

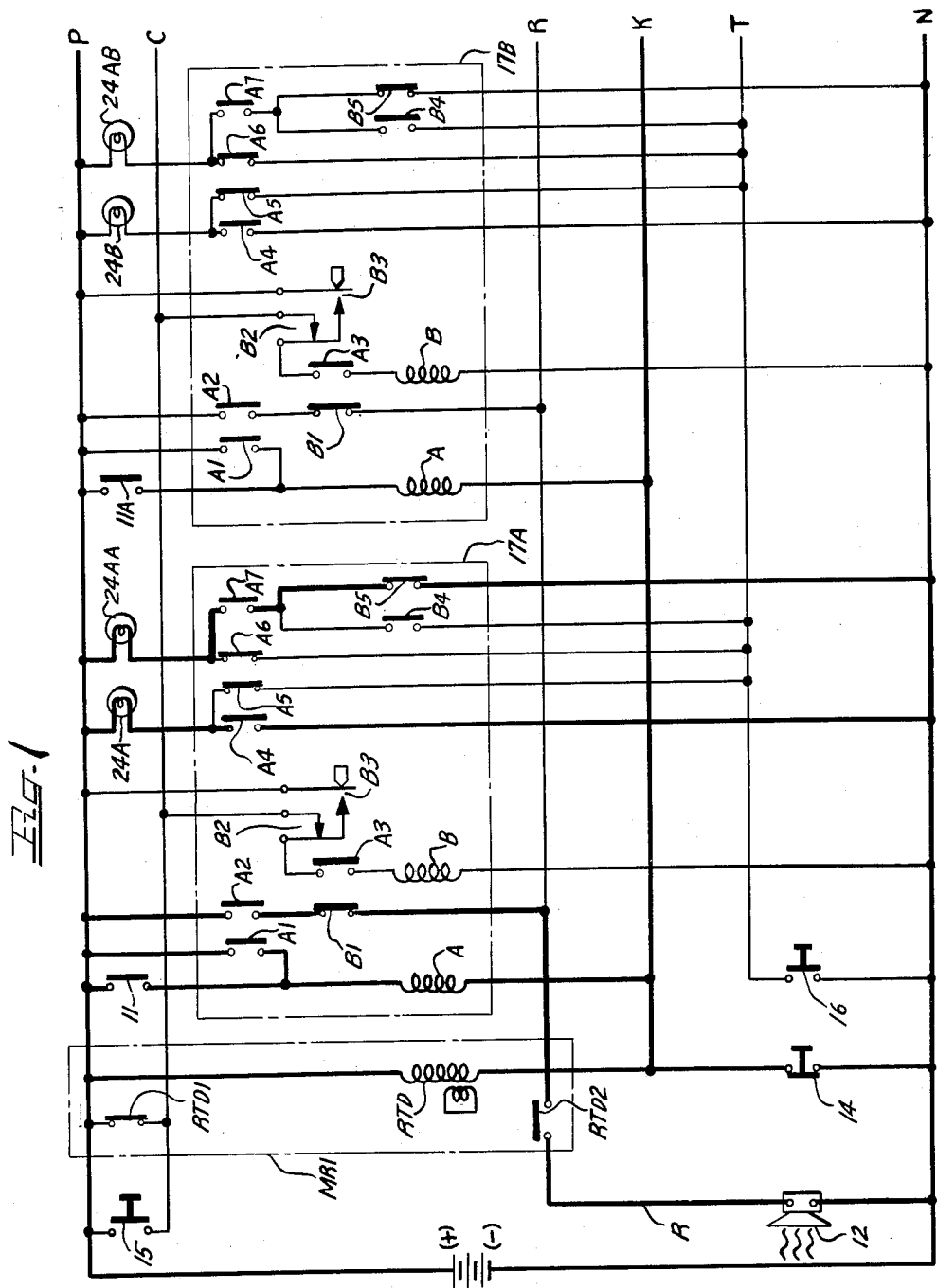
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R. J. MARMORSTONE
ALARM SYSTEM

