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Richardson

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[54] **INFRA-RED COUPLING MECHANISM FOR A LIGHT PROJECTOR**

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[51] **Int. Cl.**[5] **F21V 21/00**

[52] **U.S. Cl.** **362/286**; 362/269; 362/285; 362/287; 362/418

[58] **Field of Search** 359/142, 143, 144, 154, 359/152, 147, 165; 362/35, 269, 271, 272, 285, 286, 287, 418, 419, 428

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,842,403	10/1974	Konopka	359/147
3,924,120	12/1975	Cox, III	359/165
4,320,385	3/1982	Bleiweiss et al.	362/35
4,598,345	7/1986	Kleeman	362/272
4,797,795	1/1989	Callahan	362/272
5,031,082	7/1991	Bierand	362/272

FOREIGN PATENT DOCUMENTS

3013406	10/1981	Fed. Rep. of Germany	362/271

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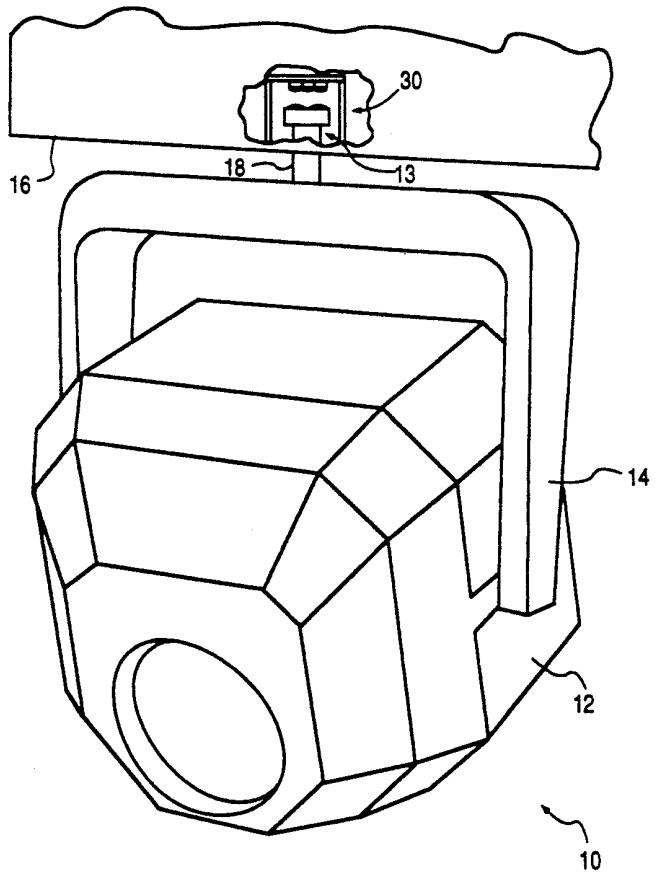
[57] **ABSTRACT**

A light projector is presented including a wireless power coupling mechanism and infra-red communications coupling mechanism which provide a portion of the projector with the capability of complete full-circle rotation about its pan-axis. A stationary base is provided which includes a first transmitter and receiver means for transmitting control signals to and receiving information signals from a second transmitter and receiver means on the rotating portion of the projector. A pan-axis shaft includes the second transmitter and receiver means for transmitting information signals to and receiving control signals from the transmitter-receiver means on the stationary base, and is operative to rotate the rotatable portion of the projector. The infra-red coupling mechanism and wireless power coupling mechanism eliminate the need for hard-wiring between the base and rotating portion of the projector, greatly facilitating continuous and efficient motion thereof.

