July 3, 1951 A. F. HORLACHER 2,559,075

ROTARY STEP SWITCH

Original Filed Oct. 13, 1945 3 Sheets-Sheet 1

Fig. 1

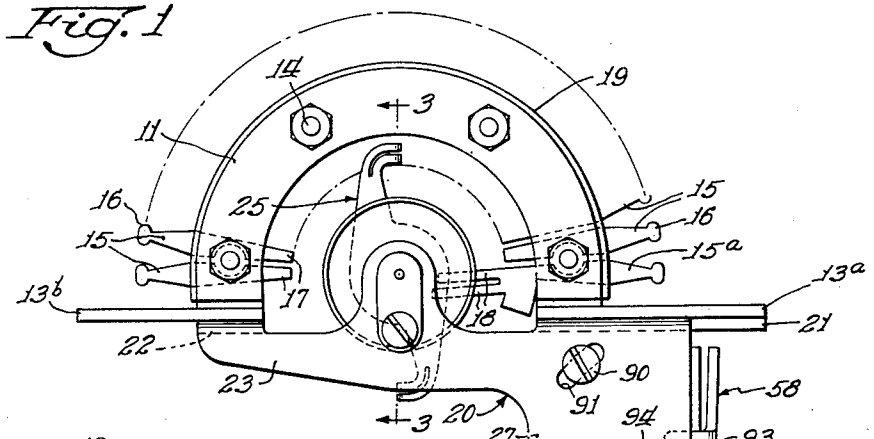


Fig. 3

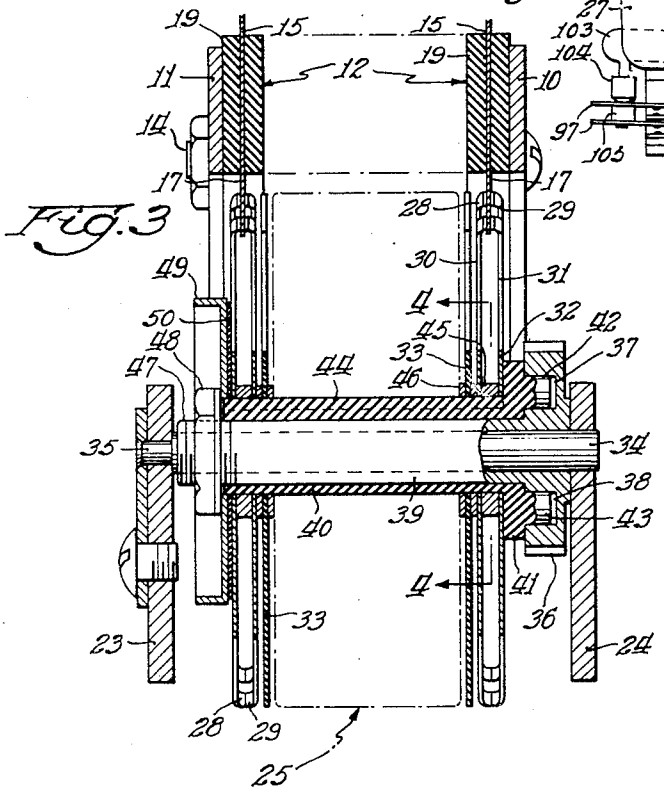
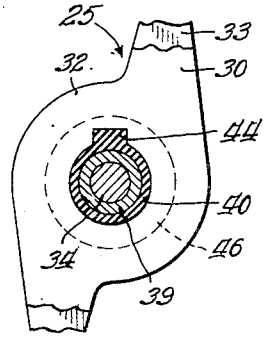