2,730,702

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2 Sheets-Sheet 1



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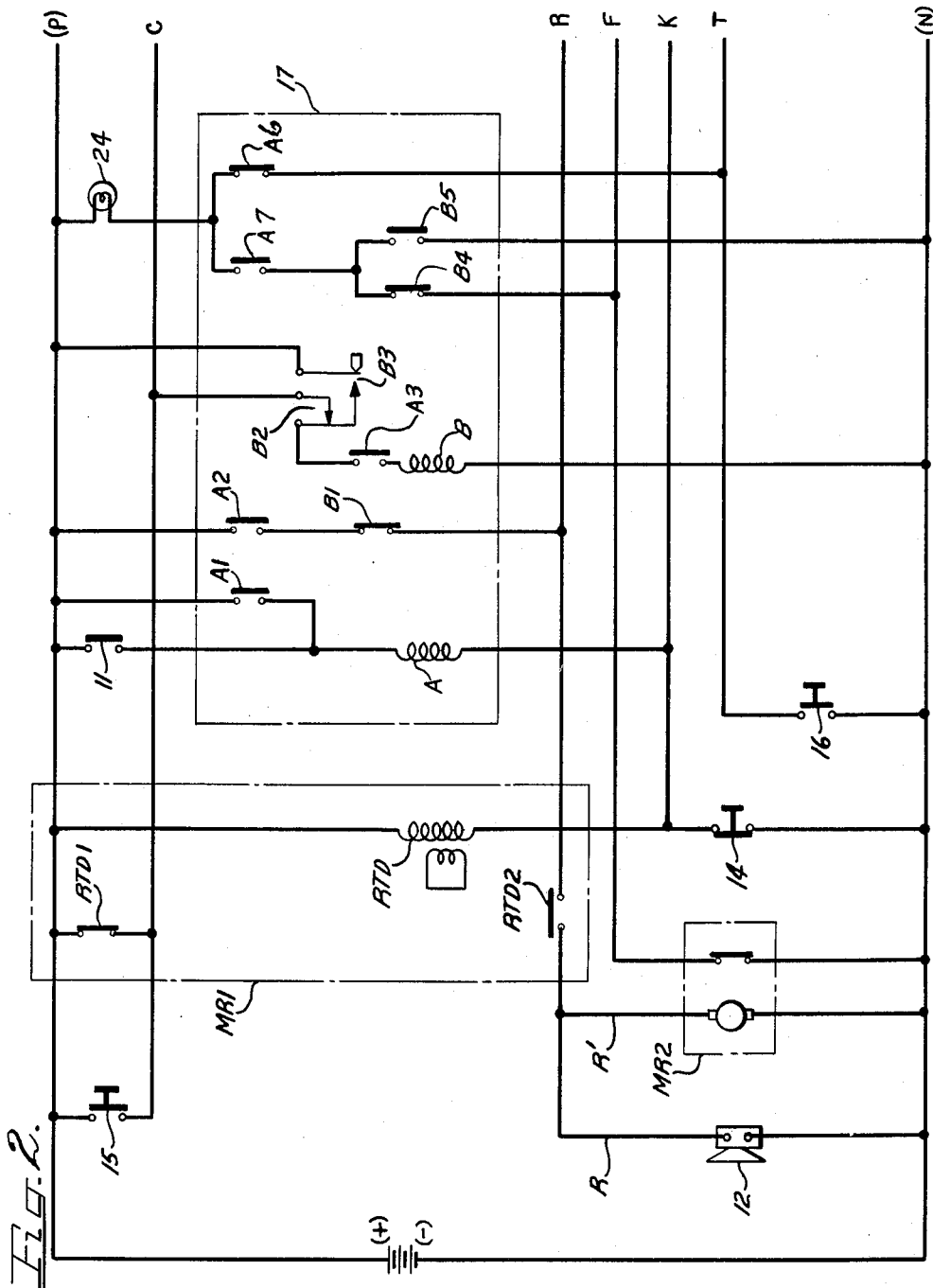
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ALARM SYSTEM

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Application January 27, 1953, Serial No. 333,427

9 Claims. (Cl. 340—213)

This invention relates to electric alarm systems for power plants and the like. It provides particularly a low drain, high versatility, manual reset alarm system.

