Oct. 26, 1954 L. J. A. LE GOFF 2,692,921

REMOTE-CONTROL AND INTERLOCKING SWITCH

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Fig. 1

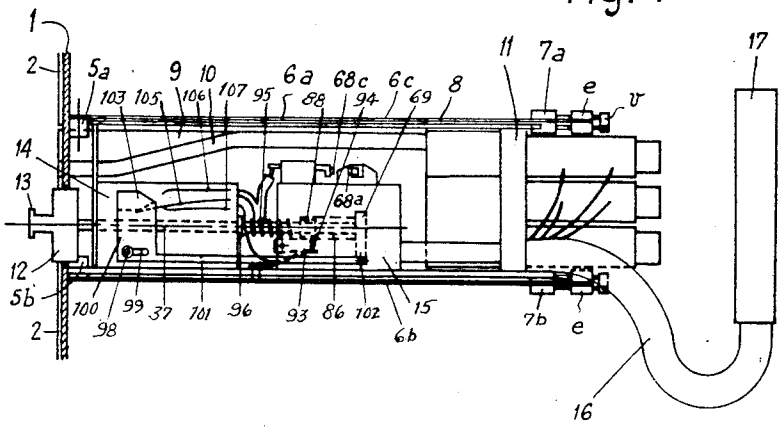


Fig. 2

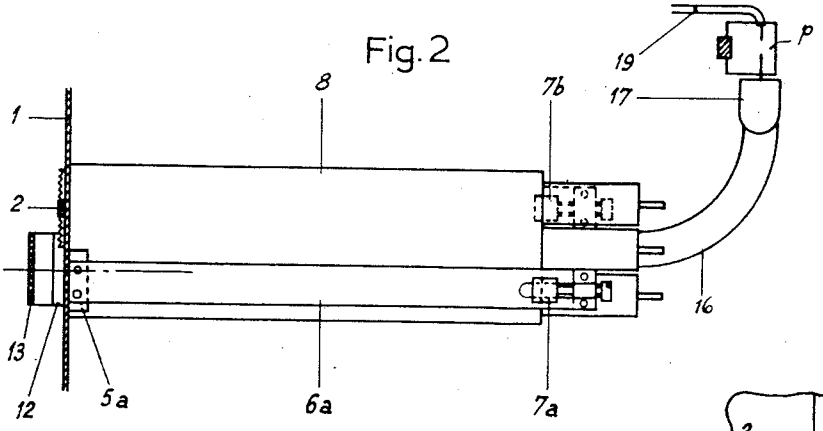


Fig. 3

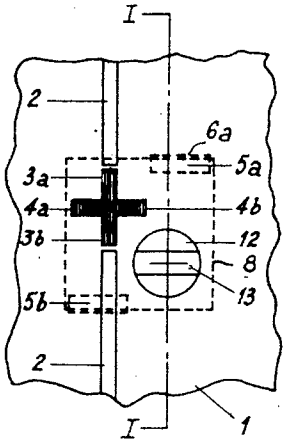
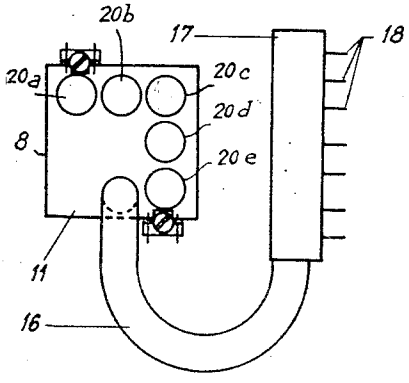


Fig. 4



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Fig.6.

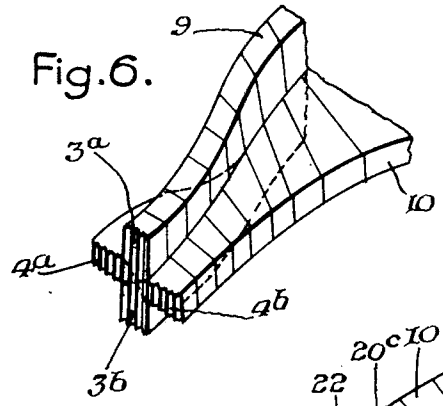
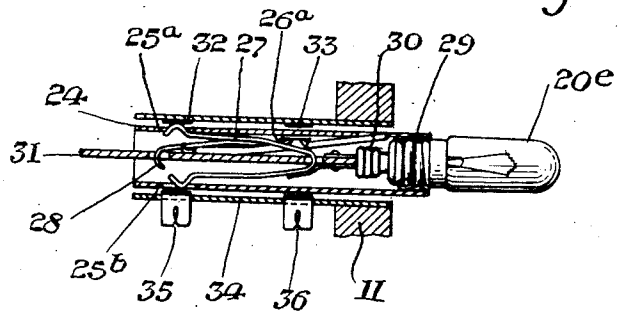


Fig.5.

Fig.7.



