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O. S. FIELD

2,748,857

TIME ELEMENT RELAY

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3 Sheets-Sheet 1

FIG. 1.

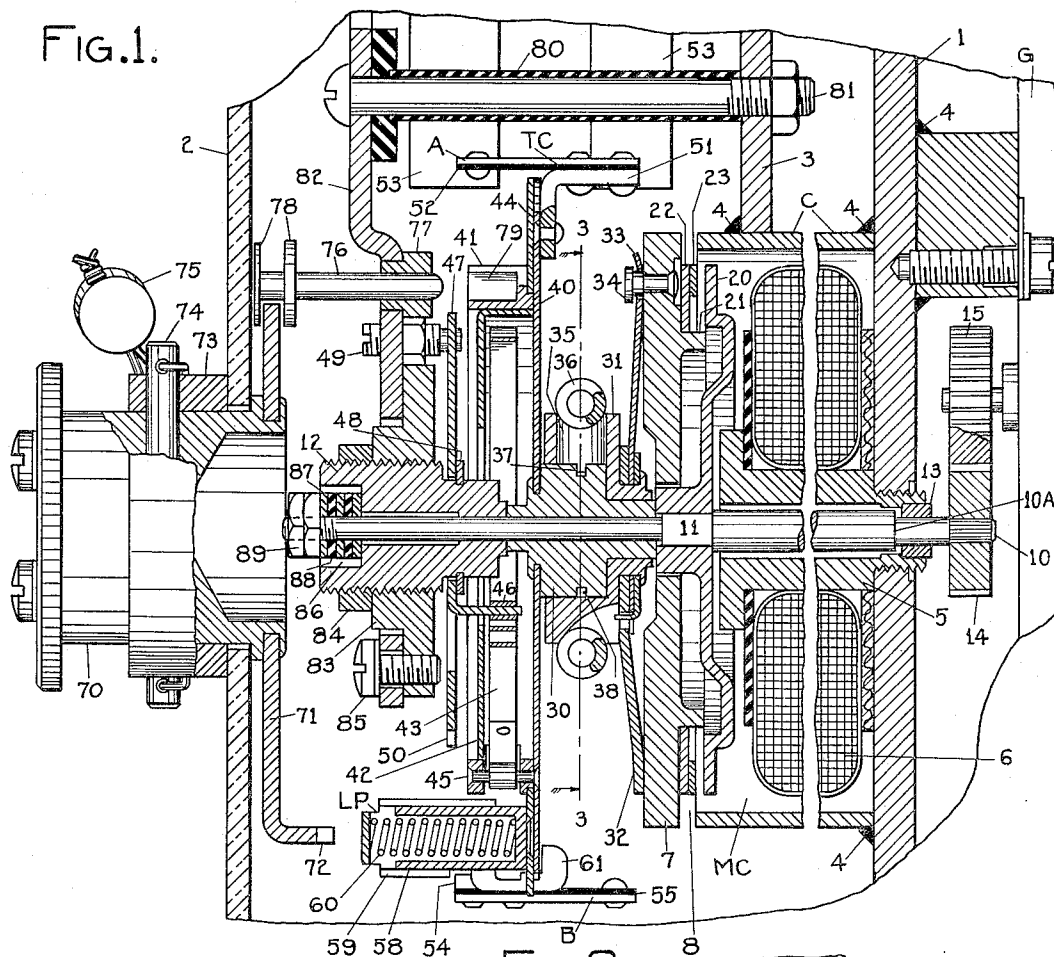


FIG. 2.

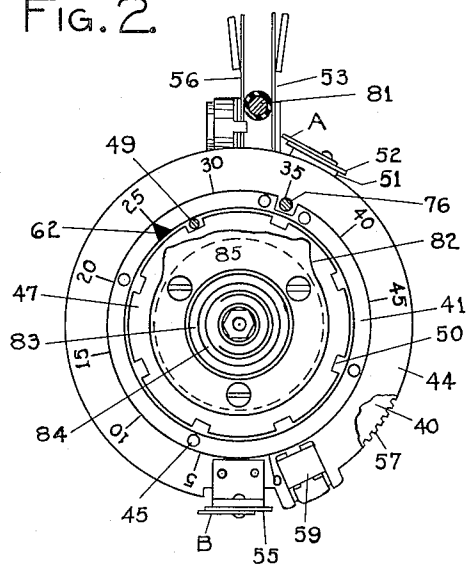
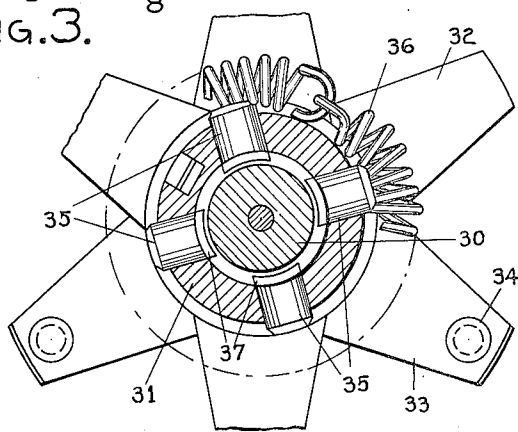


