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CHANGE-OF-STATE DETECTOR

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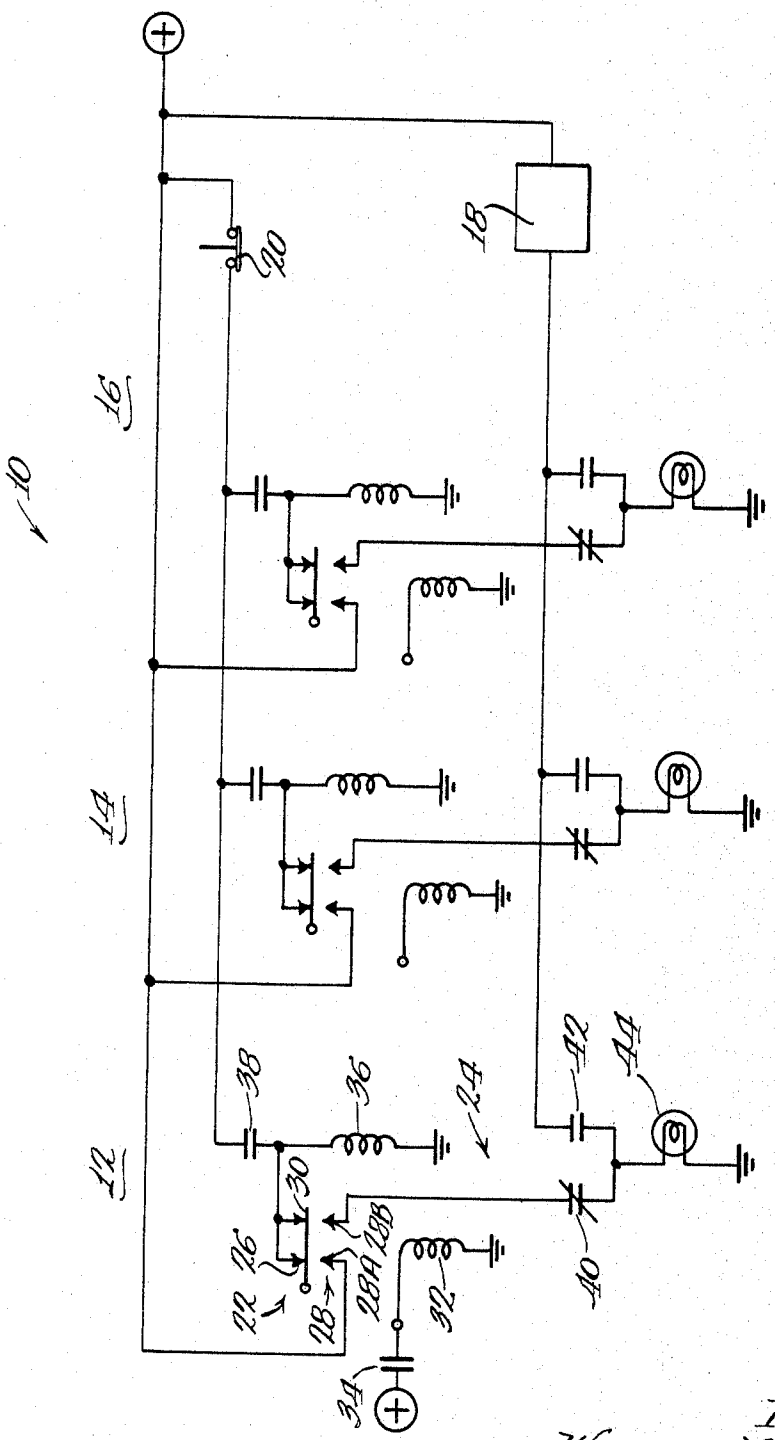

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CHANGE-OF-STATE DETECTOR

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ABSTRACT OF THE DISCLOSURE

A change-of-state detector in which spaced contacts of a mercury relay are connected in series between a potential source and an indicator control. The armature of the mercury relay momentarily bridges the spaced contacts to operate the indicator control each time that the mercury relay is operated or released by the field contacts in response to a change in the state of the monitored value or device.

This invention relates to a change-of-state detecting or indicating circuit and, more particularly, to a new and improved arrangement for detecting each change in the state of a monitored variable or device.

Telemetering systems, variable monitoring systems, process control systems, and various other types of data handling and processing systems and control systems frequently utilize some type of circuit or other means for detecting any change in the state of any component or value. As an example, it is desirable to determine each time that a pump or fan changes between operative or inoperative states or to determine each time that the value of a variable, such as temperature, moves into and out of a given range of limit values. Many arrangements are now known for detecting these changes of state and for indicating any such change. However, these prior arrangements are frequently excessively costly and require numerous components and often are not capable of use in adverse operating environments.