15 Claims, 4 Drawing Sheets



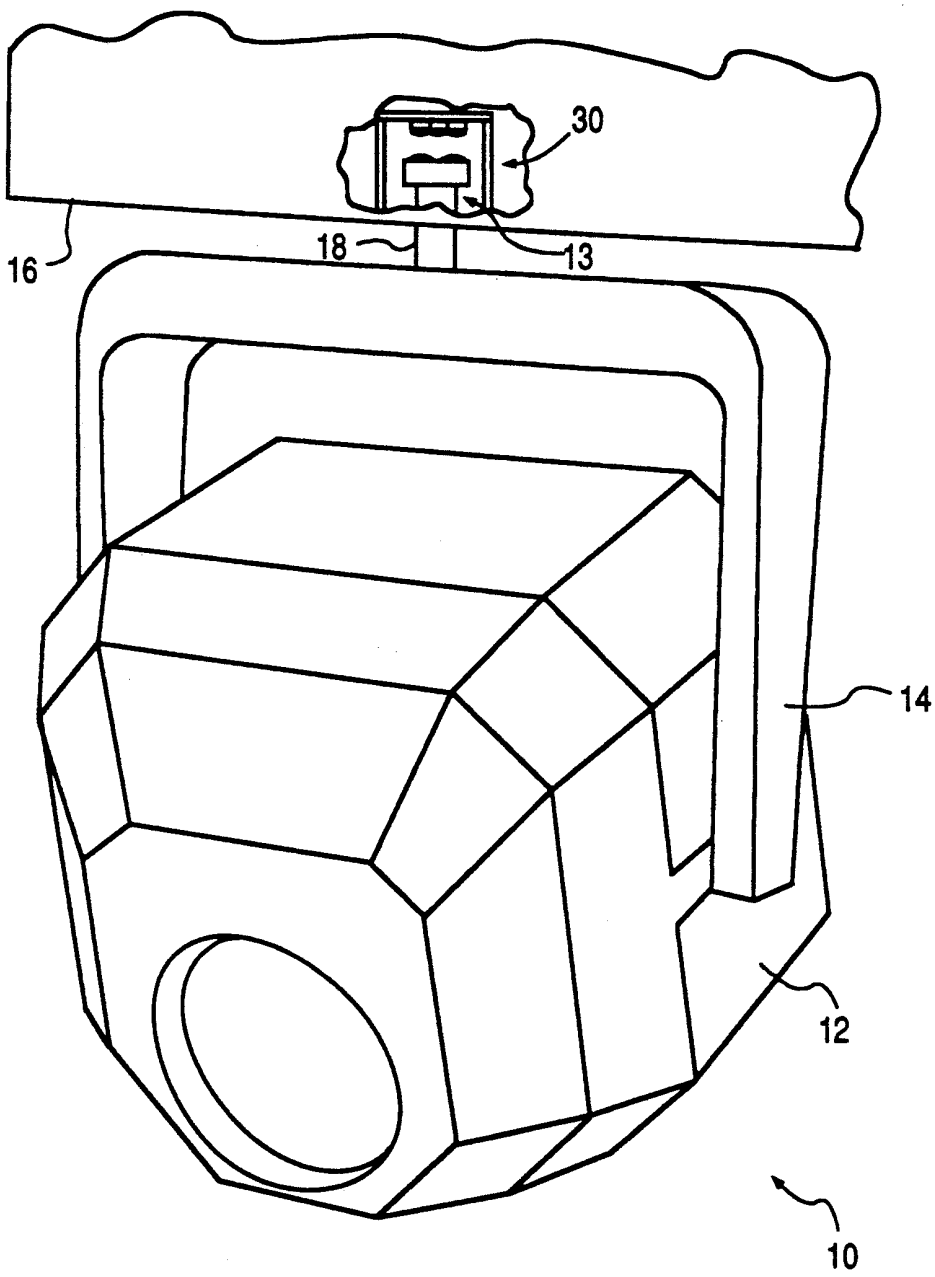


Fig. 1

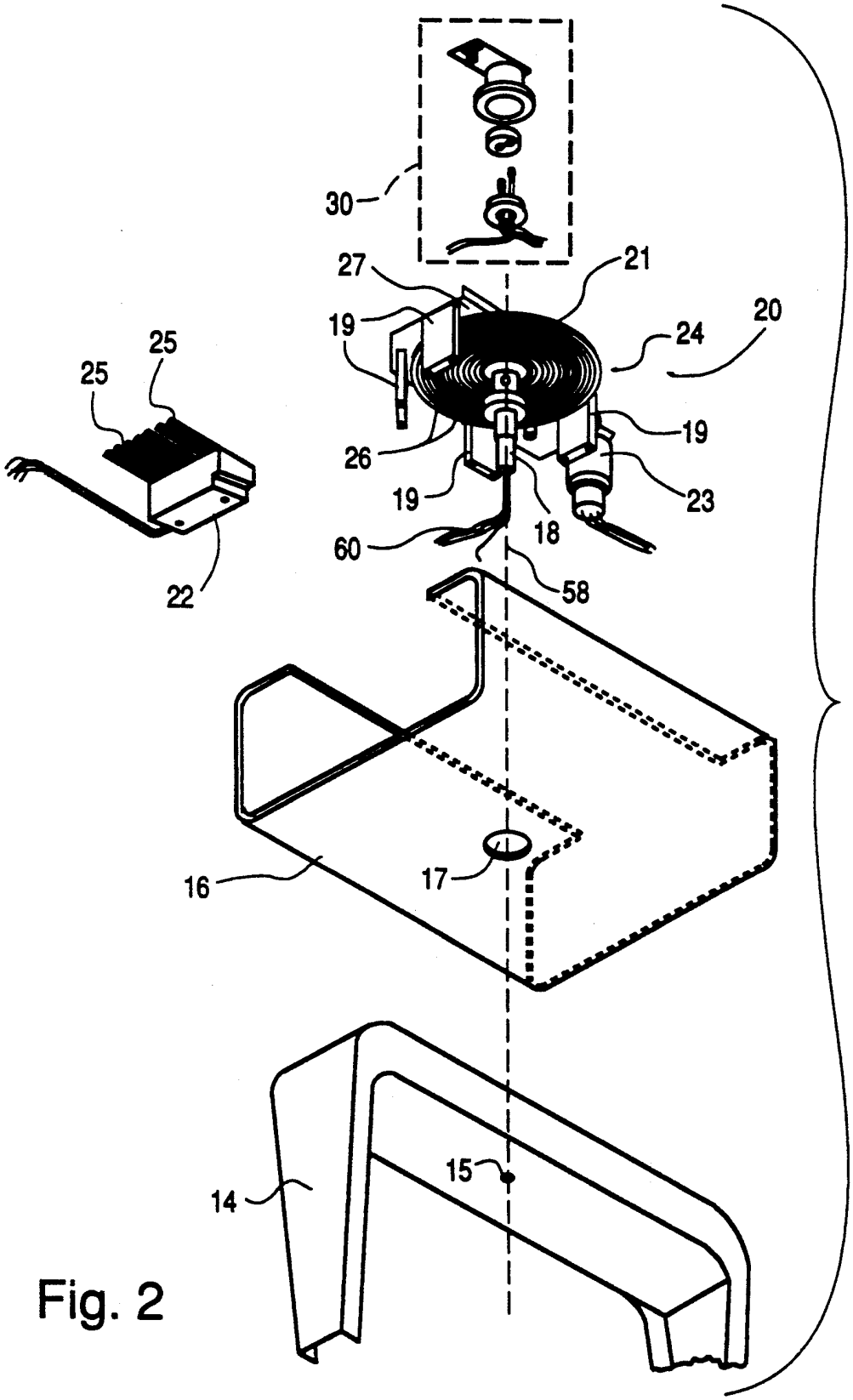


Fig. 2

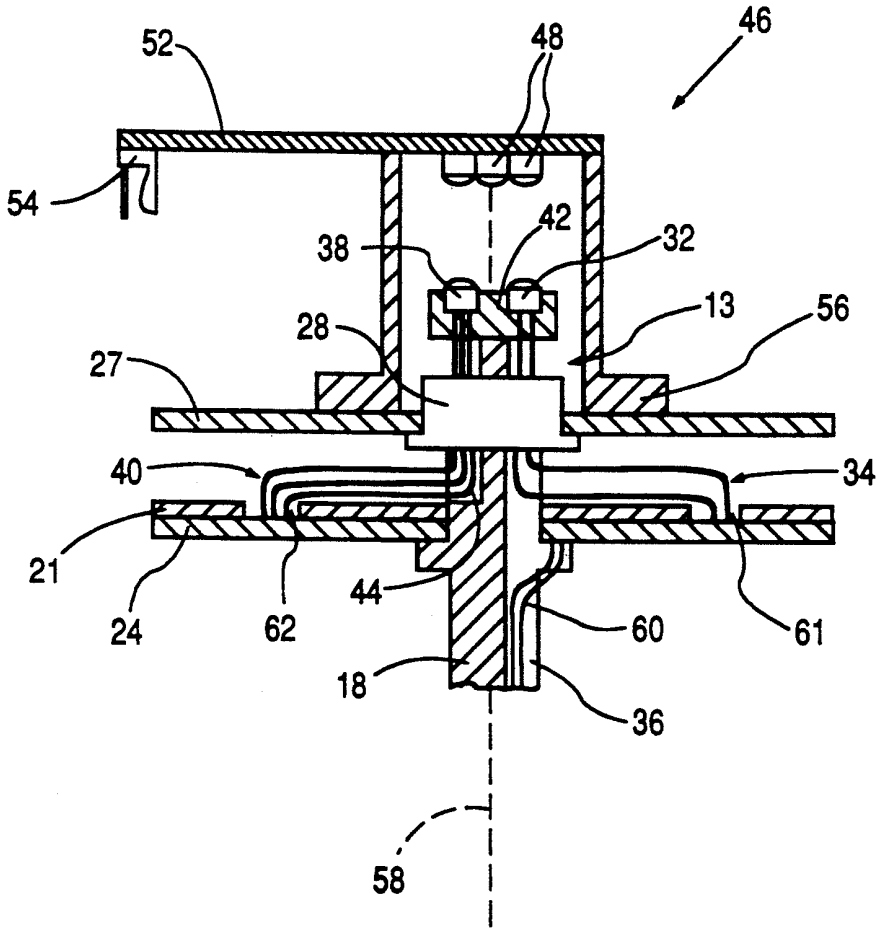


Fig. 3

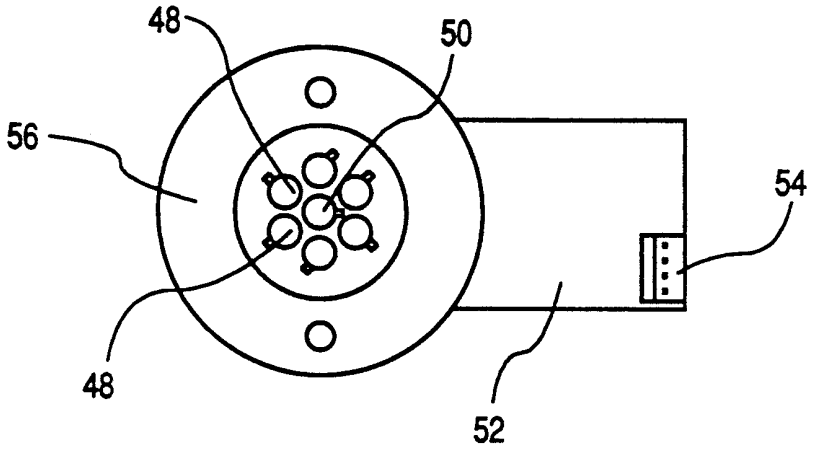


Fig 4a

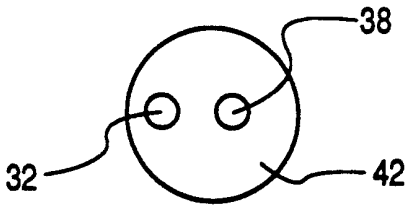


Fig 4b

INFRA-RED COUPLING MECHANISM FOR A LIGHT PROJECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to lighting systems, and more particularly to a light projector including an electro-optical coupling mechanism and wireless power coupling mechanism for facilitating increased range of motion and decreased response time for projector movement.

2. Brief Description of the Prior Art

Lighting systems have enjoyed expanded consumer interest and proliferation in recent years, evolving into a standard component of concert shows and theatrical presentations. The light shows associated with these events often capture more attention than the human element involved and can provide a significant level of overall audience satisfaction. As a result, contemporary lighting systems must offer increased functional flexibility and diversity over that demanded of the lighting systems used in the past.