Fig. 4



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Fig. 2

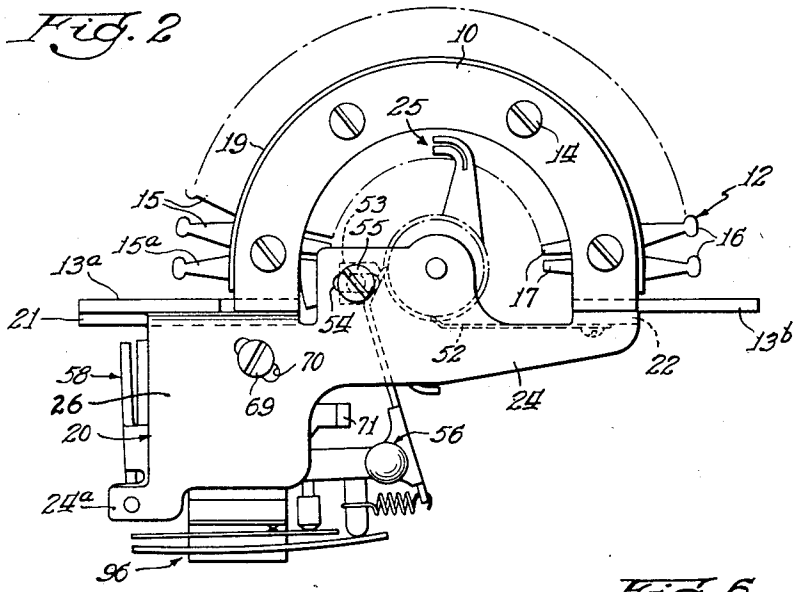


Fig. 5

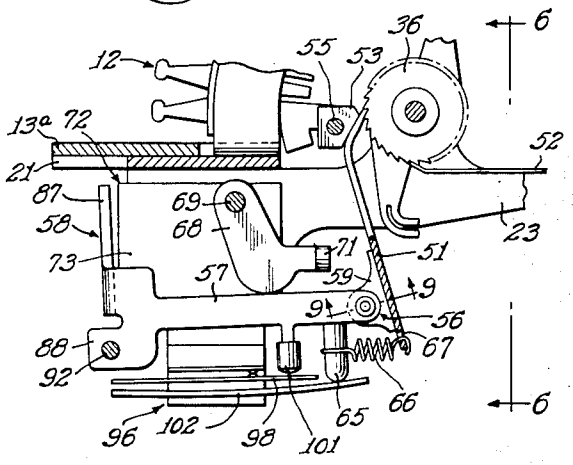
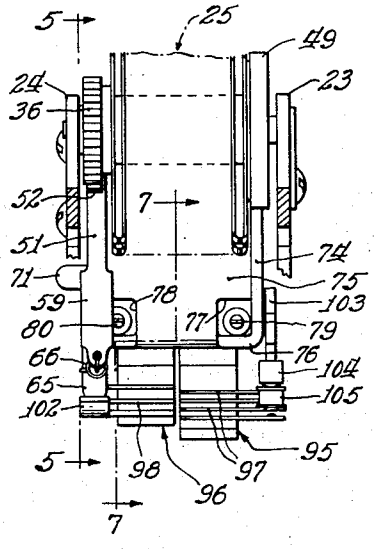