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Fig. 8

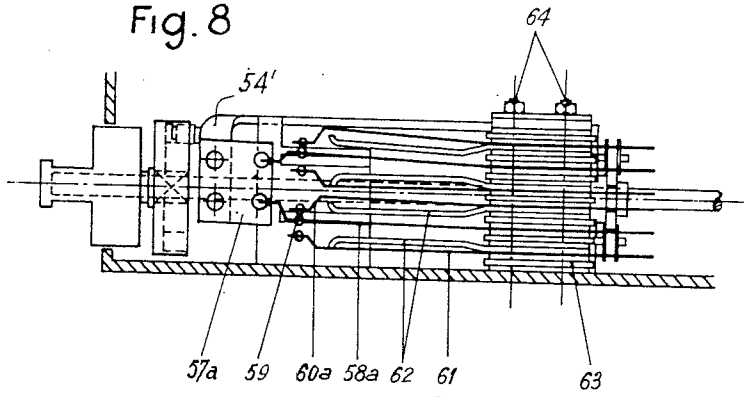


Fig. 9

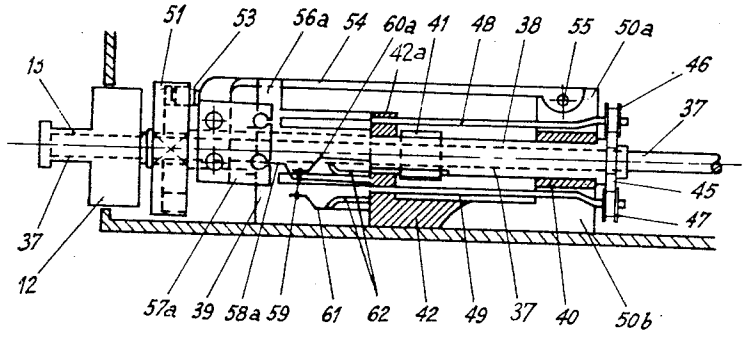


Fig. 10

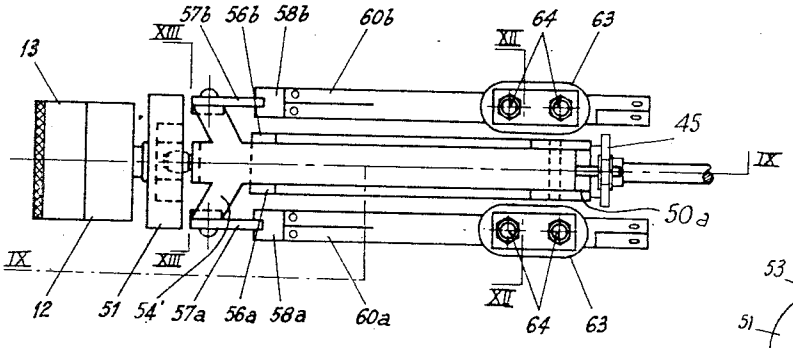


Fig. 13

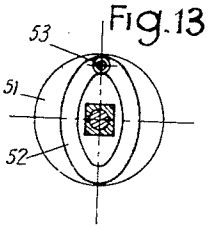


Fig. 12

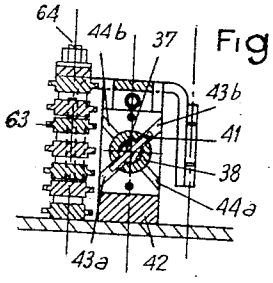
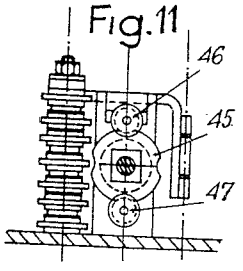


Fig. 11



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Fig. 15

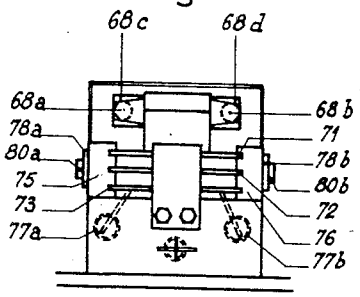


Fig. 14

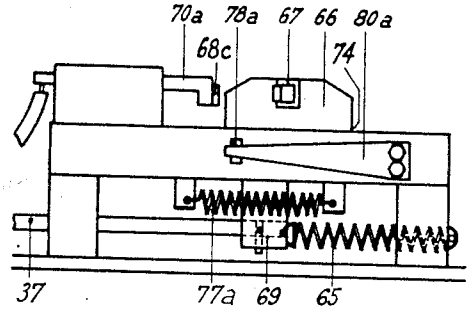


Fig. 16

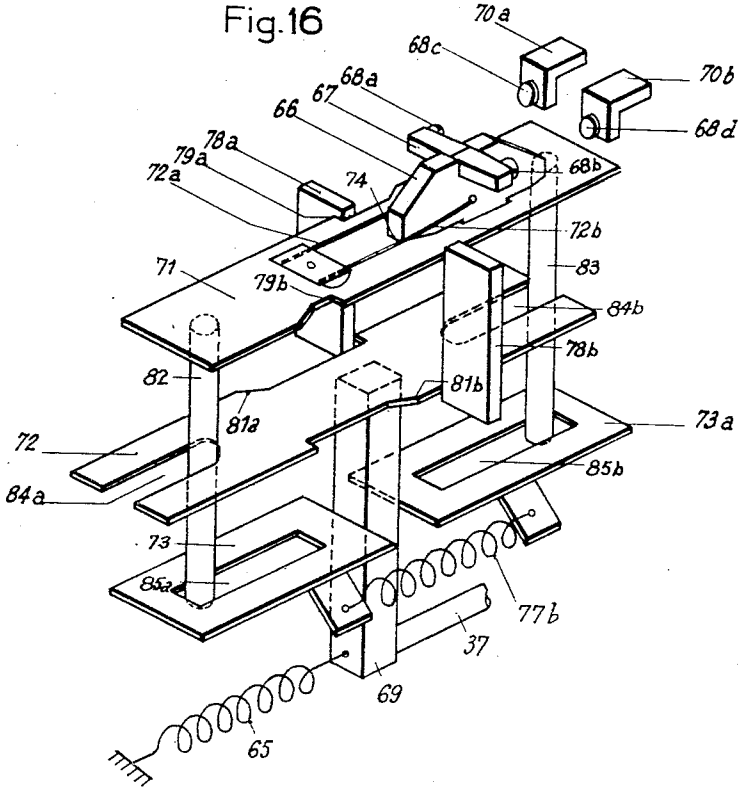
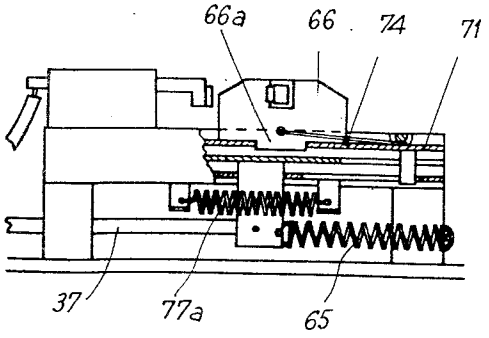


Fig. 17



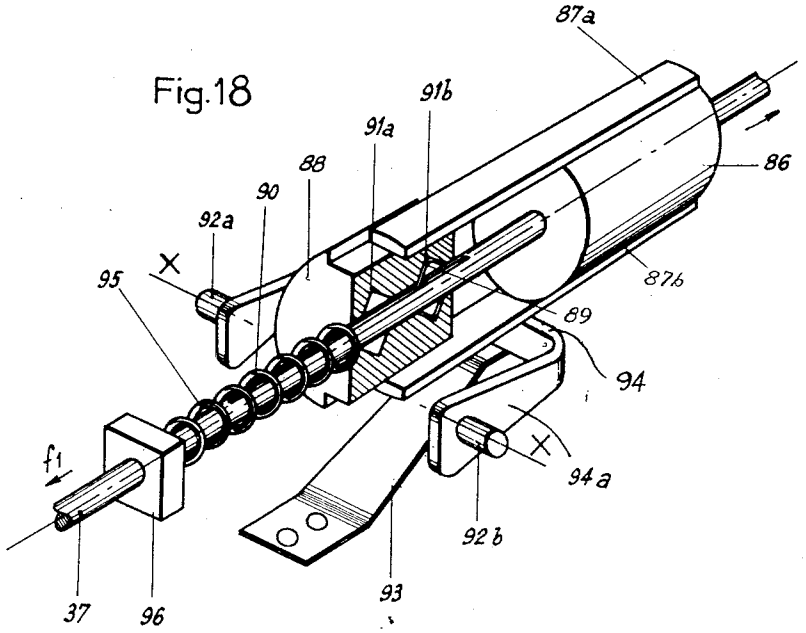
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Fig.18



