United States Patent

Appleton

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[54] LIGHT CONTROL DEAD FRONT CONNECTOR

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[52] **U.S. Cl.**.....**250/215,** 250/215, 250/239
[51] **Int. Cl.**.....**H01j 5/02,** H01j 39/12
[58] **Field of Search**.....250/215, 239

[56] **References Cited**

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[57] **ABSTRACT**

In a mating plug and socket assembly one prong of the plug has a light and photocell associated with it when it is in place in the socket so that light is transmitted to the photocell thereby indicating that the plug and socket are mated. This photocell controls a relay having contacts in series between the electrical source and the socket so as to only close the circuit to the socket when the plug and socket are so mated. There are various arrangements of the light and photocell in conjunction with the one prong and the socket.

8 Claims, 5 Drawing Figures

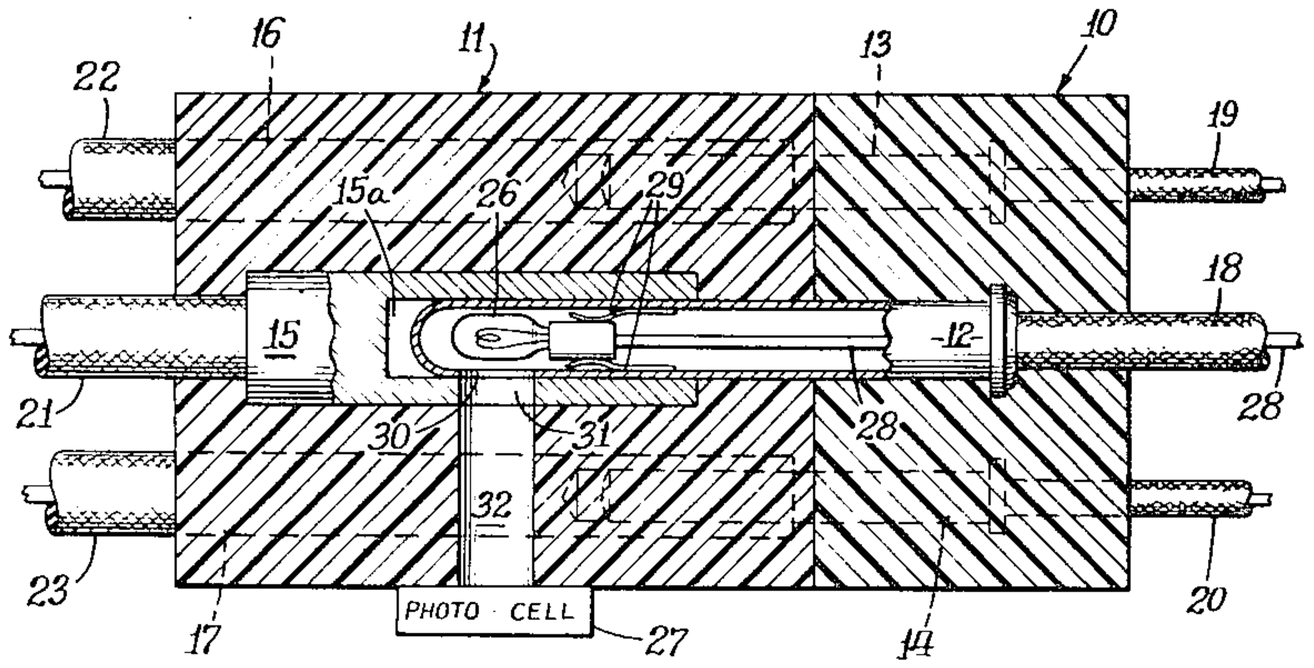


Fig. 1.

