

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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FORD MOTOR COMPANY,

Petitioner,

-vs-

PAICE, LLC & ABELL FOUNDATION, INC.,

Patent Owner.

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U.S. Patent No. 7,237,634 to Severinsky, et al.

IPR Case No: IPR2014-01416

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DEPOSITION OF GREGORY W. DAVIS, Ph.D.

Taken at 1000 Town Center, 21st Floor,

Southfield, Michigan,

Commencing at 9:05 a.m.,

Wednesday, June 3, 2015

Reported by:

Laura J. Steenbergh

Job no: 14291A

APPEARANCES:

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Appearing on behalf of the Patent Owner.

\* \* \* \*

Southfield, Michigan
Wednesday, June 3, 2015
About 9:05 a.m. 09:05:47AM
MR. LIVEDALEN: Good morning. 09:06:36AM
THE WITNESS: Good morning. 09:06:38AM
GREGORY DAVIS, PhD, 09:06:38AM
having first been duly sworn, was examined and testified 09:06:38AM
on his oath as follows: 09:06:38AM
EXAMINATION BY MR. LIVEDALEN: 09:06:38AM
Q. Can you please state your name for the record? 09:06:40AM
A. Sure. Dr. Gregory W. Davis. 09:06:42AM
Q. And you understand you've taken an oath this morning? 09:06:44AM
A. Yes. 09:06:48AM
Q. And I think by now you're familiar with all the 09:06:48AM
deposition rules. Do you want me to go over any of 09:06:51AM
those again? 09:06:54AM
A. No. I think I'm in pretty good shape on those. 09:06:54AM
Q. Okay. Great. 09:06:57AM
All right. I'm going to hand you what we'll 09:06:58AM
mark as Exhibit 1. 09:07:08AM
DAVIS EXHIBIT 1 09:07:18AM
U.S. Patent 5,842,534 09:07:18AM
WAS MARKED BY THE REPORTER 09:07:18AM
FOR IDENTIFICATION 09:07:18AM
09:07:18AM

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(Exhibits attached to transcript)

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BY MR. LIVEDALEN: 09:07:18AM
Q. Can you please identify for the record what I've handed 09:07:22AM
you as Exhibit 1? 09:07:36AM
A. Yes. It's a U.S. Patent 5,842,534, to Andy Frank. 09:07:37AM
Q. So you'd be okay if we called this the Frank reference? 09:07:45AM
A. That would be fine. 09:07:48AM
Q. Or Frank for short. 09:07:49AM
Dr. Davis, why do you cite to this reference 09:07:52AM
-- or let me strike that. 09:07:57AM
Do you cite to this reference in your 09:07:58AM
declaration for this matter? 09:08:01AM
A. Yes, I believe I do. 09:08:02AM
Q. And why did you do that? 09:08:04AM
A. Well, I think if you refer to my report you'll see that 09:08:35AM
I talk about that in several spots. And I was using the 09:08:41AM
Andy Frank reference as a teaching that discloses using 09:08:47AM
a setpoint to switch when to turn on or off the engine, 09:08:54AM
and using a time delay in order to prevent unwanted 09:08:59AM
engine starts. 09:09:06AM
Q. So it's your testimony that Frank teaches using a time 09:09:06AM
delay? 09:09:13AM
A. Yes, it is. 09:09:13AM
Q. Okay. And you referenced a setpoint, what type of -- 09:09:15AM
what do you mean by a setpoint? 09:09:23AM
A. The setpoint would be that point at which you would be 09:09:24AM

