

June 23, 1964

A. L. WHITWELL ET AL
GANTRY CRANE SAFETY DEVICE

3,138,357

Filed July 13, 1961

4 Sheets-Sheet 1

FIG. 1.

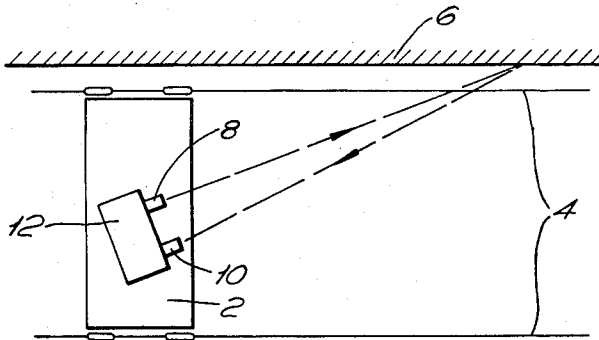
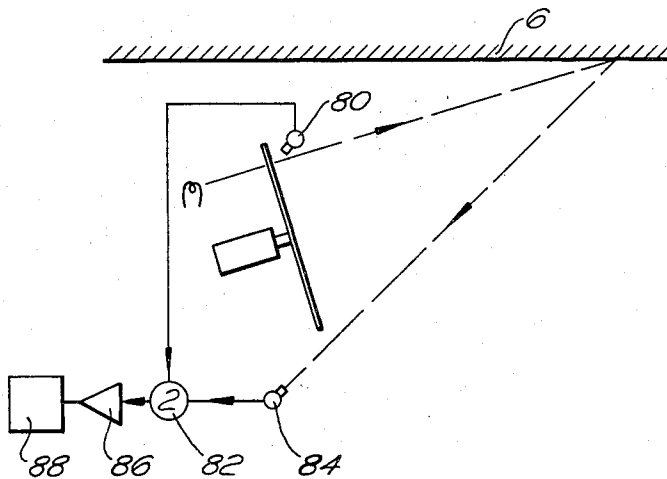


FIG. 6.