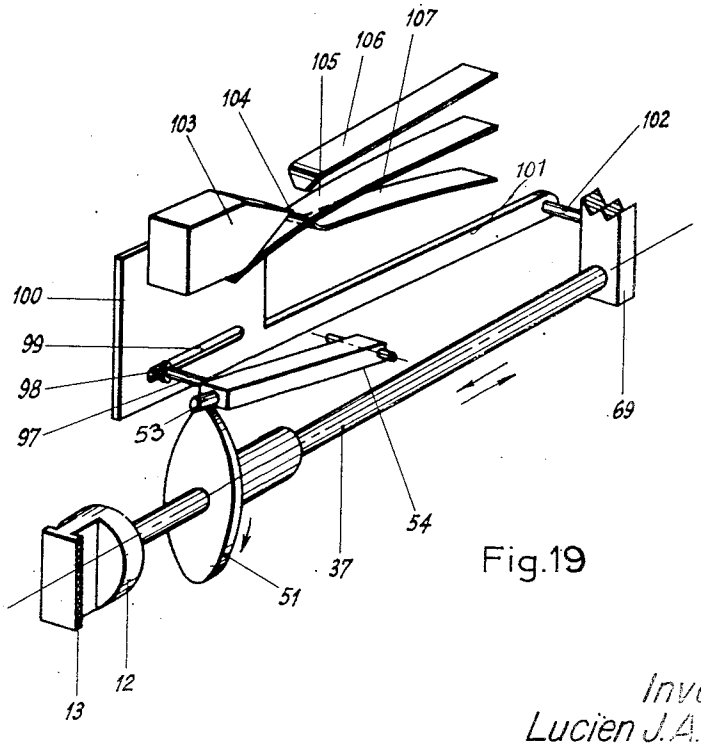


Fig.19

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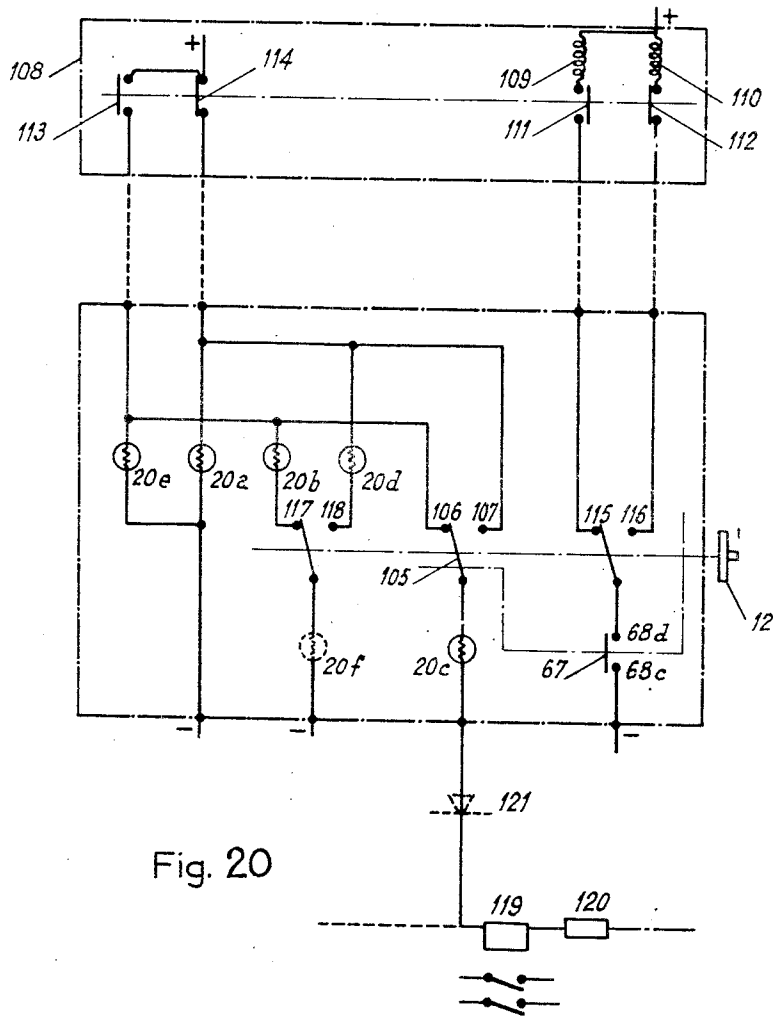


Fig. 20

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Patented Oct. 26, 1954

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UNITED STATES PATENT OFFICE

2,692,921

REMOTE-CONTROL AND INTERLOCKING SWITCH

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Application January 22, 1951, Serial No. 207,152

Claims priority, application France February 3, 1950

7 Claims. (Cl. 200—17)

1

GENERAL DESCRIPTION

It is common practice to group on one panel the remote control devices and indicating elements for apparatus controlling the flow of fluids (including both liquids, gases and electric current). The controlled apparatus may include electric circuit-breakers, section switches and/or cut-off switches, where the fluid is electric current, or valves and/or movable flashboards or gates, where such fluid is water.

Inasmuch as any operation capable of altering the conditions in the network may seriously affect the safety and integrity of the personnel and plant involved, it is important that such operations be effected under the best possible conditions of reliability and that all possible causes of error be minimized. An essential requisite for this purpose is that the various control and indicating elements be grouped in an array of such arrangement and character as to be very easily supervised, and, as a rule, within a minimum space in order to afford the operator with an over-all view of the situation prevailing at any time.

The new and improved arrangement according to this invention accomplishes just this purpose. It further affords the possibility of preparing or pre-conditioning or pre-setting the movements to be executed and of finally executing them only after a general survey of the situation has been made, as made possible by certain specific optical arrangements.

The essential features of the invention are:

(1) The control apparatus is provided with manually operable pre-conditioning or pre-setting elements and with executive elements, responding to actuating movements of total or partial rotation, or of push or pull translation. The pre-setting and the executive elements may be grouped in one, in which case the common element would be responsive to different modes of actuation, respectively for pre-setting, and for executive action.

(2) Separate code signals are made to correspond conventionally with the various positions (or operating conditions) of the load apparatus or apparatuses controlled, and are adapted to be illuminated in correlation with such positions or conditions, according to predetermined codes involving different colours and/or rhythms.

(3) The pre-setting action causes illumination of a preparatory signal corresponding to the contemplated position of the apparatus.

(4) The executive action causes operation of the load apparatus being controlled. This results in a disappearance of the signal indicative of the old position, disappearance of the pre-setting signal, and display of the signal indicative of the new position.

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(5) A spontaneous change of position of the load apparatus causes illumination of the signal corresponding to the new position in the corresponding colour-and-rhythm code, and the display of a signal of the signal-lamp of the old position in a predetermined colour and rhythm code may if required be caused to be displayed in clear supervision over the signal corresponding to the pre-setting of the operation to be performed.