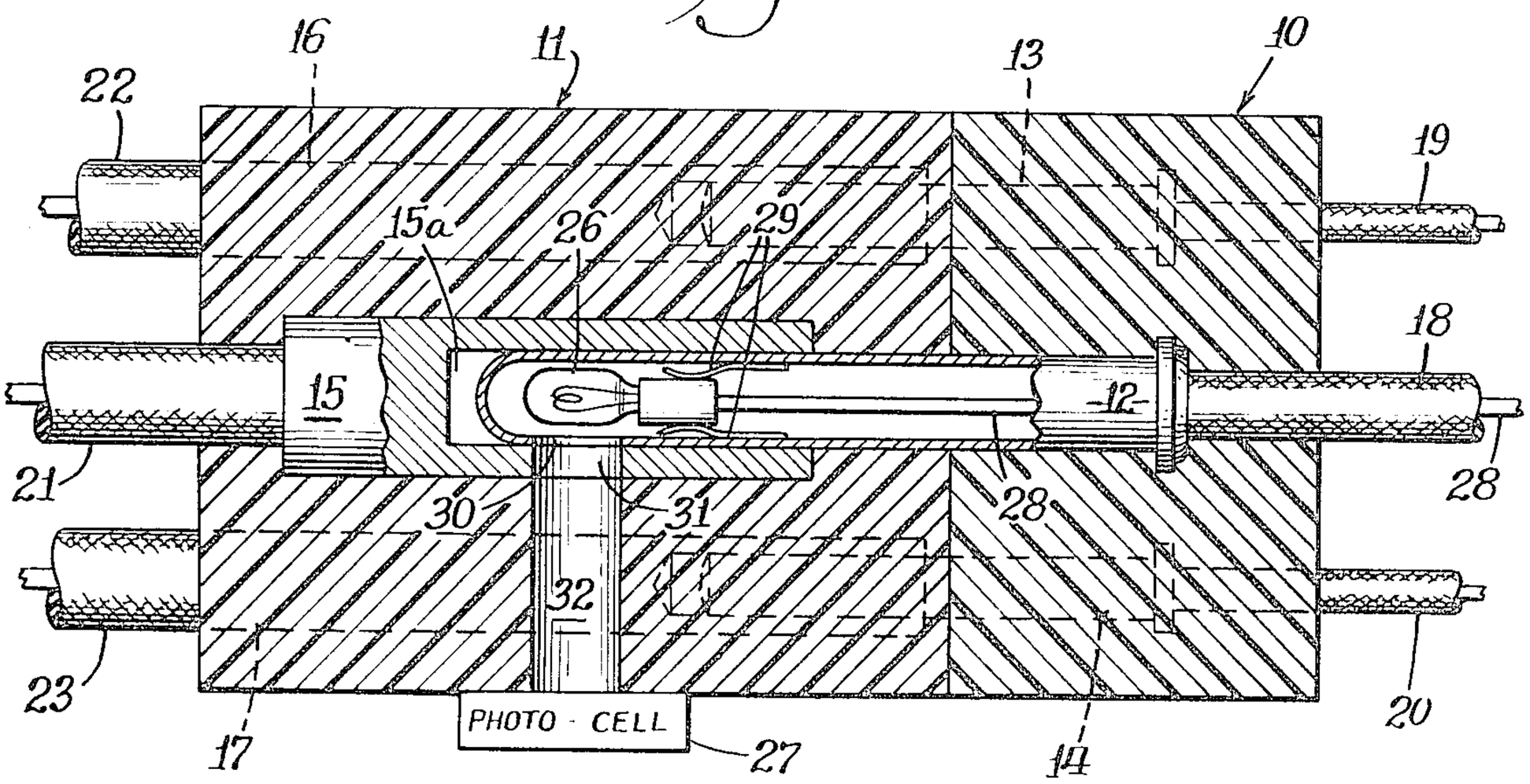