Fig. 6



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ROTARY STEP SWITCH

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Fig. 7

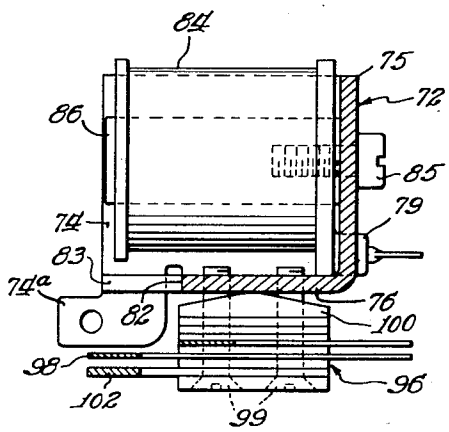


Fig. 8

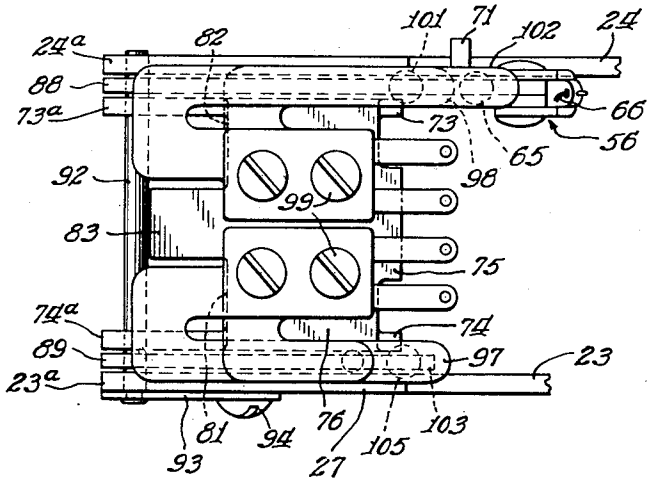
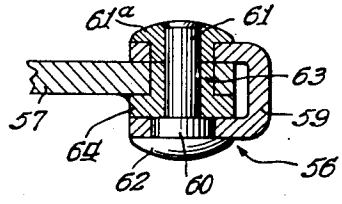


Fig. 9



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2,559,075

UNITED STATES PATENT OFFICE

2,559,075

ROTARY STEP SWITCH

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Original application October 13, 1945, Serial No. 622,164. Divided and this application April 11, 1949, Serial No. 86,643

4 Claims. (Cl. 74—142)

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The present invention relates to rotary step switches. It is the principal purpose of my invention to provide an improved switch of this type whereby it is possible to obtain a much greater speed of operation of the switch than has heretofore been possible. Switches of this character are used in a great many automatic devices for high speed selection of desired circuits. They are relay operated by impulses to the relay, and in the field today it is customary to have them operated at speeds up to about fifty-five steps of the wiper per second. The stationary contacts are built up in banks and have individual wiring terminals thereon for the multiplicity of circuit connections which must be made. The stationary contacts are traversed by wipers that are advanced step by step in response to energizations of the relay. The improved. stepping mechanism by means of which the wipers are advanced comprises a drive spring and a pawl operatively connected to an armature of an electromagnet in such fashion that the inertia of the armature is taken off the pawl. The driving power for the armature is obtained by utilizing a short box type magnetic structure with a low time constant to give high speed operation of the armature. Accurate adjustment of the switch is obtained by a novel assembly of the switch frame and magnetic structure with the armature which minimizes loss in the magnetic circuit and improves the operating speed characteristics thereof.

Another purpose of my invention is the provision of a novel pawl and spring connection to the armature which drives the switch whereby to improve the life of the pawl under high speed operation.

It is also a purpose of my invention to provide in a switch of this character a novel assembly of the power unit with the switch frame whereby to improve the power unit efficiency and simplify the adjustment of the power unit with respect to the pawl and the switch frame.

The nature and advantages of my invention will appear more fully from the following description and the accompanying drawings wherein a preferred form of the invention is shown. The particular structural features shown are in themselves novel, but in the broader combination of the entire switch it is evident that they may be varied within the skill of the mechanic without departing from the scope of the invention as outlined in the claims. The drawings and description, therefore, should be taken as illustrative and not as a limitation of the invention.

In the drawings:

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Figure 1 is a view in side elevation of a rotary step switch embodying my invention;

Figure 2 is a similar view showing the opposite side of the switch;

Figure 3 is an enlarged sectional view taken on the line 3—3 of Figure 1;

Figure 4 is a fragmentary sectional view taken on the line 4—4 of Figure 3;

Figure 5 is a sectional view through the switch frame and the power unit, taken on the line 5—5 of Figure 6;

Figure 6 is a view taken on the line 6—6 of Figure 5;

Figure 7 is a sectional view taken substantially on the line 7—7 of Figure 6, and illustrating the construction of the power unit;

Figure 8 is a view looking up at the construction shown in Figure 6; and

Figure 9 is a fragmentary sectional view taken on the line 9—9 of Figure 5.

