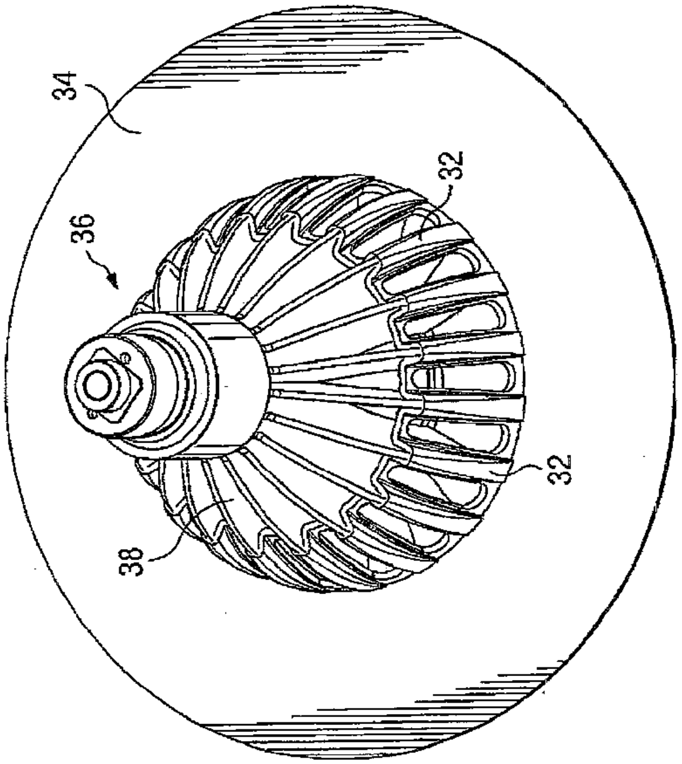

FIG. 6b

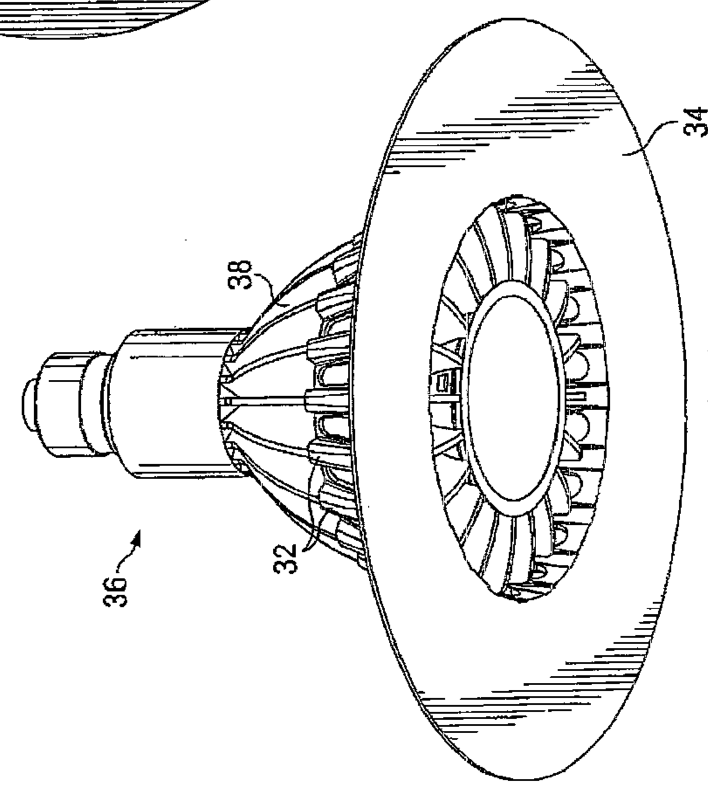

FIG. 6a

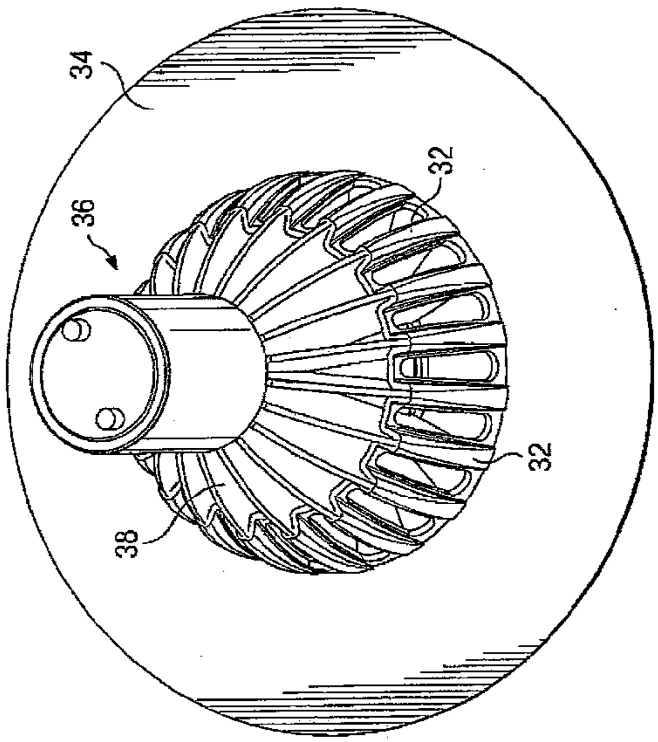

FIG. 7b

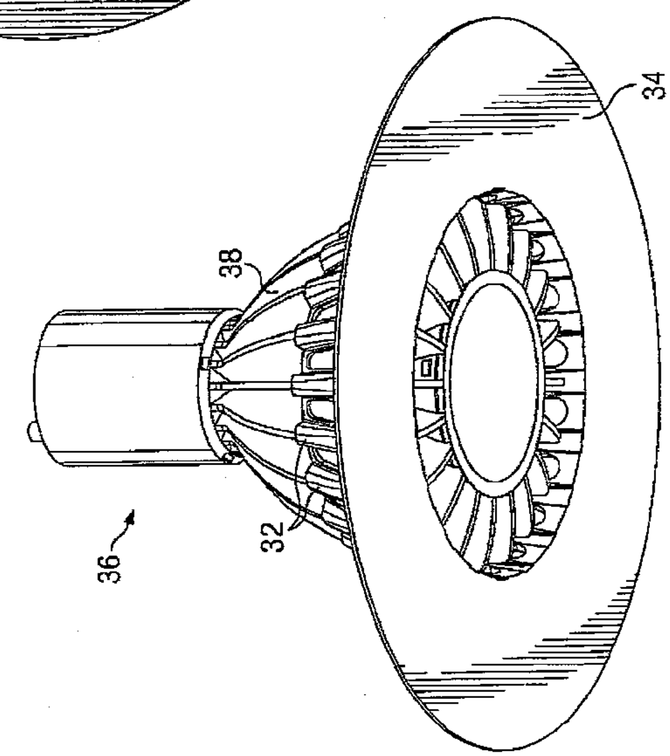

FIG. 7a

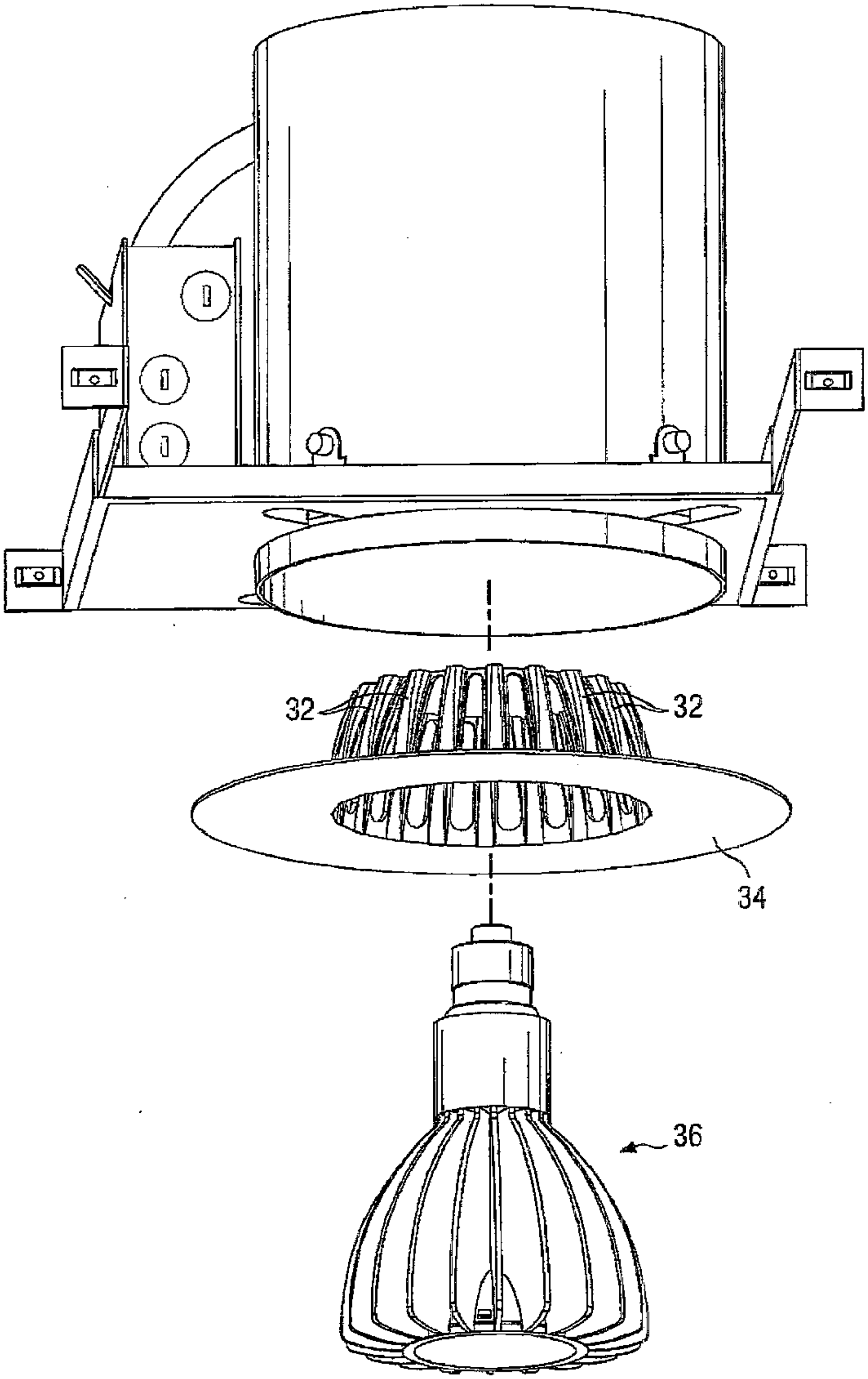

FIG. 8

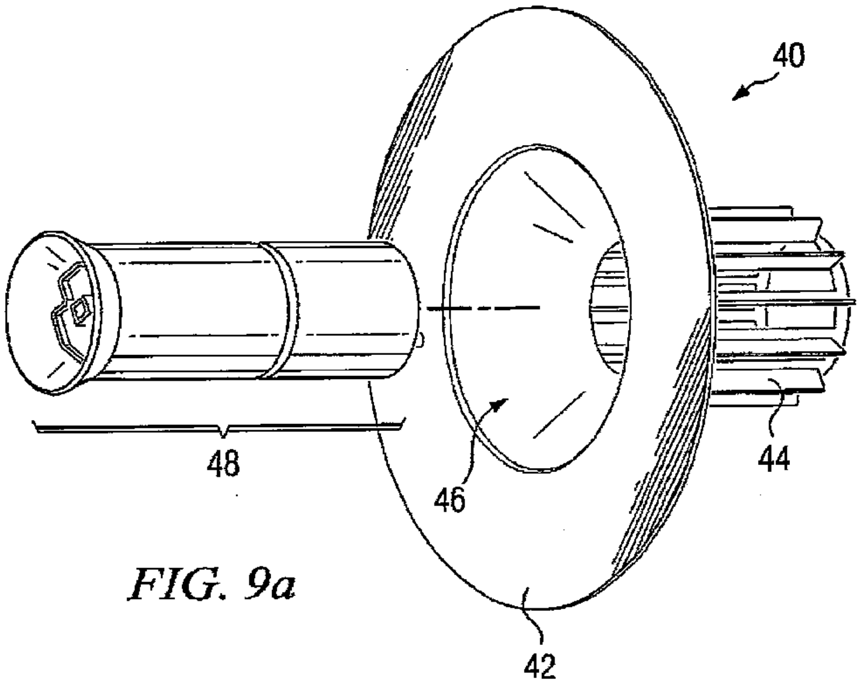

FIG. 9a

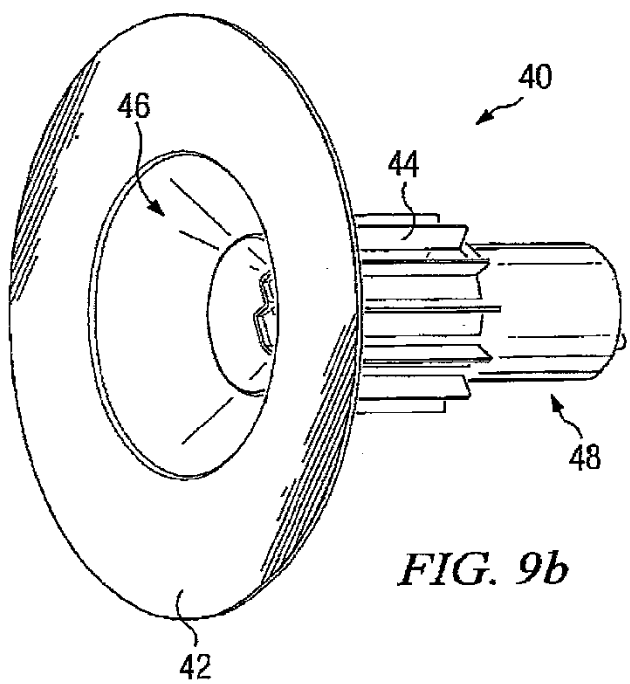

FIG. 9b

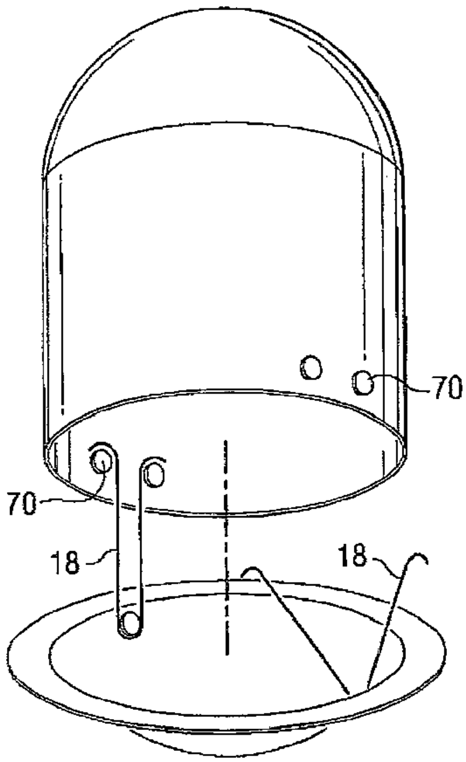

FIG. 10a

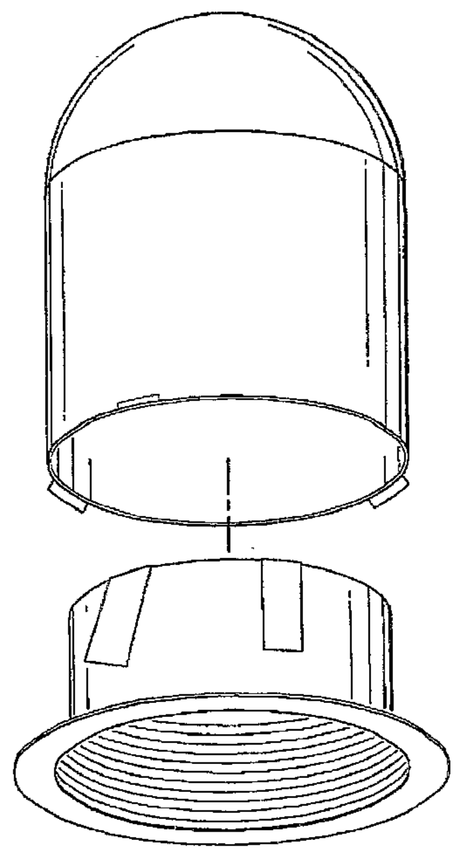

FIG. 10b

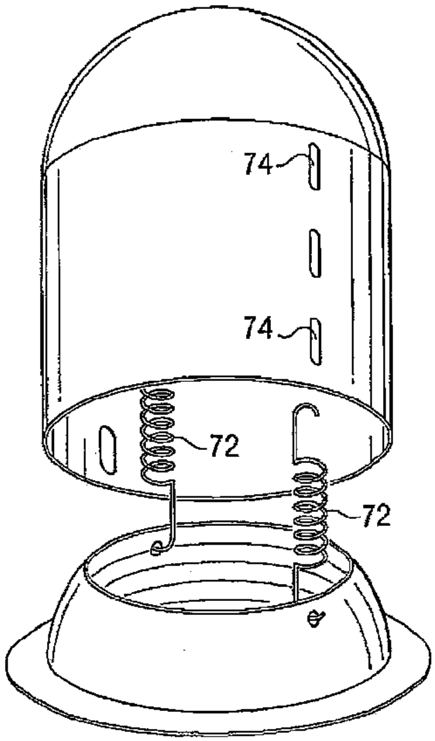

FIG. 10c

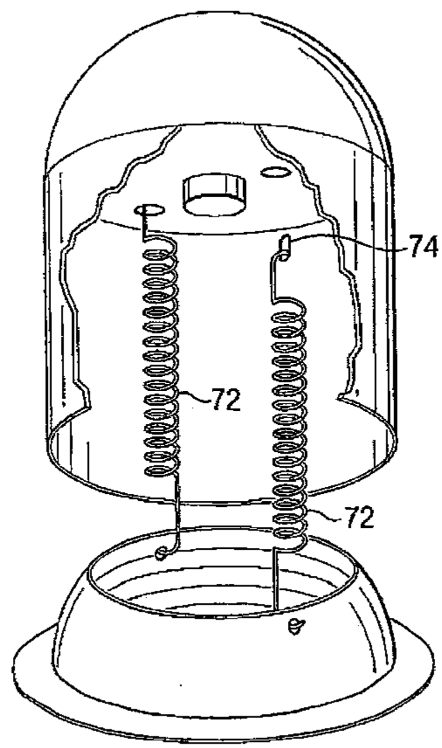

FIG. 10d

METHOD AND APPARATUS FOR THERMALLY EFFECTIVE TRIM FOR LIGHT FIXTURE

CLAIM TO DOMESTIC PRIORITY

The present non-provisional patent application claims priority to Provisional Application No. 60/975,657 entitled "Thermally Effective Trim for LED Light in Recessed Can Fixture Applications," filed on Sep. 27, 2007, and claims priority to the foregoing application pursuant to 35 U.S.C. § 120.

FIELD OF THE INVENTION