FIG. 3.



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1

2,748,857

TIME ELEMENT RELAY

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2 Claims. (Cl. 161—1)

This invention relates in general to electrically operated time element relays, and more particularly pertains to improvements in timing devices of a character which are actuated by a constant speed motor and are especially adapted for railroad use.

In certain railway signalling systems, a train may be required to consume a certain minimum amount of time to travel a predetermined distance between two points to avoid a penalty. This requires a timing device having a high degree of accuracy measured in seconds and a quick restoring feature to condition the device for a following train. Such a type of timing device is already disclosed in my prior Patent No. 2,378,293, dated June 12, 1945, and the patent to Merkel, No. 2,507,989, dated May 16, 1950. The present invention is in the nature of an improvement over the above mentioned patents and provides a timing device of greater accuracy and with more serviceable qualities.

One object of the present invention is the provision of a direct drive from the motor to the contact operating means thus insuring no lost time in starting the timing period due to gear meshing and back-lash as found in previous structures.

Another object of the invention is that the drive mechanism assure quick and positive freedom of return of the timing mechanism to its initial position.

A still further object of the invention is the provision of an anti-bounce friction drive device to absorb the shock and prevent bobbing of the timing mechanism upon its return to its initial position.

Another feature of the invention is the ease of positive adjustment of the time interval, the airgap of the electromagnetic clutch armature, and the end play of the time setting parts.

An additional feature of the present invention is the provision of an electromagnetic friction type clutch constructed to avoid sticking due to molecular adhesion and to be a self-clearing structure.

Further objects, purposes and characteristic features of the present invention will appear as the description progresses, reference being made to the accompanying drawings showing, solely by way of example, one form which the invention can assume.

In the drawings:

Fig. 1 is a sectional elevation view of the electromagnetic clutch, friction drive device, contact structure and biasing mechanism, and time adjusting means embodying the invention, the relay housing and motor being broken away for simplification purposes;

Fig. 2 is a front view of the contact structure and time adjusting means shown in section in Fig. 1;

Fig. 3 is a partial sectional view taken on the line 3—3 in Fig. 1 and shows the structure of the frictional drive device located between the electromagnetic clutch and contact structure mechanism;

Fig. 4 is a plan view of the spacer ring of the electromagnetic clutch having radial undulations;

Fig. 5 is an isometric exploded view of the timing de-

2

vice as shown in Fig. 1 and includes a simplified circuit diagram showing one form of control of operation.

Fig. 6 is a functional diagram of the timing device embodying the present invention with various parts shown to illustrate the respective functions and without regard to their actual forms and relative sizes.

Referring now more particularly to Fig. 1 of the drawings, there has been shown part of the relay housing back portion supporting wall 1 and part of the transparent front and side walls 2, inside of which is mounted the timing device constituting the invention. This timing device comprises in part a magnetic clutch MC having a housing or casing C which is suitably welded to the back wall 1 and a central support 3 of the relay housing as shown at 4; a core 5 which is threaded into the back wall 1 of the relay housing; a coil 6 mounted on the core 5; and an armature 7 suitably supported, as described hereinafter. The core 5 and coil 6 are mounted within the casing C; and the armature 7 is mounted adjacent the open end of the casing C with a suitable airgap, as shown at 8, maintained therebetween.

