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RELAY DEVICE FOR INDICATING IF INPUT DIGIT LIES WITHIN A PREDETERMINED RANGE

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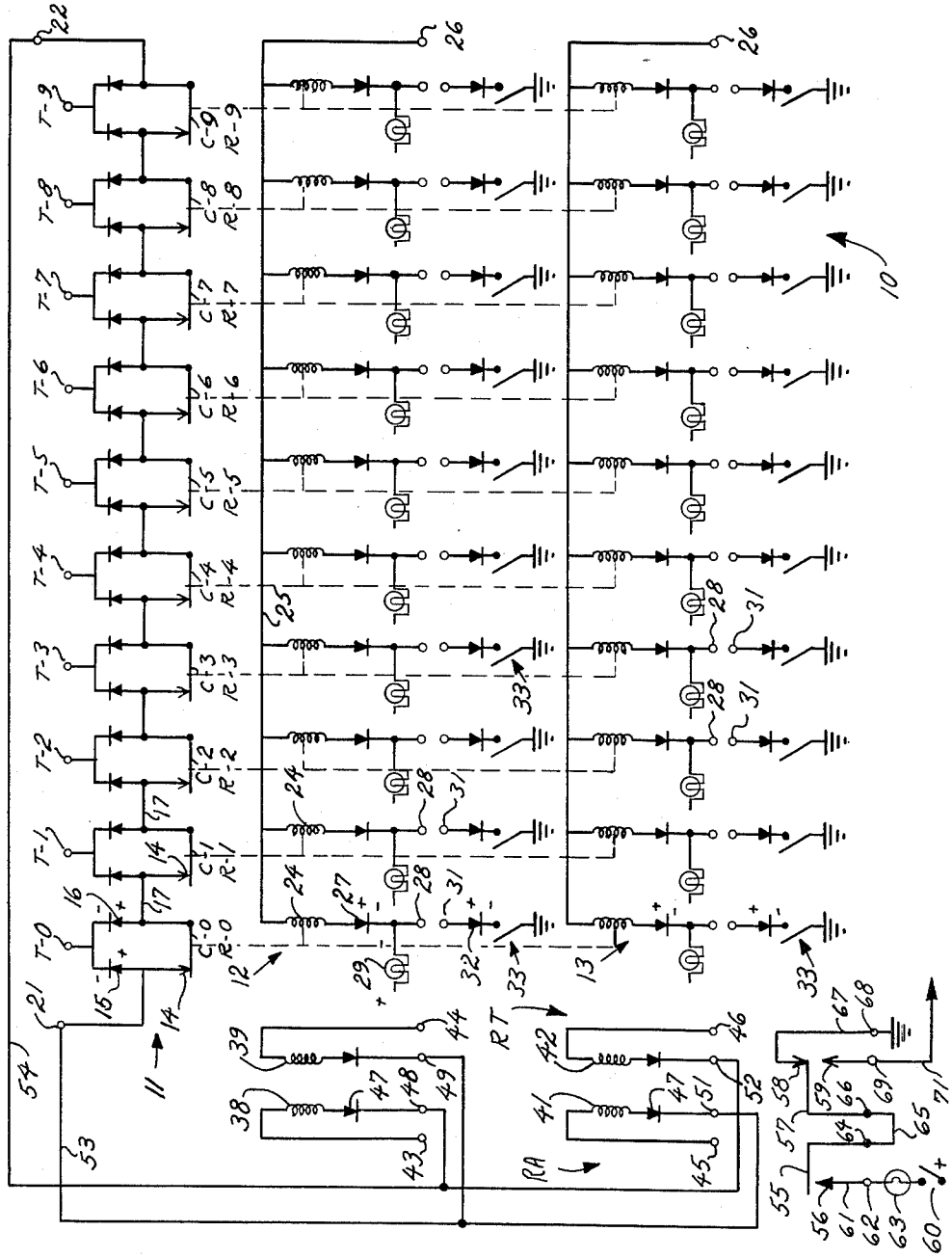