The present invention relates in general to light emitting devices and, specifically, to a recessed light fixture having a thermally effective trim.

BACKGROUND OF THE INVENTION

Light emitting diodes (LEDs) have been used for decades in applications requiring relatively low-energy indicator lamps, numerical readouts, and the like. In recent years, however, the brightness and power of individual LEDs has increased substantially, resulting in the availability of 1 watt and 5 watt devices.

While small, LEDs exhibit a high efficacy and life expectancy as compared to traditional lighting products. A typical incandescent bulb has an efficacy of 10 to 12 lumens per watt, and lasts for about 1,000 to 2,000 hours; a general fluorescent bulb has an efficacy of 40 to 80 lumens per watt, and lasts for 10,000 to 20,000 hours; a typical halogen bulb has an efficacy of 20 lumens and lasts for 2,000 to 3,000 hours. In contrast, red-orange LEDs can emit 55 lumens per watt with a life-expectancy of about 100,000 hours.

Because LED devices generate heat, the use of LEDs or LED lamps in a recessed can fixture or housing can present problems due to the thermal constraints of LEDs—heat negatively affects the optical and electrical performance of LEDs. Because conventional recessed can applications tend to be thermally inefficient and do not provide adequate heat ventilation, an LED device installed into a recessed can housing will quickly generate substantial amounts of heat within the housing that can damage the device.

Presently, most of the recessed can housings for residential and commercial applications are fully sealed at the can top, which means there is no air passage from the can to the space above the housing. Also, in most cases, the thermal insulation in the attic is placed around the can further restricting the flow of heat out of the housing. As a result, there is no effective heat dissipation path from the can housing to the attic.

