July 23, 1957 E. B. FARMER 2,800,536

TIMING SWITCH

Filed Jan. 8, 1954 2 Sheets-Sheet 1

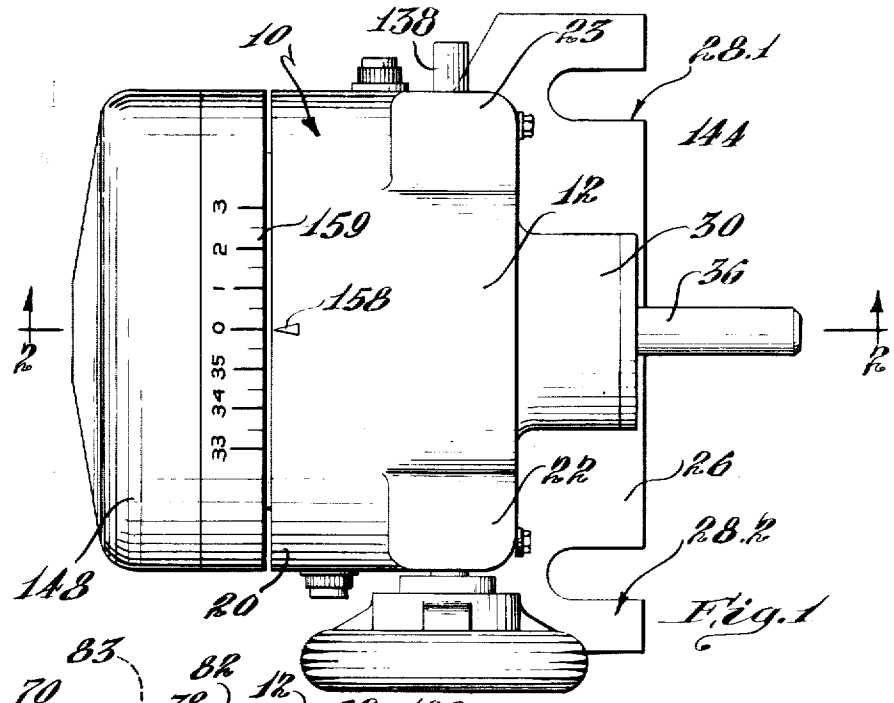


Fig. 1

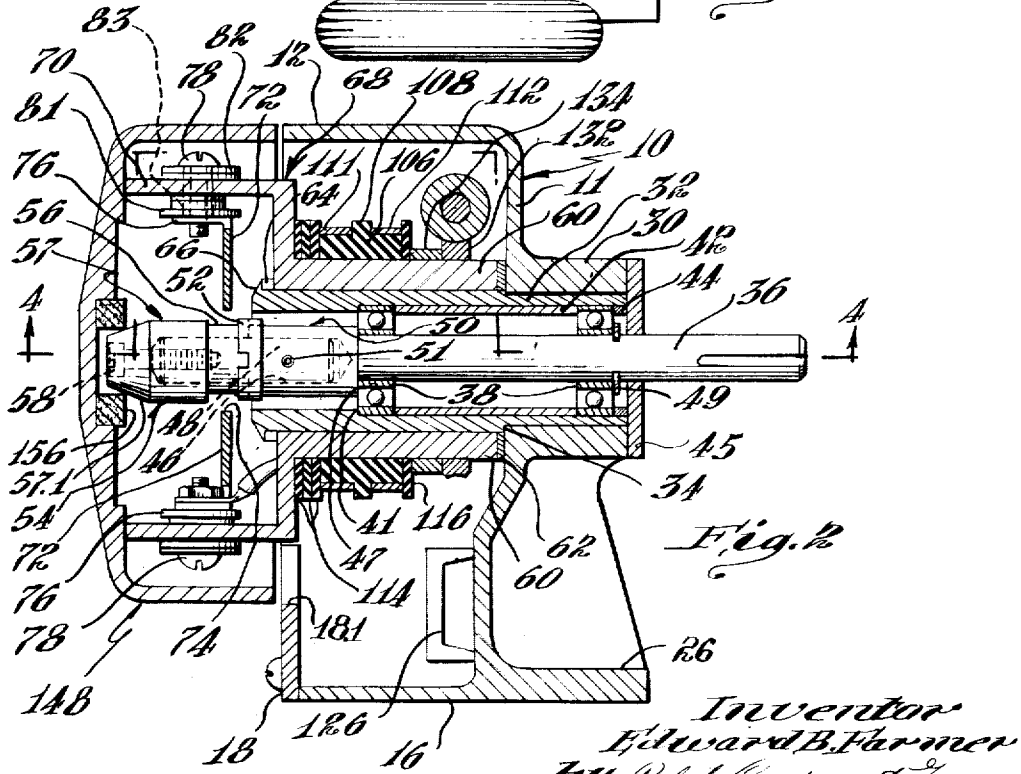