Accordingly, one object of the present invention is to provide a new and improved change-of-state detector or indicating circuit.

Another object is to provide a change-in-state detecting or indicating circuit requiring a minimum number of components operable over extended periods of time in an adverse atmosphere.

A further object is to provide a change-of-state circuit using the transfer characteristic of a bridging relay to produce a positive indication of each change of state in a monitored value or device.

In accordance with these and many other objects, an embodiment of the invention comprises a change-of-state detecting and indicating circuit including for each device or value to be monitored a bridging type relay, preferably a mercury relay, controlled by the condition to be monitored and a single additional control relay whose operation is selectively controlled by the bridging or mercury relay. The bridging or mercury relay has two spaced sets of contacts that are alternatively closed or engaged by an armature movable between two alternate positions in each of which one of the sets of contacts is engaged. The mercury relay possesses the characteristic of bridging or electrically interconnecting the two sets of contacts, each time that the armature moves from one of the alternate positions to the other alternate position.

Accordingly, by selectviely moving the armature between its two alternate positions under the control of the condition to be monitored, the spaced contact sets are only momentarily interconnected incident to each armature transfer. A control relay is connected in series with the spaced pairs of contacts to be operated each time the relay is operated or released corresponding to each

change of the monitored condition. The control relay includes contacts for selectively establishing a holding circuit for the indicating or control relay and for selectively energizing an indicator such as a lamp to provide different visual indications of the change-of-state of the monitored condition. For example, a lamp can be intermittently energized to provide a flashing indication of an unacknowledged change-of-state which reverts upon acknowledgement to a termination of illumination or a steady illumination in dependence upon whether another change-of-state has occurred since the initial change-of-state.

Many other objects and advantages of the present invention will become apparent from considering the following detailed description in conjunction with the drawing which comprises a schematic diagram of a change-of-state detecting or indicating circuit embodying the present invention.

Referring now more specifically to the drawings, therein is illustrated a change-of-state detecting and indicating circuit which is indicated generally as **10** and which is illustrated as including three identical change-of-state circuits **12**, **14**, and **16** for individually indicating each change-of-state in three respectively individually associated values, conditions, or devices to be monitored. Each of the stations **12**, **14**, and **16** includes only two relays, and the common equipment for the system **10** includes a flasher or periodic signal source **18** of conventional construction and a manually operable acknowledge key or switch **20** together with a suitable potential source.

Each of the change-of-state detecting circuits **12**, **14**, and **16** includes a bridging type or mercury relay indicated generally as **22** and a control relay indicated generally as **24**. The relay **22** can be of any suitable type having bridging contact action but preferably comprises a sealed mercury switch or relay of a known construction having first contact means **26** and spaced second contact means **28** consisting of two spaced and electrically insulated contacts **28A** and **28B**. The first contact means **26** is normally engaged by an electrically conductive armature **30** which is moved out of engagement with the contact means **26** and into engagement with the contact means **28** by the energization of a winding **32**. When the energization of the winding **32** is terminated, the collapse of the operating field permits the armature **30** to return to a position engaging the contact means **26**.

Known mercury relays can provide either break-before-make (non-bridging) or make-before-break (bridging) action. The mercury relay **22**, as set forth above, provides bridging action. This bridging action is provided by the mercury used to wet the contacts **26** and **28** and the adjacent portion of the armature **30**. When the armature **30** is, for instance, moved from a position engaging the contact means **26** toward the contact means **28**, the mercury forms one or a plurality of electrically conductive fillets which, when the armature **30** engages the contact means **28**, bridge or electrically connect the contact means **26** and **28**. In the usual bridging mercury relay, the contact means **26** and **28** are bridged or electrically interconnected for a period of about 500 μs. Preferably, however, the relays **22** used in the circuit **10** are modified by reducing the spacing of the contact means **26** and **28** to provide a bridging time of around 2 ms. Accordingly, whenever the armature **30** is moved from a position engaging the contact means **28** to a position engaging the contact means **26** or the reverse, these contact means are electrically interconnected for a period of around 2 ms.

The relay **22** is operated each time that the device or condition to be monitored changes from one state to another state and is released each time that the monitored device or condition returns to its former or normal condition. To accomplish this, the operating winding **32** of the

relay 22 is connected to a source of positive potential through a device that is placed in conductive or non-conductive condition in dependence upon the state of the device or condition that is to be monitored. In the drawing, this device is shown as a pair of normally open contacts 34, although it could comprise a normally closed contact or a controlled conduction device capable of being placed in conductive and non-conductive conditions in dependence upon the state of the associated monitored variable. The control device, such as the normally open contacts 34, can be directly associated with a device to be monitored or can be controlled by an intervening device such as a pressure or temperature transducer. In the illustrated system 10, it is assumed that the open field contacts 34 represent a variable or device in a normal condition or first state. These contacts are closed when the state changes to an abnormal state or the second alternate condition.