Referring now in detail to the drawings, my invention is embodied in a rotary step switch wherein two side frames 10 and 11 support a plurality of banks 12 of switch contacts. The frame 10 has two flat mounting portions 13a and 13b thereon while the frame 11 is merely a semi-circular plate that clamps the several banks 12 to the frame 10. Screw bolts 14 are utilized to clamp the banks in place. As shown best in Figures 1, 2 and 3, the individual contact banks each comprise a multiplicity of contact strips 15 each having a wiring terminal portion 16 and a wiper engaging portion 17. In addition, one of the strips 15a of each bank has two bridging contact strips 18 thereon, the purpose of which is to engage the central annular portions of wiping contacts to be later described. The several contact strips 15 are held in a common plane by a semi-circular body 19 of insulation in which the strips are moulded in making the contact bank.

The bank assembly is mounted to a wiper and electromagnet supporting frame 20 which has a base portion 21 mounting the parts 13a of the member 10, a bridging portion 22 mounting parts 13b of the member 10, spaced apart arms 23 and 24 which carry a wiper assembly 25 and which merge into side plates 26 and 27 that carry the electromagnet and its armature and the driving pawl for the wiper assembly 25.

The wiper assembly 25 is shown best in Figures 1, 3 and 4. Each of the contact elements 15 is adapted to be engaged by opposed fingers 28 and 29 on a pair of wiping contacts 30 and 31. These contacts have hub portions 32 which are engaged by the bridging contact strips 18. Each wiping

element extends in opposite directions from the hub, and has the inturned fingers such as 28 and 29, at both ends. There is one pair of wiping contacts 30—31 for each bank level of the contacts 15. Intermediate the adjacent pairs of the wiping contacts there are strips 33 of insulation to prevent electrical contact of one pair with the other.

The several wiping contacts 30—31 and the insulating members 33 are mounted together upon a shaft 34 which is secured at one end by a reduced portion 35 to the portion 23 of the frame 20. The other end of the shaft is mounted in an aperture in the portion 24 of the frame 20. The shaft rotatively mounts a ratchet wheel 36 which has two sockets 37 and 38 therein, and which has a reduced sleeve 39 extending the full length of the shaft 34. A sleeve 40 of insulating material has a head 41 thereon which is provided with two pins 42 and 43, fitting into the recesses 37 and 38. The sleeve 40 also has a key 44 thereon. The several wiping contacts 30—31, the insulating strip 33, and the metal spacing rings 45 and 46 all have key slots therein to match the key 44, so that the wiping contacts, the spacing rings and the insulating strips can be stacked on the sleeve 40, and connot rotate thereon once they are so stacked. The sleeve 40 is somewhat shorter than the sleeve 39, and the sleeve 39 is threaded as shown at 47 to receive a nut 48 that secures the counter wheel 49 in place on the sleeve 40. The counter wheel is insulated from the adjacent wiping contact by a washer 50 of insulating material.

The ratchet wheel 36 is adapted to be driven by a driving pawl 51, and is prevented from reverse rotation by a holding pawl 52. The holding pawl is a spring that extends to the cross piece 22 and is fastened thereon by a suitable screw. The driving pawl is directed against the ratchet wheel by a block 53 that is mounted on the arm 24 in a slot 54 by means of a screw bolt 55, so that the block 53 can be adjusted properly to guide the pawl 51.

The pawl is pivoted by a pivotal connection 56 to an arm 57 which is integral with an armature 58 of the electromagnet that furnishes the power to drive the pawl. The pivotal connection is shown best in Figure 9 of the drawings. The pawl itself has a U-shaped portion 59 thereon. This portion is apertured to receive a bearing pin 60 which is provided with a reduced portion 61. A head 62 is formed on the pin. The armature arm 57 receives a bushing 63 which is brazed therein. The bushing 63 has a head 64 thereon. The reduced end 61 of the pin 60 has a headed member 61*a* riveted on it. This heavy duty connection is necessary because of the extremely hard wear upon the connection between the arm 57 and the pawl 51. The arm 57 also mounts a post 65 of metal to which a spring 66 is connected. The spring 66 is in turn anchored to the end of the pawl 51 by having its end hooked through an opening 67 therein.