For reasons of safety which are paramount in an alarm system, and also for reasons of economy, such a system should be kept as simple as possible. Nevertheless it must provide a versatile cycle of alarm operations in order to distinguish the usual alerting, acknowledge and reset or normal conditions of the plant equipment. Complications have arisen due to the fact that electric energy for the system gradually drains away, depleting the usual storage battery which should energize the system to safeguard proper alarm operation even in case of a general power failure.

Other complications have been caused by corrosion or electrolytic decomposition of metallic parts. These difficulties are aggravated when attempts are made to incorporate a desirably simple system of control busses in the circuitry of the system while still providing a versatile cycle of operations.

It is an object of this invention to overcome these complications and problems. A particular object is to provide a safe and versatile system with zero current drainage through the alarm circuits. A more particular feature of the new system is that current drainage through a master relay is allowed, but allowed only at a rate which is both constant and unobjectionably small. Another particular object is to protect a system of this type from damage due to corrosion or electrolytic action.

These objects have been achieved, and in particular it has been discovered that they are most simply achieved together rather than independently, by the use of a new and distinctive system of circuitry, wherein certain elements well known from former alarm arrangements are used in entirely novel positions and for entirely novel functions.

Each alarm signal switch as used in the present system has four basic circuit systems co-related therewith: a first circuit system for the control of a general, audible annunciator; a second circuit system for the control of a specific, visual annunciator co-related with the signal switch; and third and fourth circuit systems controlling respectively a first and second relay coil. These coils in turn control relay switches for the control of the four circuit systems. The coils and switches mentioned up to this point are installed in relay units or plug-in containers, one such unit or container being used for each signal switch. In addition the system requires a single master relay which can serve any number of alarm relay units or plug-in containers. Novel features are provided particularly in the fourth circuit system of each alarm unit, controlling the second relay coil and in the arrangement of the master relay. At these points, special applications of known devices for continuity transfer and time delay are provided, thereby allowing what is believed to be extreme simplicity for a system of the type as generally described.

Another electric alarm system for a power plant and the like has been described in my co-pending application Serial

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No. 320,549, filed November 14, 1952, now Patent No. 2,709,250; and other electric alarm systems of the manual reset type have been described in my co-pending applications Serial Nos. 316,186, filed October 22, 1952, now Patent No. 2,707,777, and 325,393, filed December 11, 1952. Because of the provision of manual resetting facilities, the present system as well as those of applications Serial Nos. 316,186 and 325,393 is somewhat more complex than that of application Serial No. 320,549; however, it is believed that all of the presently referred to resetting systems are considerably simpler than resetting alarm systems heretofore available, and that such simplification has been obtained by novel utilizations of continuity transfer features which heretofore were used for entirely different alarm purposes. A novel utilization of a continuity transfer feature is also employed in the non-resetting system of application Serial No. 320,549.

The specific advantages and features of the new arrangement will be understood most clearly upon a study of specific embodiments thereof, shown in the drawing appended hereto and described in the following part of this specification. It should be understood however that a number of specific features of said embodiments are subject to considerable change, within the scope of the claims set forth at the end hereof.

In the drawing:

Figure 1 is a schematic diagram of a typical embodiment of this invention.

Figure 2 is a schematic diagram of a slightly modified embodiment.

Referring first to Figure 1:

The alarm system comprises signal contacts or field switches as shown at 11 and 11A. A typical alarm system as contemplated herein comprises several dozens or hundreds or sometimes thousands of such signal contacts. Each signal contact is normally open in the interest of low drain operation. It is closed in predetermined danger situations; for instance it may be closed by well known thermostatic means, fluid flow responsive means or equivalent apparatus (not shown).

Such closure of any one signal contact, for instance contact 11, is expected to excite the alarm system and to cause a general, plantwide announcement, such as the sounding of a strong horn 12, in order to alert the plant personnel to the danger. The closure of the switch 11 is expected simultaneously to cause a more specific announcement, for instance the lighting up of red and white alarm lamp units 24A and 24AA, associated with the contact 11. This will allow proper supervision of emergency operations. The lamp units associated with the different signal contacts are best installed in a central control room. The operations of the annunciators 12, 24A, 24AA are obtained by said first and second circuit systems and indirectly by said third and fourth circuit systems as will be explained in detail hereinafter.