An LED-based lamp installed into a recessed can housing requires an effective heat dissipation path to operate and to maintain its optical and electrical performance, longevity and reliability. FIG. 1 is an illustration of an LED parabolic aluminized reflector (PAR) lamp with a conventional base socket that may be installed into a conventional recessed can housing. Although the fins on the lamp are designed for dispersing the heat generated from the LED light engine, the heat is captured within the housing and does not dissipate. Lab experiments show that the fin temperature of a 15 watt LED lamp operated under open air conditions generates a rise in fin temperature of 25° C. over ambient temperature. When the lamp is positioned flush with the lid of a recessed can housing there is a 45° C. rise over ambient air temperature in the housing. If the lamp is further recessed into the can 2.54 cm

behind the can lid, the temperature increase is approximately 60° C. At the ceiling of a typical home the air temperature will be 40° C. in the summer. As a result, the LED die junction temperature inside the LED lamp may be over approximately 100° C. when the LED lamp is flush with the trim lid.

The recessed can is one of the most widely used light fixtures in modern homes in the United States. There are millions of incandescent light bulbs installed into recessed can fixtures. Successful retrofit of an LED lamp to the existing and new recessed can housings may result in an 80% decrease in lighting energy consumption and an increase of the lamp's operating life from a typical 2,000 hours incandescence to the 50,000 hours of an LED device.

SUMMARY OF THE INVENTION

In one embodiment, the present invention is a method of manufacturing a lighting assembly comprising providing a light fixture by (a) forming a trim by a stamping or die casting process. The trim has thermally conductive properties and includes a flange around a perimeter of the trim. Providing the light fixture includes (b) mounting a light source to a central portion of a front surface of the trim, and (c) forming a heatsink by an extrusion or die casting process. The heatsink has thermally conductive properties. Providing the light fixture includes (d) mounting the heatsink to a back surface of the trim opposite the light source, and (e) connecting an attachment mechanism to the light fixture. The method includes providing a recessed can housing mounted to a surface and mounting the light fixture to the recessed can housing by (f) inserting the heatsink into the recessed can housing, and (g) engaging the attachment mechanism to an interior portion of the recessed can housing to brace the flange against the surface.

In another embodiment, the present invention is a method of manufacturing a light fixture comprising forming a trim. The trim has thermally conductive properties and includes a flange around a perimeter of the trim. The method includes mounting a light source to a central portion of a front surface of the trim, and forming a heatsink. The heatsink has thermally conductive properties. The method includes mounting the heatsink to a back surface of the trim opposite the light source, and connecting an attachment mechanism to the light fixture.

In another embodiment, the present invention is a method of manufacturing a light fixture comprising forming a trim including a flange around a perimeter of the trim, mounting a light source to a front surface of the trim, mounting a heatsink to a back surface of the trim, and connecting an attachment mechanism to the light fixture.

In another embodiment, the present invention is a light fixture comprising a trim formed by a stamping or die casting process. The trim has thermally conductive properties and includes a flange around a perimeter of the trim. The light fixture includes a light source mounted to a central portion of a front surface of the trim, and a heatsink mounted to a back surface of the trim opposite the light source. The heatsink is formed by an extrusion or die casting process and has thermally conductive properties. The light fixture includes an attachment mechanism connected to the light fixture.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a light emitting diode (LED)-based light source incorporating a plurality of heatsink fins and operating as a parabolic aluminized reflector (PAR) light source;

FIG. 2*a* illustrates a perspective view of a recessed can light fixture including a thermally conductive trim and heatsink for redistributing heat;

FIG. 2*b* illustrates a cross-sectional view of a recessed can light fixture including a thermally conductive trim aud heatsink for redistributing heat;

FIG. 3 is a perspective view illustrating the installation of the light fixture of FIGS. 2*a*-2*b* into a recessed cau housing;

FIGS. 4*a*-4*b* illustrate perspective views of the thermally conductive trim section of the light fixture of FIGS. 2*a*-2*b* illustrating the heatsink and light source attachment points;

FIG. 5 is a perspective view of a thermally conductive trim section configured to connect to the light source shown in FIG. 1;

FIGS. 6*a*-6*b* illustrate perspective views of the thermally conductive trim of FIG. 5 coupled to the light source of FIG. 1 having an E26/E27 electrical socket;

FIGS. 7*a*-7*b* illustrate perspective views of the thermally conductive trim of FIG. 5 coupled to the light source of FIG. 1 having a GU24 electrical socket;

FIG. 8 is a perspective view illustrating the installation of the light fixture of FIGS. 6*a*-6*b* into a recessed can housing;

FIGS. 9*a*-9*b* are perspective views of a thermally conductive trim having an integrated heatsink and being configured to couple to a light source; and

FIGS. 10*a*-10*d* illustrate perspective views of mechanisms for coupling a light fixture to an interior portion of a recessed can housing.

DETAILED DESCRIPTION OF THE DRAWINGS

The present invention is described in one or more embodiments in the following description with reference to the Figures, in which like numerals represent the same or similar elements. While the invention is described in terms of the best mode for achieving the invention's objectives, it will be appreciated by those skilled in the art that it is intended to cover alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims and their equivalents as supported by the following disclosure and drawings.

FIGS. 2*a* and 2*b* illustrate recessed can fixture 10 housing a light source. FIG. 2*a* shows a perspective view of fixture 10, while FIG. 2*b* shows a cross-sectional view. Light fixture 10 is a thermally efficient structure that enables a heat-generating light source such as an LED lamp to safely operate in a typical top sealed recessed can housing. Although recessed light fixtures provide various aesthetic and architectural benefits to homeowners and businesses, they generally provide poor ventilation and, as a result, can cause a significant amount of heat build-up within the housing. In addition to the potential fire risk of excessive heat build-up, heat may negatively affect the performance of the light fixture itself.

Excessive heat minimizes the lifespan of both conventional light bulbs and LED light sources. In some cases, excessive heat also modifies the operating properties of a light source. For example, because the light generation properties of many LED light sources are at least partially governed by temperature, a significant change in the ambient temperature surrounding an LED light source may cause a change in the output color of light emitted from the device. Accordingly, a thermally efficient fixture minimizes both the risk of fire and the effect of temperature on the output color and lifespan of the light source contained within the fixture.

Fixture 10 is configured to install into both conventional 12.7 cm (5 inch) and 15.24 cm (6 inch) recessed can housings. However, fixture 10 may be configured to be installed into a

recessed can housing having other geometries. Depending upon the installation, different attachment mechanisms may be used to secure fixture 10 within the housing. As new recessed housings are developed with different geometries, new attachment mechanisms with different lengths or other attributes can be manufactured for coupling to and installing fixture 10 into those housings.