In order to prevent the inertia of the armature from being carried by the pawl, I provide a stop member 68 on the side piece 26 of the frame 20. This stop member is in the form of a cam which is mounted to the side piece 26 by a screw 69 that rides in a slot 70 provided in the side piece. The cam can be rotated or moved bodily along the slot 70 to position it correctly to take the blow of the arm 57 when this arm is advanced. A finger piece 71 projects laterally from the cam beyond the side piece 26 so that it may be used to adjust the cam whenever necessary.

The screw 69 also serves to fasten the side piece 26 to a frame 72. This frame is box shaped and comprises two side pieces 73 and 74, which are substantially rectangular in shape, a rear end piece 75 and a top piece 76 all bent from a single sheet of metal. The side pieces 73 and 74 are not cut away, but the rear end piece is cut out at 77 and 78 to pass terminals 79 and 80 of a relay coil 84. The top piece 76 is also cut out as indicated at 81 and 82 (see Figure 8) so as to leave a forwardly projecting tongue 83. The coil 84 is secured against the back piece 75 by means of a screw 85 that is threaded into the core 86 of the coil. The coil 84 is of the usual spool type with the core 86 projecting beyond the coil to cooperate with the armature 58.

The armature 58 comprises a flat front portion 87 which extends the full width of the frame 72 so as to overlap the side pieces 73 and 74. The armature 58 has ears 88 and 89 to mount the armature on a shaft 92 that is fixed to ears 23*a* and 24*a* on the side pieces 23 and 24. Thus the entire connection between the armature 58 and the frame 20 is by means of the shaft 92. This shaft is a hardened steel pin which is held in place by a lock plate 93 that is fastened to the side frame 24 by a screw 94. The lock plate has a small pin that is inserted into the shaft to prevent rotation of the shaft with respect to the ears 24*a* and 23*a*. The side pieces 73 and 74 of the frame 72 are adjustably secured by the screw 69 and a cooperating screw 90 in a slot 91 of the side piece 27. These screws permit the frame 72 to be adjusted about the shaft 92 as a pivot since the side pieces 73 and 74 of the relay frame have ears 73*a* and 74*a* that are also journaled on the shaft 92.

The armature 58 has its upper end fitting closely to the extension 83 of the top piece of the frame 72, and this extension 83 provides a low reluctance path when the armature is in the unattracted position. The whole magnetic assembly, that is the frame 72 and the coil, can be rotated about the armature shaft by releasing the screws 69 and 90 for adjustment of the switch to give the proper stroke to the armature, and thereby the proper stroke to the pawl 51, without providing a screw in the armature which would introduce an additional loss in the magnetic circuit.

The top piece 76 of the frame 72 is utilized to mount an additional bank of contacts to be operated by the electromagnet in conjunction with the operation of the pawl 51. This construction is illustrated best by Figures 6, 7 and 8 of the drawings. Insulating blocks 95 and 96, and two series of contact springs 97 and 98 are mounted upon the top piece 76 by screws 99. The block 96 can be rocked to accommodate itself to adjustment of the armature arm 57 by means of a base block 100 of metal which is tapered toward both ends as shown best in Figure 7, so that by tightening one or other of the screws 99 holding this assembly in place, the contacts can be tilted. This is necessary because of the fact that the arm 57 carries an insulating actuating pin 101 for actuating the spring contacts 98. This same support mounts a drive spring 102 which furnishes the driving force to push the armature arm 57 down in opposition to the magnetic attraction of the armature 58 by the core 86 for advancement of the pawl 51. The spring 102 is a heavy steel spring shaped as shown in the plan view Figure 8. The contacts 97 are actuated by another armature arm 103, which is integral with the armature on the side opposite

to the arm **57**, and which carries a pin **104** to engage the lower spring of the series **97**. A spacer **105** is interposed between the lower spring and the upper spring of the series **97** so that the one pin **104** can operate both springs.