Inventors

Arthur Leslie Whitwell

Norman Williams

By *Sterens, Wain, Miller & Mosher*
ATTORNEYS

June 23, 1964

A. L. WHITWELL ET AL

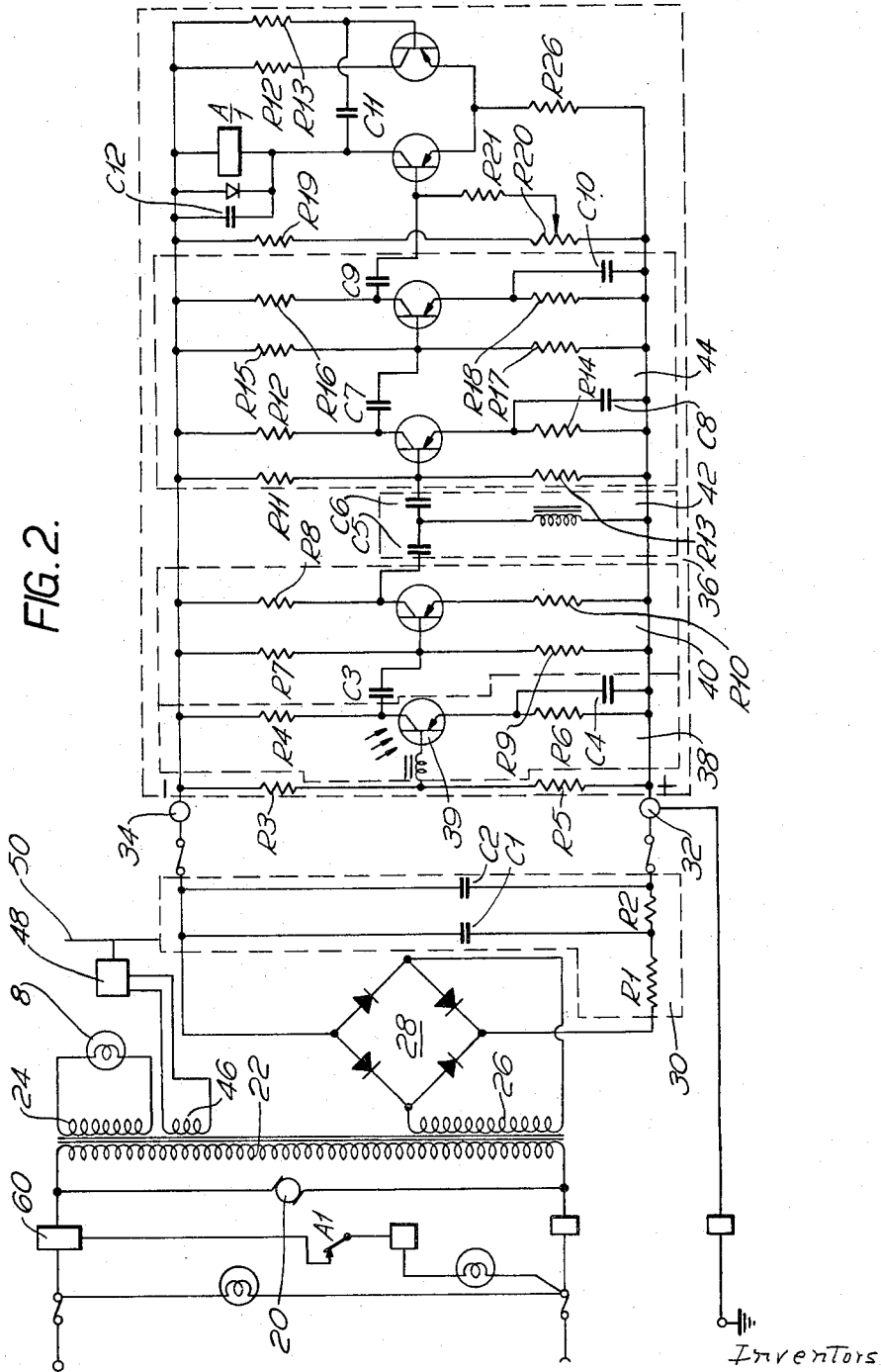
3,138,357

GANTRY CRANE SAFETY DEVICE

Filed July 13, 1961

4 Sheets-Sheet 2

FIG. 2.



Arthur Leslie Whitwell

Norman Williams

By Stevens, Wain, Miller & Mosher
Attorneys

Attorney's

June 23, 1964

A. L. WHITWELL ET AL
GANTRY CRANE SAFETY DEVICE

3,138,357

Filed July 13, 1961

4 Sheets-Sheet 3

FIG. 3.

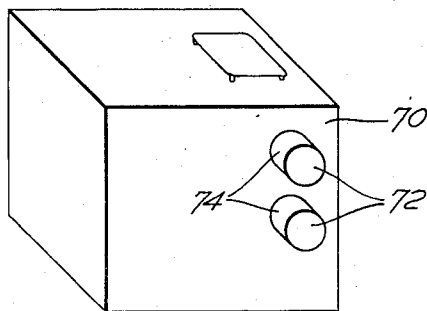


FIG. 4.

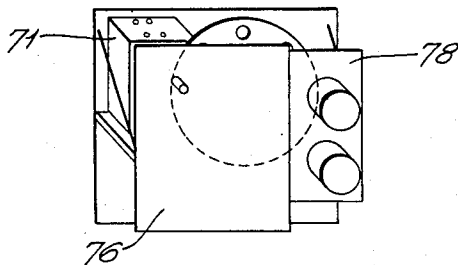
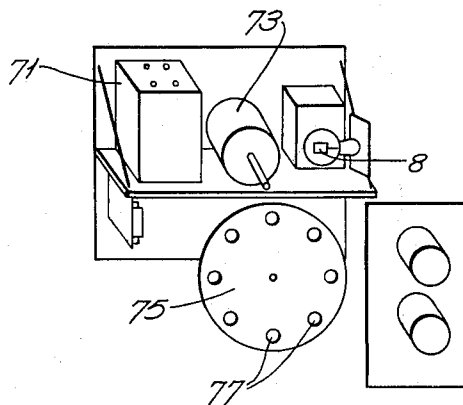


FIG. 5.