Fig. 2

Inventor
Edward B. Farmer
By Robert Cushman & Inow
Att'ys.

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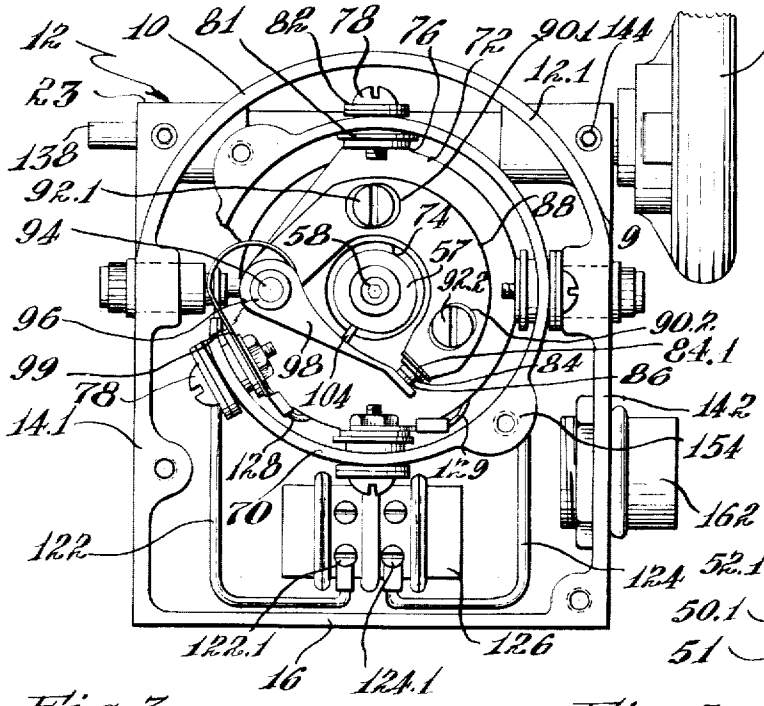