(6) The pre-setting and executive elements actuate electric contact-switches; however, the executive elements may be adapted to act directly on a control fluid, non-electrical in character. The contacts of the pre-setting element are used:

(*a*) For selecting the light sources of the signal lamps;

(*b*) For selecting the control circuits.

The contacts of the executive elements are adapted to make and break the control circuits. A mechanical interlock between the pre-setting elements and the executive elements provides the positive assurance that the contacts of the pre-setting element will only be actuated in open-circuit condition, inasmuch as their function is limited to allowing the flow of current, while the circuit-making and -breaking operations are always performed by the executive element. This functional discrimination makes it possible to dimension the elements in direct correlation with the type of action performed by them and thus to minimize the size of the assembly.

(7) A mechanical interlock device prevents repetition of the executive action, so that the position of the load apparatus cannot be directly restored or reset after a spontaneous change therein. The confirmative effect of a pre-setting, followed by an executive action, corroborates the newly acquired position and cancels the action of the anti-repeat interlock. This device may involve one or more positions of the load apparatus.

(8) To facilitate grouping within a restricted space, a control and indicating apparatus is used having reduced dimensions in a frontal plane, characterized by a linear arrangement of the pre-setting and executive switches, the use of luminous and optical systems in which the sources are located rearwardly to improve accessibility and facilitate dismantling, and the use of "light conductors."

The invention is further characterized by a number of features and arrangements which will appear from the ensuing description relating to one specific and exemplative embodiment of the invention, as applied to the control of the circuit-breakers in an electrical network.

In this example a signal code is used to indicate the closed or open condition of the breaker. A cross pair of luminous lines are interposed on the circuit diagram. One line indicates the circuit breaker to be closed; the other line transverse to the first shows the circuit breaker to be opened.

One advantageous form of construction for this cross-streak signal is that obtained by using strips of transparent material (e. g. methyl methacrylate), the edge section of one end of which provides the streak or line, and which is illuminated from the other end of the strip by one or more lamps, with the possible interposal of colour filters. Such strips of transparent material provide "light conductors" which operate by a series of successive reflections of the light rays from the side walls bounding the strip.

While this arrangement is applicable to an entirely luminous signalling system involving all the parts of an installation placed under electric tension, the ensuing disclosure, which is merely exemplative, is restricted to the application of such means to indications relating to cut-off apparatus.

Associated with the signalling element just mentioned is a control element, which may be a pull-rod in which only a strip member is visible and which is provided with the possibility of having selectively imparted to it a movement of translation and movement of rotation. In the disclosure, the signalling and the control elements are grouped in a common casing, thus forming a single apparatus unit. However, alternative embodiments of the invention may include arrangements wherein the signalling elements are grouped in one unit, and the control elements in a separate unit.

The rotational movement of the control element is the presetting action required to set the apparatus to a position which corresponds, on the circuit diagram, to the position to which the strip has been placed.

The translatory of sliding movement is operative to start a current flow for executing the actual operation.

A combination or contacts, cams and mechanical interlock or latching means, on the pull-member and the signal lamps, is organized in accordance with a circuit diagram which fulfills the following conditions, with the purpose of discriminating between the positional, pre-set and warning signals:

(1) A line or streak of light indicates the position of the apparatus. Preferably a fixed white light is used for this code signal.

(2) The pre-setting action, consisting in a rotation of the symbol, illuminates the light streak corresponding to the position to which the load apparatus is to be set, in a way differing from the signal code indicating the fact that the load has actually assured said position. Thus, a fixed red light may be used for the pre-set signal.

(3) Spontaneous operation of the load apparatus results in the display of a light differing from either of the foregoing, and called "warning signal," in the streak representing the position which has just been given up. Preferably an intermittent light, e. g. white, is used for the warning signal. This light is advantageously linked with a relay sounding an audible alarm. The warning signal is stopped upon confirmation of the operation produced by pulling the pull-rod.

The warning signal may be superimposed over the pre-set or "disagreement" signal; in the examples given above, this would result in an intermittent white light on a fixed red background.

A judicious choice of the colours used makes it possible to reduce to a minimum the number of signal lights required. Thus with the white light erasing the red, and the intermittent white light being rendered invisible by the presence of a fixed white light, there may be provided a signal red (pre-set) lamp for both luminous lines in the circuit diagram. The same may be done for the intermittent white warning signal lamp.

The control contacts are preferably of the quick-acting type and there may be provided only one pair of such contacts the control current being switched selectively to the circuit-closing element or to the circuit-breaking element, by a reverser switch operated by the rotational movement of the pull-member.

The accompanying drawings illustrate one exemplary embodiment of the invention.

Figs. 1, 2, 3 and 4 are respectively a sectional elevation on line I—I of Fig. 3, a plan view, a left-hand side view and a right-hand side view, of a combined control and indicating device assembly in position on a panel, said panel being partly shown.

Fig. 5 is an isometric perspective view of the signal-lamp assembly, extracted from the general assembly and seen from the rear.

Fig. 6 is a detail of the signal-lamp in isometric perspective from the front.

Fig. 7 is a longitudinal section of a lamp-holder.

Figs. 8 to 13 relate to the rotary preparatory switch. Fig. 8 is an elevation, Fig. 9 a partial section, Fig. 10 a plan, Fig. 11 an end view from the right of Figs. 8 to 10, Fig. 12 a section on line XII—XII of Fig. 10 and Fig. 13 a section on line XIII—XIII of Fig. 10.

Figs. 14 and 15 are respectively an elevation and a side view of the quick-acting switch.

Fig. 16 is an isometric perspective showing details of the quick-acting making and breaking mechanism of the executive switch.

Fig. 17 is a partial longitudinal section of said mechanism.

Fig. 18 is an isometric perspective, partly in section, of the anti-repeat interlock device.

Fig. 19 is an isometric perspective of the warning contacts-control device. And

Fig. 20 is a circuit diagram of the electric connections.

VISUAL SIGNAL STRUCTURE

As shown in Figs. 1, 2, 3 and 4, there is provided a front wall 1 of a panel upon which the component apparatus units and circuit elements of a network are represented by lines drawn or embossed thereon, such as 2 (Fig. 3). In the representation of the circuit, there is interposed a symbol element or signal light in the form of a vertical element 3*a*, 3*b* and a horizontal element 4*a*, 4*b* forming a cross, the element 3*a*, 3*b* when illuminated establishing a continuous line through the circuit conductor on the diagram, while the element 4*a*, 4*b* indicates the disconnected condition of the apparatus.

Small blocks 5*a*, 5*b* secured to the inner surface of the front panel wall, support strips 6*a*, 6*b* at the end of each of which a groove serving to guide hooks 7*a*, 7*b* subjected to the action of set

screws *v* engaging nuts *e*, rigid with the strips **6***a*, **6***b*. The hooks act on the body of the casing **8** of the control-and-indicator unit, applying said casing firmly against the front panel wall, accurate positioning being secured by means of notches in the casing into which the blocks **5***a*, **5***b* are adapted to engage.