An example of the inflexibility in the design of prior systems is the restricted range of motion available to the individual projector units. This inflexibility is mainly caused by the placement and connection of wires between the rotational and stationary portions of a projector. Connections are frequently made through the pan-axis of the projector (as shown in U.S. Pat. No. 4,701,833) or off to the side of this axis (as shown in applicant's co-pending application Ser. No. 07/224,437). This wire placement hinders the range and direction of revolution of the fixture, often complicating the implementation of a lighting program in a show that requires ultra-accurate precision light movements and timing. Additionally, because of the restricted range of motion, the rotational portion of a projector must often backtrack up to 360 degrees in order to reach a position that is actually juxtaposed to its last operational position. This translates into a reduced response time of the rotational portion to repositioning commands, which further inhibits overall projector performance.

SUMMARY OF THE PRESENT INVENTION

It is therefore an object of the present invention to provide a light projector with increased range of motion and movement flexibility about its pan axis.

It is another object of the present invention to provide a projector of the type described which is capable of complete and continuous full-circle rotation about its pan axis in both clockwise and counter-clockwise directions.

It is a further object of the present invention to provide a projector of the type described which exhibits a decreased repositioning response time, thus increasing the speed with which the projector can be moved to and from various operational positions.

These and other objects of the present invention are achieved in the preferred embodiment by providing a light projector with an infra-red communications link for transmitting and receiving data between the rotational and non-rotational components of the projector. A housing, which contains, in part, the lighting elements, actuators and lenses of the projector, is supported by a yoke. The yoke is attached to a shaft which is rotatable via a panning mechanism secured to a stationary base. A lower command card is provided, the function of which is to, in part, facilitate control the various mechanisms within the housing. Electro-optical transmitting and receiving means are secured to the shaft and coupled to the lower card and are operative to transmit information signals to and receive control signals from separate electro-optical transmitting and receiving means coupled to a stationary control unit secured to the base.