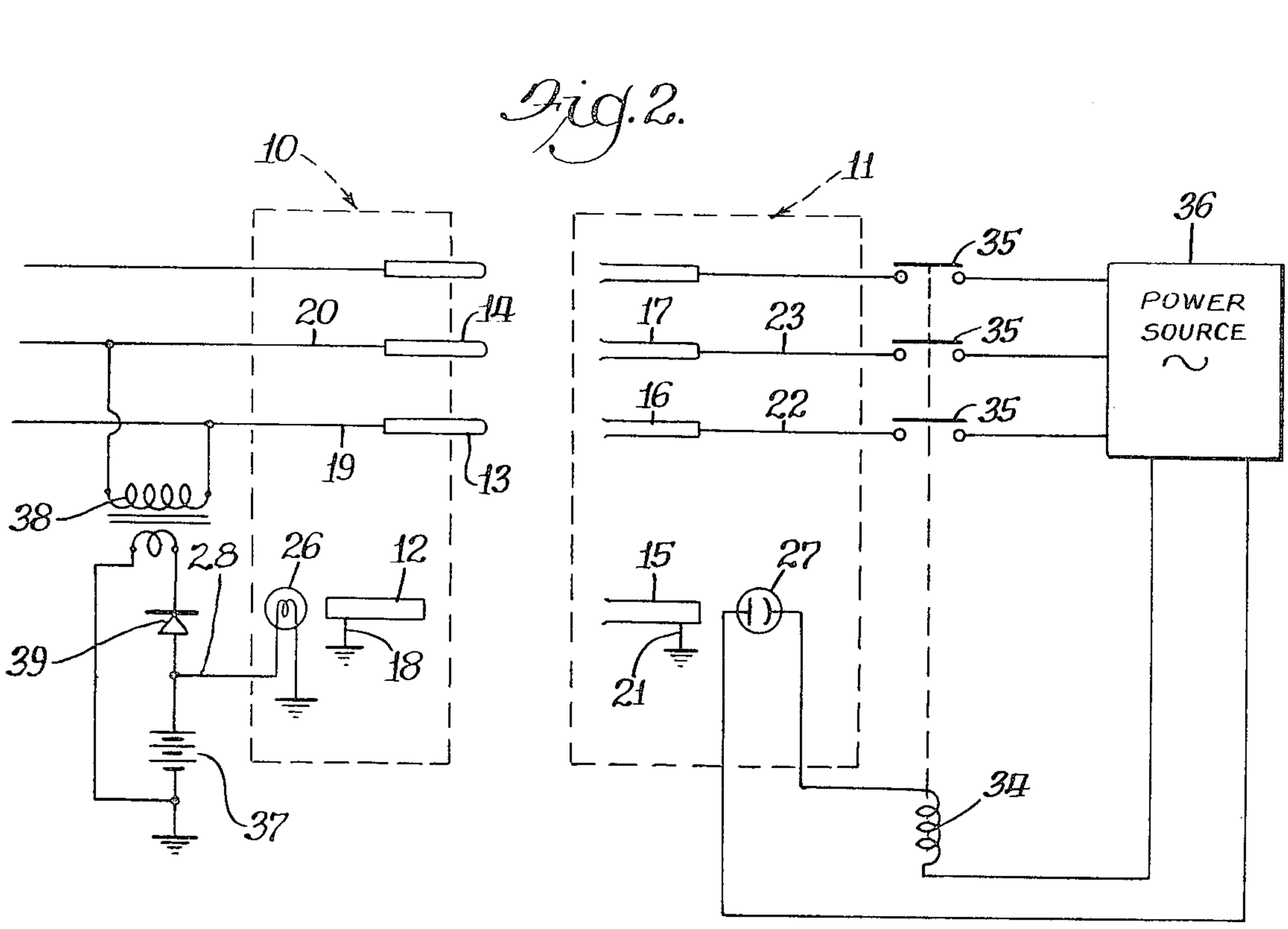