Inventors

Arthur Leslie Whitwell

Norman Williams

By *Sterens Hans Miller & Mosher*
Attorneys

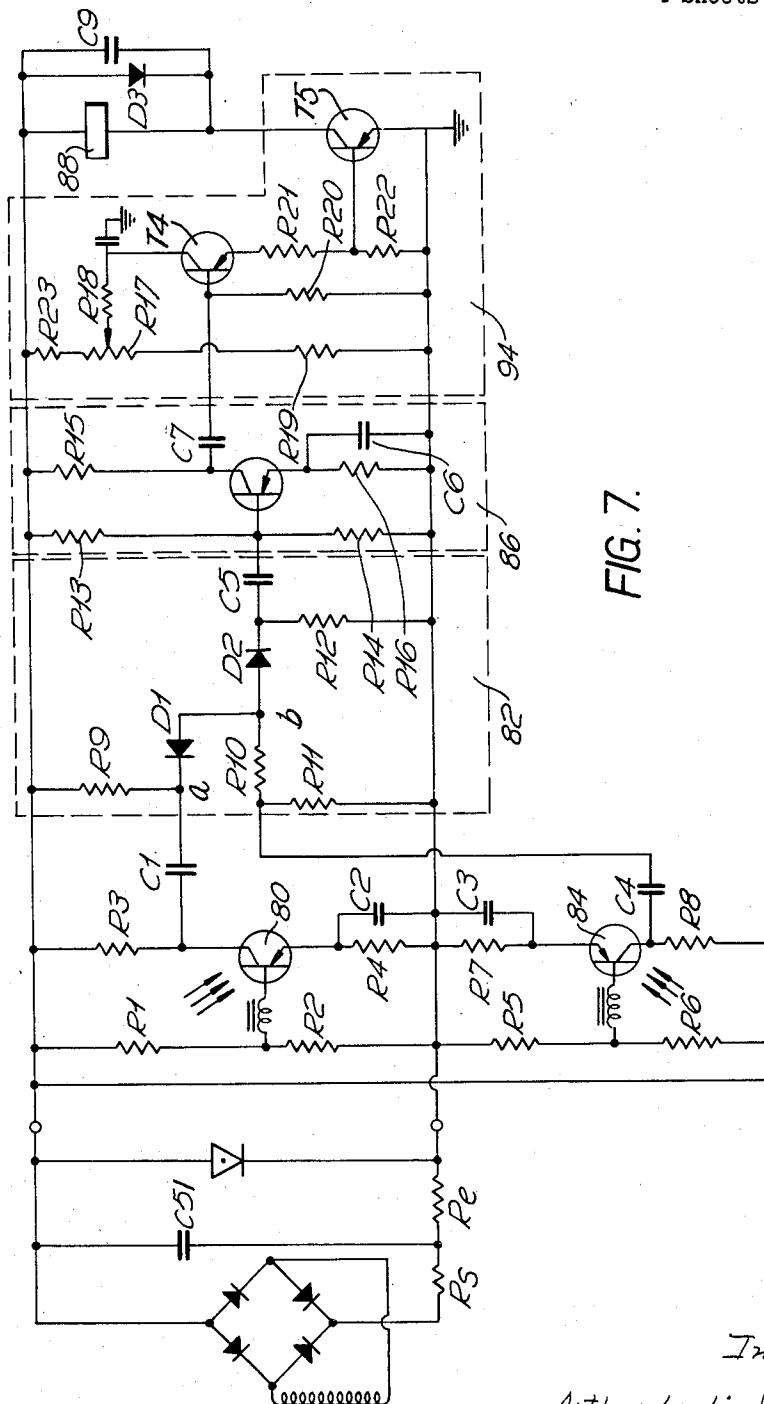
June 23, 1964

A. L. WHITWELL ETAL
GANTRY CRANE SAFETY DEVICE

3,138,357

Filed July 13, 1961

4 Sheets-Sheet 4



Inventors

Arthur Leslie Whitwell

Norman Williams

By Stevens, Davis, Miller & Mosher
Attorneys

1

3,138,357

GANTRY CRANE SAFETY DEVICE

Arthur Leslie Whitwell and Norman Williams, both of Glasgow, Scotland, assignors to James Scott (Electronic Engineering) Limited, Glasgow, Scotland

Filed July 13, 1961, Ser. No. 126,800

Claims priority, application Great Britain July 13, 1960

1 Claim. (Cl. 246—187)

The present invention relates to safety devices for travelling cranes.

When two or more travelling crane gantries move relatively on the same pair or set of supporting rails or the like, it is desirable to provide a safety system so that a crane cannot move into a position dangerously close to a neighbouring crane, or to a body of workmen in the path of the crane, without a warning signal being given, the signal serving to operate a warning bell or the like and/or to cut off the power supply to the motor moving the crane along the rails.