In this manner, it is possible for the stationary control unit to transmit control signals to the lower card without using hard wiring techniques. This design configuration allows the yoke to freely revolve about the shaft without the constriction due to the wires associated with the design of prior art devices. That is, without any wires connecting the housing and yoke assembly to the stationary base, the yoke can freely and continuously rotate in either a clockwise or counterclockwise direction.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a partially broken perspective view of the housing and yolk assembly for a light projector in accordance with the preferred embodiment of the present invention.

FIG. **2** is an exploded view of the yoke and base assembly, including the shaft and panning mechanism, power coupling mechanism, and infra-red coupling mechanism.

FIG. **3** is a cross-sectional view of the infra-red coupling mechanism as it appears in its operational configuration.

FIG. **4***a* is a plan view of the stationary base-mounted transmitting and receiving means of the infra-red coupling mechanism.

FIG. **4***b* is a plan view of the distal end of the shaft with the retaining means secured thereto.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, shown is the preferred embodiment of the present invention which generally comprises a lower light projector portion **10** including a housing **12** supported by a yolk **14**. Yolk **14** is physically coupled to a stationary base **16** via a shaft **18** which is fixedly secured to the yolk. Shaft **18** is coupled to a panning mechanism **20** (attached to base **16** and not shown in FIG. **1**) and is rotatable thereby. Housing **12** contains the light generating and influencing components of projector **10**, and is movable both independently of yolk **14**, at its points of suspension at the arms of the yolk, and by rotation of shaft **18** by panning mechanism **20**. A more detailed description of the actuating and control elements of a projector in accordance with the preferred embodiment is provided in applicant's co-pending application Ser. No. 224,437 and U.S. Pat. No. 4,837,665, the disclosures of which are hereby incorporated by reference.

Referring now to FIG. **2**, shown is an exploded view of a projector in accordance with the preferred embodiment, including panning mechanism **20**, a power coupling mechanism (including a brush mechanism **22** and a contact plate **24**), and an electro-optical coupling mechanism **30**. In its operational embodiment, shaft **18** is positioned through hole **17** of base **16**, and further secured to yolk **14** via hole **15** located centrally therethrough.

Panning mechanism **20** includes a stationary foundation **27** which is secured to base **16** by means of four connecting supports **19**. A rotating gear **21** is secured to shaft **18**, and is operative to turn the shaft in either a clockwise or counterclockwise direction. Motor **23** provides actuating means to drive gear **21**, and receives control signals from a central control unit (not shown). One end of shaft **18** protrudes through a hole in foundation **27** (not shown in FIG. **2**) and provides operational access for an electro-optical transmitter and receiver as further described below.

An important feature of the present invention is the elimination of control and power wires normally connected between the lower rotatable projector portion **10** and the upper stationary projector base **16**. In the prior art devices, this hard-wiring has proved a significant hinderance to the continuous and efficient panning movement of a projector.

Power to the electrical components of lower projector portion **10**, including a lower control card and the electrical elements contained within housing **12**, is supplied by a wiping contact assembly which includes brush mechanism **22** and contact plate **24**. Brush mechanism **22** includes a plurality of individual brushes **25** and is connected to an external power supply (not shown). Contact plate **24** includes a plurality of concentric annular copper strips **26** disposed on the outer surface thereof which ultimately provide conductive connections between brush mechanism **22** and various components of lower projector portion **10**. Plate **24** is secured to the surface of gear **21** by appropriate securing means. In the preferred embodiment, an insulating sheet is placed between the gear and contact plate, and the contact plate is attached to the gear using a plurality of screws.

Brush mechanism **22** is secured to stationary base **16** and is disposed in relation to panning mechanism **20** and gear **21** such that the individual brushes **25** make substantial contact with the concentric copper strips **26** of plate **24**. This coupling configuration facilitates a continuous power input path to the electrical components of the non-stationary lower portion without the difficulties associated with hard-wiring. Specifically, there are no wires connecting the rotatable lower portion **10** to base **16**, and thus no Wires to become twisted or tangled by the continuous full-circle rotation of yolk **14**. This arrangement accommodates unrestricted projector movement; and, although gear **21** rotates, the individual brushes of the brush mechanism make continuous contact with the copper strips of rotating plate **24**, thus providing potential for an uninterrupted power supply to the various lower projector portion components.

