United States Patent [19]
Gordin

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[54] **COMPOSITE PHOTOMETRIC METHOD**

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[51] **Int. Cl.**[3] **B60Q 1/00**
[52] **U.S. Cl.** **362/61;** 362/66; 362/249; 362/250; 362/285; 362/427; 362/428; 362/431
[58] **Field of Search** 362/61, 66, 249, 250, 362/285, 427, 428, 431

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,220,981 9/1980 Koether 362/250

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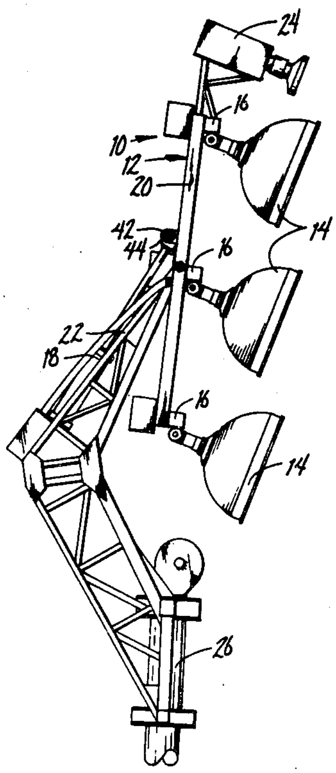
Attorney, Agent, or Firm—Zarley, McKee, Thomte, Voorhees & Sease

[57] **ABSTRACT**

A method of producing a composite beam of uniform light from a plurality of defined beam, high-intensity, luminaires mounted on a luminaire assembly, adapted for use with a mobile mounting pole. By determining the characteristics of the defined beam produced by each luminaire, the area to be lighted, and the placement and number of luminaires to be used, the individual luminaire fixtures can be aligned to form a composite photometric beam, meeting the predetermined lighting requirements. The luminaire assembly is adjustably designed as a composite unit for a mathematically derived model of light energy configuration required to illuminate various shaped and sized target areas, such as football fields, etc.