Fig. 2.



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Fig. 3.

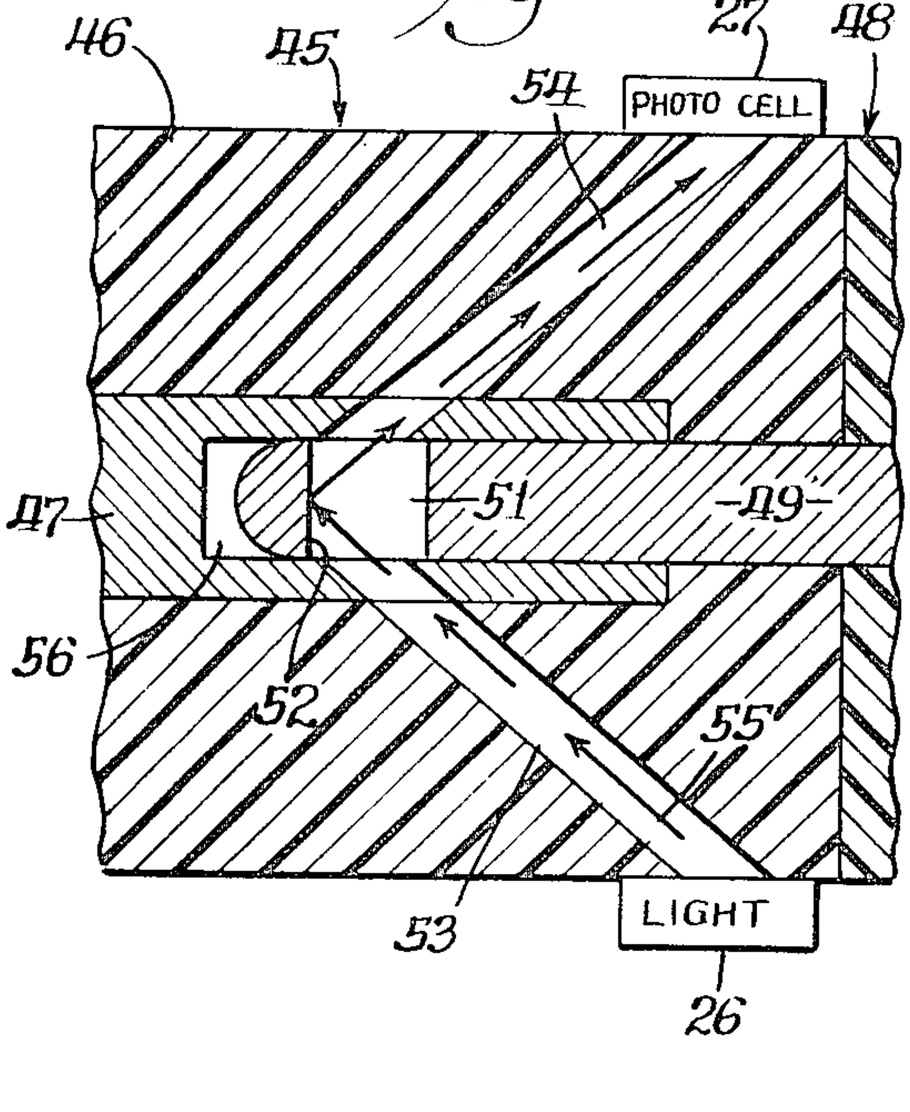
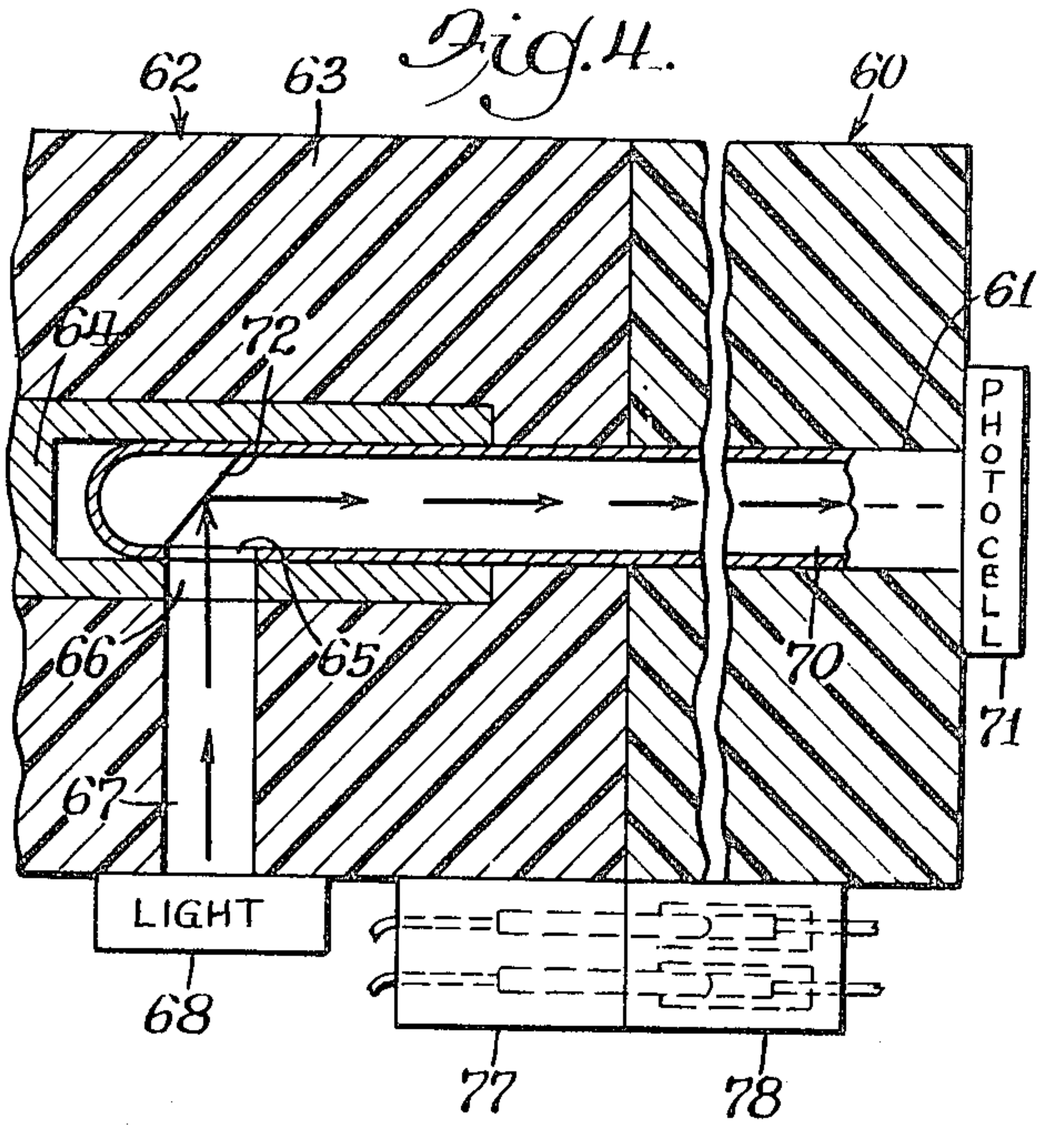