FIG. 1

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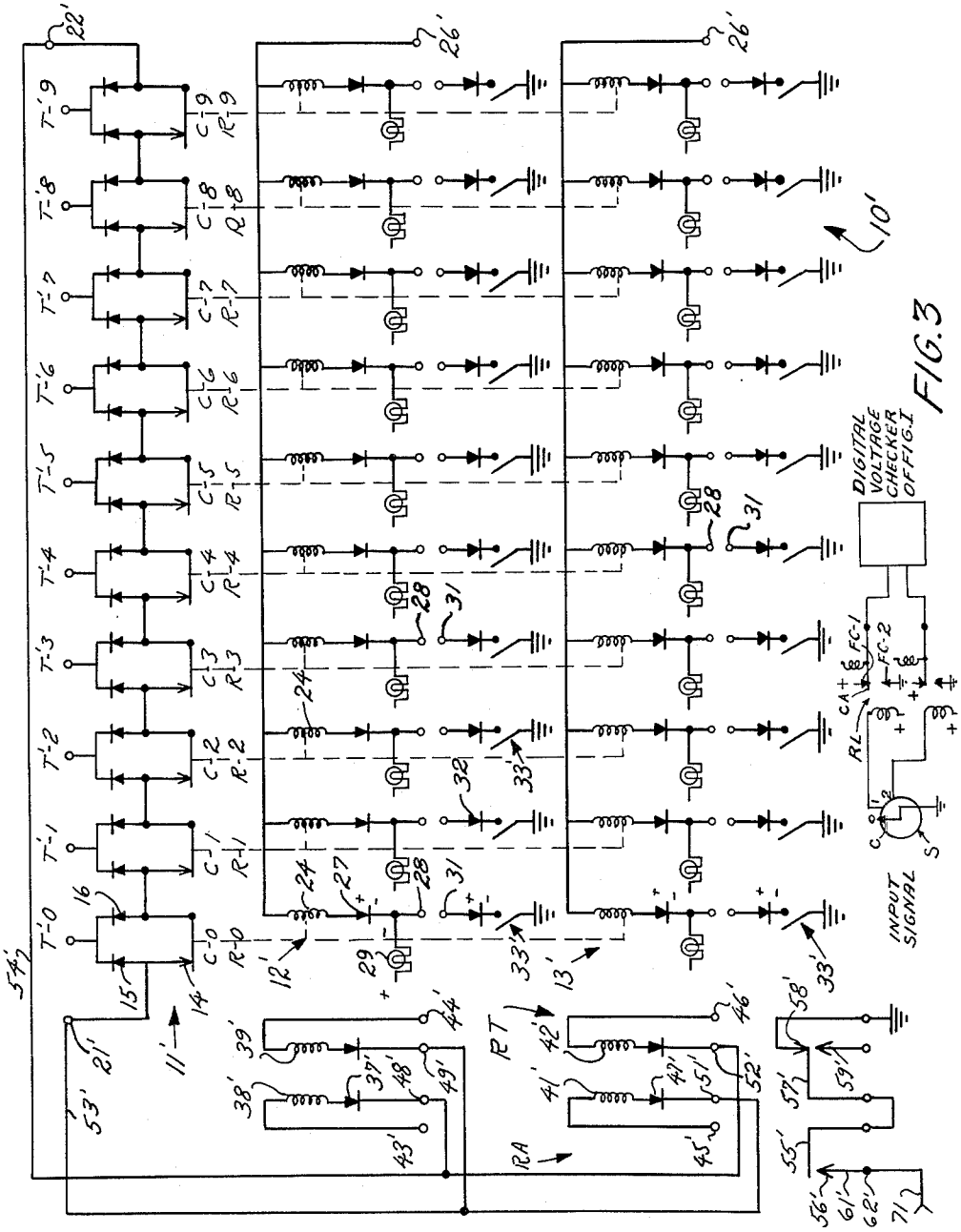


FIG. 3

FIG. 2

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RELAY DEVICE FOR INDICATING IF INPUT DIGIT LIES WITHIN A PREDETERMINED RANGE

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This invention relates to the art of digital comparators and more particularly to a comparator for determining whether a digital input is greater or less than a pre-set digital reference value.

It is among the objects of the invention to provide a unit of the above type which is relatively simple in construction and is not subject to errors due to transient signals, and which will dependably determine if a digital input signal is below or above a pre-set reference value and provide an alarm if such undesired condition is present.

According to the invention, these objects are accomplished by the arrangements and combination of elements hereinafter described and more particularly recited in the claims.