The core 5 is hollow and extending therethrough is a shaft 10 having a centrally located squared portion 11. The left-hand end of this shaft 10 is mounted in and extends through a bearing 12 suitably supported and adjusted as described hereinafter; and the right-hand end of this shaft 10 is mounted in and extends through a bearing 13 which is pressed into the right-hand end of the hollow core 5. This right-hand end of the shaft 10 which extends through the bearing 13 has a gear 14 fastened thereto, which gear meshes with a similar gear 15 which is part of a gear train G connected to a constant speed motor M (diagrammatically indicated in Fig. 5) which drives the complete timing mechanism.

Fixedly mounted on the square portion 11 of the shaft 10, and so located that it lies between the enlarged end of the core 5 and the armature 7 and within the casing C, is a cup-shaped disc 20 whose left-hand face forms one surface of a friction drive. The right-hand face of the armature 7 forms the other surface of the friction drive. Inserted between these two surfaces and supported by the shoulder 21 on the armature 7 are two friction rings 22 and 23, the ring 23 being undulant in plan (see Fig. 4). The cup-shaped disc 20 and the friction ring 22 are preferably made of a non-magnetic type of stainless steel. The undulant shaped friction ring 23 is preferably made of German silver.

In brief, the frictional portions of the electromagnetic clutch are arranged to provide different metals for adjacent contacting surfaces. The armature 7 is cadmium plated next to which is located a stainless steel ring 22 with a German silver ring 23 between it and the cup-shaped disc 20 also of stainless steel. The metals being different in character tend to prevent molecular adhesion. In addition, the ring 23 has radial undulations as shown in Fig. 4, and these undulations make it so that the ring 23 has a little more than half the area of ring 22, the ring 22 being outlined in dot and dash lines to show this comparison. The main point of this structure is that there are a plurality of edges of the ring 23 which wipe the surfaces of the ring 22 and the disc 20 giving a cleaning effect and variations in the contacting conditions such as to prevent a close adhesive condition as found in many structures of this general character. With this arrangement, the deenergization of the winding 6 of the electromagnetic clutch allows the immediate retraction of the armature 7 by the trefoil springs 33.

From the description already given of the electromagnetic clutch MC and with reference to the drawings, it can be understood and seen that with the motor M and gear train G energized and running, the shaft 10 and cup-shaped disc 20 are revolving at a constant speed

3

through the medium of the gear connection 14—15. When the coil 6 is energized, the armature 7 is attracted to the casing C, tending to close the air-gap 8. This attraction and movement of the armature brings the clutch faces of the armature 7 and cup-shaped disc 20 and the friction rings 22 and 23 together forming a friction drive between the motor M and the armature 7.

Another friction drive is provided between the armature 7 and the timing contact assembly TC for reasons hereinafter explained. This friction drive has a collar 30 rotatably mounted on the shaft 10 adjacent to the armature 7, said collar 30 being rigidly staked to the housing of the timing contact assembly TC. Mounted so as to rotate about the collar 30 is a hub 31 and staked and keyed to this hub 31 is a trefoil stop 32 and a trefoil spring 33 which support the armature and bias it to its retracted position. This trefoil spring 33 has a hole in the end of each of its three prongs (see Fig. 3), these prongs being slightly bent towards the armature. Shouldered rivets 34 are passed through these holes and into similar aligned holes in the armature, whereupon the rivets are staked over. This assembly allows the armature 7 to be attracted to the casing C when the coil 6 is energized, the movement of the armature creating a tension in the prongs of the spring 33, which tension returns the armature 7 against the three prongs of the stop 32 when the coil 6 is deenergized.

The friction drive takes place between the collar 30 and the hub 31; and comprises four plungers 35 (see Fig. 3) located in four radial holes in the hub 31, the inside ends of said plungers bearing against the periphery of the collar 30. These plungers are forcibly pressed against the collar 30 by means of an endless tension spring 36 which is wrapped around and bears against the outside ends of the four plungers 35. The inside ends of the plungers 35 are provided with fins 37 which ride in an annular groove 38 in the collar 30, the purpose of which is to prevent more than a slight longitudinal movement between the collar and the hub 31.

Under normal operating conditions with the armature 7 revolving as previously described, it can now be understood that the armature 7 in turn drives the hub 31 through the medium of the rivets 34 and the trefoil spring 33, which hub 31 drives the collar 30 through the medium of the friction between the inside ends of the plungers 35 and the collar 30.