5 Claims, 9 Drawing Figures



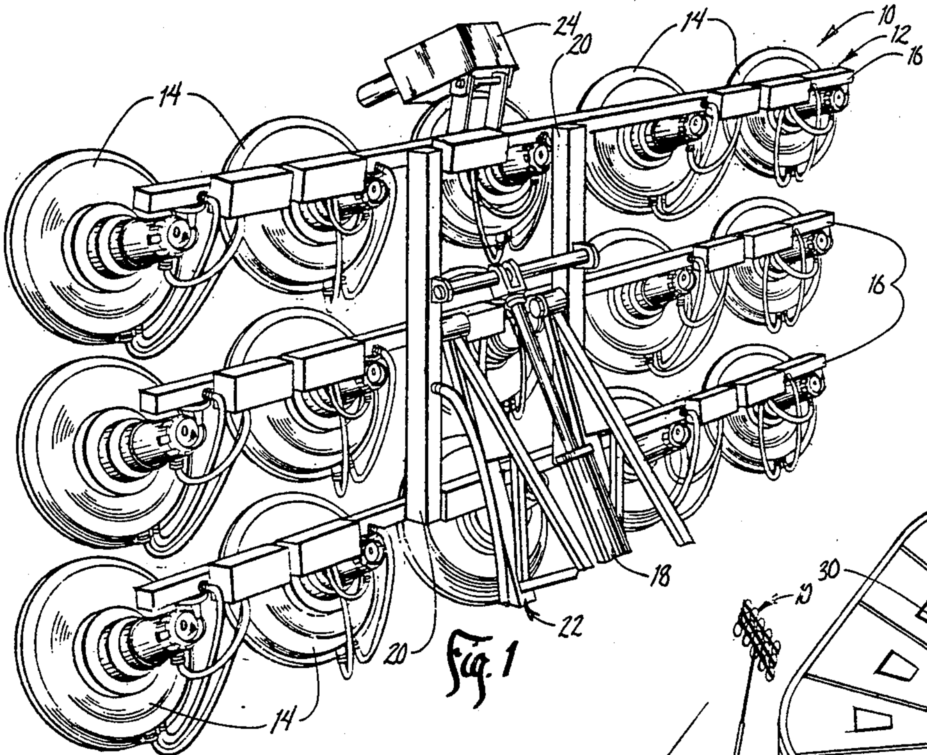


Fig. 1

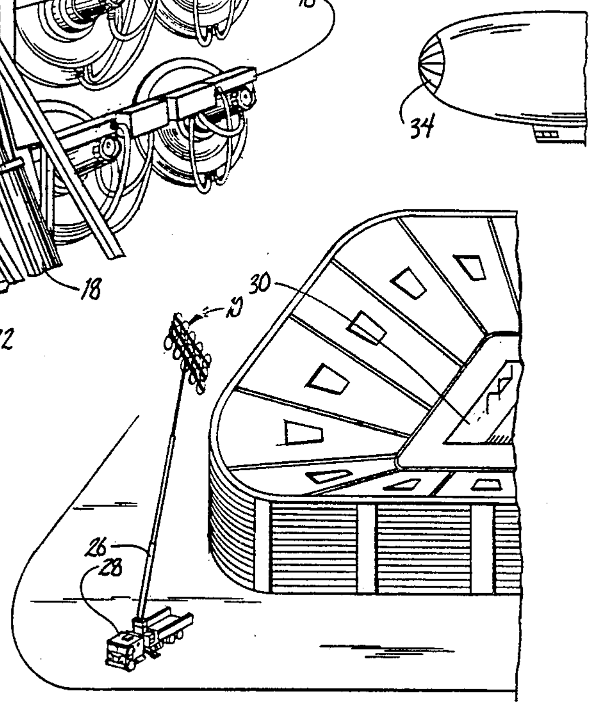


Fig. 2

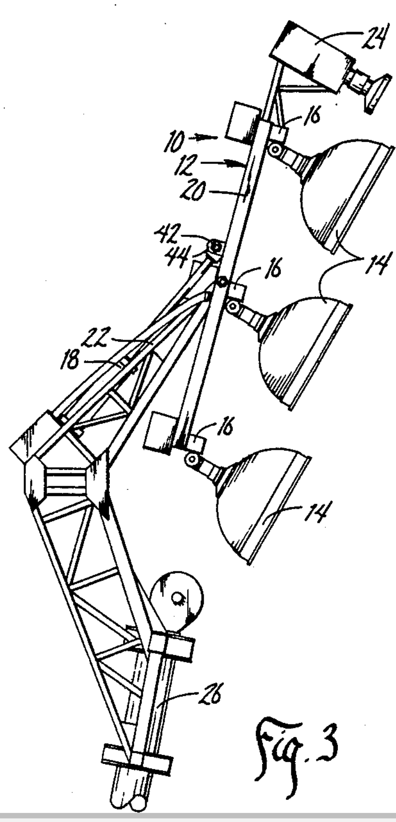


Fig. 3

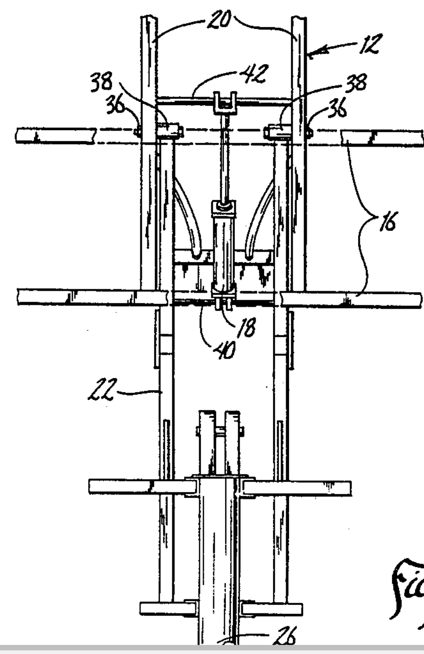


Fig. 4

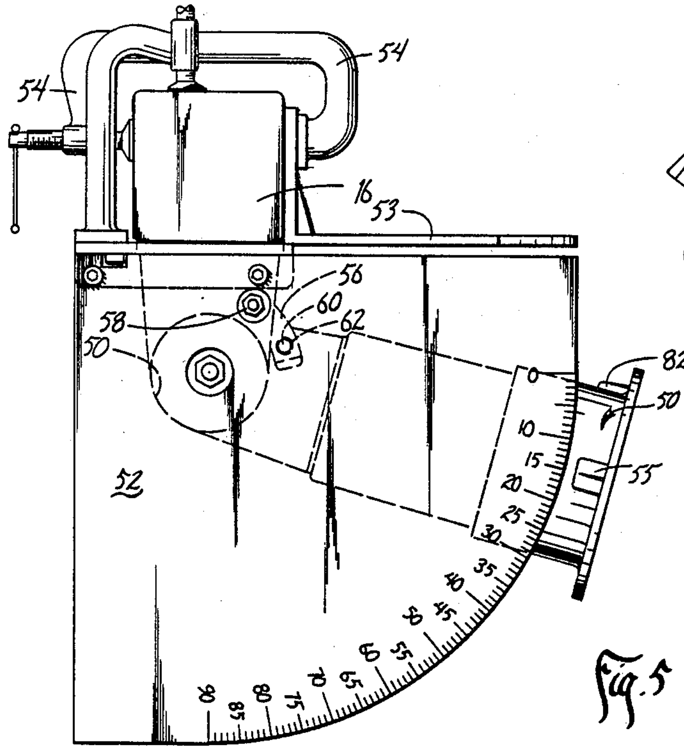


Fig. 5

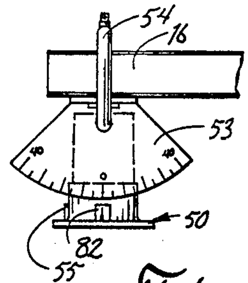


Fig. 6

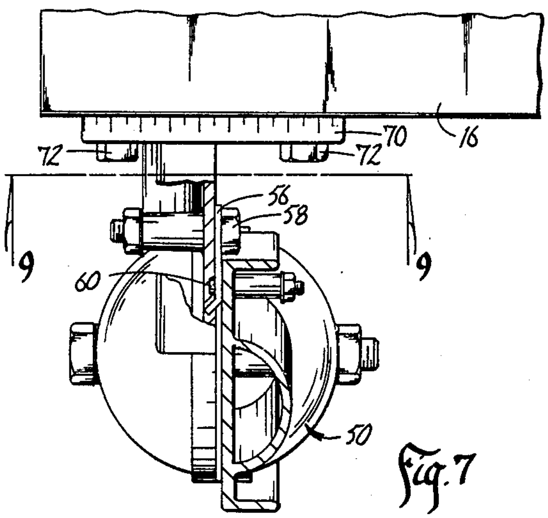


Fig. 7

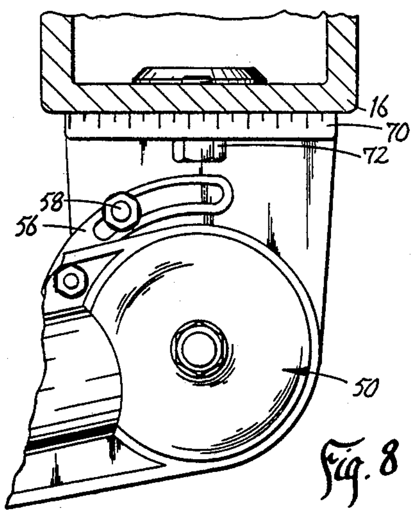


Fig. 8

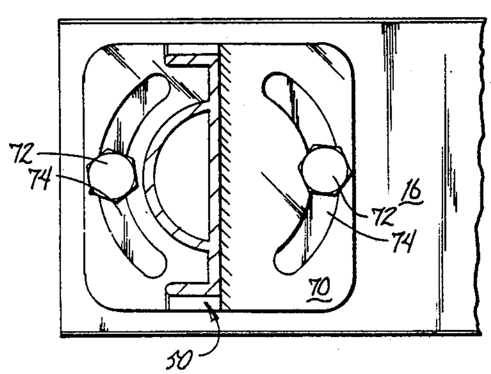


Fig. 9

COMPOSITE PHOTOMETRIC METHOD

BACKGROUND OF THE INVENTION

1. Field of Invention.

This invention relates to the composite aiming of a plurality of individual luminaires, more particularly to the aligning of a plurality of defined beam, high-intensity luminaires to produce a composite beam of uniform light for use with mobile lighting systems.

2. Description of the Problems in Art.

Traditional methods of providing uniform light from a plurality of luminaries have relied on structures which are erected on-site, at which time individual luminaire fixtrues are aimed with respect to different points on the targeted area. Target areas as large as baseball diamonds or football fields require very substantial time and effort for post-erection, on-site aiming to produce the desired lighting effect. Literally each lamp of each lighting unit holding a plurality of luminaire fixtures must be individually aimed upon the selected target site (playing field) by utilizing at least one person at the top of the lighting unit support pole and one person at the target site.

Attempts have been made to reduce this on-site adjustment and aiming time by predetermining the lighting requirements of the targeted area, and then designing the make-up of the lighting fixtures to best solve the lighting requirements, taking into account efficiency, economy and limited interference with the events happening on the targeted area. Examples of this "pre-designing" are Neely, U.S. Pat. No. 4,141,056 a tennis court floodlighting system (and Neely Reissue No. 26,588). However, on-site manual aiming of the luminaire fixtures is still required, though the process is simplified by the pre-designing.