In the accompanying drawings, in which is shown one of various possible embodiments of the several features of the invention,

FIG. 1 is a circuit diagram of a comparator unit for one decade,

FIG. 2 is a view similar to FIG. 1 of a comparator unit for the second decade, and

FIG. 3 is a circuit diagram of means to actuate the equipment.

Referring now to the drawings, the digital comparator comprises a plurality of substantially identical comparator units 10, 10', one for each decade.

As shown in FIG. 1, each comparator unit comprises a plurality of relays R–0, R–1 to R–9 inclusive, one for each digit of a decade. The relays form contact bank 11 and two coil banks 12 and 13, for high and low alarm respectively.

The contact bank 11 has ten positions, 0, 1–9 inclusive, each with a contact arm C–0 to C–9, corresponding to the ten digits 0 to 9 inclusive, each contact arm normally engaging a fixed contact 14. The contact arm C and fixed contact 14 at each position are connected respectively to the positive side of an associated diode 15, 16, the negative sides of the diodes being connected together, and to an associated terminal T–0 to T–9 respectively, to which the input to the comparator is connected.

The input in the illustrative embodiment shown is designed to connect one of the terminals T–0 to T–9 to ground as set forth herein. This may be accomplished in any suitable manner such as, for example, as is shown in FIG. 3.

Thus, a switch S is provided having a plurality of contacts 0–9 respectively designed to be engaged by a contact arm C connected to ground. Each of the contacts 0–9 is connected to one side of a coil of an associated relay RL, the other side of the coil being connected to a source of positive potential.

Each relay has a contact arm CA connected to an associated terminal T–0 to T–9 and normally engaging a fixed contact FC–1 connected to a source of positive potential and spaced from a fixed contact FC–2 connected to ground.

Thus. as the contact arm C is rotated, depending upon the value of the input signal, the terminals T–0 to T–9 will successively be connected to ground.

The contact arm C of a preceding position is connected by a lead 17 to the fixed contact 14 of the succeeding position, and the fixed contact 14 of the first position associated with the digit "0" and the contact arm C–9 of the tenth position associated with the digit "9" are connected to terminals 21, 22 respectively.

As the coil banks 12 and 13 are identical, only the former will be described. Thus, bank 12, which is for the high alarm, has a coil 24 for each of the ten positions of bank 11 and controlling the contact arms C thereof. One end of each of the coils 24 is connected by common lead 25 to terminal 26. The other end of each coil is connected to the positive side of a diode 27, the negative side of which is connected to a terminal 28 and to one side of a lamp 29, the other side of which is connected to a source of positive potential.

The terminal 28 is associated with a terminal 31, the latter being connected to the positive side of a diode 32, the negative side of which is connected through normally open switch 33 to ground. The terminals 28 and 31 are adapted to be connected in any suitable manner as by a plug-in pin in the manner to be hereinafter described.

Associated with high alarm bank 12 and low alarm bank 13 are alarm and transfer relays RA and RT respectively, each of which has two coils 38, 41 and 39, 42 and a contact arm 55, 57 respectively adapted to be controlled by either of the associated coils. The contact arm 55 of the alarm relay RA is normally spaced from fixed contact 56 when coils 38, 41 are not energized, and the contact arm 57 of the transfer relay RT is normally engaging fixed contact 58 and spaced from fixed contact 59 when coils 39, 42 are not energized.

One end of each of the coils 38, 39, 41, 42 is connected to a terminal 43, 44, 45 and 46 respectively. The other end of each coil is connected to the positive side of a diode 47, the negative side of which is connected to a terminal 48, 49, 51, 52 respectively.

Terminal 21 of bank 11 is connected by lead 53 to terminals 49 and 51 of coils 39 and 41 and terminal 22 is connected by lead 54 to terminals 48 and 52 of coils 38 and 42.

Fixed contact 56 is connected by lead 61 to terminal 62, which is connected to one side of alarm lamp 63, the other side of which is connected through normally open switch 60 to positive. Contact arm 55 is connected to terminal 64, which is connected by lead 65 to terminal 66 to which contact arm 57 is connected.

Fixed contact 58 is connected by lead 67 to terminal 68, which is connected to ground, and fixed contact 59 is connected to terminal 69, which is connected by lead 71 to terminal 62' of the second comparator unit 10' (FIG. 2) for the second decade.