Fig. 3

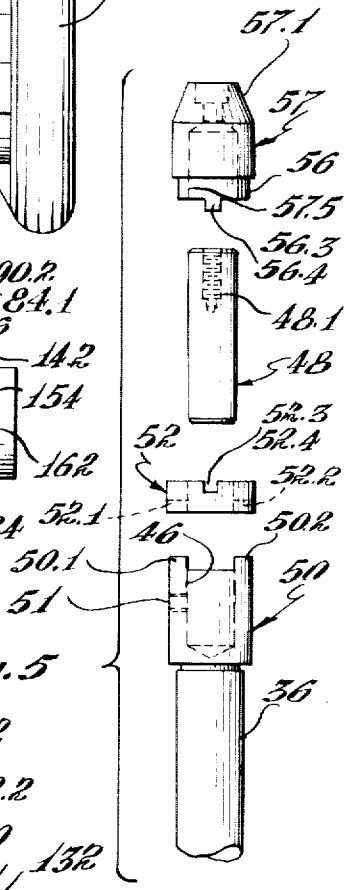


Fig. 5

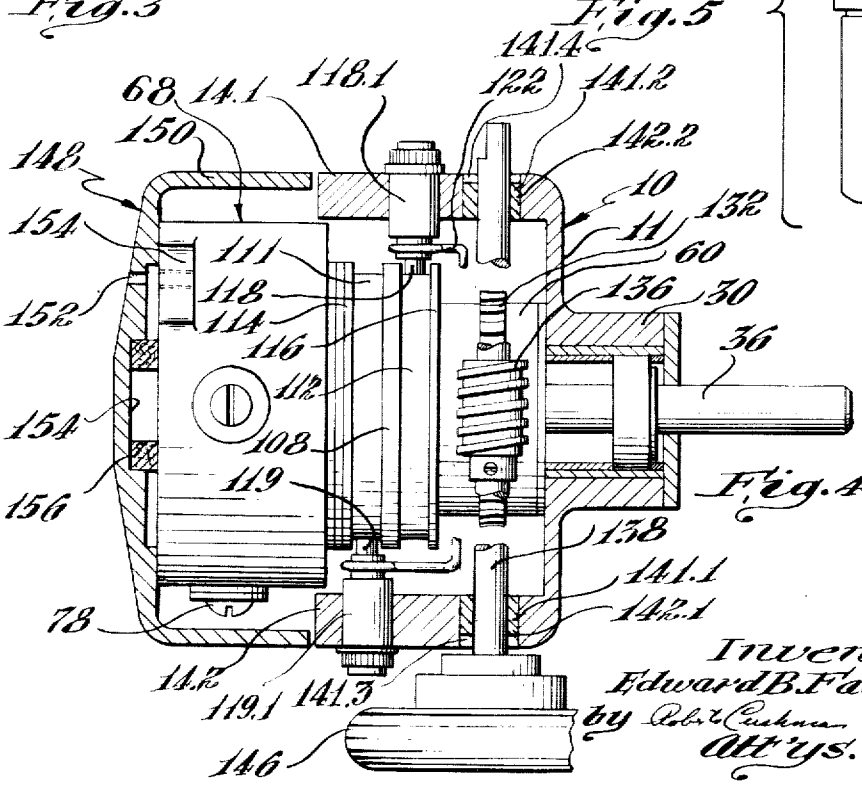


Fig. 4

Inventor
Edward B. Farmer
by Robt. Cushman & Grover
Att'ys.

United States Patent Office

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TIMING SWITCH

Edward B. Farmer, Waban, Mass.

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8 Claims. (Cl. 200—31)

The invention relates to electric switch gear, especially to high speed rotary timing switches.

Objects of the invention are to provide a rotary switch which can be driven at high speed, with a minimum of wear on the moving parts, to open and close a circuit at predetermined times during each revolution of a driving shaft, to provide a switch which can be continuously adjusted to vary and securely to hold the timing with reference to the angular position of the shaft, which has means for varying the rotational torque required to adjust the switch, and which can be easily adapted to perform varied timing operations, and to provide a switch which is compactly and securely mounted in a housing permitting convenient access for inspection and repair, and which has easily observable means for indicating the angular position of the switching point with reference to the shaft at any given time.

To accomplish these and other objects, high speed rotary timing switches according to the invention are driven by a shaft journalled in a base on which a switch support is rotatably mounted. Switch means having relatively movable contacts and means adjacent the shaft for making and breaking contact are mounted on the support and cam means are interchangeably attached to the shaft for actuating the making and breaking means at a given position thereof relatively to the base. For adjusting the spatial relation between the switch support and the base, self-arresting means such as low pitch worm gear are provided, preferably together with a slip ring arrangement for connecting the contacts to terminals on the base, and together with index means for indicating the relative position of the base and the switch support, whereby the switch is operated by the cam in a predetermined position of the switch support relatively to the base which position, and hence a selected phase relation between shaft rotation and the contact making and breaking, can be established and maintained by the adjusting means, with the aid of the index means.

These and other objects and aspects of novelty of the invention will appear from the herein presented outline of its principles and practical possibilities together with a description of a practical embodiment illustrating its novel characteristics. These refer to drawings in which:

Fig. 1 is a top view of the switch;

Fig. 2 is a vertical section taken on line 2—2 of Fig. 1;

Fig. 3 is a front view of the switch with the cover removed;

Fig. 4 is a horizontal section taken on line 4—4 of Fig. 2; and

Fig. 5 is an exploded detail view of the cam assembly.

The switch according to the invention is mounted on a supporting base such as a substantially rectangular open face shell **10** having a back wall **11** (Figs. 1 and 2), and forwardly projecting top, side and bottom walls **12**, **14** and **16**, respectively. The open front is partially closed by a front wall strip **18** (Fig. 2) fastened across the lower part of the housing and forming with the forward edges

of the top and side walls **12**, **14.1**, **14.2**, respectively, a substantially circular opening. To this end the portion **12.1** of the top wall (Figs. 1, 3) is made circular near its forward edge and merges with the side walls at about the horizontal diameter of the circular opening while the bottom wall strip **18** has a circular upper edge **18.1** (Fig. 2) which forms the lower half of the circular opening. Towards the rear wall **11**, side walls **14** and top wall **12** form two substantially rectangular shoulders **22**, **23** (Figs. 1, 3). The frame has at its bottom a rearwardly extending mounting or base flange **26**, with a pair of slots **28** for bolts. Rear wall **11** has a rearwardly extending bearing boss **30**.