Fig. 4.



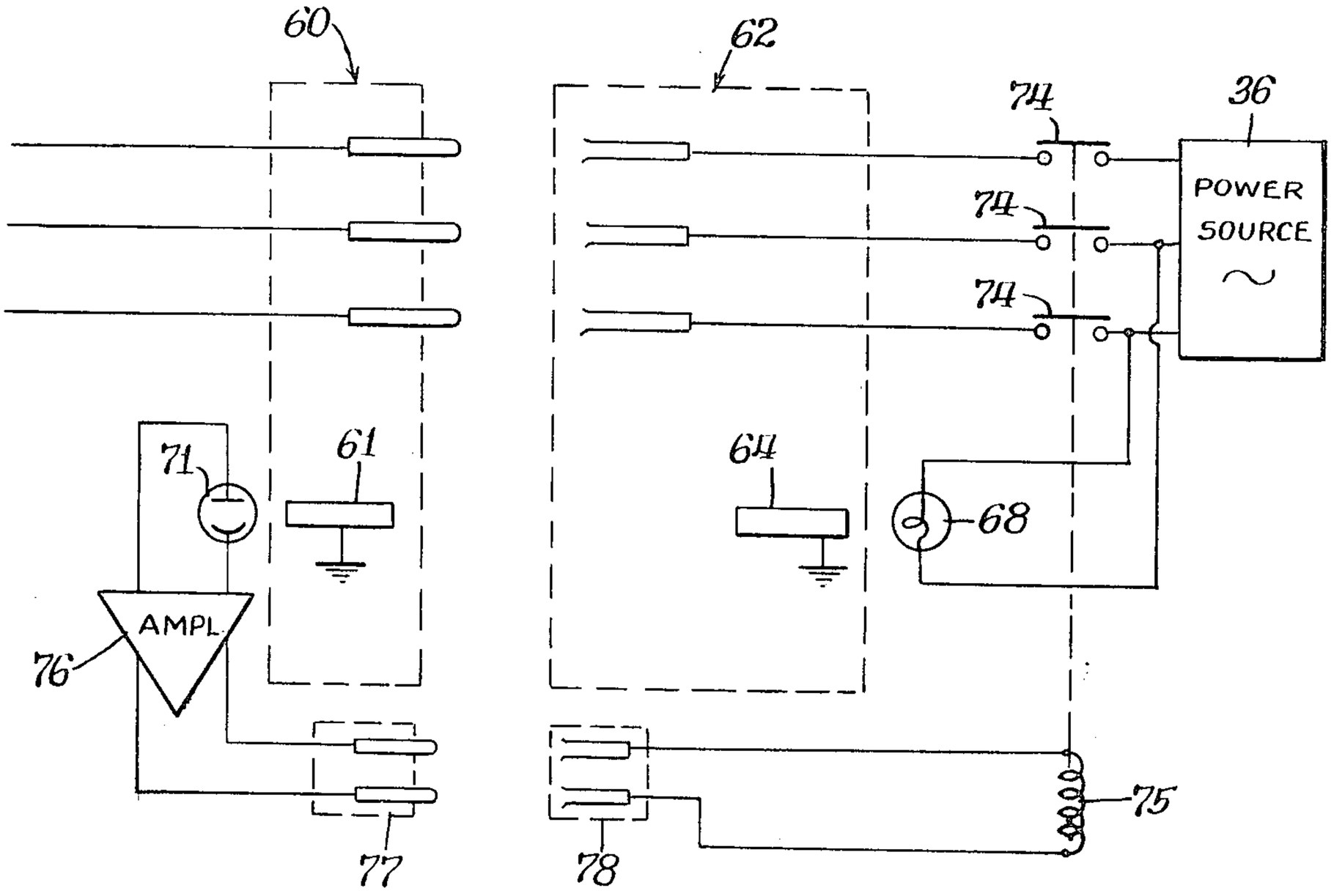


Fig. 5.

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LIGHT CONTROL DEAD FRONT CONNECTOR

SUMMARY OF THE INVENTION

The present invention relates to a fail-safe control apparatus for providing a "dead front" on a socket except when the mating plus is in the operative position on the socket, and one wherein no physical contact between the control apparatus and the movable elements or the prongs of the plug are required.

DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal section through an embodiment of the invention;

FIG. 2 is a schematic illustrating the electrical circuitry of the apparatus of FIG. 1;

FIG. 3 is a partial longitudinal section through an alternative embodiment;

FIG. 4 is a partial longitudinal section through a further alternative embodiment; and

FIG. 5 is a schematic of the wiring diagram of the apparatus of FIG. 4.

DESCRIPTION OF SPECIFIC EMBODIMENTS

The following disclosure is offered for public dissemination in return for the grant of a patent. Although it is detailed to ensure adequacy and aid understanding, this is not intended to prejudice that purpose of a patent which is to cover each new inventive concept therein no matter how others may later disguise it by variations in form or additions or further improvements. The claims at the end hereof are intended as the chief aid toward this purpose, as it is these that meet the requirement of pointing out the parts, improvements, or combinations in which the inventive concepts are found.

The concept of the present invention is applicable to plug-in socket assemblies that might be employed with almost any electrical power capacity. The following description is not intended to in any way limit the use of the invention to any particular power application, whether it be single-phase, three-phase, 110-volt, 440-volt, etc. From the following description, a competent electrical engineer will have no difficulty in modifying the details of the actual apparatus to achieve an assembly embodying the invention usable for the particular power application with which he is dealing.

In FIG. 1 there is illustrated a mating plug assembly, generally **10**, and socket assembly, generally **11**. The plug assembly has a plurality of prongs (or probes) **12**, **13** and **14**, which are received in the recesses (such as **15***a*) of a plurality of sockets **15**, **16** and **17**, respectively, when the plug assembly and socket assembly are mated, so as to provide electrical connections through the two. To achieve mating or separation the two are moved relative to each other along an axis which is best illustrated by the longitudinal dimension of prong **12**. Wires **18**, **19** and **20** are connected to the respective prongs **12**, **13** and **14**. Wires **21**, **22** and **23** are connected to the respective sockets **15**–**17**.

