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RELAY PULSING CIRCUIT
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FIG. 1

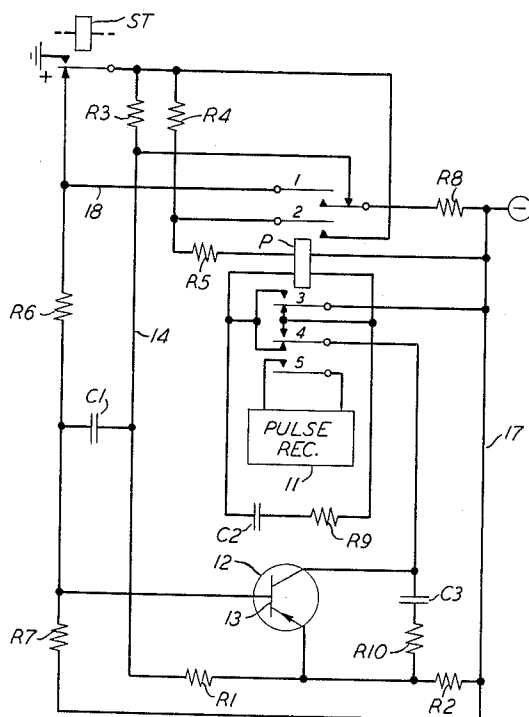


FIG. 2

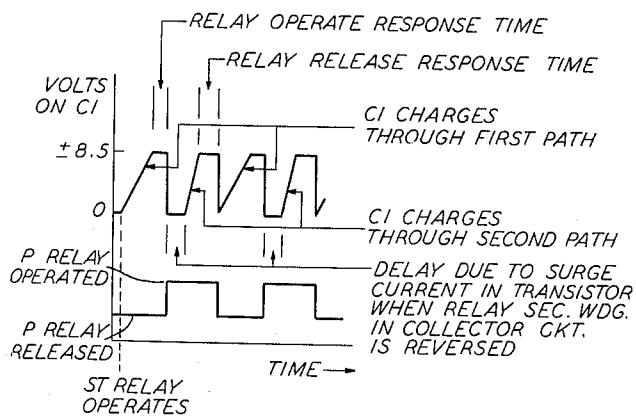
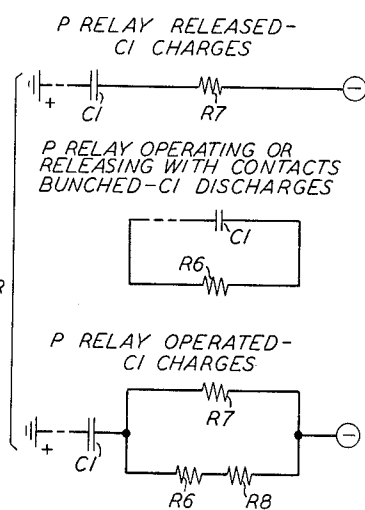


FIG. 3



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RELAY PULSING CIRCUIT

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This application relates to a relay circuit and more particularly to a relay pulsing circuit.

Relay pulsing circuits have been widely used for many years for the production of timed pulses of required percent break. In general, while these circuits have performed satisfactorily, they have been relatively complicated and expensive, comprising as they usually do at least two relays and a substantial number of resistors and capacitors. Obviously, a simplification of such a widely used type of circuit would be highly advantageous.

Accordingly, it is an object of the present invention to improve the operation and arrangement of relay pulsing circuits.

Another object of the invention is to improve the economic aspects of relay pulsing circuits by reducing the cost thereof.

A more specific object of the invention is to reduce the number of relays required in a relay pulsing circuit while maintaining the efficient operation thereof.