A hollow cylindrical arbor **32** (Fig. 2) having a shoulder **34** intermediate its ends is press-fitted into the bearing boss **30**, with the shoulder **34** abutting the inner end of the boss so that the larger portion of the arbor extends forwardly from the rear wall **11**. A shaft **36** is journaled within the hollow arbor in spaced ball bearings **38**, the inside diameter of the arbor being enlarged to form a shoulder **41**. The bearings are held in spaced relation within the enlarged portion by a spacer sleeve **42**, a follower ring **44** and a cap plate **45** fastened to the outer end of the bearing boss **30**. The shaft **36** is fastened to its bearing race rings by a shoulder **47** at its forward end which engages the forward side of the forward race ring, and by a lock ring **49** set in an annular groove and engaging the rear side of the rear race ring. Forward of the shoulder **47** the shaft has an end or socket portion **50** on which is mounted a cam **54** (Fig. 2) in the manner shown in Fig. 5, as follows. The end portion **50** has an axial socket **46** (see also Fig. 2) for the rear end of an insulator pin **48** made for example of Bakelite. This pin is retained in the socket **46** by means of a set screw in a tapped hole **51** of the socket wall of the shaft end portion. An insulating spacer **52**, made for example of nylon, engages with two slots **52.1**, **52.2**, two corresponding studs **50.1**, **50.2** of the socket portion **50**. The spacer **52** has on the other side two further slots **52.3**, **52.4**. The forward end of insulating pin **48** has an axially tapped hole **48.1**. The cam body **54**, made of steel, has a sleeve portion **56** with two studs **56.3**, **56.4** corresponding to slots **52.3**, **52.4** of the spacer ring **52**. The cam proper **57** is a hardened and polished eccentric (Fig. 1) terminating in a conical lubricating portion **57.1**. The cam body has a socket portion **57.5** for the insulating pin **48** and a counterbored hole for a screw **58** (Figs. 2 and 3) fitting the tapped hole **48.1** of the pin **48**. This construction provides an angularly exact fit between cam and shaft and at the same time permits ready exchange of cam bodies simply by removing screw **58**. Furthermore, spacer **52** and pin **48** provide reliable electrical insulation between shaft and cam. The cam lubrication will be described below.

A hub **60** (Fig. 2) is mounted on the outside of the arbor **32** for rotation thereon with its rear end abutting a thrust ring **62**, made for example of nylon, resting against the inner end of the bearing boss **30**. The hub is retained by a lock ring **64**, placed between the hub end and a radial flange **66** on the forward end of the arbor **32**. The hub **60** carries at its forward end a switch support such as an open drum **68**, having a forwardly extending cylindrical wall **70** (Figs. 2 and 3), which is concentric with the shaft **36** and for the most part projects beyond the forward edges of the walls of the housing. Within the drum **68** is a switch plate **72** (Figs. 2 and 3) which has a circular opening **74** at its center through which projects the forward part of the shaft **36**. The switch plate **72** is supported on the drum by means of four forwardly projecting ears **76** (Figs. 2 and 3) with threaded openings for screws **78** inserted through correspondingly located holes in the cylindrical wall **70**. The switch plate **72** is completely insulated from the drum by insulating washers

81, 82, placed between the ears, the drum wall, and the heads of the screws, and by sleeves 83 surrounding the shank of the screws where they pass through the wall.