As previously mentioned, the collar 30 is staked to the housing of the timing contact assembly TC. This timing contact assembly TC comprises a gear wheel 40 which also forms the back wall of the housing, a cylindrical ring 41 riveted to the gear wheel 40 by rivets such as rivet 45, a cap 42 pressed into the open end of the cylindrical ring 41 to form an enclosed housing for a flat spiral spring 43, and contacts A and B which are attached to, but insulated from, the gear wheel 40 and an adjustable dial 44 respectively. This adjustable dial 44 lies next to the gear wheel 40 and within a groove in the periphery of the cylindrical ring 41, and is adapted to turn with respect to said gear wheel 40. The outer end of the flat spiral spring 43 is fastened to the cylindrical ring 41 by the rivet or pin 45 while the inner end of this spring 43 is anchored to a projecting lug 46 which is part of a notched wheel 47. This notched wheel 47 is adapted to turn on the hub of bearing 12 and is held in place on bearing member 12 by a split ring 48. As the projecting lug 46 on this wheel 47 is anchored to the inner end of the spring 43, this wheel 47 may be turned to set the desired tension of the spring 43, after which a set screw 49, located in a central support 82 is turned to engage one of the various notches 50 in the periphery of the wheel 47 (see Fig. 5).

As previously mentioned, the gear wheel 40 carries a bridging contact A fastened thereto by means of an angle support 51 which is riveted to the gear wheel 40, a piece

4

of insulating material 52 riveted to the angle support 51 and the bridging contact A being riveted in turn to the insulating material 52. This contact A bridges a pair of contact springs 53 suitably mounted in the relay housing, when the timing device is in the normal position as shown.

Also, as previously mentioned, the adjustable dial 44 carries a bridging contact B fastened thereto by similar means as just described in connection with contact A and gear wheel 40, that is, an angle support 54, and an insulating member 55, and is adapted to bridge a pair of contact springs 56 when the timing device is in its fully operated position. These contact springs 53 and 56 also act as stops for the timing mechanism when in either of its two extreme positions and are held fairly rigid by bearing against an insulated sleeve 80 which is mounted on a bolt 81 which passes between the two central supports 3 and 82. The adjustable dial 44 also carries a spring biased locking plunger LP which normally locks the adjustable dial 44 and gear wheel 40 together by means of the plunger LP passing between two of the teeth 57 of the gear wheel 40. This locking plunger LP comprises two telescoping squared cups 58 and 59 biased apart by a coil spring 60, the inside cup 58 being fastened to the adjustable dial 44 while the outside cup 59 carries a hook shaped arm 61 which engages the teeth 57 of the gear wheel 40.

From the description already given and with reference to the drawings, it should now be understood how the motor M and gear train G drives the armature 7 through the medium of one friction drive, how the armature 7 drives the collar 30 through the medium of another friction drive device, and how the collar 30 drives the timing contact assembly TC to its fully operated position. This fully operated position is determined when the contact B bridges the contact springs 56 and cuts off current to the operating motor M and the magnetic clutch MC.

The cylindrical ring 41, which is fastened to the gear wheel 40, has a suitable indicating arrow 62 marked thereon and the adjustable dial 44 has graduated second timing marking thereon as shown. In the initial assembly, the timing may be changed or initially set merely by holding the gear wheel 40 stationary, pressing the outside cup 59 inward to compress the spring 60 and disengage the hook shaped arm 61 from the teeth 57 of the gear wheel 40, and then turning the dial 44 until the desired second timing lines up with the indicating arrow 62, as shown for example on the drawing which indicates that the timing is set for 25 seconds.

It is a standard railway requirement that such timing relays be properly sealed after their initial setting to prevent tampering with the timing adjustment for malicious purposes or for the purpose of defeating penalties in connection with the operation of trains.

For this reason, suitable sealing means and adjusting means are provided on the outside of the relay housing for authorized personnel to make adjustments when required. This outside adjusting means comprises a shouldered knob 70 which extends through the transparent front wall 2 of the relay housing and has a round plate 71 staked on the end thereof. This round plate 71 has a forked lug 72 thereon for engaging the locking plunger LP when pressed into the operating position. However, this shouldered knob 70 cannot normally be pressed into engagement with the locking plunger LP because of the sealing means which comprises a collar 73 mounted on the knob 70, a pin 74 which passes through aligned holes in the collar 73 and the knob 70, and a seal 75 which passes through holes located in both ends of the pin 74 outside the periphery of the collar 73. A plunger 76 is provided inside the relay housing for holding the gear wheel 40 stationary when the timing dial is being adjusted. This plunger 76 is slidably mounted in a bushing 77 located in the central support 82 of the relay housing and is formed with a grooved collar 78 at its left-hand end to accommodate the edge of the plate 71. The right-hand