At any suitable central location, preferably in the same control room, a push-button 15 is provided in order to enable the control room operator or superintendent to acknowledge and silence the alerting signal sounded by the horn, that is to de-energize the first circuit system. It is also desirable, in a versatile alarm installation, to modify the position of the second circuit system and the visual alarm caused thereby, for instance to change it from energization of the red and white light units to energization of the red light unit only, by the same operation of the acknowledgment push-button.

When normal conditions are re-established in the field, the signal contact 11 returns to its normal, open position. Ultimately this should lead to the turning off of the last alarm lamp; but not at once. The closing of the contact 11 was expected automatically to start the alarm cycle; whereas the reopening of the contact 11 must not directly

terminate such a cycle, in a manual reset system as used herein. Such a manual reset system is frequently preferred, for instance where the plant operation might be disturbed by indiscriminate restarting of the equipment protected by the alarm system, or where it is desired to keep a detailed log of in service and out of service periods for such equipment. Accordingly the present system provides a reset push-button 14 for the termination of the alarm operation. Depression of this push-button is expected to open all circuits previously closed, directly or indirectly, by signal switches which are now open. On the other hand the push-button 14 must not interfere, practically with circuits the signal contacts of which are still closed. To avoid such interference has been a problem of considerable difficulty in many systems of this kind. I have discovered however that the object can be achieved very economically and efficiently by a rearrangement of parts, to be described presently, which rearrangement also safeguards protection against electrolytic damage in a novel manner.

For these purposes the new system comprises an electric storage battery with a positive terminal P and a negative terminal N; a control bus C forming a branch of the positive line P and normally disconnected therefrom by the acknowledgment switch 15; and another control bus K, forming a branch of the negative line N and normally connected therewith through the reset switch 14. The busses P and C constitute the positive side while K and N constitute the negative side of the system described so far. Between these sides a series of alarm relays 17A, 17B, etc. are provided, one for each signal contact 11, 11A, etc. In addition a master or reset relay MR1 is provided, for the control of the series of alarm relays 17A, 17B, etc.

The master relay MR1 has a coil RTD permanently connected between the positive line P and the control bus K, so that this coil is energized at all times except during depression of the reset push-button 14. The master relay coil RTD controls a normally closed switch RTD1, which due to the functionally normal energization of the coil RTD is actually open at all times except on depression of the reset push-button 14. In addition the coil RTD controls a normally open switch RTD2, which is actually closed at all times except upon depression of push-button 14. The switch RTD1 is shunted around the acknowledgment push-button 15, being connected between the P and C busses as shown. The switch RTD2 is interposed on a bus R for the energization of the annunciator horn 12. The master relay MR1 is of the slow operating time delay type. It may and preferably should be capable of the usual rapid de-energization. For instance it may have a time constant of about 18 milliseconds for energization, causing a corresponding time delay in the opening of switch RTD1 and closing of switch RTD2. The de-energization may occupy about 10 milliseconds as usual.

Each relay unit 17A, etc. contains two relay coils A and B. Each coil A is shown as having five switch units controlled thereby, some of which are double throw switches and which are identified by the symbols A1, A2, A3, A4/A5 and A6/A7. Each coil B is shown with three switch units B1, B2/B3 and B4/B5.

Each relay coil A is controlled by said third circuit system, comprising in addition to the respective signal contact 11 or 11A, etc., a normally open seal-in switch A1 shunted around said contact and thereby connecting the coil A with the positive terminal P. Each relay coil B is controlled by said fourth circuit system, comprising the continuity transfer switch B2, B3, which in this system is used mainly for two purposes: to provide separate starting and seal-in circuits for the B coil and also to provide a continuity transfer or time delay function, incident to a certain type of energization of the B coil as will be explained hereinafter. The normally open pole of the switch B2, B3 is connected to the positive line P and the normally closed pole to the bus C. The intermediate pole,

connected either with the normally open or the normally closed pole, is connected, through a normally open switch A3, to the B coil, the other end of which is connected to the negative terminal N.