The switch plate 72 carries the switch proper which consists of the contacts 84 and 86 (Fig. 3) of a make and break switch, preferably of the conventional automotive breaker point design. The contact element 84 is fast to an ear 84.1 at one end of a U-shaped contact plate 88 in which are elongate openings 90.1, 90.2 through which are inserted screws 92.1, 92.2, one of which is an eccentric, for adjustably fastening it to the plate 72 in conventional manner. The other end of the plate 88 has fixed to its forward side a pin 94 with an insulating sleeve 96, and on this sleeve is pivoted an arm 98 which carries at its free end the other contact 86. The arm 98 is normally urged to closed switch position, with contact 86 in engagement with contact 84, by a bowed spring 99 fastened at one end to the drum wall 70 by one of the bolts 78, and at its other end to arm 98. The arm 98 has fast to the inner side of its free end a lifter 104 of an insulating material such as Bakelite, which bears against the outer surface of the cam sleeve 57. Hence, whenever the high point of the cam moves beneath the lifter the switch elements 84 and 86 are separated. Accordingly, once every revolution of the shaft 36, the contacts are momentarily separated and then allowed to return to engagement throughout the remainder of the rotation of the shaft. While only one high point is shown on the cam, it is to be understood that this cam can have an extended high portion, or a number of high points or peaks so that the contacts can be separated from and restored to engagement several times during each rotation of the shaft. Furthermore, cams with depressions instead of peaks can be used in order to provide a normally open instead of normally closed switch. The duration of separation or contact at any given time can be adjusted by means of slots 90.1, 90.2, of plate 88 and screws 92.1, 92.2 fastening it to switch plate 72.

The hub 60 carries a sleeve 106 (Fig. 2) of insulating material, having a collar 108. A pair of slip rings 111 and 112 are mounted on sleeve 106 between collar 108 and insulating washers 114, 116. Graphite brushes 118 and 119 (Fig. 4) of conventional design are mounted, by means of brush holders 118.1 and 119.1, in the walls 14.1, 14.2 for engagement respectively with the slip rings 112 and 111. Lead wires 122 and 124 tie the brush holders 118.1 and 119.1 to connections 122.1 and 124.1 on a terminal strip 126 (Figs. 2 and 3) fastened to the back of the housing near its bottom. The slip rings 111 and 112 are in turn connected to the contacts 84 and 86 by way of lead wires 128 and 129 (Fig. 3) the former being connected to the arm 98 through spring 99 and the latter to the plate 72 through one of the ears 76.

To effect rotation of the drum 68 and hence to displace the switch contacts angularly with respect to the housing 10, thereby to advance or retard the actuation of the switch relatively to the rotation of the shaft 36, the following mechanism is provided. A worm wheel 132 (Figs. 2 and 4) is made fast to the hub 60, a spacer ring 134 being interposed between it and the slip ring assembly. A worm 136 is mounted in the upper part of the housing in engagement with the worm wheel 132, on a horizontally arranged worm shaft 138 which is journaled in eccentric bushings 141.1, 141.2 (Fig. 4) rotatably mounted in bearing openings 142.1, 142.2 formed in the shoulders 22, 23. Set screws 144 (Fig. 3) are provided for fixing the eccentric sleeves in any desired angular position thus to permit movement of the axis of the shaft 138 to and from the center of rotation of the worm wheel. Adjusting movement toward the worm wheel increases the torque necessary to turn the shaft, while movement away from the worm wheel decreases the torque. Slots 141.3, 141.4 (Fig. 4) in the exposed ends of the eccentric bushings permit engagement with a spanner to turn the bushings. A hand wheel 146 (Fig. 3) is fastened to an end of the shaft 138 for rotating it. The worm and worm wheel have a low pitch so that this gear is self-locking and the switch drum 68 securely held in any position to which it is turned.

The open end of the drum 68 is covered by a cap 148 (Figs. 1, 2, 4) having a rearwardly extending cylindrical wall 150 which meets and is concentric with the forwardly extending walls of the shell or housing 10. This cap is provided with spaced holes 152 for screws which are threaded into bosses 154 (Fig. 4) formed on the walls of the drum, thus fastening the cap to the drum so that it will rotate therewith. To provide for lubrication, the cap has at its inside a concentric recess 154 (Figs. 2, 4) in which is set a felt washer 156 saturated with light oil; the forward end of the cam sleeve 57 has a conical projection 57.1 which enters the washer and picks up oil therefrom feeding it to the cam thus providing a film of oil for the cam surface to increase the life of the Bakelite lifter 104.

In order easily to indicate the angular position of the switch with respect to the housing at any given time, a reference mark 158 (Fig. 1) is provided on the upper, curved portion of the top wall 12, and a scale 159 is marked on the periphery of cap 148. The scale 159 is graduated in degrees from 0° to 360°. Thus the continuous adjustment of the point of switch operation, through 360° of rotation can be easily controlled. As mentioned above, if once set, it is automatically locked in position by the worm drive.