Fixture 10 includes several components that are coupled together to provide efficient dissipation of heat energy from within the device. Fixture 10 includes trim 12. Trim 12 includes a flange that, after installation of fixture 10, protrudes from the recessed can housing. Heatsink 14 is coupled to trim 12 to facilitate the removal of heat energy from trim 12 and fixture 10. Light source 15 (shown on FIG. 2*b*) is directly mounted to a front surface of trim 12 and acts as the light source of the device. Fixture 10 includes an electrical socket 16 for connecting the light source to an electricity source. Socket 16 may include an E26/E27 bulb socket or a GU24 socket. Depending upon the application, the electricity source may be a standard 120 VAC, 220 VAC, 277 VAC, or other AC source or a DC power source. If the power source is an AC power source and the light source is configured to operate using a DC power source, an AC to DC converter circuit may be connected between socket 16 and the light source to convert the AC power source into a DC source. In one embodiment, the conversion circuit includes circuit board 17 mounted within heatsink 14. In such a configuration, heatsink 14 facilitates the removal of heat energy from both trim 12 and circuit board 17. Window or lens 23 is connected to trim 12 to form an output portal for light generated by light source 15. Attachment clips 18 are connected to fixture 10 and allow fixture 10 to be mounted within a recessed can housing. In one embodiment, clips or torsion springs 18 are connected to trim 12. The geometry of clips 18 is adjusted to install fixture 10 into recessed can housings having different sizes. Mounting brackets (not shown) configured for a particular recessed can housing may be connected between clips 18 and fixture 10 to adjust the placement of clips 18.

Turning to FIG. 3, fixture 10 is inserted into recessed can housing 21. Socket 16 is connected to an electricity source made available within recessed housing 21. Clips 18 are compressed and inserted into housing 21. After insertion, clips 18 expand and engage with apertures 19 fixed to the interior surface of the housing to secure fixture 10 within housing 21. After installation, heatsink 14 resides substantially within the housing and trim 12 resides substantially outside the housing. The outer flange of trim 12 may contact a structural surface that surrounds the recessed housing such as a ceiling or wall surface (not shown). As clips 18 expand and exert force against an interior surface of the recessed can housing (such as apertures 19), clips 18 exert force on fixture 10 and, specifically, pull the flange portion of trim 12 against the surface surrounding the recessed can application.

During operation, the light source generates heat. In a conventional recessed can fixture, the heat would ordinarily be generated by the light bulb and travel upwards within the housing. After leaving the light bulb, the heat is trapped in the recessed housing. As the device generates additional heat, the temperature within the housing increases and negatively affects the performance of the light fixture. In some cases, the excess heat shortens the operative lifetime of the device or degrades the optical qualities of the light source. In other cases, the excess heat may result in a fire risk. Typical incandescent recessed can fixtures require thermal cutoff devices to be connected in series with the incandescent lamp to prevent a fire risk when overheating.

In the present embodiment, however, as the light source operates, heat is transferred directly into trim **12** from the light source. As the temperature of trim **12** increases, heat is vented from the flange portion of trim **12** that resides outside the recessed can housing. Also, because trim **12** is connected to heatsink **14**, a portion of the heat residing in trim **12** is transmitted into heatsink **14** where it is then vented within the recessed housing. Although some heat is vented into the recessed housing via heatsink **14**, a majority of heat is dissipated from trim **12** outside the housing. Accordingly, fixture **10** minimizes heat build-up within the recessed housing.

In this configuration, heat energy flows from the light source, into trim **12**, where a portion of the heat energy is dissipated from trim **12**. Heat energy remaining in trim **12** is transferred into heatsink **14**. As such, heatsink **14** may be regarded as acting as a heatsink for trim **12** rather than the light source directly.

Trim **12** and the flange of trim **12** generally dissipates more heat energy from the light source than heatsink **14**. By doing so, trim **12** minimizes heat build-up within the recessed can housing. The following analysis describes an example installation of fixture **10** and illustrates a process for determining the ratio of energy dispersed from trim **12** versus heatsink **14**. In the example, trim **12** includes a thermally conductive material such as aluminum, and has an outer diameter of 200 mm, an inner diameter of 130 mm and a depth of 42 mm (see FIG. 4*a*). Accordingly, trim **12** has an approximate surface area of $A_{trim}=0.0296\ m^2$. To determine the percentage of heat dissipated by both trim **12** and heatsink **14** the convection heat transfer and radiation heat transfer for each component must be determined.

Convection heat transfer (Q_{conv}) for trim **12** is shown by equation (1):

$$Q_{conv}=\eta h A_{trim}\, dT \qquad (1)$$

where

η: trim efficiency;

h: convection heat transfer coefficient (W/° C.-m²), typical free convection coefficient=5, plus approximated radiation effect of 5, giving a total estimated value of 10; and

dT: temperature difference between the trim and the ambient air (° C.).

In equation (1), $\eta=\tan h\ mL/mL$ where $mL=(h/(k*t*L))^{1/2}*L^{3/2}$. Accordingly, $mL=(10/(180\times0.002\times0.064))^{1/2}\times0.064^{3/2}$ or 0.33. As such, $\eta=\tan h\ 0.33/0.33=0.965$.

Radiation heat transfer for trim **12** is shown by equation (2):

$$Q_{rad}=\epsilon\sigma A_{trim}F(T_{trim}^4-T_{amb}^4) \qquad (2)$$

where

ε: emissive ~0.90;

σ: Stefan-Boltzmann constant 5.669×10^{-8} (W/° K.⁴-m²); and

F: shape factor of ~0.95.

The same equations can be established for heatsink **14**. In the example, heatsink **14** includes a thermally conductive material and has a plurality of fins having an effective surface area of approximately $A_{heatsink}=0.065\ m^2$.

Convection heat transfer (Q_{conv}) for heatsink **14** is shown by equation (3):

$$Q_{conv}=\eta h A_{heatsink}\, dT \qquad (3)$$

where

η: heatsink efficiency=η(heatsink base)×η(heatsink fins);

h: convection heat transfer coefficient (W/° C.-m²), typical free convection coefficient=5;

dT: temperature difference from the heatsink base to the ambient air (° C.); and

$\eta=\tan h\ mL/mL$.

In equation (3), $\eta=\tan h\ mL/mL$ where $mL=(2*h/(k*t*L))^{1/2}*L^{3/2}$. Accordingly, $mL=(2\times5(20*23*2+52*\pi)/52*\pi)/(180\times0.005\times0.060))^{1/2}\times0.060^{3/2}$ or 0.52. Accordingly, $\eta=\tan h\ 0.52/0.52=0.91$.

Radiation heat transfer for heatsink **14** is shown by equation (4):

$$Q_{rad}=\epsilon\sigma A_{heatsink}F(T_{heatsink}^4-T_{amb}^4) \qquad (4)$$

where

ε: emissive ~0.30;

σ: Stefan-Boltzmann constant 5.669×10^{-8} (W/° K.⁴-m²); and

F: shape factor of ~0.5.