The signal lights or symbol **3***a*, **3***b* and **4***a*, **4***b* constitute the ends of light conduits **9** and **10** (Fig. 5) issuing out of light boxes provided with removable lamp-socket assembled on the bottom **11** thereof and described in detail later.

Alongside the crossed apertures for the symbol elements, the panel wall is formed with a circular aperture out of which a knob **12** projects, provided with a projecting strip **13** adapted to have two different movements imparted to it. It may be moved in rotation so as to occupy either a position parallel with the element **3***a*, **3***b* symbolizing the "connect" condition of the load apparatus or a position perpendicular thereto. It can during this rotary movement and through mechanism to be later described, actuate a preparatory switch **14** (Fig. 1) which includes contacts and, accessorily, mechanical means are provided for stabilizing the normal positions of the knob.

The knob is moreover adapted to be actuated in translation by pulling action and during such movement it acts on a switch **15** described hereafter.

Safety means enclosed in the switch **14** provide the mechanical impossibility of pulling the strip when it occupies any one of its intermediate positions of rotation, and conversely prevent rotation of the strip unless the latter has returned to rest from its translatory movement.

The various conductors feeding the lamps and switches are grouped in a cable **16** leading to a connector member **17** provided with multiple contacts **18** selectively adapted to engage fixed conductors **19** (Fig. 2) through connector parts *p*.

The above arrangements make it possible to obtain a greatly reduced over-all dimension in the frontal plane parallel to the panel as the various components are placed behind one another. The lamp-holder system is located at the rear to allow ready access in service. As will become apparent, various combined control-and-indicator units may easily be juxtaposed without any intermediate loss of space, owing (1) to the quick-attachment system to be described, and (2) to the fact that it is unnecessary to provide access clearances to the electric connecting terminals. This results in the possibility of highly compact circuit arrangements.

A combined control-and-indicator unit according to the invention may be easily dismantled since it is merely necessary to disengage the connector member **17**, release the two set-screws *v* and slightly separate their supporting strips, in order to withdraw the unit rearwardly.

In Fig. 5, the component parts of the luminous equipment are shown extracted from the combined unit assembly just described, while Fig. 6 is a detail of the illuminatable symbol elements. The portions **3***a* and **3***b* of the symbol element indicating circuit continuity are the ends of a "light conductor" **9** slotted in the form of a fork. Similarly the symbol element **4***a*, **4***b* indicating the "disconnect" condition constitute the outer ends of a second "light conduit" **10** slotted in the form of a fork. The elements **3***a*, **3***b* and **4***a*, **4***b* are assembled crosswise by double interfitting bevel (Fig. 3), so as to be assembled without any break in continuity, this arrangement providing a particularly attractive appearance of the circuit diagram owing to the continuity of the illuminated part. The light conductor **10** is brought out of the fork-slot of the light conduit **9**. The rear ends of both light conductors are perpendicular to each other and are interfitted with 45° bevels. An opaque wrapping strip *r* provides for the requisite light-insulation between the two light-conductors. Score lines of suitable configuration formed on the narrow edges of the light conductors, ensure the desired distribution of the emergent light flux and a proper utilization of the incident light flux.

Light sources **20***a*, **20***b*, **20***c*, **20***d*, **20***e* are arranged adjacent to the rear ends of the light conduits. An opaque screen partition means, partly illustrated at **21**, separates the lamps from each other and provides for the independency of their respective actions. The lamp **20***a* directly illuminates the light conductor **10**, the lamp **20***b* illuminates the light-conductor **10** with the interposal of a colour filter **22**. The lamp **20***c* directly illuminates both the light conductors **9** and **10**. The lamp **20***d* illuminates the light conductor **9** with the interposal of a colour filter **23**. The lamp **20***e* directly illuminates the light conductor **9**.

In the example shown therefore, the lamp **20***a* when energized illuminates the symbol **4***a*, **4***b* in white light. The lamp **20***b* when energized illuminates the symbol **4***a*, **4***b* in coloured light; the lamps **20***c* when energized with pulsing current cause intermittent illumination of both symbols **4***a*, **4***b* and **3***a*, **3***b*. The lamp **20***d* when energized causes coloured illumination of the symbol **3***a*, **3***b*. The lamp **20***e* when energized causes white illumination of the symbol **3***a*, **3***b*, the appearance of the resulting signals being in all cases uniform owing to the excellent light distribution obtained by the successive total reflections of the light beam from the walls of the light conductors. With the lamp **20***b* energized, if the lamp **20***a* is energized at the same time, the symbol **4***a*, **4***b* will appear illuminated in very slightly tinged white colour owing to the predominating action of the white light, with the light sources equal in illuminating intensity. The same is true for the symbol **3***a*, **3***b* in the case of the simultaneous illumination of the lamps **20***d* and **20***e*.

With the lamp **20***a* energized, the pulsed energisation of the lamp **20***c* will cause white illumination of the symbol **4***a*, **4***b* at a variable brightness, while the symbol **3***a*, **3***b* is alternately lit and extinguished. The resulting physiological impression is that of a fixed permanent illumination of the symbol **4***a*, **4***b* and an intermittent illumination of the symbol **3***a*, **3***b*. If, starting from this condition, the lamp **20***d* is energized, the corresponding added coloured light flux will not have any noticeable effect on the aspect of the symbol **4***a*, **4***b*. On the other hand, energizing the lamp **20***d* will cause illumination of the symbol **3***a*, **3***b* over which the intermittent white flux issuing from the lamp **20***c* will be superimposed.

Owing to the predominant efficiency of the white light, the symbol **3***a*, **3***b* will display a succession of white and coloured appearance at the same rhythm as the pulsing current supplying the lamp **20***c*. Similar results will obviously be obtained if the lamp **20***e* is substituted for the lamp **20***a*, lamp **20***d* for lamp **20***b*, under similar conditions as those previously described, with a

reversal of the apparent effects on the symbols 3a, 3b and 4a, 4b.

Each lamp with its lamp-holder is inserted into an insulating bushing 34 supported on the bottom wall 11. A set of movable contacts enables current to flow as later described. Figs. 5 and 7 show in partial section the lamp-holder of lamp 20e and the bushing of the lamp-holder of the lamp 20b.

The lamp-holder consists of a tubular insulating body 24 formed with openings 25a, 25b (Fig. 7) through which the ends of a hairpin-like contact spring member 27 may project laterally. A body 24 also has openings 26a, 26b through which the ends of a further hairpin contact spring member 28 may project laterally, the plane of spring 28 being at right angles to the plane of spring 27.