In the operation of the equipment, it will be assumed for purposes of illustration that there are only two decades and the alarm lamp 63 is to indicate if the digital

value being checked is greater than 35 or less than 24 for a given point under test.

To this end connections are made between the terminals 28, 31 of position 3 in bank 12 of comparator unit 10 and of position 5 in bank 12' of comparator unit 10' for the high alarm, and between the terminals 28, 31 of position 2 in bank 13 of comparator unit 10 and of position 4 in bank 13' of comparator unit 10' for the low alarm.

Assuming that the point under test has a digital value of 33 and that the terminals T–3 and T'–3 of comparator units 10 and 10' are connected to ground as a result of such value of 33, and that the remaining terminals T are connected to a positive potential, if terminals 26 and 26' of high alarm banks 12 and 12' are now connected to a source of positive potential, coils 24 of positions 3 and 5 of said banks of units 10 and 10' will be readied for energization.

At this time, through the action of a programmer (not shown), terminals 43, 44 and 43', 44' of units 10 and 10' are connected to a source of positive potential and the switches 33 and 33' of banks 12 and 12'' are closed.

Closing of switches 33 and 33' will complete a circuit through coils 24 of positions 3 and 5 of banks 12 and 12' of units 10 and 10' to move the contacts C–3 and C–5 of banks 11 and 11' away from their associated fixed contacts.

In addition, a circuit will be completed through the lamps 29 of positions 3 and 5 of units 10 and 10' to illuminate the digits 3 and 5 which is the selected reference value.

Terminal T–3 of unit 10 is connected to ground as previously described, due to the first digit of the point under test having a value of "3," and terminals 43, 44 to a source of positive potential. Hence, current will flow in two paths, from such terminals 43, 44 through coils 38, 39, diodes 47, terminals 48, 49, leads 54, 53 to terminals 22, 21, thence through the closed contacts C and 14 of the positions 9 to 4 inclusive, diode 16 to terminal T–3 and through the closed contacts C and 14 of the positions 0, 1, 2, diode 15 to terminal T–3.

Hence, coils 38 and 39 will be energized and contact arms 55, 57 will be moved to engage fixed contacts 56 and 59 to connect lamp 63 to terminal 69 and thence by lead 71 to terminal 62' of unit 10'.

Thus, the control of the alarm lamp 63 has been transferred to unit 10', as the value of the first digit "3" of the point under test is equal to the value of the digit "3" to which it has been compared.

The high alarm bank 12' of unit 10' has been set as previously described so that position 5 has been selected as the reference for the second digit. Consequently, contact arm C–5 of bank 12' is spaced from fixed contact 14.

However, since the value of the second digit of the point under test is "3," and since contacts C–5 and 14 are open, current will flow only from positive terminal 44', through coil 39' and lead 53' to terminal 21' and thence through closed contacts C and 14 of positions 0, 1 and 2 of bank 11', diode 15 of position 3 to terminal T'–3.

The consequent energization of coil 39' will cause the associated contact arm 57' to engage fixed contact 59', breaking the circuit to ground, and in addition, since contacts 55', 56' are open there will not be a complete circuit to lamp 63.

Thereupon, the programmer (not shown) closes the switch 60 associated with lamp 63, but as no circuit is completed thereto it will not be energized and no alarm will be given as is proper, since the point under test does not exceed 35.

The programmer then cycles to connect terminals 26, 26' of low alarm banks 13 and 13' of units 10 and 10' to a source of positive potential, and coils 24 of positions 2 and 4 of said banks of units 10 and 10' will be readied for energization.

At this time, through the action of the programmer, terminals 45, 46 and 45', 46' of units 10 and 10' are connected to a source of positive potential and the switches 33 and 33' of banks 13 and 13' are closed.

Closing of switches 33 and 33' will complete a circuit through coils 24 of positions 2 and 4 of banks 13 and 13' of units 10 and 10' to move the contacts C–2 and C–4 of banks 11 and 11' away from their associated fixed contacts.

In addition, a circuit will be completed through the lamp 29 of positions 2 and 4 of units 10 and 10' to illuminate the digits 2 and 4, which is the selected reference value.

