March 18, 1941. O. A. PEARCE ET AL 2,235,038

ELECTROMAGNETIC RELAY

Filed May 25, 1938

Fig. 1.

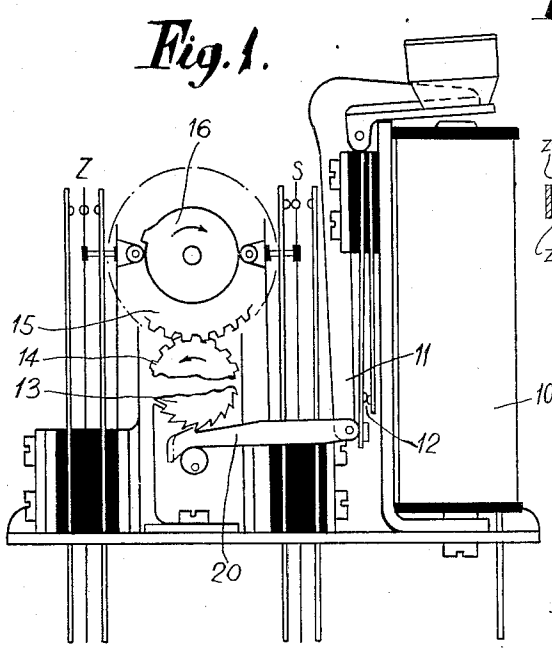


Fig. 3.

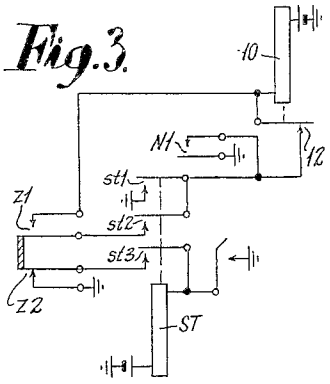


Fig. 2.

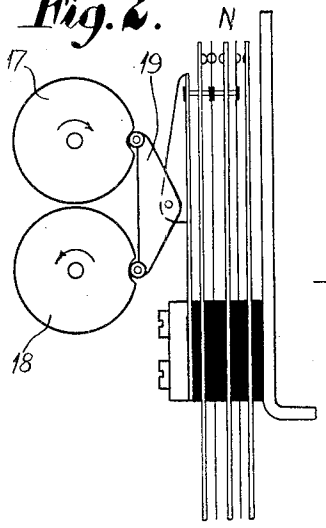


Fig. 4.

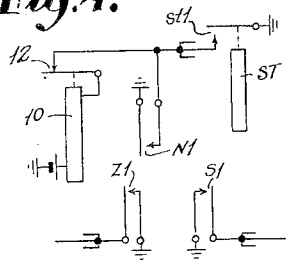
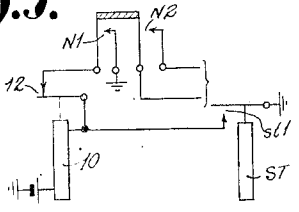


Fig. 5.



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UNITED STATES PATENT OFFICE

2,235,038

ELECTROMAGNETIC RELAY

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Application May 25, 1938, Serial No. 209,904
In Great Britain June 16, 1937

3 Claims. (Cl. 200—105)

The present invention relates to electromagnetic relays of the type used in light current electrical circuits and has for its main object the provision of a cheap and yet efficient mechanism whereby such a relay may be simply adapted to give a substantial delay in the operation of its external circuit contacts after the closure of an energising circuit for its coil.

According to one feature of the invention in an electromagnetic relay the operation of the armature drives a pawl and ratchet mechanism whereby a cam is rotated and operates contacts after a predetermined travel, the magnet being arranged to interrupt its own circuit which after initial operation extends over further contacts controlled by the pawl and ratchet mechanism.

According to another feature of the invention in an electromagnetic relay arranged to operate contacts after a predetermined period of delay the armature operates through pawl and ratchet mechanism to rotate a cam controlling the contacts the operation being by self interruption in a circuit extending over contacts which are closed shortly after the movement starts and are only opened after a predetermined extent of movement has taken place.