5

end of this plunger 76 is adapted to fit into a slot 79 in the cylindrical ring 41 when in its operated position. When making an adjustment from the outside of the relay housing, it is first necessary to break the seal 75 and remove the pin 74. The knob 70 may now be pressed inwardly and turned if necessary until the forked lug 72 engages the outer cup 59 of the locking plunger LP. Further inward movement of the knob 70 disengages the hook shaped arm 61 from the teeth 57 of the gear wheel 40 and also forces the end of the plunger 76 into the slot 79 located in the cylindrical ring 41. With the knob 70 held in the position just described, the dial 44 is disengaged from the gear wheel 40 while the gear wheel is held stationary and it is only necessary to turn the knob 70 to the desired timing position whereupon the knob may be released and it will return to its original outward position due to the action of the coil spring 60 located within the locking plunger LP. The relay may now be resealed by replacing pin 74 and seal 75.

With reference to the left-hand shaft bearing 12, this bearing is threaded into a flanged collar 83 and is held in place with a lock nut 84. The flanged collar 83 is mounted in an opening in the central support 82 by means of three screws 85 which pass through slightly enlarged holes in the central support 82. The purpose of the enlarged holes is to allow radial adjustment of the bearing 12 so that the shaft 10 can be properly aligned with respect to the hole through the core 5. The bearing 12 is hollowed out at its extreme left-hand end as shown at 86 and the left-hand end of the shaft 10 is threaded and provided with lock nuts 89. Alternate washers 87 of stainless steel and washers 88 of nylon are slid over the shaft 10 and into the hollowed out portion 86 of the bearing 12 after which the nuts 89 are tightened down until the end play is taken up between the bearing 12, hub 30 and the disc 20. The washers 87 and 88 absorb the friction which is produced by the thrust of the shaft 10 in a right-hand direction which is caused by the pressure against the disc 20 when the magnetic clutch MC is energized. The bearing 12 is adjustably mounted as previously described so that the airgap 8 between the armature 7 and the casing C of the magnetic clutch MC may be suitably varied as required. Suitable clearance is provided between the hub 10A of the shaft 10 and the bearing 13 to facilitate making this airgap adjustment.

The operation of the timing device can probably best be understood by reference to Fig. 5 of the drawings which in addition to showing the various parts in isometric and separated fashion also includes circuit connections of a simplified nature to indicate one way in which the timing device may be connected to perform its timing operation. Also, for the purpose of considering the operation, reference may be made to the functional diagram of Fig. 6. This functional diagram will not be described separately but may be considered in connection with the description given with respect to the actual structure previously described. This functional diagram of Fig. 6 has been made without regard to the size and shape of parts and in some cases some parts have been made of different form in order to illustrate the functions involved. It is believed that these various relationships between the functional diagram and the actual structure shown in Figs. 1 to 5 will be readily understood so that no effort will be made to provide a separate description of this Fig. 6.

For convenience in the exploded view of Fig. 5, a switch SW is shown as the device giving the control to be timed. This switch SW is normally in a position shown but it can be manually actuated to an operated position and later restored to its normal position as desired. Obviously, this switch SW is merely representative of any device having a movable contact the operation of which initiates a timing operation.

As shown, a secondary relay SR is associated with the switch SW and the timer so as to provide suitable control

6

more specifically described hereinafter. A check circuit is provided to check the restoration of the device SW, the secondary relay SR, and the timer to their normal positions. The timed circuit is shown as being completed upon the closure of front contact 102 of the secondary relay SR.

More specifically, the check circuit is shown as including the switch SW in its normal position, a back contact 100 of the secondary relay SR, through the stationary contacts 53 of the timer as bridged by movable contact A of the timing device. When this circuit includes a relay or indicator lamp and is closed, an indication is given that the timing device and other associated devices are in their normal positions ready for a timing operation.

When the switch SW is actuated to an operated position, the check circuit is opened, and the timing operation is initiated by the closure of the energizing circuit for the motor M and the magnetic clutch MC. More specifically, this circuit includes the switch SW in operated position, back contact 101 of relay SR, the motor M in multiple with the windings of the magnetic clutch MC. The motor M is assumed to be of the constant speed type and operates through the gear train G to drive gears 14 and 15. This rotates the shaft 10 and the cup-shaped disc 20 at a constant speed in a clockwise direction.