1 making a determination about, in this case, deciding 09:09:31AM  
 2 whether to turn on or turn off the engine. 09:09:34AM  
 3 Q. And is that -- what type of setpoint is that? 09:09:36AM  
 4 MR. RONDINI: Objection, vague. 09:09:42AM  
 5 THE WITNESS: I'm not sure I can answer, or -- 09:09:46AM  
 6 BY MR. LIVEDALEN: 09:09:49AM  
 7 Q. Is it a torque value, is it a speed value? 09:09:49AM  
 8 A. Are you talking about Andy Frank's or the Frank 09:09:53AM  
 9 reference? 09:09:57AM  
 10 Q. Yeah. 09:09:58AM  
 11 A. He's using kind of a speed and depth of discharge. 09:09:59AM  
 12 Q. So the setpoint you're referring to is -- it's part 09:10:05AM  
 13 speed and part depth of discharge, is that right? 09:10:12AM  
 14 A. Yeah. I think we could get probably a better idea of 09:10:15AM  
 15 that if we look at, for example, paragraph 368 of my 09:10:18AM  
 16 report. 09:10:21AM  
 17 Q. Let me -- before you go, why don't we just mark that as 09:10:23AM  
 18 an exhibit since you're referring to that. 09:10:27AM  
 19 A. Okay. 09:10:30AM  
 20 DAVIS EXHIBIT 2 09:10:31AM  
 21 Declaration of Gregory Davis 09:10:31AM  
 22 WAS MARKED BY THE REPORTER 09:10:31AM  
 23 FOR IDENTIFICATION 09:10:31AM  
 24 BY MR. LIVEDALEN: 09:10:31AM  
 25 Q. And, Dr. Davis, could you please identify Exhibit 2 for 09:10:50AM

1 the record? 09:10:55AM  
 2 A. Exhibit 2 appears to be a copy of the -- my declaration 09:10:55AM  
 3 in support of the IPR review. 09:11:33AM  
 4 Q. Could you read the number? 09:11:38AM  
 5 A. Yeah, I was going to say, a Ford designation of 1107 if 09:11:41AM  
 6 you want, or if want the IPR case number is 09:11:45AM  
 7 IPR2014-01416. 09:11:53AM  
 8 Q. Yeah, that's great. Thanks. 09:11:54AM  
 9 All right. So let's go back to Exhibit 1, 09:12:04AM  
 10 Frank. And if you want to go to Figure 4. Does Figure 09:12:13AM  
 11 4 show the speed and battery depth of discharge 09:12:26AM  
 12 thresholds that you're referring to? 09:12:33AM  
 13 A. It shows a series of setpoints for making these 09:12:35AM  
 14 decisions, and in this case they're using a hysteresis 09:12:39AM  
 15 based on a band instead of a time. So if you look, for 09:12:48AM  
 16 example, at my discussion I have in paragraph 368, he 09:12:51AM  
 17 talks about really two alternatives. And this is a 09:12:55AM  
 18 quote out of the patent at Column 7, line 66, through 09:12:59AM  
 19 Column 8, line 11, and it says, After the ICE is turned 09:13:07AM  
 20 on and vehicle is operating in a hybrid electric vehicle 09:13:12AM  
 21 mode, or HEV mode, if the vehicle's speed/depth of 09:13:17AM  
 22 discharge parameters fall below the off-threshold curve 09:13:23AM  
 23 the ICE is decoupled and turned off. Then since the EM 09:13:26AM  
 24 is still online, the vehicle again operates in a ZEV 09:13:30AM  
 25 mode. The control band between the on threshold curve 09:13:35AM

1 and the off threshold curve prevents undesirable or 09:13:38AM  
 2 excessive cycling of the ICE due to fluctuations in 09:13:42AM  
 3 sense, speed and depth of discharge. And that's what 09:13:48AM  
 4 he's disclosing in Figure 4. 09:13:51AM  
 5 But then he goes on to say, As an alternative 09:13:53AM  
 6 to separate on and off thresholds a single threshold 09:13:57AM  
 7 could be used in combination with a time delay between 09:14:00AM  
 8 the on and off modes to prevent frequent cycling. 09:14:03AM  
 9 So he showed a band type of hysteresis in 09:14:06AM  
 10 Figure 4, but he also contemplates the idea that you 09:14:11AM  
 11 could do the same thing without a band and use a time 09:14:14AM  
 12 delay. 09:14:18AM  
 13 Q. Okay. Let's look back at Figure 4 here. And so do you 09:14:19AM  
 14 see the section of Figure 4, it says between 0 percent 09:14:23AM  
 15 and 50 percent battery depth of discharge? 09:14:28AM  
 16 A. Yes, I do. 09:14:32AM  
 17 Q. And in that area what is Frank using as the threshold 09:14:33AM  
 18 for determining when to turn on the engine? 09:14:41AM  
 19 A. He's using a series of speeds in that particular region 09:14:46AM  
 20 from 0 to 50 percent depth of discharge. He appears to 09:14:52AM  
 21 be turning on the engine at 113 kilometers per hour. 09:14:56AM  
 22 But then he goes on in the other depth of discharge to 09:15:00AM  
 23 change the setpoints progressively going down as we go 09:15:07AM  
 24 to the right, let's say going down lower. So he drops 09:15:12AM  
 25 down, for example, from 113 kilometers per hour at 50 09:15:16AM