Having determined the convection and radiation heat transfer equations for trim **12** and heatsink **14**, it is possible to determine the energy balance of the system. The system includes trim **12**, heatsink **14**, and the LED light source that generates heat energy. The energy balance is given by equation (5):

$$Q_{led}=Q_{trim}+Q_{heatsink} \qquad (5)$$

Assuming worst case conditions, the energy generated by an LED light source (Q_{led}) is approximately 15 watts. The ambient temperature of heatsink **14** ($T_{heatsink}$) deposited within a fully-insulated recessed can housing is approximately 50° C. The ambient temperature of trim **12** (T_{trim}) residing outside the recessed can housing is approximately 35° C. The ambient temperature of the room (T_{amb}) is approximately 25° C. Given these conditions, it is possible to determine the energy stored in trim **12** and heatsink **14**. The energy within trim **12** (Q_{trim}) is determined by equation (6):

$$Q_{trim}=Q_{conv}+Q_{radi} \qquad (6)$$

With reference to equation (6), $Q_{trim}=\eta h A_{trim}dT+\epsilon\sigma A_{trim}F\ (T_{trim}^4-T_{amb}^4)$. $Q_{trim}=0.965\times5\times0.0296\times(T_{trim}-35)+0.95\times5.669\times10^{-8}\times0.0296\times0.9\times(T_{trim}^4-308^4)$. Accordingly, $Q_{trim}=(0.143\ T_{trim}-4.99)+(1.43\times10^{-9}\times T_{trim}^4-12.86)$.

The energy within heatsink **14** ($Q_{heatsink}$) is determined by equation (7):

$$Q_{heatsink}=Q_{conv}+Q_{radi} \qquad (7)$$

With reference to equation (7), $Q_{heatsink}=\eta h A_{heatsink}\, dT+\epsilon\sigma A_{heatsink}\ F\ (T_{heatsink}^4-T_{amb}^4)$. $Q_{heatsink}=0.91\times0.065\times5\times(T_{heatsink}-50)+0.3\times5.569\times10^{-8}\times0.065\times0.5\times(T_{heatsink}^4-323^4)$. Accordingly, $Q_{heatsink}=0.295\ T_{heatsink}-14.78+5.527\times10^{-10}\ T_{heatsink}^4-6.01$.

Assuming the temperature of heatsink **14** is equal to the temperature of trim **12** ($T=T_{trim}=T_{heatsink}$), equations (6) and (7) can be combined to generate equation (8):

$$15=0.438T+1.983\times10^{-9}T^4-38.64 \qquad (8)$$

Numerical analysis of equation (8) results in a value of T=~61° C.

With the energy balance for the system, it is possible to determine the amount of heat transfer from trim **12** and heatsink **14** into the ambient air surrounding fixture **10**. The energy dissipated by trim **12** at approximately 64.1° C. is given by equation (9):

$$Q_{trim}=Q_{conv}+Q_{radi} \qquad (9)$$

With reference to equation (9), $Q_{trim}=\eta h A_{trim}\, dT+\epsilon\sigma A_{trim}\ F\ (T_{trim}^4-T_{amb}^4)$. $Q_{trim}=(0.143\ T_{trim}-4.99)+(1.43\times10^{-9}\times$

$T_{trim}{}^4-12.86$). Accordingly, $Q_{trim}=9.78$ Watts. As such, trim **12** dissipates approximately 65% of the heat energy generated by the LED light source.

The energy dissipated by heatsink **14** at approximately 64.1° C. is given by equation (10):

$$Q_{trim}=Q_{conv}+Q_{radi} \quad (10)$$

With reference to equation (10), $Q_{heatsink}=\eta h\ A_{heatsink}\ dT+\epsilon\sigma A_{heatsink}\ F\ (T_{heatsink}{}^4-T_{amb}{}^4)$. $Q_{heatsink}=(0.295\ T_{heatsink}-14.78)+(5.527\times10^{-10}\ T_{heatsink}{}^4-6.01)$. Accordingly, in this example, $Q_{heatsink}=5.22$ Watts. As such, heatsink **14** dissipates approximately 35% of the heat energy generated by the LED light source.

As shown in the example, fixture **10** efficiently dissipates a majority of heat generated by the light source through trim **12** and outside of the recessed can housing. By doing so, fixture **10** minimizes heat build-up within the recessed can housing and mitigates the deleterious effects of heat on the light source of fixture **10**.

Trim **12** includes a thermally conductive material such as aluminum, aluminum alloys, copper, thermally conductive plastics, or thermally conductive carbon fiber composite material. Trim **12** is formed using a one-piece stamping manufacturing process, however other processes such as die casting, deep draw stamping, and those that combine multiple pieces to form trim **12** may be used. Trim **12** includes an outer flange portion and a light source attachment point. The outer flange protrudes from fixture **10** and, after installation of fixture **10**, may contact a ceiling or wall surface. Depending upon the application, the flange portion of trim **12** may include features such as grooves and beveled edges that increase the surface area of trim **12** and allow it to dissipate heat energy more efficiently. Trim **12** may also be painted with a thermally conductive material, or include other surface decorations.

Trim **12** includes a light source attachment point located inwardly from the flange. The attachment point provides a mount point for physically mounting the light source to trim **12**. The attachment point may include features such as openings or recesses to facilitate the formation of an electrical connection between socket **16** and the light source. For example, the attachment point includes one or more holes through which electrical wiring passes, see FIGS. **4***a* and **4***b*. As the light source generates heat, the heat is transferred into trim **12** at the attachment point. From there, the heat is transferred into both the flange of trim **12** and into heatsink **14**.

FIGS. **4***a* and **4***b* illustrate an embodiment of trim **12**. In FIG. **4***a* a front surface of trim **12** is shown. Trim **12** is manufactured as a single piece of stamped aluminum and includes a central attachment area **20**. Attachment point **20** serves as a mount point for the light source. The light source is connected to attachment area **20** of trim **12** using a plurality of screws or other fasteners. A thermally conductive material such as thermal grease or phase change thermally conductive pad is deposited over attachment area **20** between the light source and trim **12** to facilitate the efficient conduction of heat energy from the light source to trim **12**. A plurality of holes **20***a* are formed close to attachment area **20** through which wires can pass to electrically connect the light source to socket **16** and an electricity source. A seal or grommet may be placed within holes **20***a* around the wires to prevent air flow through holes **20***a*. Trim **12** includes flange **22**. After installation of fixture **10** into a recessed can housing, flange **22** projects from the housing and the front surface of trim **12** faces away from an interior portion of the recessed can housing. Accordingly, as heat energy enters trim **12** and moves to flange **22**, flange **22** dissipates the heat from fixture **10** outside the recessed can housing into a room or office rather than into the housing itself.

Turning to FIG. **4***b*, a rear surface of trim **12** is shown. Trim **12** includes heatsink attachment point **24**. Heatsink attachment point **24** includes a plurality of fixture points **24***a* for connecting heatsink **14** to trim **12** and is located approximately opposite light source attachment area **20**. A thermally conductive material is deposited between trim **12** and heatsink **14** to facilitate the transfer of heat. Accordingly, after installation, the central portion of trim **12** is disposed between the light source and heatsink **14**.