It should be noted that at this point that both coils A and B are connected permanently to the negative side of the line N. More particularly it is preferred that the negative line N be connected to the innermost windings of both coils A and B. These precautions place the positive side P of the line as far as possible from all metal parts of the relay whereon copper might be deposited by any electrolytic currents due to moisture in contact with such parts. Preferably the presence of moisture is also counteracted by hermetically sealing the entire relay unit 17A, 17B, etc., with a dry, neutral gas enclosed therein. Such double precaution is desirable for an alarm relay system, where electrolytic decomposition, failure or shorting of any one out of hundreds of relays could lead to untold harm and damage. Heretofore, it has not been practical in battery operated alarm systems to connect the negative side of the line permanently with one end of each alarm coil, and other methods had to be relied upon to counteract electrolysis. The present arrangement, with the seal-in switch A2 on the positive side of the coil A is usual and mainly with the continuity transfer switch B2, B3 on the positive side of the coil B, simplifies the corrosion protection of the unit while also simplifying, in a rather unobvious manner, the safe and efficient resetting operation.

Returning now to the description of the first or horn circuit system it will be noted that this system comprises, in series, a normally open switch A2 and a normally closed switch B1, interposed between the positive and horn busses P and R. The second or lamp circuit system comprises in parallel two sub-systems. In one of these the red lamp 24A is connected between the positive or P terminal and two branches, controlled respectively by the normally open and normally closed sides A4, A5 of a double throw switch and connected respectively to the negative or N line and to a testing or T bus, the latter being connected with the negative or N line through a normally open push-button 16. In the other sub-system the white lamp 24AA is connected between the positive line and two branches controlled respectively by the open and closed sides A7, A6 of a double throw switch, the normally closed side being connected to the T bus and the normally open side to another pair of branches. This pair has normally open and normally closed parts designated respectively as B4 and B5 of a further double throw switch, B4 again being connected to the test bus and B5 to the negative bus.

In operation the four circuit systems of each relay 17A, etc. are normally de-energized and the signal switch 11 is open. The master reset coil RTD is energized, holding the switch RTD1 open and RTD2 closed. This position of the system is shown in Figure 3.

Closing of the switch 11 causes a first or alerting circuit sequence, the completion of which is shown in Figure 1. It comprises (a) closing of a signal circuit P, 11, A, K, 14, N, starting energization of coil A; (b) closing of an A coil seal-in circuit P, A1, A, K, 14, N, continuing such energization even in the case of fluctuations between open and closed positions of the signal switch 11 as frequently encountered; (c) closing of a horn circuit P, A2, B1, R, RTD2, 12, N; (d) closing of a red lamp circuit P, 24A, A4, N and (e) closing of a white lamp circuit P, 24AA, A7, B5, N. In addition a subsequent circuit is prepared by the closing of switch A3. The horn sounds and both the red and white lamps are bright.

Depression of the acknowledgment push-button 15 energizes the control bus C thereby causing a second or alarm modifying circuit sequence. It comprises (a) closing of a coil B starting circuit P, 15, C, B2, A3, B, N; (b) closing of a B coil seal-in circuit P, B3, A3, B, N, whereby coil B is kept energized even after release of the push-button 15; (c) opening of said horn circuit, at B1

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and (d) opening of said white lamp circuit, at B5. The horn stops, the white lamp is extinguished, only the red lamp remains bright.

A return to normal condition, in the equipment protected by the signal switch 11, opens that switch. If this happens either during the alerting condition or during the modified alarm condition of the system it prepares for a resetting but does not effect it. It only opens the signal circuit.

The manual resetting of the system, by depression of the push-button 14, inherently occurs either before or after the return to normal and the corresponding reopening of the switch 11.

If it occurs after such reopening it causes the following resetting circuit sequence: (a) opening of the master relay circuit P, RTD, 14, followed by (b) rapid closing of switch RTD1 and rapid opening of switch RTD2. This is further accompanied by (c) de-energization of the A coil seal-in circuit at 14. This in turn is followed by (d) rapid opening of the same circuit at A1; (e) protection of the horn from subsequent energization by opening of A2, which permanently inactivates, until the next alarm, the horn circuit in spite of the immediately following closing of the switch B1; (f) de-energization of the coil B at A3; (g) de-energization of the lamp 24A at A4 and (h) de-energization of the lamp 24AA at A7. The de-energization of the coil B also reverses the continuity transfer switch B2, B3, thereby re-establishing its normal position. This operation has no effect upon the other parts, the B coil circuit being open at A3. Thus the normal de-energization of all four circuit systems of the relay unit 17 is re-established. The horn remains silent and both red and white lamps are now dark. Also all current drainage through the relay unit 17 stops. The master relay circuit is re-established; this is effected by the release of the push-button 14.