A cable clamp 162 is fastened to a side wall of the housing to accommodate the leads from the controlled circuit.

In operation, the shaft 36 is coupled to a driving member of the controlling apparatus; a typical example for the use of switch gear according to invention is the control of high speed punch presses which are started and stopped by means of pneumatic clutches and of brakes, actuated by means of solenoid valves. The operation of such machines involves speeds of 200 to 900 R. P. M. and ordinary switches do not stand up to continuous actuation at such speeds. Eqpuipment according to the present invention not only operates reliably at these speeds, but provides operation of the dependent component (for example a valve solenoid in a holding circuit) at the proper point of a cycle so that for example a brake actuated by the valve can be operated at the top of the stroke of a press, each time a stop is made.

The shaft 36 having been connected in this manner, the switch operation is adjusted by turning hand wheel 146 to establish the proper phase relation between the switch actuation and the working cycle of the controlling and controlled mechanisms and circuits. It will now be evident that the adjustability through 360° permits the setting of any such phase relation between the switch actuation and the position of the shaft, and the secure locking of this relation thereafter. As mentioned above, the length of the time interval during which the contacts 84, 86 are opened or closed can be adjusted by shifting the contact plate 88 on the switch plate 72 after loosening screws 92. The switch can be easily inspected by removing cap 148 after taking out the two screws through holes 152 which fasten the cap to bosses 154 of the drum 68; if defective, the switch can be easily removed. The cam 54 is likewise readily accessible by removing cap 148 and it can be exchanged by loosening screw 58 as above described.

It will now be evident that the cam lifts contact arm 98 by means of lifter 104 when the latter encounters the raised portion or portions of the cam. The two contacts are connected through their respective brushes, slip rings and lead wires to the terminal connectors on strip 126 where they are tied into the control circuit in question. Changes in phase relation such as for example due to change in press speed are compensated for by advancing

or retarding the switch element by means of the hand wheel **146**.

It will be noted that this device can be used in circuits which can not be grounded, because the switch assembly is insulated from the metal housing by insulating washers and tubes **81, 82, 83**. The insulating bushing **52** provides an insulation from shaft **36**, as protection against wear of the lifted **104**. If this lifter is neglected until it wears out to a degree that it lets arm **98** touch cam **54**, the switch housing is still safe and free from electrical shock potential, due to insulator **52**.

As mentioned above, the cam **54** can be easily exchanged by means of the coupling arrangement shown in Fig. 5, merely by removing cap **148** and loosening screw **58** whereupon the cam can be pulled from the insulating pin **48**. The new cam can be inserted and fastened, and the cap replaced without affecting the relation between index, scale, cam and switch points.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A rotary timing switch comprising a supporting base; shaft means journalled in said base; a switch support rotatably mounted on said base; switch means carried by said support, having relatively movable contacts and means for making and breaking contact thereof; cam means; means for interchangeably mounting said cam means on said shaft means for actuating said making and breaking means; a continuous drive, including a self-arresting transmission member, for adjusting the spatial relation beween said base and said support; yielding conductor means leading from said base to said support and said contracts; and index means for indicating the relative position of said base and said support; whereby the switch means can be variably operated by interchangeable cam means in predetermined positions of the switch support relatively to the base, which positions, and hence a selected phase relation between shaft rotation and the making and breaking of contact, can be established and maintained by the adjusting means.

2. A rotary timing switch comprising a supporting base; shaft means journalled in said base; a switch support rotatably mounted on the base coaxially with said shaft means; switch means carried by said support, having relatively movable contacts and means for making and breaking contact thereof; cam means; coupling means including an insulating stud and slot connection for interchangeably mounting said cam means at an essentially fixed angular relation on said shaft means for actuating said making and breaking means; and an automatically locking movement for adjusting the spatial relation between said base and said support; whereby operation of the switch means can be selected by interchanging the cam means, and whereby the position of the switch support relatively to the base, and hence a selected phase relation between shaft rotation and the making and breaking of contact, can be established and maintained by said coupling means and said adjusting means.