The principal features to which I attribute the fact that this switch may be operated at the greatly increased speed and efficiency are the arrangement of the armature with the short box type of magnetic structure having a low time constant with a low reluctance when the armature is in unattracted position. The drive connection to retract the pawl is from the armature through the arm **57** to the pawl. The spring **102** works directly on the arm **57** near the pawl and the cam **68** takes the blow of the armature arm when it is advanced by the spring **102**. This arrangement gives a minimum load to be overcome by a build up of the magnetic attraction in the armature itself. It also aids in speeding up the action of the pawl **51**. The new type of construction employed in the bank levels and the rigidity of alignment of the wiper contact elements makes a light load on the pawl **51** so that less power is actually required to move the wiper contact elements over the contacts in the bank levels than in any previous construction of this type of switch with which I am familiar. The entire assembly of the switch frame makes it possible to adjust the stroke of the pawl quite exactly at the most efficient point of operation for the armature. The switch readily lends itself to replacement of burned out contacts since it is not necessary to destroy the assembly of all the contacts to replace a bank level in which the contacts are burned.

This application is a division of my application Serial No. 622,164, filed October 13, 1945, for Rotary Step Switch.

Having thus described my invention, I claim:

1. In a driving mechanism for a rotary step switch, a ratchet wheel, a frame mounting said wheel for rotation, a pawl operably engaging the wheel, an armature having an arm to which said pawl is pivoted, an electromagnet having a spring thereon operatively connected to said arm for urging it in one direction and having a pole face to attract the armature in opposition to the spring, means pivotally mounting the armature with respect to the electromagnet and pivotally mounting the electromagnet to the frame on a common axis remote from the ratchet wheel, whereby the electromagnet and the armature may be turned together on said axis to control the position of the pawl with respect to the ratchet wheel, and means to secure the electromagnet to the frame in adjusted position.

2. In a driving mechanism for a rotary step switch, a ratchet wheel, a frame mounting said wheel for rotation, a pawl operably engaging the wheel, an armature having an arm to which said pawl is pivoted, a post on the arm, an extension on the pawl, a spring connecting the post and extension, an electromagnet having a spring thereon operatively connected to said arm for urging it in one direction and having a pole face to attract the armature in opposition to the spring, means pivotally mounting the armature with respect to the electromagnet and pivotally mounting the electromagnet to the frame on a common axis remote from the ratchet wheel, whereby the electromagnet and the armature may be turned together on said axis to control the position of the pawl with respect to the ratchet wheel, and means to secure the electromagnet to the frame in adjusted position.

3. In a driving mechanism for a rotary step switch, a ratchet wheel, a frame mounting said wheel for rotation, a pawl for driving the wheel, a pawl carrying arm pivoted in said frame at a remote point from the mounting of said wheel, a bearing at the free end of said arm, the pawl being pivoted intermediate its ends on said bearing, a post on the arm, a spring connecting the end of the pawl remote from the wheel to said post to press the pawl against the ratchet wheel, an electromagnet adjustably pivoted in the frame on the same axis as the arm and having a leaf spring thereon urging the arm in a direction to cause the pawl to rotate the ratchet wheel, and an armature fixed to the arm, cooperating with the electromagnet to retract the arm and pawl against the pressure of said last named spring.

4. In a driving mechanism for a rotary step switch, a ratchet wheel, a frame mounting said wheel for rotation, a pawl for driving the wheel, a pawl carrying arm pivoted in said frame at a remote point from the mounting of said wheel, a bearing at the free end of said arm, the pawl being pivoted intermediate its ends on said bearing, a post on the arm, a spring connecting the end of the pawl remote from the wheel to said post to press the pawl against the ratchet wheel, an electromagnet adjustably pivoted in the frame on the same axis as the arm and having a leaf spring thereon urging the arm in a direction to cause the pawl to rotate the ratchet wheel, a cam member secured on the electromagnet in the path of said arm to limit the movement of said arm by said last named spring, and an armature fixed to the arm, cooperating with the electromagnet to retract the arm and pawl against the pressure of said last named spring.

ALBERT F. HORLACHER.

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