If manual resetting is tried tentatively or inadvertently after the end of the alert but before the reopening of the signal switch 11, it causes the same resetting circuit sequence. In this case however the release of the push-button 14 leads to the following further resetting sequence: (i) re-establishment of signal and seal-in circuits for the A coil; (j) re-establishment of the B coil starting circuit. This is achieved in spite of the fact that the acknowledgment push-button 15 at this time is open. It is achieved by the time delay of about 8 milliseconds, caused by the slow operating characteristics of the master relay MR1, which keeps the shunt switch RTD1 closed for a sufficient time to energize the coil B. This coil again breaks any possible white lamp circuit at B5 and any possible horn circuit at B1.

A momentary sounding of the horn might be caused in this further resetting sequence, by a momentary closed position of both switches A2 and B1, due to slight differences in the energizing speeds of coils A and B. However even such momentary sounding of the horn is prevented very simply by the relatively slow reclosing of the switch RTD2. In this manner a very simple master relay MR1 is operative not only to provide basic, distinctive resetting operations but also to avoid even the slightest plant disturbance incident to the performance of such operations by the simple devices described. It will be noted that these features are basically achieved by the cooperation, as described, between the sequence control means or continuity transfer switch B2, B3 and the time delay means or relay MR1.

It remains to note that in an alarm system of this kind, testing of the alarm lamps is important. This can be achieved by depressing the test push-button 16. Thereupon any red lamps not lighted at such time in their proper cycle of operation are energized through the switch A5 connected therewith. Any white lamps not lighted at such time in their proper cycle of operation are then energized through the respective switch A6 or B4.

Further analysis of the system will show that no con-

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fusion, feed-back or the like can be caused even by inadvertent reversals of the sequence in which the operating push-buttons 15 and 14 should be depressed. Likewise, each relay unit 17A, 17B, etc. is independent from operation and possible maintenance operations or the like in other relay units.

Further simplification of each relay unit and lamp system is possible, at the expense of one additional bus wire, by means of a slightly different visual announcing system. This modified system is shown in Figure 2 and uses an alarm lamp 24 of the back-lighted name plate type with a flasher arrangement MR2 in the master relay. Back-lighted name plates and flashers are preferable mainly in two instances: (1) in central control rooms where there is a great multiplicity of alarms in a relatively small space and where the attendant must read some definite legend in order to interpret the appearance of an alarm light properly, and (2) in graphic panels where a lettered name plate forms an integral part of a flow diagram symbol and where the use of more than one lamp unit, for the representation of one field apparatus, would be confusing. On the other hand the combination of two light elements of different color as shown in Figure 1 has the advantage of compactness coupled with excellent visibility over a wide range of distances and viewing angles, mainly when each lamp is arranged in form of a so-called bullseye unit. When such considerations control the system of Figure 1 is preferable.

Incidentally it is also possible, so long as all of the bus wires of Figure 2 are provided, to construct and operate some of the units in accordance with Figure 1 and others in accordance with Figure 2. There will be no mutual interference or feed-back in that case.

This system provides a flasher relay MR2 the flasher motor of which is connected in parallel with the horn 12, between the time delay switch RTD2 and the negative line N. The flasher switch of this relay is connected between the negative side N and the added flasher bus F. A single lamp unit 24 is used, which takes the place of the white lamp unit 24AA of Figure 1 and which is similarly connected in principle, except that the switch B4 in this case is not connected to the test bus T but to the flasher bus F.