A screw-socket 29 secured to the holder body 24 is electrically connected with the hairpin spring 28. A spring 30 adapted to make contact with the central terminal in the lamp-base is electrically connected with the contact spring 27. An insert strip 31 (Fig. 5) is provided for supporting the spring 30 and guiding springs 27 and 28.

The laterally projecting ends of springs 27, 28 make contact with conductive rings 32, 33 within a bushing 34. Extensions 35, 36 of the rings extend through the bushing and allow the current-input conductors to be secured thereto.

By pulling on the outer extension of the insert strip 31, the lamp-holder may be easily withdrawn and the lamp may then be easily screwed in or out of its socket. The arrangement described affords the further important advantage of having an extremely reduced size in cross-section; it secures faultless electric operation, especially owing to the high quality of the contact between the fixed elements and the lamp-holder, resulting from the use of long and hence very flexible springs making double contact with the inner rings in the bushing.

SWITCH CONTROL STRUCTURE

Turning to Figs. 8 to 13, the knob 12 with its manual actuating strip 13 is integral with a spindle 37. The spindle 37 is extended through and beyond the rotary switch as far as a block operating the switch 15 to be described later.

(a) *The interlock*

The spindle 37 is slidably mounted in a tubular shaft 38. The tubular shaft is supported in two bearings 39, 40 in which it is rotatable. A key member 41 extending diametrically through and secured in the spindle 37, projects through slots formed in opposite sides of the tubular shaft and extending towards the knob. The key member 41 ensures that the tubular shaft is driven upon rotation of the spindle 37, while the axial displacements of the spindle do not affect the tubular shaft, since the key will then slide in its slots. The bearing 39 is connected with the bearing 40 by a frame 42 formed with an enlargement extending the bearing 39 as far as a point adjacent to the key 41, this enlargement being formed with grooves 43a, 43b, 44a, 44b at right angles (Fig. 12) adapted to allow the projecting parts of the key 41 to extend therethrough.

As a result of this arrangement, in the idle position shown, rotation of the tubular shaft caused by the rotation of the knob and its spindle, can be accomplished without interference. Translatory displacement of the knob can be effected only in either one of the mutually perpendicular positions corresponding to the positions of the manual strip 13 respectively indicating the connected and disconnected conditions of the circuit, in which the projecting parts of the key are engaged in the grooves 43a, 43b or 44a, 44b but is impossible in any intermediate position. At the beginning of a pulling movement on the knob, the projecting parts of the key become engaged into the grooves 43a, 43b or 44a, 44b, thus precluding any possibility of rotation.

(b) *Indexing*

An indexing cam disc 45 (Fig. 11) is secured on the tubular shaft 38 and is provided on its periphery with four notches in opposite pairs, into which rollers 46, 47 may engage, the rollers being urged towards each other by their long spring-like pivots 48, 49. The springs are guided in their movement by notches 50a, 50b, in the frame formed with the strictly necessary width. Rotation of the knob acts to separate the rollers, owing to the action of cam 45. Conversely, the action of springs 48, 49 tends to insert the rollers into the cam notches, and hence to stabilize the positions of the knob corresponding either to circuit-continuity or -discontinuity.

(c) *Rotary selector switch*

A further cam disc 51 (Fig. 13) is secured on the tubular shaft, and is formed with an elliptic groove 52 in its radial face having its center in the axis of the shaft 37 and having its major axis at right angles to the strip 13. A roller 53 rides in the elliptic groove, and is carried at the end of a lever 54 pivoted about the pin 55 mounted in parallel upward extensions of bearing 40 and laterally guided by parallel upward extensions 56a, 56b of the bearing 39 (Fig. 10). This lever may occupy either one of two positions corresponding respectively to the circuit-connecting and disconnecting positions of the knob, depending on whether the roller stands on the minor or the major axis of the elliptical groove.

Fins 54' extending laterally and downwardly from the lever 54 carry insulated contact-pusher members 57a, 57b adapted to act on springy metallic strips such as 58a, 58b (Figs. 8 and 10) provided with contact buttons 59 adapted to make contact with similar contact buttons carried by free springy metallic strips such as 60a, 60b on the one hand and 61 on the other. These free strips are inserted under initial tension and their idle position is determined by springy metallic backing strips 62. The contact strips and backing strips are maintained and insulated by interleaved insulating insert strips such as 63 provided with set screws 64 (Fig. 12), the extensions of the strips allowing electric conductors to be soldered thereto. The number and character of the strips of the stack are so selected as to allow making contact selectively with or without a common strip, such contact being made or broken in the different positions of the knob as desired.

(d) *Control circuit push-pull switch*

The switch designated 15 on the general view of Fig. 1 is shown in Figs. 14, 15 and 16.

In these figures, 37 designates the extension of the spindle integral with the knob 12. The spindle 37 projects into a block 69 in which it is freely rotatable, but the block moves with the shaft in its movements of translation. A traction spring 65 urges the sliding assembly towards the pushed-in position of the knob. The block 69 is connected through a quick-make and -break contact device with an insulating support 66 carrying a conductive rocker lever 67 provided

with contact buttons 68*a*, 68*b* adapted to engage cooperating fixed contact buttons 68*c*, 68*d* then to complete the electric path between fixed terminals 70*a*, 70*b* through the lever 67. The contact buttons are made from a suitable material to provide low contact resistance and good arc suppressing characteristics. The contacts are kept clean and the low electric resistance between them is maintained by the action of the insulating support 66 which for this purpose carries a stud 66*a* on its bottom edge (Fig. 17) engaged in a cooperating aperture formed in the plate 71 and retained thereagainst by a double spring 72*a*, 72*b*. Continuing movement of the plate 71 for a certain period after the contact has been made causes the part 66 to pivot about its edge 74 as a fulcrum, flexing the spring 72*a*, 72*b*. This lifts the lever 67 and hence causes the contact buttons 68*a*, 68*b* to slide over the lugs 68*c*, 68*d* during the compression stroke of the contacts, whereby a self-cleaning effect is obtained for the contacting surfaces.

The quick-acting make and break device shown in Fig. 16 includes four parallel plates 71, 72, 73 and 73*a*, movable in translation, guided in slideways formed in the longitudinal frame members 75, 76 (Fig. 15) at three different levels thereof. As stated, the plate 71 carries the contact device. The plate 72 carries the block 69 and is directly movable therewith. The plates 73 and 73*a* arranged in a common plane, are urged towards each other, by a pair of springs 77A, 77B attached to each and arranged to either side of a block 69 which is interposed between the adjacent ends of said plates.

The contact-mounting plate 71 is adapted to be blocked in its idle position by a latch 78*a* (Fig. 16) adapted to drop into a notch 79*a* one edge of plate 71 under the action of a leaf spring 80*a*. The leaf spring is mounted on one side of the frame member 75 and engages a portion of the latch bar 78*a* which enters an aperture in the frame member 75. In the same way, the plate 71 is adapted to be blocked in its contact-making position by a latch bar (Fig. 15) adapted to drop into a notch 79*b* in the opposite edge of plate 71 under the urge of a leaf spring 80*b*.