Referring back to FIG. **2**, lens **23** is mounted over the light source attachment point of trim **12** and provides a portal through which light generated by the light source is transmitted from fixture **10**. Lens **23** is attached to trim **12** using a friction coupling, adhesive, or a fastener such as a clip or screw. Lens **23** includes a substantially transparent material such as glass or clear plastic. In one embodiment, lens **23** includes poly-carbonate material. Lens **23** may include one or more optical features that alter light passing through lens **23** to provide a desired optical effect. For example, lens **23** may be translucent or frosty and may include polarizing filters, colored filters or additional lenses such as concave, convex, planar, "bubble", and Fresnel lenses. If the light source generates light having a plurality of distinct colors, for example, lens **23** may be configured to diffuse the light to provide sufficient color blending.

Heatsink **14** includes a thermally conductive material such as those used to fabricate trim **12** and is formed using an extrusion, die casting or stamping process. Heatsink **14** includes a plurality of fin structures to facilitate dissipation of heat energy collected within heatsink **14** into the surrounding air. Heatsink **14** is mechanically connected to trim **12** to provide for transfer of heat energy from trim **12** to heatsink **14**. In one embodiment, heatsink **14** is connected to trim **12** with a plurality of fasteners such as screws or bolts. A thermally conductive material such as thermal grease, a thermally conductive pad, or a thermal epoxy is deposited between heatsink **14** and trim **12** to enhance the thermal connection between the two structures. The thermal grease may include a ceramic, carbon or metal-based thermal grease.

Light source **15** is connected to trim **12** and acts as a light source for fixture **10**. To facilitate transmission of thermal energy from light source **15** to the attachment area of trim **12**, a layer of thermally conductive material is deposited between light source **15** and trim **12**. The thermally conductive material may include thermal grease, epoxy, a thermal interface pad, or a phase change thermally conductive material. In various embodiments, the light source may include conventional incandescent light bulbs, light emitting diodes (LEDs), light engines or other light sources. In one embodiment, the light source is a light engine that includes a plurality of LEDs. The plurality of LEDs are electrically interconnected and a single electrical input into the light engine is used to power each of the LEDs. Any class of LED device may be used in the light engine, including individual die, chip-scale packages, conventional packages, and surface mounted devices (SMD). The LED devices are manufactured using semiconductor materials, including, for example, GaAsP, GaP, AlGaAs, AlGaInP, GaInN, or the like. In one installation, the light engine includes a single printed circuit board (PCB) having a plurality of connected LEDs. The LEDs are electrically interconnected using PCB traces or wirebonds so that when a supply voltage is applied to the light engine, each of the LEDs is activated and outputs light.

In the light engine, each of the individual LEDs have a particular color output corresponding to particular wavelengths. The various output colors of each of the LEDs combine together to form an output color for the entire light engine device. Accordingly, by selecting multiple LEDs of various colors to be combined into the light engine, the overall output color of the engine can be controlled. In one embodiment, the selected combination of LED devices includes x red LEDs, y green LEDs, and z blue LEDs, wherein the ratio x:y:z is selected to achieve a particular white light correlated color temperature (CCT) having a temperature of approximately 2700K, 3000K, or 3500K. In a further alternative embodiment, the light engine includes a plurality of red, green, blue and amber LEDs.

In general, any number of LED colors may be used in any desirable ratio. A typical incandescent light bulb produces light with a CCT of 2700K (warm white light), and a fluorescent bulb produces light with a CCT of about 5000K. Thus, more red and yellow LEDs will typically be necessary to achieve 2700K light, while more blue LEDs will be necessary for 5000K light. To achieve a high color rendering index (CRI), a light source must emit white light with a spectrum covering nearly the entire range of visible light (380 nm to 770 nm wavelengths), such that dark red, light red, amber, light green, dark green, light blue and deep blue should be placed in the mix. In one embodiment, for example, the mixing ratio (with respect to number of LEDs) of R (620 nm):Y (590 nm):G (525 nm):B (465 nm) is 6:2:5:1 to achieve 3200K light. A R:Y:G:B mixing ratio of 7:3:7:2 may be used to achieve 3900K light. In yet another embodiment, a ratio of 10:3:10:4 is used to achieve 5000K light. In addition to white light, fixture **10** may incorporate light engines that generate non-white colors of light using similar color blending techniques. In some embodiments, the light engine includes two or more colors of LEDs that are combined to form a composite output color.

In addition to the use of RAGB or RGB LEDs to emit white light, other combinations of LEDs may be used. For example, the light engine may include blue LEDs coated with phosphor or uV LEDs coated with phosphor.

FIG. **5** illustrates a recessed can trim that may be coupled to a light source, the light source integrates a heatsink. Trim **30** includes a plurality of louvers **32** that are connected to flange **34**. As shown in FIGS. **6***a* and **6***b*, trim **30** is connected to light source **36** (as shown in FIG. **1**) having attached heatsink **38**. In FIGS. **6***a* and **6***b*, light source **36** includes an E26/E27 style electrical socket. Louvers **32** of trim **30** are coupled via friction, adhesive or another fixture mechanism to the fins of heatsink **38**. A thermally conductive material may be deposited between louvers **32** and the fins of heatsink **38**. Due to their mechanical connection, as heat energy is created by the light source, it is transmitted into heatsink **38**. From there, the heat energy is transmitted into the fins of heatsink **38** and, eventually, into louvers **32** of trim **30**. As trim **30** absorbs heat energy from heatsink **38** via louvers **32**, it is dissipated from trim **30** via flange **34**. The light source of FIGS. **6***a* and **6***b* includes a conventional e26/e27 light socket, however in alternative embodiments the light source includes other electrical sockets. FIGS. **7***a*-**7***b* illustrates the device of FIGS. **6***a*-**6***b* wherein light source **36** includes a GU24 style electrical socket.

FIG. **8** illustrates a process for installing the fixture of FIGS. **6***a*-**6***b* into a recessed can housing. The light source of FIG. **1** is installed into trim **30**. Trim **30** is mounted within the recessed can housing a suitable attachment mechanism.

FIGS. **9***a* and **9***b* illustrate a thermally effective trim structure that includes a heatsink device. Trim **40** includes flange **42**. Heatsink **44** is mounted to flange **42**. Flange **42** and heatsink **44** may be formed as a single piece of material via an extrusion molding process, or may include separate pieces that are connected by a bonding process or by mechanical coupling. In one embodiment, flange **42** is connected to heatsink **44** using a plurality of fasteners. A thermally conductive material is deposited between flange **42** and heatsink **44**. Trim **40** includes opening **46** that is configured to receive light source **48**. Light source **48** includes an LED lamp, however other light sources such as conventional light bulbs may be used. Light source **48** is inserted into opening **46** (see FIG. **9***b*), and an outer surface of light source **48** contacts an inner surface of heatsink **44**. As light source **48** generates heat energy, it is transmitted into heatsink 44 via the mechanical connection between light source **48** and heatsink **44**. The mechanical connection may be enhanced by depositing a thermally conductive material between heatsink **44** and the outer surface of light source **48**. As heatsink **44** absorbs energy from light source 48, some of the energy is dissipated via the fins of heatsink 44 and communicated to flange 42 from which it is also dissipated.