1 percent, to -- well, kind of eyeballing it, at 75 09:15:20AM  
 2 percent depth of discharge. It appears to be, I don't 09:15:29AM  
 3 know, on the order of about 60 kilometers per hour. 09:15:32AM  
 4 Q. Okay. Let's just focus on the 0 to 50 percent just to 09:15:35AM  
 5 keep things simpler for now and we can move on to the 09:15:39AM  
 6 other range in a moment. 09:15:43AM  
 7 So looking at Figure 4, it's your opinion then 09:15:45AM  
 8 that between 0 and 50 percent battery depth of discharge 09:15:50AM  
 9 Frank turns the engine on and off based on the speed of 09:15:55AM  
 10 the vehicle, right? 09:15:58AM  
 11 A. Yes. He's using the depth of discharge and the speed of 09:15:58AM  
 12 the vehicle to make a decision about whether to turn on 09:16:06AM  
 13 the engine or turn off the engine. 09:16:11AM  
 14 Q. Can you go to Column 3 for me, please, of Exhibit 1, 09:16:14AM  
 15 which is Frank? And at line three it says, At speeds 09:16:36AM  
 16 greater than approximately 113 kilometers per hour the 09:16:49AM  
 17 vehicle operates in an HEV mode where the ICE is used as 09:16:52AM  
 18 a primary source of power. 09:16:57AM  
 19 Do you see that? 09:16:59AM  
 20 A. Yes, I do. 09:16:59AM  
 21 Q. Does that confirm your opinion that Frank turns the 09:17:00AM  
 22 engine on and off based on the speed of the vehicle? 09:17:04AM  
 23 A. Well, as I said before, first of all he disclosed two 09:17:07AM  
 24 ways to do it. One way was based on using these bands, 09:17:12AM  
 25 these hysteresis bands based on speed and depth of 09:17:16AM

1 discharge of the batteries. And then the other way is 09:17:22AM  
 2 instead of using a hysteresis band he disclosed the idea 09:17:27AM  
 3 of using time delays. 09:17:31AM  
 4 Q. Let's not worry about the hysteresis aspect right now. 09:17:32AM  
 5 Fundamentally I want to understand your opinion as far 09:17:37AM  
 6 how Frank decides to turn the engine on and off. 09:17:39AM  
 7 And so my question is, is the sentence I just 09:17:42AM  
 8 read, and I'll read it again for you, Column 3, line 3, 09:17:45AM  
 9 At speeds greater than approximately 113 kilometers per 09:17:48AM  
 10 hour the vehicle operates in an HEV mode where the ICE 09:17:52AM  
 11 is used as a primary source of power. 09:17:55AM  
 12 Do you see that there? 09:17:59AM  
 13 A. Yes, I do. 09:18:00AM  
 14 Q. Does that indicate to you that, at least in certain 09:18:00AM  
 15 regions, Frank turns the engine on and off purely based 09:18:04AM  
 16 on speed? 09:18:09AM  
 17 A. No. Because, again, when you look at Figure 4 you see 09:18:10AM  
 18 it's more than just speed disclosed, it's speed and 09:18:14AM  
 19 depth of discharge. In that particular region the 09:18:17AM  
 20 design -- he made the design decision to cycle the 09:18:22AM  
 21 engine based on constant values for the speed, but as he 09:18:26AM  
 22 clearly discloses in other regions, he's varying the 09:18:34AM  
 23 setpoint values for speed based on the depth of 09:18:37AM  
 24 discharge. 09:18:40AM  
 25 Q. Understood. But my question was, and I think you 09:18:41AM