Accordingly the present invention provides safety device for two or more travelling gantry cranes adapted to move along the same path, a strip of reflective material being arranged to and extending alongside the path, each gantry being provided with a light source and a photo-electric cell disposed to receive light from the source after reflection from the reflective strip, means being provided to generate a warning signal when the light beam entering the cell is interrupted.

The effect of ambient daylight entering the cell is eliminated by modulating the light beam and examining the electrical output from the cell for signals at the modulation frequency, cessation of these signals indicating interruption of the light beam.

The cell may be provided with a strictly-defined line of sight, as by masks and the like, so that the only light entering it is from the light source.

The light beam may be interrupted by means of non-reflective screens placed over the reflective strip. These screens may be positioned, for example, on both sides of an area in the path of the cranes in which workmen are working. Thus when a crane is travelling towards the area the screen interrupts the light falling on the cell mounted on the gantry and the crane is stopped, either automatically or manually as a result of the warning signal, before it enters the area.

The screens, which may be canvas or the like, may be permanently mounted adjacent the reflective strip and in the form of aligned sections whereby each section, when placed over the strip, is long enough to interrupt the beam for a time sufficient to cause a crane travelling at its maximum speed to be stopped.

Two cranes using the same rails may be stopped before this jibs or other parts can come into contact by providing each gantry with a device which interrupts the light beam of the other crane when they come within a prescribed distance of each other. The device may consist of a board or the like extending parallel to the framework of the gantry crane and positioned to intersect the light beam at the prescribed distance.

The present invention has the great advantage that it "fails safe" i.e. that should the light beam be interrupted for any reason, e.g. the failure of a lamp or an interruption in the power supply to the safety device, the gantry will be stopped, in contradistinction to known gantry proximity-indicating devices which operate only when a light beam received by a photocell rises above a certain level.

By "reflective material" throughout this specification is meant material which is able to reflect incident light towards the light source at an angle only slightly divergent from the angle of incidence. A suitable ma-

2

terial is "Scotchlite," which comprises a surface coated with tiny spherules of glass or similar material, each spherule acting to reflect incident light towards the source by total internal reflections.

An example of the present invention is illustrated with reference to the accompanying drawings, in which:

FIG. 1 is a diagram indicating the principle of operation of the present invention;

FIG. 2 is the circuit diagram of one form of circuit suitable for the arrangement shown in FIG. 1;

FIG. 3 is a perspective view of a transmitter-receiver unit for mounting on a gantry crane;

FIG. 4 is a perspective view of the unit shown in FIG. 3 with the outer cover removed;

FIG. 5 is an exploded view of the apparatus shown in FIG. 4;

FIG. 6 is a schematic diagram illustrating preferred form of safety device; and

FIG. 7 is a diagram of an electrical circuit suitable for the apparatus as shown in FIG. 6.

As shown in FIG. 1, a gantry crane 2 is designed to move along, and be supported by, a pair of parallel rails 4. Electrical power is supplied to the gantry by means of electrical conductors (not shown) extending in parallel with the tracks and engaged by a conventional pantograph mechanism mounted on the gantry.

Extending in parallel with the tracks 4 at a height corresponding with the height of the gantry crane, is a strip of light reflective material 6 as hereinbefore defined.

Mounted on the gantry is a light source 8 arranged to project a beam of light onto the strip of light reflective material at a suitable distance in front of the gantry crane 2. Light reflected from the strip 6 passes back to the gantry crane at an angle slightly divergent from the angle of incidence of the light on the strip. This reflected light is received by a photo-electric cell 10 from which signals are passed to the operating device 12.

The apparatus is designed so that when the photo-electric cell 10 is generating a signal caused by reflected light falling upon it, the safety device 12 is held in its working position. However when the reflected light beam is interrupted for any reason the device 12 is effective to generate a warning signal and/or to cut off the electrical supply to the motor driving the gantry crane 2 along the tracks 4. The device 12 preferably includes a trip switch in order that the safety device must be manually reset after operation.

In the circuit diagram as shown in FIG. 2 the gantry motor 20 is energized from a main electrical supply of 240 volts. Connected in parallel with the motor is the primary coil of a transformer 22 from one secondary winding 24 of which an electrical supply is used to operate a signal lamp 8 as shown in FIG. 1.

From a second secondary winding 26 a voltage of 18 volts is tapped off, rectified by a rectifier circuit 28 and supplied through a smoothing circuit 30 to the input terminals 32 and 34 of the receiver 36 at a voltage of 12 volts.