A plurality of copper connecting strips are provided on the upper non-contacting surface of plate **24** (opposite the surface of plate **24** shown in FIG. **2**) and are configured to terminate at the center region of plate **24**. Electrical circuitry common in the art for the proper operation of the electro-optical coupling mechanism **30** is also included on this non-contacting surface. Conductive connections are made between the connecting strips of the non-contacting surface and the concentric copper strips **26** on the opposite surface of the plate. This configuration allows a plurality of wires **60** to be coupled to the concentric copper strips **26** at the center region of plate **24**, a number of the wires **60** being operative to couple operating power to the various components of lower projector portion **10**, and a number of the wires **60** being operative to couple communication signals between the lower control card and mechanism **30**, as described below. Because wires **60** are connected to rotatable plate **24**, and are further connected to other lower projector portion components that are rotatable by the same actuating means (panning mechanism **20**), the wires are actually stationary with respect to the frame of reference of the rotating portion of the projector. This means that regardless of the direction or continuity of rotation of shaft **18**, the wires remain in their proper positions, free from twisting or entanglement. A groove **36** or bore is provided along or through the longitudinal axis **58** of shaft **18** to accommodate proper positioning of the connecting wires **60** therein. This allows the wires to be efficiently and compactly disposed, further diminishing the complications normally associated with a rotational light system.

Referring now to FIG. **3**, the electro-optical coupling mechanism **30** will now be explained in further detail. The principal function of coupling mechanism **30** is to facilitate the transmission and reception of information between the lower rotational portion **10** and the stationary portion of the projector without limiting full projector movement. This is accomplished by implementing photo-receiver and transmitter combinations in the communications portion of the projector design in place of the normal hard-wiring used in the data coupling systems of the prior art devices.

Gear **21** and plate **24** are attached to shaft **18**, the distal end **13** of which protrudes through a hole centrally located through foundation **27** and coupled thereto by bearing **28**. A photo-transmitter **32** and photo-receiver **38** are secured to this distal end **13** of shaft **18** by a retainer **42**. Photo-transmitter **32** is connected through a hole **61** in gear **21** to a first connector on the upper surface of plate **24** via wires **34**. Wires **34** are disposed within groove **36** through shaft **18**. Photo-receiver **38** is connected through a hole **62** in gear **21** to a second connector on the upper surface of plate **24** via wires **40**. Wires **40** are disposed within groove **44** which runs parallel to central longitudinal axis **58** through the upper portion of shaft **18**. Appropriate connections are made between the first and second connectors and the connecting strips on the upper surface of plate **24** to ensure effective operation and coupling of photo-transmitter **32** and photo-receiver **38**. The connecting strips coupled to photo-transmitter **32** and photo-receiver **38** are further coupled to the lower control card via a number of the connecting wires **60**.

Upper communications link **46** comprises a plurality of photo-receivers **48** which surround a single photo-transmitter **50** (shown in FIG. **4***a*) all of which are connected to an upper printed circuit board **52**. Connector **54** is provided to couple receivers **48** and transmitter **50** (and associated circuitry) to an appropriate control center. A cover **56** is secured to PCB **52** by appropriate securing means, and is further secured to stationary foundation **27**. In this manner, cover **56** is operative to secure the entirety of upper communications link **46** to foundation **27** in a predetermined position relative to axis **58** and transmitter **32** and receiver **38** such that transmitter **50** lies along axis **58** directly above the center of shaft **18**. Cover **56** is further operative to provide physical protection for receiver **38** and transmitter **32**, as well as receivers **48** and transmitter **50**.

In operation, information signals are sent by transmitter **32** to receivers **48** which subsequently relay the received signals to the control center of the projector. These information signals normally contain position

information and the like which allow the control center to make position adjustments and output further position commands Because transmitter **32** (and receiver **38**) is secured to shaft **18** by retainer **44**, it will rotate in the same direction and at the same rate as the shaft. A continuous communications link is established by providing a plurality of receivers **48** each of which is operative to receive communications signals, in effect acting in the conjunctive as a single reception source. As is depicted in FIG. **4***b*, transmitter **32**, which is affixed to shaft **18**, is limited to an orbital path circumscribed about the center longitudinal axis **58** and having a radius equal to transmitter **32**'s distance from the axis. Receivers **48** are arranged such that they lie in a fixed circular pattern having substantially the same diameter as the circular path around which transmitter **32** must travel. Thus, regardless of the position of transmitter **32** during the rotation of shaft **18**, a sufficient communicative link will be established between transmitter **32** and at least one of the receivers **48** such that information signals can be effectively transmitted and received.

In the preferred embodiment depicted in FIG. **4***a*, six receivers **48** are closely arranged in a circular path, the diameter of which is substantially the same as the diameter of the circular path that transmitter **32** must travel along during the rotation of shaft **18**. Because of the close proximity between each of the receivers **48**, an effective communicative link is established with transmitter **32** regardless of its position along its orbital path. That is, the physical gaps between the juxtaposed receivers **48** are insufficient to cause a communications breakdown even if transmitter **32** is positioned between two adjacent receivers. A signal of sufficient strength will be received by the adjacent receivers individually or in combination to accommodate reception from the transmitter.