A detector apparatus is provided to ascertain when the plug and socket are in the mated condition. In accordance with the present invention, this detector apparatus comprises a light source consisting of lamp **26** and means (including photocell **27**) for producing an electrical switching operation in response to light reception. In the embodiment of FIG. **1**, one of the prongs (i.e., **12**) is hollow to receive the light bulb **26**. It is highly advantageous if the "ground" prong is employed for this purpose since a number of problems are thereby avoided. A wire **28** connects to the light bulb **26** and the other connection to the light bulb can be the grounded prong **12** making contact through a spring arrangement **29**. Prong **12** has a window (aperture) **30** which registers with a window **31** in socket **15** and an opening **32** in the insulated body **11** when the plug and socket are fully mated together; thus, at that time, the light will be transmitted to photocell **27** which is aligned with the opening **32**.

Referring to FIG. 2, a relay, comprising solenoid **34** and contactors **35**, is arranged with its contactors **35** in series between a power source **36** and the electrical socket connections of socket assembly **11**. The solenoid **34** and the photocell **27** (in the form of a photoresistor) are connected in series with the power source **36**. Light bulb **26** is connected across a rechargeable battery **37** to be energized thereby. A stepdown transformer **38** and a rectifier **39** are employed to form a charging circuit for battery **37**. The charging circuit in FIG. **2** is merely illustrative and in an actual embodiment would probably be more sophisticated to include a full-wave rectifier and/or a charging limit control, as is well known to those skilled in the art.

So long as the windows **30** and **31** of the prong and socket are not in registry, the photocell **27** does not receive light and, as a photoresistor, has a relatively high resistance. This resistance is sufficient so that solenoid **34** is insufficiently energized and as a result the circuits through the contactors **35** remain open. However, when the plug **10** and socket **11** are mated, as illustrated in FIG. **1**, the windows **30** and **31** are in registry so that photocell **27** is receiving light. This drops the resistance of the photoresistor to a point such that solenoid **34** picks up its armature to thereby close the circuits through contactors **35**. Thus, the electrical connections of the socket **11** only become energized after the plug and socket are brought into the mating condition.

For many applications a photoresistor (FIG. **2**) has the advantage of providing a simple arrangement. However, it does not have a rapid response when the light is removed from it and the relay **34**, **35** may continue briefly to supply electrical energy to the sockets **16**, **17** after the plug assembly **10** has been separated from the socket assembly **11**. Thus, it is potentially possible that arcing could occur upon separation and for this reason the construction of FIG. **2** cannot be regarded as explosion proof. If such a situation were a disadvantage in a particular application, it could be remedied by using a photocell and circuit breaking arrangement that had a more rapid response so that between the time that the windows **30** and **31** moved out of registry but before the prong **12** had moved away from its socket **15**, the electrical circuit was broken by the opening of contactors **35**.

FIG. **3** illustrates an alternative arrangement in which both the light **26** and the photocell **27** are mounted on the socket assembly, generally **45**. This socket assembly **45** comprises a body **46** in which there are a plurality of electrical socket connections, only one of which is illustrated at **47**. The plug assembly, generally **48**, likewise includes a plurality of correspondingly positioned prongs, one of which is illustrated at **49**.

Prong **49** has an opening **51** extending thereacross and one side of the prong at this opening forms a reflective surface **52**. When the plug **48** and socket **45** are fully mated the opening **51** is in registry with openings **53** and **54** in the socket assembly **45**. The latter openings **53** and **54** are aligned with light **26** and photocell **27**, respectively. When the plug **48** and socket **45** are mated the light beam **55** passes between the two. However, when prong **49** is not in place, the light beam **55** does not get reflected to the photocell **27**. In some such embodiments it may be desirable to blacken the inner walls about opening **56** to insure that it forms a light sink and that no light is reflected when the prong **49** is not in place. The electrical circuitry of FIG. **2** can be employed with the embodiment of FIG. **3**.

An arrangement of the FIG. **3** type keeps both the light and the photocell on the socket assembly. Also, the special configuration of the "active" prong is relatively simple. This is particularly desirable arrangement in a situation in which (for one reason or another) it is desired that the "active" prong not be a "ground" prong. Like the other embodiments, there is no physical actuation necessary, such as, for example, parts of the plug and socket assemblies making electrical contact or pushing a switch, to achieve the control function or signal.