All the above mentioned problems are further amplified when applied to mobile lighting systems. With the proliferation of color TV, there is a real need for a mobile lighting system which is not only easily assembled, dissembled, and moved from location to location, but also produces a uniform, beam to promote reproduction. In one particular application of the invention, there is a desire to broadcast sports activities, such as football games, at night, so that the game may be more freely scheduled for television convenience rather than on the basis of whether or not the playing field has permanent lights. This, of course, cannot be done without lighting which is sufficient for quality transmission of the event by television. Significantly the expense of installing permanent lights when the number of nightime televised events will be very small, compared to the cost of the ighting, is not cost-efficient for many schools. Additionally, the aiming and maintenance problems discussed above, coupled with the initial high expense, render permanent lighting installations often impractical.

As earlier mentioned, nightime television broadcasting also presents the problem of scheduling flexibility. Many times a network may desire to show a game at night so it will not conflict with other scheduled events. Currently this cannot be done unless the schools involved have permanent lights. However, since nightime television lighting would be needed for only a handfull of games (usually only one) for each particular stadium in a year, permanent installation of lighting for such an occasional happening is not justified.

Therefore, there is a real need for mobile lighting systems which are efficient, economical, easily transportable, and can produce the strict defined lighting standards needed for television broadcasts.

Performance standards for lighting level are measured in foot candles (fc), the common measurement of light levels. The needed foot candles are determined by the sport being played, the size of the field, the shape of the stadium, its location, etc. The following are examples of standards used for different sports:

1. Baseball —recreational skill level; greater than 320 foot field radius 50 fc infield/30 fc outfield.
   University —100 fc infield/70 fc outfield.
   Major league —200 fc infield/150 fc outfield.
2. Football -University —100 fc.
   Professional —200 fc.

Another performance standard for the lighting systems is the maintenance of the minimum standard for uniformity of lighting throughout the playing area. This is important not only for television coverage, but also for the sport being played. The evenness of the lighting is called "uniformity" and expresses a ratio between the maximum and minimum foot candles on the area. Uniformity of light is just as important as absolute level of light. Objects such as baseballs will appear to change speeds as they pass from dark to light areas in a non-uniform light, thus making them difficult to follow.

The minimum standard for unifomity for most sporting events is three to one. This means that no spot on the field should be less than one-third of the brightest illumination of another spot on the field. Uniformity is as important on a 30 foot candle recreational softball field as it is on a major league ball field lighted to 200 foot candles, since the lack of it will have an adverse effect on player performance.

Uniformity is directly related to aiming of the lights, and again, becomes an amplified problem when dealing with mobile lighting.

Pre-aiming of a plurality of luminaires contained in one lighting unit, has been attempted for permanent lights. By determining and organizing the lighting properties of the individual luminaires and applying this to the targeted area, lighting units have been designed wherein the individual fixtures are preset to produce a cetain beam pattern. Hayakawa, U.S. Pat. No. 4,025,777, a clinical illumination apparatus, presets a plurality of luminaires to produce a pinpoint, high intensity light for use in medical applications. Cahill, U.S. Pat. No. 1,235,527, an illuminating system for baseball and other games, predesigns a light pattern for the illumination of a playing surface, based on a number of lighting units. Van Dusen, J., U.S. Pat. No. 3,660,650, utilizes a plurality of luminaires that are adjustable so that several pre-selected lighting patterns can be utilized.

However, none of these prior art attempts show or contemplate the factory aligning of a plurality of luminaire fixtrues with respect to one another as measured against a fixed cross-beam reference to present a composite, uniform photometric beam which can be used in combination with an adjustable mobile rigging to allow numerical adjustment of lighting quality and quantity to match predetermined computer derived models. Also, as a result of this invention, only one aiming of a single fixtrue is needed on-site to effectively aim the entire lighting unit. While some of the referenced patents do show a predetermined beam pattern formed from a number of luminaires, these patterns are not afjustable for different fields by simple movement of a mobile rigging unit and on-site aiming of a single luminaire for each unit assembly, resulting in the capability of lighting quality and quantity.

The prior art has not solved the problem of efficiently and economically designing and implementing lighting systems which can be pre-aligned, transported to site, used, then removed from the site to be transported to a different site and realigned by adjusting only a single luminaire to meet the defined lighting standards required for an entirely different field.

Finally, the prior art has not surrmounted the inevitable problem of inadvertent or acdidental misalignment of a lighting unit.

If prior art lighting units are misaligned because of wind, shock, or other calamity, there is no easy method to re-aim the unit without re-aiming all luminaires. This is especially critical if the misalignment occurs during an athletic event which is in progress.