Transmitter **50** is provided to transmit control signals from the upper projector portion to receiver **38** and further on to the lower control card. Receiver **38**, like transmitter **32** described above, is limited to movement in a circular path around the central longitudinal axis **58** of shaft **18**. A continuous communications link is established between transmitter **50** and receiver **38** by angling receiver **38** with respect to axis **58**, and towards transmitter **50**. When receiver **38** is set at the proper angle, a communicative path is established between transmitter **50** and receiver **38** regardless of the rotational position of shaft **18**. This communicative path is independent of shaft rotation because the angle at which receiver **38** is disposed relative to transmitter **50** remains constant, regardless of this rotation. Thus, once receiver **38** is angled appropriately, such that signal reception is achieved from transmitter **50**, there will be a constant viable path for the transmission and reception of communication signals.

It should be noted that the above described specific transmitter-receiver arrangement is not integral to the operation of the infra-red coupling mechanism. The prominent feature of the coupling mechanism is the implementation of communication means which obviate the need for hard-wiring between the rotating and stationary components of the projector. Thus any transmitter-receiver arrangement which is capable of effectuating these ends are contemplated. Thus, a single directional communications link could be established by providing a single transmitter, for transmitting control signals from a control center, and single receiver, for receiving these signals and relaying them to the operative components of the projector.

One embodiment employing this single transmitter and receiver arrangement would include a photo-receiver centrally located on the end of the shaft which couples the rotatable portion to the stationary base, and a photo-transmitter mounted to the base where the central longitudinal axis of the shaft intersects the base. This arrangement would provide a constant communications path regardless of shaft rotation. Additionally, other physical arrangements of the transmitters and receivers could be utilized in effectuating a one-way or two-way communications link without disturbing the overall effectiveness of the present invention.

Although the present invention has been described in terms of a preferred embodiment, it will be appreciated by those skilled in the art that modifications thereof may be made without departing from the essence of the invention. It is therefore intended that the following claims be interpreted as covering any and all such modifications falling within the true spirit and scope of the invention.

What is claimed is:

1. A light projector of the type including a stationary portion having a panning mechanism mounted thereon and a rotatable portion suspended from said stationary portion by a support means coupled by a rotatable shaft to said panning mechanism, and further including a communications means for coupling information and control signals between the stationary portion and the rotatable portion, said communications means comprising:

first transmitting and receiving means affixed to said rotatable portion; and

second transmitting and receiving means affixed to said stationary portion for transmitting signals to and receiving signals from said first transmitting and receiving means, said first transmitting and receiving means and said second transmitting and receiving means being conjunctively operative to communicatively couple information between said upper and lower portions during continuous full-circle rotation of said rotatable portion relative to said stationary portion.

2. A light projector as described in claim **1** wherein said first transmitting and receiving means includes a first photo-transmitter unit and a first photo-receiver unit, and further wherein said second transmitting and receiving means includes a second photo-transmitter unit and a second photo-receiver unit for optically communicating with said first photo-transmitter and photo-receiver units whereby information signals can be coupled between said rotatable and stationary portions without the use of wires connected therebetween.

3. Improved communications means as described in claim **2** wherein said first photo-transmitter unit and first photo-receiver unit are secured to one end of said rotatable shaft, and further wherein said second photo-transmitter unit and second photo-receiver unit are disposed on said stationary portion opposite said one end whereby said information is effectively coupled between said stationary and rotatable portions regardless of the rotational position of said shaft.

4. A light projector as described in claim **3** wherein said first photo-transmitter unit and first photo-receiver unit are disposed on opposite sides of said one end of said shaft, and wherein said second photo-receiver unit includes a plurality of individual second photo-receiv-

ers which surround said second photo-transmitter, said second photo-receivers being disposed in a circular path having a diameter substantially equal to the diameter of the circular path circumscribed by said first photo-transmitter during rotation of said shaft, and further wherein said first photo-receiver is angled with respect to the longitudinal axis of said shaft and directed towards said second photo-transmitter, whereby information signals are effectively coupled between said rotatable and stationary portions regardless of the rotational position of said shaft.

5. A light projector comprising:

a stationary projector portion including a base with panning mechanism secured thereto;

a rotatable projector portion, including a housing and support means for retaining said housing;

a shaft having a first end and a second end, said first end being fixedly attached to said support means and said second end being fixedly attached to said panning mechanism, said panning mechanism being operative to effectuate rotation of said shaft, thereby effectuating rotation of said rotatable projector portion;

power coupling means for supplying electrical operating power to electrical components of said rotatable projector portion from said upper projector portion without the use of wires connected therebetween, said power coupling means functioning to supply power during continuous full-circle rotation of said rotatable portion; and,

communication coupling means for transmitting and receiving control and information signals between said rotatable portion and said stationary portion without the use of wires connected therebetween, said communication coupling means functioning to supply said control and information signals during continuous full-circle rotation of said rotatable portion.