Assuming that the variable monitored by the field contacts 34 changes from its first state to its second state, the contacts 34 are closed and the winding 32 of the relay 22 is energized. When the winding 32 is energized, the armature 30 moves from the position engaging the first contact means 26 to a position engaging the second contact means 28. During this movement, the first and second contact means 26 and 28 are momentarily bridged or electrically connected for a period of around 2 ms. During this period, an operating winding 36 of the control relay 24 is connected to a positive potential and is energized to operate the control relay 24.

In addition to the operating winding 36, the control relay 24 includes a pair of normally open contacts 38 provided by a conventional magnetic reed switch and a pair of normally closed contacts 40 and normally open contacts 42 provided by a single-side-stable mercury relay preferably providing make-before-break or bridging action. Although the control relay 24 is described as using sealed magnetic switches of the dry reed and mercury wetted contact type, other known relays such as telephone type relays could be used.

Accordingly, when the winding 36 is momentarily energized by the operation of the relay 22 described above, the flux field developed by the winding 36 closes the contacts 38 and 42 and opens the contacts 40. The closure of the contacts 38 completes a circuit extending through the normally closed contacts of the acknowledgement switch 20 for maintaining the energization of the winding 36 following the 2 ms. conducting period of the relay 22. The opening of the contacts 40 does not produce any useful function. The closure of the contacts 42 connects an electrically controlled annunciator, such as an electric lamp 44, to the output of the pulse source or flasher 18. Accordingly, the lamp 44 now provides a flashing indication that a change-of-state has occurred at the device or variable monitored by the circuit 12.

This flashing indication continues until the indication is noted and acknowledged by momentarily opening the switch 20. The momentary opening of the switch 20 interrupts the holding circuit extending through the closed contacts 38 and terminates the energization of the winding 36 so that the contacts 38 and 42 are opened and the contacts 40 are closed, the contacts 40 closing prior to the opening of the contacts 42 because of the make-before-break characteristic of the switch controlled by the winding 36. The opening of the contacts 38 interrupts an additional point in the holding circuit for the winding 36, and the opening of the contacts 42 terminates the periodic energization of the lamp 44 by the pulse source 18.

The change-of-state detecting circuit 12 now provides two different indications in dependence on whether the change-of-state at the device or condition to be monitored has persisted. If the change-of-state has persisted, the contacts 34 remain closed, the winding 32 remains energized, and the armature 30 remains in a position engaging the contact means 28. In this position, the armature 30 electrically connects the spaced contacts 28A and 28B of the contact means 28 and thus forwards a positive potential through the closed contacts 40 to provide a steady illumination of the lamp 44. The steady illumination of the lamp 44 provides a distinctive indication that the change-of-state has persisted and has been acknowledged. On the other hand, if the variable or device had returned to its prior or first state so that the contacts 34 are open, the winding 32 is no longer energized and the armature 30 is returned to the position shown in the drawing. In this position, the contacts 28A and 28B are not connected, and the lamp 44 is not energized to provide steady illumination.

When the variable condition or device being monitored returns to its initial state following the acknowledgement signified by momentarily opening the switch 20, the contacts 34 are opened to terminate the energization of the winding 32 of the relay 22. At this time, the armature 30 returns to a position engaging the contact means 26 and in doing so momentarily electrically connects the contact means 26 and 28 so that the winding 36 of the control relay 24 is again energized. This operates the relay 24 to close the contacts 38 and 42 and to open the contacts 40. The closure of the contacts 38 again completes the holding circuit for the winding 36. The opening of the contacts 40 coupled with the prior movement of the armature 30 from a position bridging the contacts 28A and 28B to a position engaging the contact means 26 terminates the steady illumination of the lamp 44 to remove the indication of an acknowledged change-of-state. The closure of the contacts 42 again connects the lamp 44 to the flasher 18 so that a flashing indication is again provided indicating a change-of-state, this change-of-state being from the second to the first condition or from the abnormal state to the normal state.

When this change-of-state is acknowledged by momentarily operating the switch 20, the relay 24 is again released to open the contacts 38 and 42 and to close the contacts 40. The opening of the contacts 38 interrupts the holding circuit for the winding 36, and the opening of the contacts 42 terminates the intermittent energization of the lamp 44. The closure of the contacts 40, however, does not cause a steady illumination of the lamp 44 because the armature 30 now engages the contact means 26. Thus, the absence of illumination on acknowledgement provides a positive indication that change-of-state involved is a return to the first or normal state.