FIGS. **10***a*-**10***d* illustrate a plurality of attachment mechanisms for connecting fixture **10** to a recessed can housing. FIG. **10***a* illustrates an attachment mechanism including torsion spring clips **18**. As shown in FIG. **2***a*, clips **18** may be connected to trim **12** of fixture **10**, however in other embodiments clips **18** may be connected anywhere on fixture **10**. During installation of fixture **10**, clips **18** are compressed to fit within the recessed housing. After fixture **10** is installed into the housing, clips **18** expand and an end portion of clips **18** contacts an interior surface or feature of the housing. As shown in FIG. **10***a*, clips **18** engage with slotted tabs **70**. An end portion of clips **18** includes an elbow which further secures fixture **10** into the housing and prevents the fixture from falling out of the recessed housing. Depending upon the installation, spacer brackets may be installed between clips **18** and the body of fixture **10** ensuring clips **18** are in the correct location for coupling to the housing. For example, if fixture **10** is to be installed into a 15.24 cm or larger housing, additional spacer brackets may be installed to ensure that clips **18** are sufficiently far apart to couple to the clip connection points on the interior surface of the housing. In alternative embodiments, clips **18** may be replaced with other connection devices or mechanisms such as torsion springs, pressure springs, coil springs, or other fixture mechanisms. FIG. **10***b* illustrates fixture **10** including pressure springs. FIGS. **10***c*-**10***d* illustrates fixture **10** including coil springs **72** as the attachment mechanism. A plurality of slots **74** formed in recessed can housing allow for adjustment of the placement and tension of coil springs **72** when fixture **10** is installed.

In one embodiment, the present invention is a method of manufacturing a lighting assembly comprising providing a light fixture by (a) forming a trim by a stamping or die casting process. The trim has thermally conductive properties and includes a flange around a perimeter of the trim. Providing the light fixture includes (b) mounting a light source to a central portion of a front surface of the trim, and (c) forming a heatsink by an extrusion, die casting, or stamping process. The heatsink has thermally conductive properties. Providing the light fixture includes (d) mounting the heatsink to a back surface of the trim opposite the light source, and (e) connecting an attachment mechanism, such as a torsion spring, to the light fixture. The method includes providing a recessed can housing mounted to a ceiling tile surface and mounting the light fixture to the recessed can housing by (f) inserting the heatsink into the recessed can housing, and (g) engaging the attachment mechanism to an interior portion of the recessed can housing to brace the flange against the ceiling tile surface.

In another embodiment, the present invention is a method of manufacturing a light fixture comprising forming a trim by a stamping process. The trim has thermally conductive properties and includes a flange around a perimeter of the trim. The method includes mounting a light source to a central portion of a front surface of the trim, and forming a heatsink by an extrusion process. The heatsink has thermally conductive properties. The method includes mounting the heatsink to a back surface of the trim opposite the light source, and connecting an attachment mechanism to the light fixture.

In another embodiment, the present invention is a method of manufacturing a light fixture comprising forming a trim including a flange around a perimeter of the trim, mounting a light source to a front surface of the trim, mounting a heatsink to a back surface of the trim, and connecting an attachment mechanism to the light fixture.

In another embodiment, the present invention is a light fixture comprising a trim formed by a stamping process. The trim has thermally conductive properties and includes a flange around a perimeter of the trim. The light fixture includes a light source mounted to a central portion of a front surface of the trim, and a heatsink mounted to a back surface of the trim opposite the light source. The heatsink is formed by an extrusion process and has thermally conductive properties. The light fixture includes an attachment mechanism connected to the light fixture.

While one or more embodiments of the present invention have been illustrated in detail, the skilled artisan will appreciate that modifications and adaptations to those embodiments may be made without departing from the scope of the present invention as set forth in the following claims.

What is claimed is:

1. A method of manufacturing a lighting assembly, comprising:

providing a light fixture by,

(a) forming a trim by a stamping or die casting process, the trim having thermally conductive properties and including a flange around a perimeter of the trim,

(b) mounting a light source to a central portion of a front surface of the trim,

(c) forming a heatsink by an extrusion or die casting process, the heatsink having thermally conductive properties,

(d) mounting the heatsink to a back surface of the trim opposite the light source, and

(e) connecting an attachment mechanism to the light fixture;

providing a recessed can housing mounted to a surface; and mounting the light fixture to the recessed can housing by,

(f) inserting the light fixture into the recessed can housing, and

(g) engaging the attachment mechanism to an interior portion of the recessed can housing to brace the flange against the surface.

2. The method of claim 1, wherein the trim includes a metal, thermally conductive plastic or thermally conductive carbon fiber composite material.

3. The method of claim 1, wherein the light source includes a light engine having a plurality of light emitting diodes (LEDs)

4. The method of claim 3, wherein each of the plurality of LEDs has a color selected to achieve a target correlated color temperature.

5. The method of claim 3, wherein the light engine includes blue LEDs having a phosphor coating.

6. The method of claim 1, including mounting a lens to the trim over the light source, the lens including a clear, frosty or translucent glass or plastic material.

7. A method of manufacturing a light fixture, comprising:

forming a trim, the trim having thermally conductive properties and including a flange around a perimeter of the trim;

mounting a light source to a central portion of a front surface of the trim;

forming a heatsink, the heatsink having thermally conductive properties;

mounting the heatsink to a back surface of the trim opposite the light source; and

connecting an attachment mechanism to the light fixture.

8. The method of claim 7, including:

providing a recessed can housing mounted to a surface; and mounting the light fixture to the recessed can housing by,

(a) inserting the light fixture into the recessed can housing, and

(b) engaging the attachment mechanism to an interior portion of the recessed can housing to brace the flange against the surface.

9. The method of claim 7, wherein the trim is formed using a stamping or die casting process.

10. The method of claim 7, wherein the heatsink is formed using an extrusion or die casting process.

11. The method of claim 7, wherein the trim includes aluminum, aluminum alloy, copper, copper alloy, thermally conductive plastic, or thermally conductive carbon fiber composite material.

12. The method of claim 7, wherein the light source includes a light engine having a plurality of light emitting diodes (LEDs)

13. The method of claim 12, wherein the light engine includes blue LEDs having a phosphor coating.

14. The method of claim 12, wherein each of the plurality of LEDs has a color selected to achieve a target correlated color temperature.

15. The method of claim 7, including mounting a lens to the trim over the light source, the lens including a clear, frosty or translucent glass or plastic material.

16. A light fixture, comprising:

a trim formed by a stamping or die casting process, the trim having thermally conductive properties and including a flange around a perimeter of the trim;

a light source mounted to a central portion of a front surface of the trim;

a heatsink mounted to a back surface of the trim opposite the light source, the heatsink being formed by an extrusion or die casting process and having thermally conductive properties; and

an attachment mechanism connected to the light fixture.

17. The light fixture of claim 16, wherein the trim includes aluminum, aluminum alloy, copper, copper alloy, thermally conductive plastic, or thermally conductive carbon fiber composite material.

18. The light fixture of claim 16, wherein the light source includes a light engine having a plurality of light emitting diodes (LEDs)

19. The light fixture of claim 16, wherein the light engine includes blue LEDs having a phosphor coating.

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