Terminal T–3 of unit 10 is connected to ground, as previously described, due to the first digit of the point under test having a value of "3" and terminals 45, 46 to a source of positive potential.

However, since contacts C–2, 14 of position 2 of bank 11 of unit 10 are open, current will flow only from positive terminal 46, coil 42, lead 54, terminal 22, closed contacts C and 14 of positions 9 to 4 inclusive, diode 16 of position 3 to terminal T–3 which is connected to ground.

The energization of coil 42 will cause the associated contact arm 57 to engage fixed contact 59, but as the contact 55 remains spaced from fixed contact 56, no circuit will be completed to the alarm lamp, which is the condition desired when the value of the point under test, i.e. 33, exceeds the reference value set, i.e. 24.

Where the value of the point under test exceeds the reference value of 35, i.e., if it has a value of, say, 36, then terminals T–3 and T–6 of bank 11 and 11' of units 10 and 10' will be connected to ground.

Since the value of the first digit of the point under test is equal to that of the reference, control of the alarm lamp will be switched to unit 10', as previously described.

Since contacts C–5 and 14 of bank 11' of unit 10' are open, current will flow from positive terminal 43', coil 38', lead 54, terminal 22', closed contacts C and 14 of positions 9 to 7 inclusive, diode 16 to terminal T–6 and ground. Hence, coil 38' will be energized and contact arm 55' will engage fixed contact 56'. As contact 57' remains in engagement with fixed contact 58', a circuit will be completed from ground to terminal 62' and thence through lead 71 to terminal 69 of unit 10.

As contact arms 55, 57 of unit 10 are engaging their fixed contacts 56, 59, a circuit will be completed to alarm lamp 63, so that when switch 60 is closed by the programmer, the alarm lamp will be illuminated.

Since at the same time the programmer is closing the switches 33 and 33' associated with the high alarm bank 12, 12' of units 10 and 10', the lamps 29 associated with positions 3 and 5 will be illuminated so that illumination of the alarm lamp 63 will indicate that the value of the reference of 35 has been exceeded.

Where the value of the point under test is less than the reference value of 24, i.e., if it has a value of, say, 13, then terminals T–1 and T–3 of banks 11 and 11' of units 10 and 10' will be connected to ground.

Since the value of the first digit of the point under test, i.e., "1," is less than that of the reference, i.e., "2," current will flow only from positive terminal 45, coil 41, diode 47, lead 53 to terminal 21 and thence through closed contacts C and 14 of position 0, diode 15 to terminal T–1.

Energization of coil 41 will cause contact 55 controlled thereby to engage fixed contact 56, and since contact 57 is engaging fixed contact 58 connected to ground, a circuit will be completed to one side of the lamp 63. Thus, when switch 60 is closed by the programmer, the alarm lamp will be illuminated.

Since at the same time the programmer is closing the

switches 33, 33' associated with the low alarm banks 13, 13' of units 10 and 10', the lamps 29 associated with positions 2 and 4 will be illuminated so that illumination of the alarm lamp will indicate that the value of the point under test is less than the reference value.

Although the illustrative examples of the equipment have shown its operation where the value of the point under test was between the high and low reference values and was greater than the high and less than the low reference values, it is of course to be understood that other combinations could exist.

Thus, the point under test could be greater than the low and greater than the high reference values so that only the high alarm would be given, or it could be less than the low and less than the high reference values so that only the low alarm would be given.

The operation of the equipment under such conditions would be readily apparent to one skilled in the art.

It is also to be understood that any number of comparator units could be provided depending upon the number of decades involved and the equipment would function in the manner previously described.

With the equipment above described, since only relays and diodes are utilized, transient signals will not cause errors in operation, and as the relays are dependable in operation and capable of long repeated use without breakdown, the need for servicing is kept to a minimum.