Receiver 36 consists of a signal generating stage 38 including a phototransistor 39 forming the photo-electric cell 10 described with reference to FIG. 1. Signals from the phototransistor stage are passed to an amplifier stage 40, from which the amplified signal is fed through a high pass filter circuit 42 to a capacitance-coupled two stage amplifier circuit 44.

Connected across the output of stage 44 is a switching circuit for a relay A, of which contact A1 is connected in parallel with the gantry motor 20.

The variable resistor R₂₀ connected across the output of the amplifier stages 44 is arranged to vary the sensitivity of the receiver 36.

A third secondary winding 46 is arranged to generate

3

an electrical supply driving a motor 48 rotating a light-modulating disc 50 disposed in the path of light from the signal lamp 8 to the strip 6 of reflective material. The speed of rotation of the disc 50 and the spacing between apertures are arranged to modulate the light beam received by receiver 36 at a frequency of 400 c./s. The high pass filter 42 is arranged to have a cut-off frequency of 300 c./s. By this means the effect of ambient daylight conditions is eliminated, as by the use of a phase sensitive detector.

Relay A is designed to pull in at a voltage of approximately 3.9 volts and to drop out at approximately 3.4 volts. The components of the receiver 36 are chosen so that when light is received by the device 36 a signal of about 6.4 volts is applied across the relay, holding it in the energized position in which the contact A1 is open. Under these conditions, when no light is received by the phototransistor 39 the voltage across the relay drops to 1.4 volts whereby it drops out and the contact A1 is closed.

In series with this contact and with the current supply to the motor 20 is a cut-out 60 able to carry the current load when the motor is working under normal conditions but which cuts out when the contact A1 is closed to short-circuit the motor 20. Cut-out 60 is manually resettable as desired.

As shown in FIGS. 3 to 5 the transmitter-receiver unit is mounted as a self-contained unit on the gantry crane 2. The unit includes a housing 70 provided with two 2½" lenses 72 mounted in 2" long mounts 74 which can be adjusted axially of the lenses to permit focusing for different ranges of operation.

FIG. 4 shows the apparatus of FIG. 3 with the cover 70 removed. The apparatus includes a chassis 76 for the amplifier and a support 78 for the lens mounts 74. Mounted on the chassis 76 is a transformer 71 and, as shown in FIG. 5, an electric motor 73 adapted to rotate a modulation disc 75. The chassis 76 also carries a robust signal lamp 8. The apertures 77 in the disc 75 are arranged to lie on a circle intersecting the path of light from the lamp 8 to the upper lens 72. Thus as the disc 75 is rotated by motor 73 the light beam passing from the lamp 8 is interrupted at a frequency corresponding with the frequency of rotation of the disc 75 and the arcuate spacing of the apertures 77. In one example the disc is provided with eight uniformly spaced apertures and the motor rotates the disc at 3000 r.p.m. to give a modulation frequency of 400 c./s.

After being reflected back from the reflective strip 6 shown in FIG. 1 the light enters the lower of the lens 72 and falls upon a phototransistor incorporated in the circuit shown in FIG. 2.

The embodiment of the invention shown in FIG. 6 replaces the high pass filter shown in the embodiment illustrated in FIGS. 1 and 2 by a phase-sensitive detector. With this invention the light passing through the modulation disc is picked off by a photo-electric cell 80, the signals from which are fed to a gate 82, having applied to it signals from the second photo-electric cell 83 receiving light after reflection from the strip 6. The gate 82 is coincidence gate whereby signals are only fed through amplifier 86 to the alarm relay 88 when the phases of the signals generated by cells 80 and 84 are coincident i.e. when they are both derived from the same source.

The detailed circuit of the arrangement shown in FIG. 6 is illustrated in FIG. 7.

Prior to the rectifier section the circuit is the same as in FIG. 2. From a secondary winding of the supply transformer a voltage of 24 volts is tapped off, rectified by a rectifier bridge, and supplied through a smoothing circuit comprising resistors R_s, R_e, capacitor C51 and a Zener diode to the input terminals of the receiver at a voltage of 12 volts.

The receiver comprises a signal generating stage con-

4

sisting of two identical independent circuits, including photo-transistors 80 and 84, respectively, forming the photo-electric cells 80 and 84 described with reference to FIGURE 6.