Although the present invention has been described with reference to a single illustrative embodiment thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this invention.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. A change-of-state indicating circuit for use with a field unit operated between conducting and non-conducting conditions comprising

a first relay means having an operating winding and spaced contacts momentarily bridged by an armature as the armature is moved between two alternate positions engaging the spaced contacts under the control of the operating winding,

first circuit means for connecting the operating winding of the first relay means to the field unit so that the field unit controls the energization of the operating winding to control the armature to bridge the spaced contacts once when the first relay means is operated and once when the first relay means is released,

second relay means having an operating winding and contacts selectively opened and closed under the control of the operating winding of the second relay means,

a potential source,

second circuit means connecting the operating winding of the second relay means to the potential source through the spaced contacts of the first relay means

only during the interval in which the spaced contacts of the first relay means are bridged so that the second relay means is operated each time that the first relay means is operated and each time that the first relay means is released,

indicating means,

and third circuit means connected to the indicating means and the contacts of the second relay means for operating the indicating means each time that the first relay means is operated and released.

2. The change-of-state circuit set forth in claim **1** in which

the third circuit means includes means connecting the indicating means to the potential source over a circuit including the contacts of the second relay means connected in series with given contacts of the first relay means.

3. The change-of-state circuit set forth in claim **2** in which

the given contacts of the first relay means include two electrically insulated contacts that are electrically connected by the armature when the armature is in one of its alternate positions.

4. The change-of-state circuit set forth in claim **1** including

a source of periodic signals,

and means in the third circuit means for connecting the source of periodic signals to the indicating means over a series circuit including contacts of the second relay means.

5. A change-of-state detecting circuit for use with a field unit operable between conductive and non-conductive conditions comprising

relay means including first contact means spaced from second contact means, an armature movable between alternate positions engaging the first and second contact means and momentarily connecting the first and second contact means during each movement from one of the alternate positions to the other of the alternate positions, and an operating winding for controlling the movement of the armature,

an indicator control means,

a potential source,

first circuit means connecting the potential source to the indicator control means over a series circuit including the first and second contact means so that the potential source energizes the indication control means each time that the armature of the relay means moves between its alternate positions,

and second circuit means controlled by the field unit and including the potential source for selectively energizing the operating winding to control the movement of the armature to its alternate position.

6. The change-of-state detecting circuit set forth in claim **5** in which

the relay means includes a quantity of fluid, electrically conductive material carried on the armature for electrically connecting the first and second contact means as the armature moves between the alternate positions.

7. A change-of-state indicating circuit for use with a field unit operated between conducting and non-conducting conditions comprising

a mercury relay having spaced first and second contact means, an armature movable between alternate positions engaging one or the other of the first and second

contact means, and an opearting winding for moving the armature from a normal position engaging the first contact means to an actuated position engaging the second contact means when energized, the armature having a mercury wetted portion providing a means for electrically connecting the first and second contact means as the armature moves between its alternate positions,

means including the field unit for selectively energizing the operating winding of the mercury relay to move the armature between its alternate positions,

a control relay having an operating winding and contacts selectively actuated by the operating winding of the control relay,

a potential source,

first circuit means connecting the potential source to the second contact means,

second circuit means connecting the operating winding of the control relay to the first contact means so that the control relay is operated by the potential source over a circuit including the bridged first and second contact means each time that the armature moves to one of its alternate positions,

and indicating means controlled by the contacts of the control relay for indicating the status of the field unit.

8. The indicating circuit set forth in claim **7** including a reset switch,

and third circuit means connecting the reset switch and contacts of the control relay between the potential source and the operating winding of the control relay to hold the operating winding of the control relay energized following the bridging of the first and second contact means.

9. The indicating circuit set forth in claim **8** in which the indicating means includes an electrically controlled annunciator and a periodic signal source connected to the annunciator by the contacts of the control relay when the control relay is operated.

10. The indicating circuit set forth in claim **9** including spaced contacts in the second contact means of the mercury relay which are electrically connected by the armature when the armature engages the second contact means, one of said spaced contacts being connected to the potential source,

and circuit means including contacts of the control relay connecting the other contact of the second contact means to the annunciator to energize the annunciator from the potential source.

References Cited

UNITED STATES PATENTS

2,731,627	1/1956	Herbst	340—213.2
3,287,717	11/1966	Kraus	340—213.2

FOREIGN PATENTS

52,102	8/1936	Denmark.
749,941	5/1933	France.
824,200	11/1937	France.

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