1 answered it for me, but for some regions, right, so you 09:18:45AM  
 2 just identified two regions, right, one region where the 09:18:48AM  
 3 speed is held constant, one region where the speed is a 09:18:51AM  
 4 function of the battery depth of discharge, is that 09:18:55AM  
 5 right? 09:18:57AM  
 6 MR. RONDINI: Objection, asked and answered. 09:18:57AM  
 7 THE WITNESS: Again, it's kind of the same 09:19:00AM  
 8 answer. You can't -- 09:19:02AM  
 9 BY MR. LIVEDALEN: 09:19:03AM  
 10 Q. I'm asking about the two regions, I'm not asking about 09:19:04AM  
 11 turning on and off. I just want to understand. Are 09:19:09AM  
 12 there two regions in Figure 4? 09:19:11AM  
 13 A. Well, actually there's three regions if you want to try 09:19:12AM  
 14 and separate it. I don't think one of ordinary skill 09:19:15AM  
 15 would separate that into all those spots, but I think, 09:19:17AM  
 16 again, you can't divorce the idea of his hysteresis 09:19:21AM  
 17 bands' speed from a depth of discharge. Because you'd 09:19:26AM  
 18 first have to know where the depth of discharge is 09:19:30AM  
 19 located in order to determine the setpoint value for the 09:19:33AM  
 20 speed. 09:19:37AM  
 21 Q. Okay. So in your opinion then Frank turns the engine on 09:19:38AM  
 22 and off based on speed and based on the depth of 09:19:45AM  
 23 discharge of the battery? 09:19:48AM  
 24 A. Again, but he does it in, you know, different ways. I 09:19:50AM  
 25 mean, in Figure 4 he's disclosing the idea of hysteresis 09:19:54AM

1 bands, an on band or series of setpoints, and then an 09:19:58AM  
 2 off band or series of setpoints. But, you know, later 09:20:02AM  
 3 on, as I've already read in Column 7, he discloses that 09:20:06AM  
 4 instead of using these hysteresis bands you could just 09:20:11AM  
 5 use a time delay. 09:20:15AM  
 6 Q. Okay. But are there any other factors that Frank 09:20:16AM  
 7 discloses for determining when to turn the engine on and 09:20:27AM  
 8 off other than vehicle speed and battery depth of 09:20:31AM  
 9 discharge? 09:20:37AM  
 10 MR. RONDINI: Objection, asked and answered. 09:20:37AM  
 11 THE WITNESS: At least in this operation he's, 09:20:38AM  
 12 again, he's showing that he's using a combination of 09:20:47AM  
 13 speed setpoints that vary with the depth of discharge. 09:20:52AM  
 14 In general everything that he discloses, I think I'd 09:20:58AM  
 15 have to go back and refresh myself to see if there's 09:21:02AM  
 16 other modes of operation. 09:21:05AM  
 17 BY MR. LIVEDALEN: 09:21:09AM  
 18 Q. Sitting here today, do you know of any other modes of 09:21:09AM  
 19 operation that use any other control metric besides 09:21:11AM  
 20 vehicle speed and battery depth of discharge? 09:21:16AM  
 21 MR. RONDINI: Objection, vague. 09:21:19AM  
 22 THE WITNESS: Again, Andy Frank is using 09:21:20AM  
 23 speeds in the form of these hysteresis bands for on and 09:21:30AM  
 24 off where the speed setpoints can vary as a function of 09:21:34AM  
 25 the depth of discharge, as disclosed in Figure 4. But 09:21:38AM