To provide temperature stability in the circuit of photo-transistor 80, a potential divider R1, R2 is placed across the supply, a resistance R4 bypassed by capacitor C2 is placed in series with the emitter, and the base is returned to the emitter through an inductance. The output signal is developed across a load resistor R3 in series with the collector. The circuit of photo-transistor 84 functions similarly, but includes components R6, R5, R8, R7, C4, C3, 84 which correspond to components R1, R2, R3, R4, C1, C2, 80 respectively of the circuit of photo-transistor 80.

The two photo-transistors 80 and 84 are connected in back-to-back relationship and their output signals are fed through capacitors C1 and C4 to a diode gate 82, forming the gate 82 described with reference to FIGURE 6, and including the two diodes D1 and D2.

The action of the diode gate is as follows: With no synchronising pulse applied current flows from earth through resistors R11, R10, diode D1, resistor R9 to the negative line. This holds points *b* and *a*, on the earth and non-earth sides of diode D1, respectively, at a negative voltage. Upon receipt of a reflected light signal a positive pulse coming from the photo-transistor 84 through capacitor C4 to the junction of resistors R10 and R11 will not overcome the negative potential at point *b* and consequently diode D2, connected to point *b* and via resistance R12 to earth, will remain backed off. With no signal being generated by photo-transistor 84, a positive pulse, corresponding to light passing through the modulation disc, is supplied by photo-transistor 80, through capacitor C1 to point *a*, and is effective to raise the negative potential at *a* whereby diode D1 is backed off, the potential of point *b* becoming almost earth potential. By this means when positive pulses are applied simultaneously by photo-transistors 80 and 84 the diode D2 is biased to pass a signal, developed across the resistor R12, through a capacitor C5 to the input of an amplifier stage 86.

This amplifier stage 86 is a conventional RC-coupled circuit with emitter grounded for alternating current, comprising input capacitor C5, potential divider R13, R14, collector load resistor R15, emitter bias resistor R16 bypassed by capacitor C6, and output capacitor C7. The effect of the amplifier stage 86 is to supply a negative signal to a drive circuit 94.

This drive circuit 94 is a power switch for relay 88. The first transistor (T4) stage of the drive circuit is an RC-coupled circuit with collectors grounded for alternating current, wherein the RC input coupling is formed by capacitor C7 and resistor R20, the output is taken from the junction of resistors R21 and R22 in series in the emitter circuit, the collector is taken through resistor R18 to the variable resistor R17 in the potential divider R23, R17, R19 which permits variation in the sensitivity of the receiver, and a grounding capacitor connects the collector to earth. The second transistor (T5) stage of the drive circuit is a grounded emitter transistor for which the collector load is the relay 88 bypassed by a catching diode D3 and a capacitor C9 which serve to restrict heating and to reduce the switch-off time. When a negative impulse is supplied to the input of transistor T4, a negative base current flows out of transistor T5 and is sufficient to bottom this transistor whereby the full supply voltage is developed across relay 88. With no output from the diode gate D1 and D2, the base of transistor T4 is raised to zero or greater potential and transistor T4 is cut off. Thereupon a positive base current flows into transistor T5 to cut this transistor off, upon which the relay 88 drops out. This in turn is effective to close the relay contact A1 as described in connection with FIGURE 2 and stop the motor and generate any other warning signals.

5

We claim:

A safety device for at least two movable members moving along the same path comprising means mounted on each movable member to drive same, means including a light transmitting means and a light receiving means disposed on each movable member, a reflective strip disposed adjacent the path along which said movable members move for reflecting the light transmitted by said light transmitting means onto said light receiving means, control means operatively connected between said light receiving means and said driving means to control same in the absence of light being received by said light receiving means, modulating means to modulate the light transmitted by said light transmitting means, demodulating means disposed between said light receiving means and said control means to demodulate the modulated light, and a further light receiving means disposed adjacent said modulating means, a coincidence member operatively connected to both said light receiving means, said coincidence member being operative to control said control means so long as both said light receiving means receive light transmitted by said modulating means.

6

lating means, a coincidence member operatively connected to both said light receiving means, said coincidence member being operative to control said control means so long as both said light receiving means receive light transmitted by said modulating means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,708,715	Meyers -----	May 17, 1955
2,906,885	Orthuber et al. -----	Sept. 29, 1959
2,946,931	Durbin -----	July 26, 1960
2,981,831	Walsh -----	Apr. 25, 1961

FOREIGN PATENTS

1,082,618	Germany -----	June 2, 1960
-----------	---------------	--------------