A further feature of the invention is that in an electromagnetic relay arranged to operate by self-interruption through pawl and ratchet mechanism to rotate a cam controlling contact springs for producing a desired switching operation, the stepping circuit extends over contacts controlled by a plurality of cams geared to rotate at different speeds.

An advantage of this construction is that although no great precision in adjustment is required the delay period obtainable in the external circuit will remain substantially constant over a large number of operations. Moreover by a slight alteration of the circuit connections involved the relay may be arranged to apply pulses of potential at predetermined intervals to one or more leads connected to different springsets. The relay may be used in this connection in the manner of the well-known time pulse machine which is utilised in telephone systems for the control of metering or fault conditions. Moreover, by a different arrangement of the circuit connections the relay is enabled to act as a very slow to release relay.

The invention will be better understood from the following description of one method of carrying it into effect, reference being had to the accompanying drawing comprising Figs. 1 to 5. Fig. 1 shows a side view of a relay and part of its mechanism according to the invention, the remaining part of the mechanism being shown separately for the purpose of clarity in Fig. 2. Figs. 3, 4 and 5 show three possible circuit arrangements for the relay, the first enabling it to perform a very slow to operate function, the second showing it used as a time pulse generating device, while the third shows it performing a very slow to release function. In each of the Figs. 3, 4 and 5 the springs N, S and Z are shown without their operating cams, it being understood that they correspond to the springs shown in Figs. 1 and 2.

Referring now to Fig. 1, on energisation of the magnet 10 the armature 11 operates and opens the interrupter contacts 12 which are connected in series with the magnet so that the magnet de-energises and restores the armature. Due to the reverse drive principle adopted, the pawl 20 now rotates the ratchet wheel 13 one step and this self-interrupted operation continues so long as potential is applied to the magnet. The ratchet wheel in rotating carries with it a gear wheel 14 which is mounted on the same shaft and which engages with a larger gear wheel 15. This rotates at a speed in accordance with the ratio of the reduction gear and carries with it one or more cams such as 16.

Referring now to Fig. 2, it will be understood that the cam 17 is secured on the same shaft as cam 16, whilst the cam 18 is mounted on the same shaft as the ratchet wheel 13. When the relay is in a normal position as shown, the rollers of the operating lever 19 are resting in the depressions of the cams 17 and 18 and the springset N is thereby in its normal position as shown. Other springsets S and Z, Fig. 1, are also unoperated as shown.

The use of the relay to have a slow operating characteristic will first be described and for this purpose the circuit connections of Fig. 3 will be assumed. When the operation of the stepping mechanism is to be initiated, earth will be connected to the dotted lead to energise a start relay ST whereupon in response to the closure of the armatures *st1* and *st2* thereof, the magnet 10 operates in a self-interrupted circuit and rotates the cam-operating mechanism in the manner described. Cam 18 rotates with the ratchet wheel 13 and as soon as the lower roller of the lever 19 rides on to the face of the cam 18, the springset N is operated and at contacts N1 maintains a driving circuit for the magnet irrespective of armature *st1*. Due to the reduction gear cam 17 rotates slowly with respect to cam 18 but it will

be appreciated that the upper roller of lever 19 rides on to the face of cam 17 before the lower roller can drop into the concavity of cam 18 after it has made one revolution. Hence the springset N is maintained operated throughout the actuation of the device until the cams 17 and 18 have both again arrived at their normal or original positions.

Referring again to Fig. 1, the cam 16 which is driven through the reduction gear is arranged to operate the Z springset once per revolution, while the S springset which is not required in the circuit arrangement of Fig. 3, is operated by another cam (not shown) mounted on the same shaft. After a predetermined number of revolutions of the gear wheel 14, the cam 16 will operate the Z springset and from reference to Fig. 3 it will be seen that the magnet interrupter contacts 12 will now be short-circuited over the operated armature *st2* and the operated contacts Z1. The magnet 10 thereupon holds operated the armature 11 and terminates the rotation of the mechanism.