As many changes could be made in the above constructions and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. A digital comparator comprising a plurality of relays, each having a pair of normally closed contacts and an associated coil controlling said contacts, means connecting said contacts in series, two control relays, one control relay comprising an alarm relay having a fixed contact and a contact arm normally spaced therefrom and a coil, and the other control relay comprising a transfer relay having a fixed contact and a contact arm normally engaging said fixed contact and a coil, an indicator connected to one of the contacts of said alarm relay, the other contact being connected to one of the contacts of said transfer relay, means to connect a source of potential across the indicator and the other contact of said transfer relay, means connecting the ends of said series connected contacts to one end of the coils of each of said control relays respectively, means to apply a source of potential between each of the contacts of any one of said plurality of relays and one of the ends of the coils of each of said control relays respectively, whereby two paths for current flow will be provided, one from each of the contacts to which a source of potential is applied to an associated control relay coil, and means to energize the coil of one of said plurality of relays to open the contacts thereof to break the circuit of one of said paths of current to the associated control relay coil only when the energized relay of said plurality is other than the relay to the contacts of which a source of potential has been applied.

2. The combination set forth in claim 1 in which a second plurality of relays is provided, each having a pair of normally closed contacts and an associated coil controlling said contacts, means connecting said contacts in series, a second alarm relay having a pair of normally open contacts and a coil, a second transfer relay having a pair of normally closed contacts and a coil, said first transfer relay having an additional fixed contact, the contact arm of said first transfer relay being normally spaced from said additional fixed contact, means connecting said additional contact to one of the contacts of said second alarm relay, means connecting the other contact of said second alarm relay to one of the contacts of said transfer relay, means to connect a source of potential to the other contact of said second transfer relay, means connecting the ends of said series connected contacts to one end of the coils of said second alarm relay and second transfer relay respectively, means to energize the coil of one of said plurality of relays to open the contacts thereof, and means to apply a source of potential to the contacts of at least one of said plurality of relays and to the free ends of the coils of said second alarm relay and said second transfer relay.

3. The combination set forth in claim 2 in which each pair of contacts of said first and second plurality of relays has a pair of diodes associated therewith, one side of each of the diodes of each pair being connected to an associated contact and the other sides of the diodes being connected together, the source of potential being applied to the connected sides of the pair of diodes.

4. The combination set forth in claim 2 in which each plurality of relays comprises ten relays.

5. The combination set forth in claim 1 in which one side of each of the coils of said plurality of relays is connected together, the other side of each of said coils being connected to a terminal, a second terminal is associated wih each of said first terminals, means to connect said second terminals and the connected sides of said coils to a source of potential, and the means to energize the coil of one of said relays comprises a contact member engaging the associated pair of terminals.

6. The combination set forth in claim 5 in which a diode is connected in series with each of said second terminals and a normally open switch is connected in series with each of said diodes.

7. The combination set forth in claim 5 in which a diode is connected in series between each of said coils and the first terminal.

8. The combination set forth in claim 5 in which a diode is connected in series between each of said coils and the first terminal, an indicator is connected at one side between said diode and said first terminal, a diode is connected in series with each of said second terminals, a normally open switch is connected in series with each of said last named diodes and means to apply a potential to the other side of said indicator, said diodes and said potentials being selected and arranged for current flow through said coil and said indicator and through both of said diodes in the same direction.

9. A digital comparator comprising a plurality of relays, each having a pair of normally closed contacts and a pair of coils, said coils being arranged in two banks, each coil independently controlling the associated pair of contacts, means connecting said contacts in series, two control relays, one control relay comprising an alarm relay having a fixed contact and a contact arm normally spaced therefrom and a coil, and the other control relay comprising a transfer relay having a fixed contact and a contact arm normally engaging said fixed contact, an indicator connected to one of the contacts of said alarm relay, the other contact being connected to one of the contacts of said transfer relay, means to connect a source of potential across the indicator and the other contact of said transfer relay, means connecting the ends of said series connected contacts to one end of the coils of each of said control relays respectively, means to apply a source of potential between each of the contacts of any one of said plurality of relays and one of the ends of the coils of each of said control relays respectively, whereby two paths for current flow will be provided, one from each of the contacts to which a source of potential is applied to an associated control relay coil, and means alternately to energize one of the coils in each bank to open the contacts of the associated relay to break the circuit of one of said paths of current to the associated control relay coil only

when the energized relay of said plurality is other than the relay to the contacts of which a source of potential has been applied.

10. The combination set forth in claim 9 in which said plurality of relays comprises ten relays associated with the digits 0 to 9 inclusive, one of the contacts of the relay associated with the "0" digit is connected to one end of the transfer relay coil and one of the contacts of the relay associated with the "9" digit is connected to one end of the alarm relay coil.

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