The coil winding 6 of the electromagnetic clutch MC also being energized, sets up a magnetic field in a circuit extending from the pole piece of the core 5, through the armature 7, the casing C, the relay housing wall 1 and the core 5. The cup-shaped disc 20 is preferably made of a nonmagnetic type of stainless steel but may be Phosphor bronze or other suitable nonmagnetic material so as not to affect the above described magnetic field. The setting up of this magnetic field attracts the spring biased armature 7 to the casing C through the airgap 8, and causes the armature 7 to contact the revolving disc 20 through the medium of the friction rings 22 and 23, whereupon the armature 7 will revolve at a constant speed.

The revolving armature 7 in its attracted position is pulled away from its trefoil stop 32 and against the bias of the trefoil spring 33. The armature 7 also drives the hub 31 through the medium of the trefoil spring 33. The hub 31 in turn drives the collar 30 through the previously described friction drive consisting of the four plungers 35 and the spring 36. With the collar 30 now revolving and the timing contact assembly TC being staked thereto, the timing mechanism is put into operation at a constant speed and in a clockwise direction.

With the timing mechanism now in operation, the bridging contact A moves away from the contacts 53 which also act as stops and the timing period, which is assumed to be 25 seconds and for which the time element is set as shown on the drawings, has been started. As previously described, one end of the coil spring 43 is fastened to the gear wheel 40 by the pin 45 and the other end of this spring 43 is anchored to the lug 46 of the notched wheel 47 which in turn is held in place by the set screw 49, so that, as the gear wheel 40 revolves the spiral spring 43 is wound up until the timing period is over. When the set timing period is completed, the bridging contact B will bridge the contacts 56 and complete an energizing circuit for the secondary relay SR from (+) through the switch SW in an operated position. With this relay SR energized, its contact 101, which is a make-before-break contact, will pick up and complete a stick circuit for its own relay coil at its front point before it breaks contact at its back point and de-energizes the coil 6 of the magnetic clutch MC and the constant speed motor M. Also, a contact 102 of the relay SR is picked up which completes the timed circuit for whatever purpose desired.

With the winding 6 and the motor M deenergized, the trefoil spring 33 biases the armature 7 back to normal against the trefoil stop 32 and breaks the friction drive connection between said armature 7, friction rings 22

and 23 and the disc 20. The timing mechanism now starts to return to its normal position through the action of the wound up spiral spring 43, whereupon the bridging contact B breaks the circuit between the two contacts 56, but the secondary relay SR remains energized because it is stuck up through its own front contact 101 and the switch SW in an operated position. As the spiral spring 43 is returning the mechanism to its normal position, the gear wheel 40 and its associated bridging contact A, the collar 30, the hub 31 and its associated trefoil spring 33 and armature 7 are revolving about the shaft 10 in a counterclockwise direction, the armature 7 acting as a flywheel. As the mechanism completes its return movement the bridging contact A strikes the contacts 53 which are retained in place by the retaining bolt 81 and insulating sleeve 80 and the mechanism comes to a sudden stop. Rebounding and jars which may be injurious to the mechanism are prevented because the inertia of the armature 7, acting as a flywheel, will keep it turning and it will be braked to a smooth stop through the friction drive connection previously described, the hub 31 slipping around the stationary collar 30 against the pressure exerted by the plungers 35. The timing operation now being completed, the control switch SW may be opened which causes the secondary relay SR to drop and the check circuit will again be established through the back contact of said switch SW, back contact 100 of the relay SR and the timing mechanism contacts 53 and A, this indicating that the device is conditioned for another timing operation.

The control switch SW (representing the device to be timed) may be restored to normal at any time, and whenever the back contact of this switch SW is opened, the timing devices are deenergized and restored to normal. If the back contact of the switch SW is opened during a timing operation, it is apparent that the motor M and magnetic clutch MC are immediately deenergized and they return to their normal positions. On the other hand, if the timing operation has been completed and the timing device is already in its normal position, then only the secondary relay SR is energized so that the opening of the back contact of the switch SW deenergizes the secondary relay and it quickly drops away to open the timed circuit.