In the operation of this modified system the closing of the signal switch 11 obviously leads to sounding of the horn and flashing of the back-lighted name plate unit 24. Acknowledgment at 15 silences the horn in the same manner as described above and changes the back-lighted unit 24 from flashing to steady illumination. Resetting at 14, subsequent to return to normal conditions at 11, keeps the horn silent and darkens the back-lighted name plate unit. This unit can now be tested by the test button 16. Tentative resetting at 14, prior to the return of normalcy at 11, results in the same sequence of protective operations involving the continuity transfer at B2, B3 in cooperation with the time delay at RTD1 and RTD2, as described above.

Further modification will become obvious to persons skilled in this art, upon a study of this disclosure.

I claim:

1. A manual reset alarm system for the protection of a series of devices comprising a source of direct current, positive and negative terminals connected with said source, positive and negative control busses, connected with the respective terminals through a normally open and a normally closed push-button switch respectively; a series of alarm relay units corresponding with said series of devices and interposed between said positive terminal and control bus on the one hand and said negative terminal and control bus on the other hand; relay coil and switch means in each unit comprising an alarm-modifying coil, a make-before-break switch controlled by said coil and connected in series with the positive side of said coil, and conductors to connect a normally open section of said switch to a positive terminal, the normally closed

section of said switch to the positive control bus, and the other side of said coil to the negative terminal; a switch shunted around said normally open push-button switch, and means for holding the next to the last mentioned switch open at all times except upon depression of said normally closed push-button switch and for holding said next to the last mentioned switch closed for a moment following the release of said normally closed push-button switch.

2. A low drain alarm system for the protection of a series of devices, comprising a corresponding series of alarm switches; a corresponding series of alarm relay units; a slow operating master relay associated with the entire series of units; at least one annunciator associated with each unit; each unit having a first and a second relay coil and a set of relay switch means controlled thereby and including make-before-break switch contacts controlled by at least one of the coils, said relay switch means being arranged to normally de-energize the respective annunciators, to produce a first announcement of the respective annunciators while unacknowledged alarm conditions prevail in the corresponding devices, and to produce a different announcement of the respective annunciators while acknowledged alarm conditions prevail in the corresponding devices; the first coil of each unit being arranged in a circuit with the associated signal switch and being energized through the latter signal switch and a seal-in switch controlled by said coil; the second coil of each unit operating said make-before-break switch contacts and being arranged in an energization circuit for seal-in purposes extending through a normally open pole of said make-before-break switch contacts and, alternatively, for starting purposes, extending through a transfer control system in series with a normally closed pole of said make-before-break switch contacts and normally open contacts controlled by said first coil, said transfer control system comprising a normally open manual acknowledgment switch adapted when closed to energize said second relay coil through said normally closed make-before-break switch contacts and said normally open contacts of said first relay coil, said transfer system also including in parallel with said normally open manual acknowledgment switch the functionally normally open switch of the master relay; and a momentarily operable reset switch adapted to momentarily actuate the master relay and said first coil of each unit, said master relay being slow operating when returning to its normal condition so that said functionally normally open master relay switch remains closed to re-energize said second relay coil upon release of said reset switch.

3. A system as described in claim 2 additionally comprising a common alarm annunciator associated with the entire series of units; a common alarm annunciator energization branch circuit in each of said units, and a pair of series connected switches in each common annunciator energization branch circuit, one of said switches in each of said branch circuits being a normally open switch controlled by the associated first-mentioned coil and the other being a normally closed switch controlled by the associated second-mentioned coil.

4. A system as described in claim 3 additionally comprising a bus circuit containing said common annunciator, said different common annunciator branch circuits being branched off from said bus circuit; and a functionally normally closed switch in said bus circuit controlled by said master relay.

5. A system as described in claim 2 adapted for operation with direct current, comprising a positive terminal and a negative terminal, said first and second coils of each unit having a seal-in switch and make-before-break switch, respectively, interposed between said positive terminal and the coils.