FIGS. 4 and 5 illustrate several other types of modifications that may be made. Here there is a plug assembly, generally 60, which has a plurality of electrically conductive prongs, one of which is shown at 61. There is a socket assembly, generally 62, comprising a body 63 having a plurality of electrically conductive sockets, one of which is shown at 64. The prong 61 has a window 65 which registers with a window 66 in socket 64 at the mating position. An opening 67 extends through body 63 from window 66 to the light source 68. Prong 61 has an axial opening 70 extending from window 65 to a photocell 71. A light reflective surface (mirror) 72 is positioned to reflect light from window 65 through opening 70 to photocell 71.

Referring to FIG. 5, relay contactors 74 are connected between the power source 36 and the socket assembly 62. These contactors are moved to the closed position by the energizing of a relay solenoid 75. The photocell 71, for example, a cadmium sulfide cell provides an electrical signal through amplifier 76 to energize solenoid 75 when the light beam from source 68 is received by the cell. A plug and socket arrangement comprising plug 77 and socket 78 are used to connect the amplifier to the solenoid 75. As illustrated in FIG. 4 these may be physically a part of plug assembly 60 and socket assembly 62, or they may be separate components. The most effective action will be obtained if the circuit through plug and socket 77, 78 is accomplished before the prongs of plug assembly 60 enter the electrical socket components of socket assembly 62.

The particular arrangement of FIG. 4, FIG. 5, is merely to illustrate various possible modifications. In an actual construction provision would be made so that the ambient light through window 65 would not cause photocell 71 to provide an output signal when the plug assembly 60 was displaced from the socket assembly 62. For example, this would be done by using a photocell sensitive only to infrared light and using an infrared light 68.

The invention claimed is:

1. In an electrical connector apparatus comprising a plug member and a mating socket member which are movable along an axis with respect to each other to connect or disconnect an electrical circuit from a source to which one of the members is connected through a switching device having contacts, the improvement comprising:

light-transmitting means on a first of said members for producing a beam of light and directing it along a path which, at least in part, extends at an angle to said axis;

light reception means, including a detector, on a second of said members and aligned with said part of said path when said members are sufficiently mated to provide a primary electrical circuit between the members, for directing said beam to said detector for producing an electrical signal, said detector being connected to said switching device to close the contacts thereof when said electrical signal is produced, said light reception means failing to direct said beam to said detector when said members are not sufficiently mated to provide an electrical circuit between the members.

2. In an apparatus as set forth in claim 1, wherein said second member has a recess parallel to said axis and an opening extending off at an angle from an interior point of said recess, said opening forming a part of the light path to said detector; said first member including a probe which is received in said recess when said members are mated, said probe having an aperture aligned with said opening when said members are mated, said aperture being said part of said path.

3. In an apparatus as set forth in claim 2, wherein said light transmitting means includes a battery-operated light for producing said beam.

4. In an apparatus as set forth in claim 3, including a rechargeable battery for said light and battery-recharging means for said battery.

5. In an apparatus as set forth in claim 2, wherein said members have a plurality of mating prongs and sockets parallel to said axis for providing said primary circuit, one of said prongs being said probe and also being the ground prong.

6. In an apparatus as set forth in claim 1, wherein said second member is said one member.

7. In an apparatus as set forth in claim 1, wherein said first member is said one member, and including interconnecting means on the member for providing a second electrical circuit therebetween when said members are between the condition of being fully mated and the condition of being mated to an extent insufficient to provide said primary electrical circuit, said detector and said switching device being connected to said second electrical circuit.

8. In an electrical connector apparatus comprising two members having a mated condition and an unmated condition, said members having electrical contacts which provide a primary electrical circuit when the members are mated, one of said members having a recess and the other of said members having a prong which fits into said recess when the members are mated, said members moving along an axis with respect to each other as they are being mated, and electrical switch means connected to one of the members, the improvement comprising:

a source of light;

a light detector having a first condition when light is received and a second condition when no light is received;

means defining a light path between said source and said detector when said members are in one of said conditions thereof, with said light not being received by said detector at the other condition of the members, at least a portion of said path being angularly disposed to said axis at a location of a portion of said prong when said members are mated; and

actuating means connecting said detector and said switch means to close said switch means in one of said light conditions and to open said switch means in the other of the light conditions.

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