In accordance with a specific embodiment of the invention a relay pulsing circuit includes a two-winding relay provided with a plurality of groups of contacts, one of which groups is subject to "bunching" when the relay is in the process of operating or releasing; when "bunching" occurs, the two opposed contacts of the group and the common swinger are momentarily all in engagement. At the start of the operation current is passed through the primary winding of the relay at a nonoperate level. Subsequently, current is passed through the secondary winding, first in an aiding direction to operate the relay, and then in an opposing direction to release the relay, the direction change being attained through operation of relay contacts. A transistor is included in the secondary winding of the relay, being turned "On" by voltage across a capacitor after it has been charged to a certain value. The charge and discharge paths of the capacitor include three resistors and are controlled through the bunching group of contacts; when the relay is released the capacitor is charged through a first resistor, when the relay is in the process of operating or releasing with the contacts bunched the capacitor is discharged through a second resistor, and when the relay is operated the capacitor is charged through a path comprising a third resistor in series with the second resistor and in parallel with the first resistor.

A feature of the present invention is the utilization, at different points in the operating cycle of the pulsing circuit, of different charging paths for a capacitor each with respectively different resistance values whereby to attain at these different points different charging rates for the capacitor.

A further feature of the invention is the utilization of the bunching action of a group of relay contacts during the operating and releasing periods of the relay whereby to establish a distinct discharge path for a capacitor during this period. In this way a function that would ordinarily be performed by an additional relay is per-

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formed by the single relay during its normal operating or releasing period.

A still further feature of the invention is the utilization of a transistor in the secondary winding path of a relay for controlling the flow of current therethrough in combination with means effective upon each operation and release of the relay for reversing the direction of the current flow therein.

Yet another feature of the invention is that the effective resistance of the operating circuit for the primary winding of a relay is established at respectively different values for the operated and released positions of the relay whereby when the relay is released, the flow of primary winding current alone will not operate the relay but when the relay is operated it will be held in that position by the flow of primary winding current alone.

A full understanding of the arrangement contemplated by the present invention as well as an appreciation of the various features thereof may be gained from consideration of the following detailed description in connection with the accompanying drawing, in which:

FIG. 1 shows one specific illustrative embodiment of the invention in a relay pulsing circuit;

FIG. 2 is an illustration showing the dynamic characteristics of the operation of the circuit of FIG. 1; and

FIG. 3 shows schematically charge and discharge paths for the capacitor, which paths prevail at various points in the operating cycle of the relay.

Referring now to the drawing, and first to FIG. 1, a relay pulser is shown which includes relay P which is provided with an upper, primary, winding and a lower, secondary, winding. As shown, relay P is provided with a plurality of groups of contacts, of which the upper group No. 1 is subject to bunching. That is, when the relay is in the process of operating, No. 1 make contact closes before No. 1 break contact opens and when the relay is in the process of releasing No. 1 break contact is reclosed before No. 1 make contact opens. When the relay operates, the No. 2 make contact closes at approximately the same time as No. 1 make contact closes and before any of the lower groups of contacts have altered their positions. When the relay releases, the lower groups of contacts are reversed in position just before No. 1 and No. 2 make contacts are opened. No. 5 make contact is the "pulsing" contact, completing a path to pulse receiver 11 each time relay P operates. The collector path of transistor 12 is connected in the secondary winding circuit of relay P, and the base electrode 13 of the transistor is connected to capacitor C1. When the relay is in released position, resistors R4 and R5 are connected in series with the primary winding, and when the relay is operated resistor R4 is shunted out of the path at make contact No. 2. In the specific illustrative embodiment of the invention the value of resistor R4 may, for example, be of the order of 2500 ohms and that of resistor R5 of the order of 1000 ohms. Resistor R3, of relatively low resistance, for example of the order of 160 ohms, is provided to absorb any voltage above the requirements of transistor 12 whereby to permit use of a standard 48 volt source without exceeding the transistor voltage requirements. Protective networks comprising capacitor C2 and resistor R9 and capacitor C3 and resistor R10, respectively, serve to reduce the peak voltages across the secondary winding of relay P and the transistor 12 when the relay operates or releases and reverses the connection

of the secondary winding in the collector circuit of the transistor as will be described subsequently. In the specific illustrative embodiment, transistor 12 is of the PNP type. However, if desired an NPN type transistor could be utilized with suitable changes in potential supply.