1 then he goes on to disclose that he could use a single 09:21:42AM  
 2 threshold or set setpoints that would vary -- that would 09:21:51AM  
 3 be used, but then he would use that in addition to a 09:21:57AM  
 4 time delay. So he's using a time delay as well. 09:22:00AM  
 5 BY MR. LIVEDALEN: 09:22:03AM  
 6 Q. Okay. So time, vehicle speed, and battery depth of 09:22:04AM  
 7 discharge. Any others? 09:22:08AM  
 8 A. In Frank? I'd say I think I'd have to -- I would have 09:22:09AM  
 9 to study this some more. Because I don't -- I do know 09:22:22AM  
 10 that he disclosed some information about, you know, if 09:22:32AM  
 11 the batteries become completely depleted turning on the 09:22:37AM  
 12 IC engine. For example, I think in Column 3, if we go 09:22:45AM  
 13 down to around line 39, for example, if the batteries 09:22:56AM  
 14 were completely depleted and the IC engine was running 09:23:02AM  
 15 the batteries could be slightly charged by the IC 09:23:05AM  
 16 engine, only to provide additional performance to get 09:23:11AM  
 17 home or to a charging station. 09:23:13AM  
 18 So, you know, he obviously has probably some 09:23:22AM  
 19 other operations where he's turning on and off the IC 09:23:25AM  
 20 engine as well. 09:23:32AM  
 21 Q. That is also based on the battery though, right? 09:23:33AM  
 22 A. Well, in that particular one it was if the batteries 09:23:36AM  
 23 were completely depleted, yes. 09:23:39AM  
 24 Q. Okay. Are you relying on Frank to teach load response 09:23:42AM  
 25 of hysteresis? 09:24:01AM

1 A. Now, as I point out in my report, I'm using the idea 09:24:01AM  
 2 disclosing in Frank about, you know, he discloses a 09:24:07AM  
 3 couple of ways of putting a hysteresis in to prevent 09:24:10AM  
 4 unwanted engine starts or cycling the engine. One way 09:24:14AM  
 5 was using hysteresis bands, and the other way was using 09:24:17AM  
 6 time delays. So I'm using the ideas of Frank in terms 09:24:22AM  
 7 of in particular the idea of using a time delay to 09:24:24AM  
 8 prevent unwanted engine starts. 09:24:27AM  
 9 Q. Okay. And let's go to paragraph 368 of your report. It 09:24:29AM  
 10 says, For example, Frank discloses using a hysteresis 09:24:36AM  
 11 time delay switching between engine and motor modes in 09:24:39AM  
 12 order to prevent unnecessary engine stops and restarts 09:24:43AM  
 13 when the torque required to propel the vehicle was near 09:24:47AM  
 14 the setpoint. 09:24:51AM  
 15 So are you saying that the torque required to 09:24:53AM  
 16 propel the vehicle, that's not found in Frank, right? 09:24:56AM  
 17 A. Yeah. What I'm saying is, I'm using the idea from Frank 09:25:00AM  
 18 is the hysteresis time delay. 09:25:03AM  
 19 Q. Okay. So Frank does not teach using the torque required 09:25:07AM  
 20 to propel the vehicle? 09:25:10AM  
 21 A. He's using, again, as we've looked at, he's using the 09:25:11AM  
 22 idea of setting his thresholds based on the speed and 09:25:17AM  
 23 the depth of discharge in order -- those would be the 09:25:24AM  
 24 setpoints that he was using in this instance. 09:25:30AM  
 25 Q. And those setpoints are not torque setpoints, right? 09:25:32AM

1 A. Well, they're certainly related to the torque, 09:25:36AM  
 2 obviously. I mean, I think he recognized the idea that 09:25:41AM  
 3 generally as the vehicle's going faster the 09:25:44AM  
 4 instantaneous torque required for propulsion would be at 09:25:46AM  
 5 a higher level. 09:25:50AM  
 6 Q. And where does Frank say that? 09:25:52AM  
 7 A. Therefore he would bring it in. 09:25:53AM  
 8 Q. Where does Frank say that? 09:25:56AM  
 9 A. It's been a while since I've looked at Frank. 09:25:58AM  
 10 Q. When's the last time you've looked at Frank? 09:26:00AM  
 11 A. Oh, I may have glanced at like that quotation in looking 09:26:04AM  
 12 and reviewing this report for this deposition, but I 09:26:09AM  
 13 haven't studied Frank since -- when did I do this? 09:26:12AM  
 14 About a year ago I think. Yeah, August 29th of 2014. 09:26:18AM  
 15 Q. So let me back up. 09:26:25AM  
 16 What did you do today to prepare for -- or 09:26:27AM  
 17 strike that. 09:26:30AM  
 18 What did you do to prepare for today's 09:26:30AM  
 19 deposition? 09:26:32AM  
 20 A. I studied my reports that were going to be the subject 09:26:32AM  
 21 matter of the deposition. 09:26:35AM  
 22 Q. Did you meet with anyone? 09:26:42AM  
 23 A. I met with Mr. Rondini. 09:26:43AM  
 24 Q. When was that? 09:26:44AM  
 25 A. Last Friday. 09:26:45AM