6. A light projector as described in claim **5** wherein said power coupling means includes a contact means secured to said shaft for providing a conductive path to said rotatable projector portion, and a brush means secured to said base and disposed such that substantial contact is made with said contact means, said brush means receiving power from a remote power source and being operative to couple said power to said contact means at all rotational positions of said shaft.

7. A light projector as described in claim **6** wherein said contact means comprises a circular plate with a plurality of individual annular conductive contact strips which are connected to various electrical components of said rotatable projector portion, and further wherein said brush means includes a plurality of individual brush members disposed in a manner to make substantial electrical contact with said individual strips such that said electrical contact is maintained even during continuous rotation of said shaft.

8. A light projector as described in claim **5** wherein said communication coupling means includes first electro-optical transmitter and receiver means disposed on said rotatable portion and second electro-optical transmitter and receiver means disposed on said stationary portion for establishing a wireless communications signal path between said rotatable and stationary portions.

9. A light projector as described in claim **8** wherein said first electro-optical transmitter and receiver means includes a first photo-transmitter and a first photo-receiver, both of which are attached to said second end of said shaft, and further wherein said second electro-optical transmitter and receiver means includes a second photo-transmitter and a plurality of second photo-receivers attached to said base and disposed in relation to said first electro-optical transmitter and receiver means such that a continuous communications path is provided between the rotatable and stationary projector portions regardless of the rotational position of said shaft.

10. A light projector as described in claim **9** wherein said plurality of second photo-receivers are arranged in compact relationship about said second photo-transmitter, whereby at least one of said plurality of second photo-receivers is disposed directly above said first photo-transmitter and further wherein said first photo-receiver is angled with respect to the central longitudinal axis of said shaft and toward said second photo-transmitter such that signals transmitted from said stationary projector portion can be continuously received by said rotatable projector portion and signals transmitted from said rotatable projector portion can be continuously received by said stationary projector portion at all rotational positions of said shaft and lower projector portion.

11. An individual light projector of a lighting system comprising a communications coupling mechanism, said communications coupling mechanism comprising:

a stationary base including a central control unit;

a rotatable portion including a local control unit;

a rotatable shaft having a first end and a second end, said first end being coupled to said stationary base and said second end being coupled to said rotatable portion, for coupling said rotatable portion to said stationary base;

first transmitter and receiver means attached to said rotatable portion for receiving control signals from said central control unit and for transmitting information signals to said central control unit;

second transmitter and receiver means attached to said stationary base for relaying control signals to said first receiver means from said central control unit and for relaying information signals to said central control unit from said first transmitter.

12. A light projector as described in claim **11** wherein said first transmitter and receiver means includes a first photo-transmitter unit and first photo-receiver unit, and further wherein said second transmitter and receiver means includes a second photo-transmitter unit and second photo-receiver unit disposed in communicative relationship to said first photo-transmitter and receiver units, whereby effective relay of said control and information signals is achieved between said rotating portion and said stationary base.

13. A light projector as described in claim **12** wherein said first photo-transmitter unit and first photo-receiver unit are disposed at said second end of said shaft, and wherein said second photo-receiver unit includes a plurality of individual second photo-receivers which surround said second photo-transmitter forming a substantially circular configuration with a diameter substantially equal to the diameter of the circular path circumscribed by said first photo-transmitter during rotation of said shaft, and further wherein said first photo-receiver is angled with respect to the longitudinal axis of said shaft and towards said second photo-transmitter, whereby information signals are effectively coupled between said rotatable and stationary portions at all rotational positions of said shaft.

14. A light projector comprising a communications coupling mechanism which includes a rotatable portion coupled by a shaft to a stationary portion, said communication coupling mechanism comprising:

transmitter means mounted to said stationary portion for transmitting control signals to said rotatable portion;

receiver means mounted to said rotatable portion for receiving control signals from said transmitter means, said transmitter means and receiver means effectively establishing a communicative link between said rotatable and stationary portions without the connection of wires therebetween, and providing said rotatable portion with the capability of uninterrupted communications during continuous full-circle rotation relative to said stationary portion.

15. The light projector as described in claim 14 wherein said receiver means includes a photo-receiver disposed upon said shaft coupled to said rotatable portion, and further wherein said transmitter means includes a photo-transmitter disposed in a direct optical line with said photo-receiver such that a communicative link is established therebetween at all rotational positions of said shaft.

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