6. A manual reset alarm system for the protection of a series of devices comprising a pair of energizing voltage terminals, control buses connected with the respec-

tive terminals through a normally open and a normally closed operable switch respectively; a series of alarm relay units corresponding with said series of devices and interposed between one of said energizing voltage terminals and one of said control buses on the one hand and the other energizing voltage terminal and the other control bus on the other hand; relay coil and switch means in each unit comprising an alarm modifying coil, a make-before-break switch controlled by said coil and connected in series with the side of said coil nearest said one energizing voltage terminal, and conductors to connect a normally closed section of said switch to said one control bus, a normally closed section of said switch to said one energizing voltage terminal, and the other side of said coil to said other energizing voltage terminal; a switch shunted around said normally open manually operable switch, and means for holding said next to the last mentioned switch open at all times except upon opening of said normally closed manually operable switch and for holding said next to the last mentioned switch closed for a moment following the release or closing of said normally closed manually operable switch.

7. A manual reset alarm system for monitoring a series of variables comprising a pair of energizing voltage terminals, a pair of control buses, a series of alarm relay circuits corresponding with said series of variables, each of said alarm relay circuits including a pair of relays, one of the coils of each circuit connected between one of said control buses and one of said energizing voltage terminals through a condition responsive signal switch, a slow operating master relay connected between said one control bus and said one energizing voltage terminal, a normally closed momentarily operable manual reset switch connected between said one control bus and the other energizing voltage terminal, the other coil of each circuit connected to said energizing voltage terminals through a normally open set of contacts of the associated first relay and through a normally open section of a make-before-break switch controlled by the associated second relay, each make-before-break switch having a normally closed section which connects the associated coil of the second relay and the normally open set of contacts of said first relay to the other control bus, a normally open manual acknowledge switch connected between said other control bus and said other energizing voltage terminal, whereby depression of said manual acknowledgment switch will effect energization of any second relay associated with an energized first relay, whereupon a holding circuit is established for the associated second relay through the then closed but normally open section of switch, said make-before-break said master relay having a pair of functionally normally open contacts shunting said normally open acknowledgment switch, and said slow operating master control relay being slow operating when said reset switch is returned to its normally closed position to re-establish energization of the previously energized second relays, and respective annunciator means in each annunciator circuit for providing a first signal announcement when the associated first relay coil is energized and the associated second relay is de-energized, and for providing a second acknowledged signal announcement when said first and second relay coils are energized.

8. A manual reset alarm system for monitoring a series of variables comprising a pair of energizing voltage terminals, a pair of control buses, a series of alarm relay circuits corresponding with said series of variables, each of said alarm relay circuits including a pair of relays, one of the coils of each circuit connected between one of said control buses and one of said energizing voltage terminals through a condition responsive signal switch, the other coil of each circuit connected to said energizing voltage terminals through a normally open set of contacts of the associated first relay and through a normally open section of a make-before-break switch controlled by the associated second relay, each make-before-break switch having a

normally closed section which connects the associated coil of the second relay and the normally open set of contacts of said first relay to the other control bus, a normally open manual acknowledge switch connected between said other control bus and said other energizing voltage terminal, whereby depression of said manual acknowledgment switch will effect energization of any second relay associated with an energized first relay, whereupon a holding circuit is established for the associated second relay through the then closed but normally open section of said make-before-break switch, and respective annunciator means in each annunciator circuit for providing a first signal announcement when the associated first relay coil is energized and the associated second relay coil is de-energized, and for providing a second acknowledged signal announcement when said first and second relay coils are energized.

9. A low drain alarm system for the protection of a series of devices, comprising a corresponding series of alarm switches; a corresponding series of alarm relay units; at least one annunciator associated with each unit; each unit having a first and second relay coil and a set of relay switch means controlled thereby and including make-before-break switch contacts controlled by at least one of the coils, said switch means being arranged to normally de-energize the respective annunciator, to produce a first announcement of the respective annunciator while un-

acknowledged alarm conditions prevail in the corresponding device and to produce a different announcement of the respective annunciator while acknowledged alarm conditions prevail in the corresponding device; the first coil of each unit being arranged in a circuit with the associated signal switch and being energized through the signal switch; the second coil of each unit operating said make-before-break switch contacts and being arranged in an energization circuit for seal-in purposes extending through a normally open pole of said make-before-break switch and alternatively for starting purposes extending through a transfer control system in series with a normally closed pole of said make-before-break switch contacts and normally open contacts of said first coil, said transfer control system comprising the normally open manual acknowledgment switch adapted when closed to energize said second relay coil through said normally closed pole of said make-before-break switch.

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