Therefore, it is an object of this invention to provide a method of aligning a composite photometric beam from a plurality of defined single beam high-intensity luminaires for use with a mobile lighting system.

A further object of this invention is to provide a method for the aligning of a composite photometric beam for different sized athletic field target areas and uses.

A further object of this invention is to provide a composite photometric partially prealigned beam wherein only one aiming point on the targeted athletic field area is needed for one luminaire to align the entire composite beam for all the luminaires of cross-beam assebly.

Another object of this invention is to provide a method wherein corrections in aiming can be made continuously and remotely while in use, and on-site.

A further object of this invention is to provide a method wherein a pre-aligned composite photometric beam can be intentionally moved to illuminate another object, then immediately re-aimed on the original target area, to again give the defined field lighting.

A still further object of this invention is to provide a method wherein the targeted area (i.e., a selected outdoor field) is analyzed to determine how many luminaires and composite photometric beams are to be used, and to determine the location of mounting poles, or other mounting structure, to provide a uniform target area lighting.

These and other objects of the invention will become apparent with reference to the accompanying specification, drawings and claims.

SUMMARY OF THE INVENTION

According to the method of this invention, a plurality of defined beam, high-intensity luminaires are mounted on a cross-arm assembly. The cross-arm assembly is adjustably mounted on the end of a mobile mounting structure, for convenience referred to herein as a "pole". The plurality of luminaires are pre-aligned, for example at the factory, to produce a composite photometric beam of uniform light. The cross-arm assembly is mounted to the mounting pole in such a manner that it can be adjustably tilted by remote control.

Aligning of the luminaires is accomplished by first determining the dimension characteristices of the field to be lighted. The number of mounting pole locations and individual luminaires on each cross-arm assembly are then determined. One then determines the light characteristics needed for the target area. For example, knowing that for good light beam efficiency for athletic fields an intensity brightness of light areas to dark should not vary any greater than three to one (lightest to darkest), one can determine the required intensity of light needed over the field area. Since one also knows the entire field characteristics of the individual luminaires, one can determine how each luminaire should be aligned with respect to the vertical and horizontal coordinates of the cross-arm or luminaire assembly unit.

The resulting aligned plurality of luminaire fixtures, will thus produce the desired uniform intensity in the target area. Using the adjustable cross-arm assembly's vertical and horizontal arms as fixed reference points, allows the whole lighting unit to be aimed on site by utilizing just one aiming point on the field, and adjusting a single luminaire to the field aiming point.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of the rear side of the cross-arm assembly of the mobile lighting unit.

FIG. **2** is a perspective schematic of the invention on-site at a football stadium.

FIG. **3** is a side elevation view of the lighting unit and upper boom.

FIG. **4** is a front view of the upper boom.

FIG. **5** is an elevated side view illustrating the vertical adjusting pre-aiming of a light fixture.

FIG. **6** is a front sectional view of the elbow joint of a single fixture.

FIG. **7** is a side view of the elbow joint of a single fixture.

FIG. **8** is a bottom sectional view taken along lines **8—8** of FIG. **6**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In accordance with the invention and with reference to the drawings, in particular FIG. **1**, there is shown a mobile lighting array **10** including a lighting rack framework **12** holding a plurality of aligned luminaires **14** along the horizontal cross-bars **16** of framework **12**. Framwork **12** is tiltable by means of remotely controllable hydraulic cylinder **18** which is connected to vertical support bars **20** at one end and boom jib **22** at the other. A video camera **24** is mounted upon framework **12** to facilitate remote aiming of the array **10**.

By utilizing the parallel nature of horizontal crossbars **16**, luminaires **14** can be factory aligned to produce a composite high intensity beam from the fifteen individual defined beam lamps **14**.

With reference to FIG. **2**, it can be seen how lighting array **10** is mounted upon extensible and collapsible boom **26** which is in turn 360° pivotal about its attachment point to V-shaped boom jib **22** is attached at its lower ends to the upper end of boom **26**, as shown in FIG. **3**. The upper end of V-shaped boom jib **22** is attached to vertical support bars **20** by hinge bolts **36** which extend transversely through vertical support bars **20** and horizontal tubes **38**, which are rigidly attached to the ends of boom jib **22**. Hydraulic cylinder **18** attaches at its lower end to cross member **40** which extends between opposite sides of boom jib **22**, and attaches at its upper end to pivot bar **42**. Pivot bar **42** is attached at opposite ends to ears **44** of vertical support bars **20**. The exact structure of mobile lighting array **10**, boom jib **22** and boom **26** are set out more specifically in the concurrently filed, commonly assigned application, Ser. No. 418,452, entitled MOBILE LIGHTING FIX-

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