As shown, the timed circuit is indicated as merely including the front contact 102 of the secondary relay SR. But it is to be understood that the timed circuit may, if desired, also include the back contacts 53. In such a case, the timing operation is partially completed upon the picking up of the relay SR and is only fully completed when the timing device has shortly thereafter restored to its normal position to allow the bridging contact A to complete the circuit through stationary contacts 53. This combining of the timed circuit and the back contacts makes it so that even though the timing operation is interrupted and another timing operation is immediately initiated, such operation is always assured of initiation with the timing device in its normal position.

From the foregoing explanation and by reference to the drawings, it is believed that a timing device has been provided which is a distinct improvement over other known devices, since it has the advantage of a direct drive from the motor. This eliminates any gear meshing while in motion and any unavoidable back-lashing. The device of this invention also has a positive quick return to its initial position without the accompanying shock and bobbing difficulties which result in faulty operation. This device in addition provides easy and positive adjustments of all essential elements such as armature air-gap and release, time element settings, and alignment and end play of the various parts.

It should also be understood that although the invention has been shown and explained in connection with a D. C. type constant speed operating motor as is shown

in the above mentioned patent to O. S. Field No. 2,378,293, it can also be adapted to use any other constant speed type of motor such as a synchronous A. C. type motor.

Having thus shown and described one specific form of timing device embodying the present invention, it should be understood that various adaptations, alterations and modifications may be applied to the specific form shown to meet the requirements of practice without in any manner departing from the spirit or scope of the present invention except as limited by the appending claims.

What I claim is:

1. In a contact making timing device, a shaft, a constant speed motor operatively connected through reduction gearing to said shaft for at times rotating it at a relatively slow rate, a contact carrying member freely rotatable on said shaft and operable from a fixed normal position to an operated position, fixed contact members located in said normal and said operated positions and rendered effective to close circuits when said contact carrying member is in a corresponding position, a torsional spring for biasing said rotatable contact carrying member to a normal position in a direction opposite to the direction of rotation of said shaft, means for at times causing said contact carrying member to be operated against the bias of said spring and comprising a hub member on said shaft freely rotatable with respect thereto, said hub member also having said contact carrying member attached thereto, said hub member having a groove around its outer periphery, a collar member surrounding said hub member and having a plurality of radial holes in said collar with their axes passing through the axial center of said collar and hub members, a plurality of plungers one for each hole in said collar and each having a projection to be received by said groove in said hub member, a coil spring extending around the periphery of said collar for forcing said plungers within the respective holes of said collar and against said hub member with a predetermined force, and an electromagnetic clutch comprising a disc of nonmagnetic material attached to said shaft, an armature mounted on said shaft but rotatable with respect thereto, supporting springs for said armature connected to said collar member effective to bias said armature toward said collar away from said disc and also effective to cause said collar to be rotatably fixed with respect to said armature, said armature being constructed to have sufficient moment of inertia that its angular momentum when rotating to its fixed normal position under influence of said torsional spring causes it to continue rotating for a time against the frictional braking effect of said plungers after said contact carrying member has been restored to said fixed normal position, said electromagnetic clutch when energized causing said armature to frictionally engage said disc and be rotated thereby with such action increasing the tension on said springs between said collar and said armature but with said collar being prevented from lateral movement by said projections on said plungers being engaged by the groove in said hub member.

2. In a timing device, a shaft, a constant speed motor connected to said shaft through a reduction gearing, a movable contact carrying member mounted on said shaft to freely rotate with respect thereto, a spring for rotationally biasing said contact carrying member to a particular normal position, and means for at times operatively connecting said contact carrying member to said shaft comprising an electro-magnetic clutch having a disc attached to said shaft and a rotatable armature mounted on said shaft with two thin rings of dissimilar metals being positioned between said disc and the face of said rotatable armature, one of said friction rings being of conventional annular form and the other being of a radially sinuous form to give an effective width greater than its actual width at any point, said armature being rotatable with respect to said shaft and actuatable to an

9

energized position to positively engage said disc when said electro-magnetic clutch is energized, and a friction drive device connecting said armature with said contact carrying member, said armature being constructed to have sufficient moment of inertia that its angular momentum when rotating to its original position under influence of said biasing spring causes it to continue rotating for a time against the frictional braking effect of said friction drive device after said contact carrying member has been restored to its said normal position, whereby said momentum is dissipated without shock and vibration.

5

10

10

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