It is believed that the circuit can best be further described by describing its actual operation. With the circuit in normal condition as illustrated, that is with relay P released, let us assume that the pulsing operation be started by suitable means, for example by operation of a start relay ST. When the make contact of relay ST is closed, a path is completed from positive battery, ground, resistors R4 and R5, primary winding of relay P to negative battery; this current will not be at a sufficient level to operate relay P. Capacitor C1 is fully discharged at the start of the operation, and now starts to charge from ground, lead 14, capacitor C1, resistor R7, lead 17 to battery. This path is indicated at the upper portion of FIG. 3 and, while resistor R3 is actually included in this path, it has been provided for another purpose, as pointed out above, and is not of significance with regard to the charging and discharging paths of capacitor C1. It is noted also that transistor 12 is in "Off," nonconducting condition at the start of the circuit operation.

As previously pointed out, the output of capacitor C1 is connected to base electrode 13 of transistor 12, and when the charge on the capacitor reaches a certain value, for example of the order of 8 or 9 volts in approximately 70 milliseconds in the specific illustrative embodiment of the invention, the voltage applied to the base electrode 13 will be sufficient to turn transistor 12 "On" and collector current will flow through the secondary winding of relay P. At this point the current flow in the secondary is aiding with respect to the current flow in the primary and the relay starts to operate. (In the specific illustrative embodiment of the invention the primary winding may be of the order of 8000 turns, for example, and the secondary may be of the order of 1400 turns.)

The time required for the armature of relay P to complete its operation may be, for example, of the order of 10 to 15 milliseconds, and for 2 to 3 milliseconds during this period the upper group of contacts will bunch, that is No. 1 make contact will close before No. 1 break contact opens. While the contacts are bunched, capacitor C1 will discharge through resistor R6, lead 18, No. 1 make and break contacts of relay P, lead 14 back to the capacitor, the rate of discharge depending upon the value of resistor R6. (This path is indicated at the center portion of FIG. 3.) When relay P reaches its fully operated position this discharge path is interrupted at No. 1 break contact.

Relay P, operated, holds operated over its primary winding since resistor R4 is shunted out of the path at make contact No. 2 of the relay. A path is completed at make contact No. 5 to pulse receiver 11 for transmission of a pulse. Pulse receiver 11 may be of any suitable arrangement and associated with any desired type of circuits; for example it may be a part of a service observing circuit associated with a telephone system.

Also, operation of relay P reverses the connection of the secondary winding in the collector circuit of transistor 12, this reversal being effected by the opening of No. 3 and No. 4 break contacts and the closing of No. 3 and No. 4 make contacts of the relay. This reversal causes a surge of current in the transistor circuit which results in capacitor C1 remaining discharged until the surge has dissipated. After dissipation of the current surge, capacitor C1 again starts to charge, this time at a much faster rate than before since the charging path is now as indicated at the lower portion of FIG. 3. The path is traced, referring to FIG. 1, from ground, lead 14, capacitor C1 and over two parallel paths one through resistor R7, lead 17 to battery, and the other through

resistor R6, lead 18, No. 1 make contact of relay P, resistor R8 to battery. Thus we now have, as shown in FIG. 3, a charging path which includes two parallel arms one comprising resistor R7 and the other comprising resistors R6 and R8 in series. The overall effective resistance of this charging path is substantially less than the first charging path described above, which comprised resistor R7 as a series element alone, so that the rate at which capacitor C1 now recharges is substantially higher than its first charging rate. In the specific illustrative embodiment of the invention the value of resistor R6 may be, for example, of the order of 200 ohms, and that of resistors R7 and R8 of the order of 124,000 ohms each.

As pointed out above the effective direction of the secondary winding of relay P was reversed when the relay operated, and the secondary winding is now opposing with regard to the primary winding over which the relay is being held operated. Transistor 12 at this point is in "Off" condition.

When the charge on capacitor C1 reaches the required value in approximately 40 milliseconds, transistor 12 will be turned "On," as before, and collector current will flow in the secondary winding of relay P. In this instance, however, the current in the secondary winding is opposing with regard to the holding current in the primary, and causes the relay to release.