1 Q. Okay. Did you look at Frank during that meeting? 09:26:46AM  
 2 A. I don't recall. I don't believe so, but I really don't 09:26:48AM  
 3 recall. 09:26:56AM  
 4 Q. Have you ever read Frank in its entirety? 09:26:56AM  
 5 A. Yes, I'm sure I have when I was preparing this report. 09:26:59AM  
 6 Q. Okay. That's fine. 09:27:02AM  
 7 And you keep referring to Frank as Andy Frank. 09:27:07AM  
 8 Do you know Andy Frank? 09:27:10AM  
 9 A. Yes, I do. 09:27:10AM  
 10 Q. Who is he? 09:27:11AM  
 11 A. He was, when I was developing my own hybrid electric 09:27:12AM  
 12 vehicles for the hybrid electric vehicle challenge and 09:27:18AM  
 13 also for the future car challenge, Andy Frank was the 09:27:22AM  
 14 faculty advisor -- I was the faculty advisor first at 09:27:26AM  
 15 the United States Naval Academy, and then the faculty 09:27:31AM  
 16 advisor at Lawrence Technological University, and he was 09:27:34AM  
 17 the faculty advisor for UC Davis. 09:27:37AM  
 18 Q. And what year was that? 09:27:41AM  
 19 A. It was over a number of years. I don't know when I 09:27:42AM  
 20 first met Andy, but I think it was probably in the 09:27:52AM  
 21 1992-1993 time frame through, I believe, into the 1997 09:27:59AM  
 22 time frame. So over a number of years. 09:28:04AM  
 23 Q. And during that time he was at UC Davis you said? 09:28:06AM  
 24 A. Yes, he was. 09:28:08AM  
 25 Q. Would he have been at UC Davis when he filed for this 09:28:09AM

1 patent? 09:28:14AM  
 2 MR. RONDINI: Objection, vague. 09:28:15AM  
 3 THE WITNESS: I believe so, but I don't know 09:28:16AM  
 4 for sure. But I do believe so. 09:28:23AM  
 5 BY MR. LIVEDALEN: 09:28:30AM  
 6 Q. Okay. And so getting back to my earlier question, where 09:28:30AM  
 7 in Frank does he disclose that speed is related to 09:28:38AM  
 8 torque? 09:28:59AM  
 9 A. Well, for example, if we look at Column 2, beginning at 09:31:53AM  
 10 line 53, The IC engine in accordance with the present 09:32:09AM  
 11 invention is typically very small (e.g. 0.016 kilowatts 09:32:16AM  
 12 per vehicle kilogram) and is typically sized to power 09:32:25AM  
 13 the vehicle for freeway cruise at speeds above 09:32:29AM  
 14 approximately 113 kilometers per hour for a range of 690 09:32:33AM  
 15 kilometers or more. However, in typical city driving 09:32:38AM  
 16 conditions, driving with the IC engine alone produces 09:32:41AM  
 17 less than desirable performance because of its small 09:32:46AM  
 18 size. This is an important aspect of the invention, 09:32:50AM  
 19 since it encourages the driver to periodically charge 09:32:53AM  
 20 the vehicle batteries at home. Additionally the varying 09:32:57AM  
 21 driving conditions inherent in city driving will cycle 09:33:01AM  
 22 the engine and reduce efficiency. Emissions would 09:33:04AM  
 23 increase and fuel efficiency would decrease. 09:33:07AM  
 24 So one of ordinary skill in the art would 09:33:12AM  
 25 understand when they look at that that he's sizing the 09:33:14AM



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