The Z springset might be arranged as shown to open at contacts Z2 a locking circuit for relay ST the initial energising circuit for which was only completed momentarily. Hence after initial operation it is held operated for the duration of the timed slow period and if desired further Z springs might close an external circuit momentarily at the end of this period. Alternatively relay ST might be maintained energised over its original circuit and the springs Z2 utilised to control external circuit after a delay period. When relay ST is released it opens the initial energising circuit for the magnet 10 at armature *st1* while at armature *st2* the short-circuit is removed from the magnet interrupter contacts 12. The magnet now operates again in a self-interrupted circuit from earth supplied over the operated contacts N1 and the mechanism rotates until the rollers on lever 19 drop into the concavities in cams 17 and 18, this being possible after one revolution of cam 17 since the number of teeth on gear wheel 15 is an exact multiple of the number of teeth on gear wheel 14. In this position of the cams the Z and N springsets will be restored to normal and the driving circuit will be opened by the latter at the contacts N1. The relay is now ready for a second cycle of operation.

The duration of the period timed, which is directly proportional to the reduction gear ratio and the speed of stepping of the ratchet wheel can readily be adjusted by alteration of these factors. Slower operation and more accurate timing may be obtained by the use of weighted armature as shown in Fig. 1.

Referring now to Fig. 4 in which the circuit arrangements are such that the relay may function as a time pulse generating device, it will be seen that on the operation of a start relay ST, armature *st1* completes a self-interrupted driving circuit for the magnet 10 and the mechanism commenses to rotate. The contacts S1 and Z1 of the springsets S and Z are closed at a predetermined stage in each revolution of the associated cams, and they will continue to extend pulses of earth potential on to the common leads S and Z for timing or other purposes so long as the armature *st1* remains closed and maintains the mechanism in motion. On the opening of the armature *st1* the driving circuit for the magnet will be maintained by the contacts N1 so that the mechanism will complete the cycle and restore to its normal position in the manner described in connection with Fig. 3.

Considering now the relay arranged with a very slow to release characteristic as shown in Fig. 5, the magnet 10 in this case will preferably be arranged for direct drive. Relay ST therefore on operating energises the magnet over armature *st1* whereupon the ratchet wheel 13 rotates through one step and at cam 18 operates the springset N. This at contacts N1 prepares a self-interrupted driving circuit for the magnet and at contacts such as N2 completes a control circuit for external apparatus. On the opening of contacts *st1* and removal of the start earth the interrupter contacts 12 are enabled to become effective and the mechanism thereupon slowly rotates in the manner described. When the position shown in Fig. 2 is reached, the contacts N restore and at contacts N1 open the driving circuit and at contacts N2 open the external circuit. Alternatively, if the reverse drive is maintained, an extra armature will be required on relay ST to permit the device to step by self-interruption until the off-normal contacts close and shunt the interrupter springs. When this armature engages its back contact however a restoring circuit is completed over the off-normal contacts to return the device to normal.

We claim:

1. A circuit controller comprising a motor, a stepping device operated by the motor, a series of cams rotated by said stepping mechanism, contact springs operated at intervals by certain of said cams, a pair of said cams moving at different speeds, a cam follower for each of said last cams, and a set of spring contacts operated jointly by said cam followers as long as either of said followers is in operated position.

2. In a circuit controller, a magnet, a shaft carrying a cam and a ratchet mechanism operated by the magnet, a second shaft carrying cams and geared to the first shaft in such a manner that the second shaft moves at less speed than the first shaft, contact springs controlled by certain of the cams individually, and a set of contact springs controlled jointly by a cam on each of said shafts and maintained operated until both said last cams are moved to a particular position.

3. In a circuit controller, a shaft carrying a cam, means for rotating said shaft at a certain speed, a second shaft geared to the first shaft and rotated thereby at a different speed than the first shaft, a plurality of cams on the second shafts, spring contacts operated by certain of said last cams at certain times, a cam follower controlled jointly by a cam on the first shaft and one on the second shaft, spring contacts operated thereby, said cam follower operating its spring contacts upon first movement of the first shaft and maintaining them operated until after a plurality of revolutions of the first shaft and at least one revolution of the second shaft.

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