During the time the relay armature is releasing, a period for example of from 15 to 20 milliseconds, the No. 1 group of contacts bunch for 2 to 3 milliseconds as before described and capacitor C1 again discharges through resistor R6 as indicated by the center portion of FIG. 3. During the releasing period of the relay, the lower groups of contacts have reversed their positions before the upper groups No. 1 and No. 2 contacts change their positions, which causes a momentary current reversal in lower relay winding just before group No. 1 break contacts close. The pressure of all make springs on the relay armature plus the inertia of the moving armature forces the continuity of the armature release operation until both No. 1 and No. 2 make contacts open and completes the releasing cycle. When the relay is in fully released position, resistor R4 is restored as a series element in the primary winding path by the opening of No. 2 make contact of the relay. Also, the effective direction of the secondary winding is again changed upon release of the relay and is now aiding with respect to the primary. No current is flowing in the secondary winding path at this point, however.

The capacitor C1 now starts to charge through the first described path, that is through resistor R7, and the cycle is repeated. Each time relay P operates, a pulse is originated in pulse receiver 11 by the closing of make contact No. 5 of the relay.

The above-described operations of relay P are further illustrated in FIG. 2. The upper curve is based on the charging and discharging cycles of capacitor C1 while the lower curve shows the corresponding operated and released periods of relay P. The two lines of the upper curve labeled "C1 charges through first path" represent the respective charging periods of capacitor C1 through resistor R7, while the two lines labeled "C1 charges through second path" represent the respective charging periods of the capacitor through the path comprising resistors R6 and R8 connected in series with each other and in shunt with resistor R7; the difference in slope of the respective pairs of lines indicates, of course, the different charging rates of the respective two paths. The curve also indicates the respective relay operate and relay release response times and the delay in the start of the capacitor recharging cycle caused by the current surge in the transistor.

It will be apparent from the above description that the novel arrangement of the present invention makes it feasible to provide in a single relay pulsing circuit the

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functions and advantages heretofore necessitating the provision of two or more relays. This not only results in economic advantages but also simplifies adjustment and maintenance operations. The novel utilization of the bunching action of the relay contacts is an essential factor in the attainment of three different paths (as shown in FIG. 3) through a single release or operate action of the single relay. The provision of the two different charge paths for the capacitor whereby to change the charging rate thereof makes possible an accurate adjustment of the percent break of the output pulse. The pulsing rate can be readily adjusted over a narrow range by selection of different values for resistor R6. Also, the pulsing rate can be adjusted by changing the value of capacitor C1. It will be noted, further, that a novel manipulation of primary winding resistance and secondary winding direction is carried out whereby to attain desired relay operations. That is, it will be recalled that when relay P is in released position the resistance of the primary winding is relatively high since both resistors R4 and R5 are connected in series therewith and as a consequence the relay will not operate on the current flow in the primary alone. When the relay is in fully operated position, on the other hand, the resistance of the primary winding is materially reduced by the shunting of resistor R4 and the relay will hold operated on the flow of current in the primary alone. Further, when the relay is released the secondary winding is connected in aiding relationship to the primary so that subsequent flow of current in the secondary combined with the primary current will cause the relay to operate. On the other hand when the relay is operated the secondary winding is then connected in opposition to the primary and subsequent flow of current in the secondary will result in releasing the relay.

While a specific embodiment of the invention has been selected for detailed disclosure, the invention is not, of course, limited in its application to the embodiment disclosed. The embodiment which has been described should be taken as illustrative rather than restrictive thereof.

What is claimed is:

1. A pulsing circuit comprising an electromagnetic relay having a primary winding and a secondary winding, means for applying current to said primary winding of a magnitude less than the normal operate value of the relay, means for applying current to said secondary winding, means for changing the direction of the current in said secondary winding whereby to aid the current in the primary winding and operate the relay or to oppose the current in the primary winding and release the relay, means including a capacitor for controlling initiation of the flow of current in said secondary winding, a first resistor, a second resistor, a third resistor, and means effective in turn during a single complete transition of said relay from released position to operated position for charging said capacitor through a first path, for discharging said capacitor through a second path, and for charging said capacitor through a third path, the effective resistance of said third path differing from that of said first path.