The action of springs 80*a*, 80*b* may be overcome respectively by the inclined camming surfaces 81*a*, 81*b* formed in the plate 72 and acting on the latches 78*a*, 78*b* as plate 72 moves lengthwise.

Fingers or posts 82, 83 integral with the plate 71 extend freely through the plate 72 in the elongated apertures 84*a*, 84*b* therein, and extend into slots 85*a*, 85*b* respectively formed in the plates 73 and 73*a*.

This switching arrangement operates as follows: A pull on the spindle 37 stretches the spring 65 and carries the plate 72 with it. The plate 73*a* is driven by the block 69 while the plate 73 remains stationary, since it is retained by the post or finger 82 integral with the plate 71 which is blocked by latch 78*a*. Springs 77*a*, 77*b* are tensioned, placing stress on the finger 82 and hence plate 71, but no action ensues. After a sufficient length of displacement, the incline 81*a* operates the latch 78*a*. The assembly including plate 71, finger 82 and plate 73 is then allowed to respond to the urge of springs 77*a*, 77*b* and moves, causing a sudden closure of the contacts 68*a*, 68*b* against the cooperating contacts 68*c*, 68*d*. The latch 78*b* then drops into the notch 79*a*, latching the contacts in closed condition. At the end of the stroke, the end wall of the notch 84*b* may when necessary act on the finger 83, thus confirming the contact-closing action.

In the return movement, the spindle 37 is released, the predominating spring 65 moves the block 69, placing the springs 77*a*, 77*b* under tension between the plate 73*a*, blocked by the finger 83 integral with plate 71, latched by latch 78*b*, and the plate 73 urged by the block 69; at the end of a predetermined length of travel the incline 81*b* raises the latch 78*b*. The assembly including plate 71, finger 83 and plate 73*a* can then respond to the springs 78*a*, 78*b* and is moved, causing a sudden opening of the contacts. At the end of the stroke, the latch 78*a* falls back into the notch 79*a*, locking the contacts in open position.

The above-described quick-making and -breaking arrangements, associated with the use of a suitably selected materials for the contact buttons, make it possible to provide a switch having a high circuit breaking capacity while retaining reduced size.

According to the invention, and as will be further apparent from the electric wiring diagram of Fig. 20, the different control, and make and break circuits are selected in the rotary or preparatory switch by the action of the contacts established in the corresponding positions. These contacts, owing to the interlocking means provided, can only be made and broken in the contact breaking (unpulled) position of the executive switch 15. The selection contacts are arranged in series with the high breaking capacity contacts of the switch 15 just described. Owing to the afore-mentioned interlocks, this switch 15 can only be operated when the preparatory switch 14 is occupying one of its operative positions, and not any of its intermediate positions. As a result, the rotary switch contacts will pre-set or pre-condition the control circuits in the open-circuit condition, while the actual executive circuit-making and -breaking actions are effected in the high-breaking capacity switch 15. This functional discrimination allows each element to be provided with the strictly necessary dimensions and participates in reducing the over-all dimensions of the device.

(e) *Anti-repeat device*

It may be necessary, in some cases, that the executive action of the breaking switch 15 be necessarily preceded by a pre-setting action of the preparatory switch 14 in order to prevent the occurrence of two consecutive operations of similar nature, especially in the case where the spontaneous operation of the apparatus controlled is the result of a mishap which does not allow of the situation being restored by simply repeating the executive control action.

The anti-repeat device of Fig. 18 makes it possible to achieve this result in one of the positions of the rotary switch. Duplicating this device would obviously enable the same result to be obtained, if necessary, in either position of the switch 14.

Secured on the shaft 37 is a bushing 86 carrying two strips 87*a*, 87*b* diametrically opposite each other and projecting axially beyond the end of the bushing into cooperating grooves formed in the periphery of a ring member 88 larger in diameter than the bushing 86. The ring 88 is slidable on the spindle 37 between two positions. In order to define these two positions, a wire spring has one end portion located in a longitudinal groove in a shaft 37 with a crimp or

hump formed on said end adapted to seat in one or another of axially spaced recesses 91*a*, 91*b* inside the ring 88 as the ring 88 is moved along shaft 37. The other end 90 of said spring is secured to the spindle outside the ring. A further and symmetrical spring may be provided to duplicate the action of the first spring.

A U-shaped rocker lever 94 is rockable about a fixed axis XX by means of its journals 92*a*, 92*b* mounted in fixed bearings, not shown, and is urged in the direction towards the spindle 37 by a leaf spring 93. The rocker lever is provided with a bridging cross-member 94*a* adapted to engage the spindle 37.

In the position shown in Fig. 18, a previous rotation of the spindle 37 has caused the strip 37*b* to act on the cross-member 94*a* of the rocker, thus rocking it and tensioning the spring-plate 93. It is possible, in this position, to pull on the spindle 37 in the direction of arrow f_1, the strip then sliding over the cross-member 94*a* throughout the pulling action. If this pulling movement is not effected, the movement of rotation, which still remains possible, will, at a position 90° displaced from that of the figure, allow the rocker member 94*a* urged by springs 93 to engage the spindle 37. The member 94*a* will then prevent pulling of the spindle 37 by its engagement against the face of the bushing 86.

In the position shown in Fig. 18, if the spindle 37 is pulled out, in the direction of the arrow f_1, to order "disconnect" operation of contacts 105, 106, 107, the ring 88 will tend to compress the spring 95 against the stationary stop 96. At a certain time, the action of this spring will overcome the retaining effect of the projecting spring part 89 in the groove 91*b* whereupon, the ring will move axially to engage the bushing. That position will be stabilized by the engagement of the projection 89 into the groove 91*a*, and the ring will retain this position after the spindle 37 has been moved in by spring 95 and restored to its former idle position. Assuming rotation 90° away from the position of the Fig. 18 preconditions the mechanism for the "connect" operation of the switch of Fig. 16, that operation is executed by pulling the spindle 37.

Referring again to Fig. 18, the cross-member 94*a*, prior to the pulling action, rested upon the ring 88; during the pulling action, it slides along the bushing 86. The same occurs in the return movement, until the time where said member 94*a* engages the ring 88 larger in diameter than is the bushing. The member 94*a* then retains the ring 88 which is separated from the bushing 86. The cross-member 94*a* drops down under the action of its spring 93 into engagement with the spindle, preventing any immediate repetition of the pulling action until the shaft 37 is again rotated 90°.

(*f*) *Interlocking switch*

According to the invention, and as indicated in the circuit diagram of Fig. 20, a specific electric circuit is completed when the controlled load apparatus is in a condition different from that which has been imparted to it by the last preceding executive control operation. This circuit however remains unresponsive to any presetting actions not followed by executive actions.