3. A rotary timing switch comprising a supporting base; shaft means journalled in said base; a switch support rotatably mounted on the base coaxially with said shaft means; switch means carried by said support, having relatively movable contacts and means for making and breaking contact thereof; cam means; coupling means for interchangeably mounting said cam means at an essentially fixed angular relation on the end of said shaft means for actuating said making and breaking means, said coupling means including an insulating pin fastened in a socket at said shaft end, stud means extending rearwardly from said cam means, and on said pin an insulating ring interposed between the socket and the cam means and having slot means on either side for engaging said

stud means of socket and cam means; and an automatically locking movement for adjusting the spatial relation between said base and said support; whereby operation of the switch means can be selected by interchanging the cam means, and whereby the position of the switch support relatively to the base, and hence a selected phase relation between shaft rotation and the making and breaking of contact, can be established and maintained by said coupling means and said adjusting means.

4. A rotary timing switch comprising a supporting base; shaft means journalled in said base; a switch support rotatably mounted on said base; switch means carried by said support, having contacts and means for making and breaking contact thereof; cam means; coupling means for mounting said cam means on said shaft means for actuating said making and breaking means; a self-arresting movement for adjusting the spatial relation between said base and said switch support; and index means for indicating the relative position of said base and said switch support, which index means include a cover mounted on said support, said cover extending to said base to form an enclosure, and carrying a scale playing on an index on the base; whereby the switch means can be operated by the cam means in predetermined positions of the switch support relatively to the base, which positions, and hence a selected phase relation between shaft rotation and the making and breaking of contact, can be observed and set with the aid of the scale means.

5. A rotary timing switch comprising a supporting base; shaft means journalled in said base; a switch support rotatably mounted on said base; switch means carried by said support, having contacts and means for making and breaking contact thereof; cam means having a cam portion and a conical end portion; coupling means for mounting said cam means on said shaft means with said conical portion pointing away from said support and with said cam position arranged for actuating said making and breaking means; a self-arresting movement for adjusting the spatial relation between said base and said switch support; a cover mounted on said support; and an oiling ring fastened inside said cover in contact with said conical end portion; whereby the switch means can be operated by the cam means in predetermined positions of the switch support relatively to the base, and said cam means is continuously lubricated by said oiling ring.

6. A rotary timing switch comprising a supporting base; shaft means journalled in said base; a switch support rotatably mounted on said base; switch means carried by said support, having relatively movable contacts and means for making and breaking contact thereof; cam means; coupling means for mounting said cam means on said shaft means for actuating said making and breaking contacts; a continuous drive, including a self-arresting transmission member, for adjusting the spatial relation between said base and said switch support; yielding conductor means leading from said base to said contacts, including slip ring means on said switch support and corresponding brush means fastened to said base; whereby the switch means can be operated by the cam means in predetermined positions of the switch support relatively to the base, which positions, and hence a selected phase relation between shaft rotation and the making and breaking of contact, can be established and essentially maintained by the adjusting means and the conductor means.

7. A rotary timing switch comprising a supporting base; shaft means journalled in said base; a switch support rotatably mounted on said base coaxially with said shaft means; switch means carried by said support but insulated therefrom, having relatively movable contacts and means for making and breaking contact thereof; cam means; coupling means including an insulating stud and slot connection for interchangeably mounting said cam means on said shaft means at an essentially fixed angular

relation for actuating said making and breaking means; self-arresting low pitch worm gear means for adjusting the spatial relation between said base and said support; yielding conductor means leading from said base to said support and said contacts, including slip ring means on said shaft and brush means on said base; and index means for indicating the relative position of said base and said support, including a cover mounted on said support and extending to said base to form an enclosure, and carrying a scale that plays on an index on said base; whereby the switch means can be operated by interchangeable cam means in predetermined positions of the support relatively to the base, which positions, and hence a selected phase relation between shaft rotation and the making and breaking of contact, can be established and maintained by means of the adjusting, conductor, and index means.

8. A rotary timing switch comprising a supporting base; shaft means journalled in said base; a switch support mounted on the base; switch means carried by said support, having relatively movable contacts and means for making and breaking contact thereof; cam means; coupling means for interchangeably mounting said cam means at an essentially fixed angular relation on the end of said shaft means for actuating said making and breaking means, said coupling means including an insulating pin fastened in a socket at said shaft end, stud means extending forwardly from said socket, stud means extending rearwardly from said cam means, and on said pin an insulating ring interposed between the socket and the cam means and having slot means on either side for engaging said stud means of socket and cam means; whereby operation of the switch means can be selected by interchanging the cam means.

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