2. The pulsing circuit defined by claim 1 further characterized in that said first path includes said first resistor, said second path includes said second resistor, and said third path includes said second and third resistors connected in series with each other and in parallel with said first resistor.

3. A pulsing circuit comprising an electromagnetic relay having a primary winding and a second winding, means for applying current to said primary winding of a magnitude less than the normal operate value of the relay, means for applying current to said secondary winding, means for changing the direction of the current in said secondary winding whereby to aid the current in the primary winding and operate the relay or to oppose the

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current in the primary winding and release the relay, means including a capacitor for controlling initiation of the flow of current in said secondary winding, a plurality of groups of contact springs associated with said relay, one of said groups comprising first and second opposed contacts and a common swinger member therebetween, said first contact and said swinger member being engaged when said relay is fully released, said second contact and said swinger member being engaged when said relay is fully operated and both said contacts and said swinger member being momentarily bunched with said swinger member engaging both said contacts when said relay is in the condition of operating or releasing, a first resistor, a second resistor, a third resistor, means effective when said relay is in released position for charging said capacitor through said first resistor, means effective when said relay is in the condition of operating or releasing with both said contacts and said swinger member bunched for discharging said capacitor through said second resistor, and means effective when said relay is in fully operated position for charging said capacitor through said first, second and third resistors.

4. The pulsing circuit defined by claim 3 further characterized in the inclusion in said current flow initiation means of a transistor connected in said secondary winding path and triggered by the breakdown voltage built up across said capacitor.

5. The pulsing circuit defined by claim 3 further characterized in that said current direction changing means is effected both by operation and release of said relay.

6. The pulsing circuit defined by claim 3 further characterized in the provision of means effected by operation of said relay for reducing the primary winding normal operate value thereof.

7. A pulsing circuit comprising an electromagnetic relay having a primary winding and a secondary winding, means for applying current to said primary winding of a magnitude less than the normal operate value of the relay, means for applying current to said secondary winding, means for changing the direction of the current in said secondary winding whereby to aid the current in the primary winding and operate the relay or to oppose the current in the primary winding and release the relay, means including a capacitor for controlling initiation of the flow of current in said secondary winding, a plurality of groups of contact springs associated with said relay, one of said groups comprising first and second opposed contacts and a common swinger member therebetween, said first contact and said swinger member being engaged when said relay is fully released, said second contact and said swinger member being engaged when said relay is fully operated and both said contacts and said swinger member being momentarily bunched with said swinger member engaging both said contacts when said relay is in the condition of operating or releasing, a first resistor, a second resistor, a third resistor, means effective when said relay is in released position for charging said capacitor through said first resistor, means effective when said relay is in the condition of operating or releasing with both said contacts and said swinger member bunched for discharging said capacitor through said second resistor, and means effective when said relay is in fully operated position for charging said capacitor through a path comprising said second and third resistors connected in series with each other and in parallel with said first resistor.

8. A single relay pulsing circuit comprising an electromagnetic relay having a primary and a secondary winding, means for applying a current to said primary winding insufficient to operate said relay, a capacitor, means for charging said capacitor at a first rate, means responsive to charging of said capacitor to cause current to flow in said secondary winding in a direction aiding said primary winding current to operate said relay, means including bunching of relay contacts of said relay for

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rapidly discharging said capacitor at a second rate, means responsive to operation of said relay for changing the current through said primary winding to a value sufficient to maintain said relay operated, means responsive to operation of said relay for charging said capacitor at a third rate, and means responsive to the charging of said capacitor with said relay operated to cause current to flow through said secondary winding in a direction opposing said primary winding current to release said relay, said relay in releasing effecting discharge of

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said capacitor at said second rate through said means including bunching of said relay contacts.

9. A single relay pulsing circuit in accordance with claim 8 further comprising means responsive to discharge of said capacitor with said relay operated for delaying charging of said capacitor at said third rate.

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