Fig. 19 is a diagrammatic view of the contact-controlling device used to achieve this purpose. Some of the elements shown in this figure have already been described previously; these are: the knob 12 with its strip 13; the spindle 37 integral with the knob; the block 69 of the sliding switch; the elliptic cam 51 actuating the roller 53 which actuates the lever 54 in relation with the normal switch contacts. An extension 97 of the lever carries a roller 98 which projects into the slot 99 in the plate 100 provided with an arm extension 101 pivoted on a pin 102 projecting from a block 69. As a result of this arrangement, the plate 100 is slidable in translation with the block 69, the plate being capable of thus sliding at either one of two different levels, depending on whether the cam is positioned with its major or its minor axis in engagement with the follower roller 53.

An insulated shuttle member 103 is formed with a double bevel and defining a sharp edge 104 adapted to act on the end of central flexible contact strip 105 causing it to engage either one or the other of the free flexible contact strips 106 or 107 above and below and parallel to the contact 105. When the knob 12 is pulled out, the shuttle member 103 is disengaged from the strip 105. When the knob is pushed in, the edge 104 will underlie the strip 105 depending on whether the roller is engaging the major or the minor axis, respectively, of elliptic cam 51. On pushing the bevel edge 104 will cause the strip 105 to engage one or the other of the strips 106 or 107 depending on whether the executive control action performed is for connect or disconnect operation.

The pre-set action involving a rotation of the knob will cause the level of the shuttle member to be shifted resulting in a change in flexing of the contacts previously established, without however changing it from its "connect" condition and without any action on the contact strip of the open contacts. Such rotation cannot occur when the shaft 27 is pulled out because of the engagement of key 41 in the slots 43*a*, 43*b*, or 44*a*, 44*b*.

It will be apparent from this arrangement that the particular contacts made will depend exclusively on the position of the knob (i. e. whether it occupies its "connect" of its "disconnect" position) for which an executive control operation has actually been accomplished.

The internal connections of the control-and-indicating unit and its connections with the executive apparatus are illustrated in the circuit diagram of Fig. 20.

The controlled load apparatus, contained in the block 108 includes:

(1) Solenoid windings 109 for electromagnetic control of the "connect" operation, 110 for the "disconnect" operation, acting directly or through a hydraulic fluid on the main components of the apparatus.

(2) A set of auxiliary contacts: 111—112 in the control circuits, 113—114 in the indicating circuits.

The control circuits extend: from negative battery of the control source, through quick-make and -break contacts 63*c*—67—68*d* actuated by pulling the knob 12, selector contacts 115 or 116 of the rotary switch, limiting contacts 111 or 112 of the controlled apparatus, control winding 109 or 110, to positive battery. The presetting operation completes the circuit through contacts 115 or 116, while the executive operation is effected by pulling the knob. The circuit is broken by the contacts 111 or 112 as soon as the operation is completed.

The contacts 113 and 114 are alternately made depending on whether the control apparatus is

in its "connect" or "disconnect condition. The circuit completed by them extends from positive battery, through contacts **113** or **114**, lamp **20***e* or **20***a* to negative battery. The lamps illuminate the corresponding signals indicative of the conditions of the load apparatus.

A branch circuit extending through lamps **20***b* and **20***d* is switched by the contacts **117** or **118** and extends back to negative battery. The pre-set operation, by rotation of the knob **12**, completes the circuit for either one of the lamps **20***b* or **20***d* through either one of contacts **117** or **118**. The positional-indicating symbol remains illuminated while the signal for the other position is illuminated in coloured light, as previously explained.

A further branch circuit is switched by contacts **105**—**106** on the one hand, and **105**—**107** on the other, lamp **20***c* and back to negative battery, through a totalizer relay **119** and a current-pulsing device **120**, adapted to complete the circuit periodically. As already explained, the contacts at **106** or **107** are made correspondingly with the position actually ordered by the operator by pulling the knob. These contacts are unresponsive to the pre-set actions of the knob. Any spontaneous change in the condition of the executive apparatus will close either the contacts **113** or **114**, corresponding to the pre-set contacts **106** or **107**. The warning circuit is then completed, causing intermittent illumination of the lamp **20***c* and hence of the signal, as previously described, and energizing relay **119** adapted to actuate any desired audible or visible alarm signal. The relay **119** and the pulsing device **120** may be common to a plurality of combined control and indicating units, and a valve **121** may then be inserted between each lamp such as **20***c* and the common wire supplying the relay **119** in order to prevent backflow of current over the common supply wire for relay **119** interconnecting the various lamps such as **20***c*.

It will be understood that various modifications may be provided in connection with various particular requirements in use, and involving all or part of the arrangements described, without exceeding the scope of the present invention. Thus the lamps **20***b* and **20***d* may be omitted and replaced by a lamp **20***f* adapted to act simultaneously on the light-conductors **9** and **10**, as described herein in connection with the lamp **20***c*.

Many details in the shape, constituent material and dimensions of the component elements may be altered according to specific requirements.

What I claim is:

1. An electric switch comprising a plurality of contact means, a rotatable and axially movable shaft, cam means operated by rotation of said shaft, contact actuating means operable into different positions in a predetermined path by said cam means in order to chose which of the contact means shall be actuated, and means connecting said shaft and said contact-actuating means for causing movement of the contact-actuating means in a path transverse to said predetermined path when said shaft is moved

axially, said axial movement of the shaft causing actuation of the chosen contact means.

2. An electric switch as claimed in claim 1 wherein said contact-actuating means and said contact means are constructed and arranged to cooperatively maintain the existing condition of engagement or disengagement of said contact means when said shaft is merely rotated.

3. An electric switch as claimed in claim 2 having interlocking means which is caused to engage by axial movement of said shaft to prevent rotation of said shaft in one axial position thereof whereby choice as to which of said contact means shall be operated can be exercised only in another axial position of said shaft.

4. An electric switch as claimed in claim 1 in which said cam means and said actuating means are constructed and arranged to be operable while the shaft is in contact-actuating position, for selecting which of said contact means shall be actuated on the next movement of said shaft into contact-actuating position.

5. An electric switch as claimed in claim 4 having interlocking means which is caused to engage by axial movement of said shaft to prevent rotation of said shaft in one axial position thereof so as to allow said selection only in the other axial position of the shaft.

6. An electric switch as claimed in claim 1 in which said cam means and contact-actuating means are constructed and arranged to be operable while the shaft is in contact-actuating position and without affecting the existing condition of engagement or disengagement of said contacts, for selecting which of said contact means shall be actuated on the next movement of said shaft into contact actuating position.

7. An electric switch as claimed in claim 1 in which the contact-actuating means is a member which is moved to one side or the other of a critical plane by said cam means whereby the choice of contact means to be actuated is exercised, and said member is moved substantially parallel to said plane to cause contact-actuation when said shaft moves axially.

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