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STEPPING SWITCH

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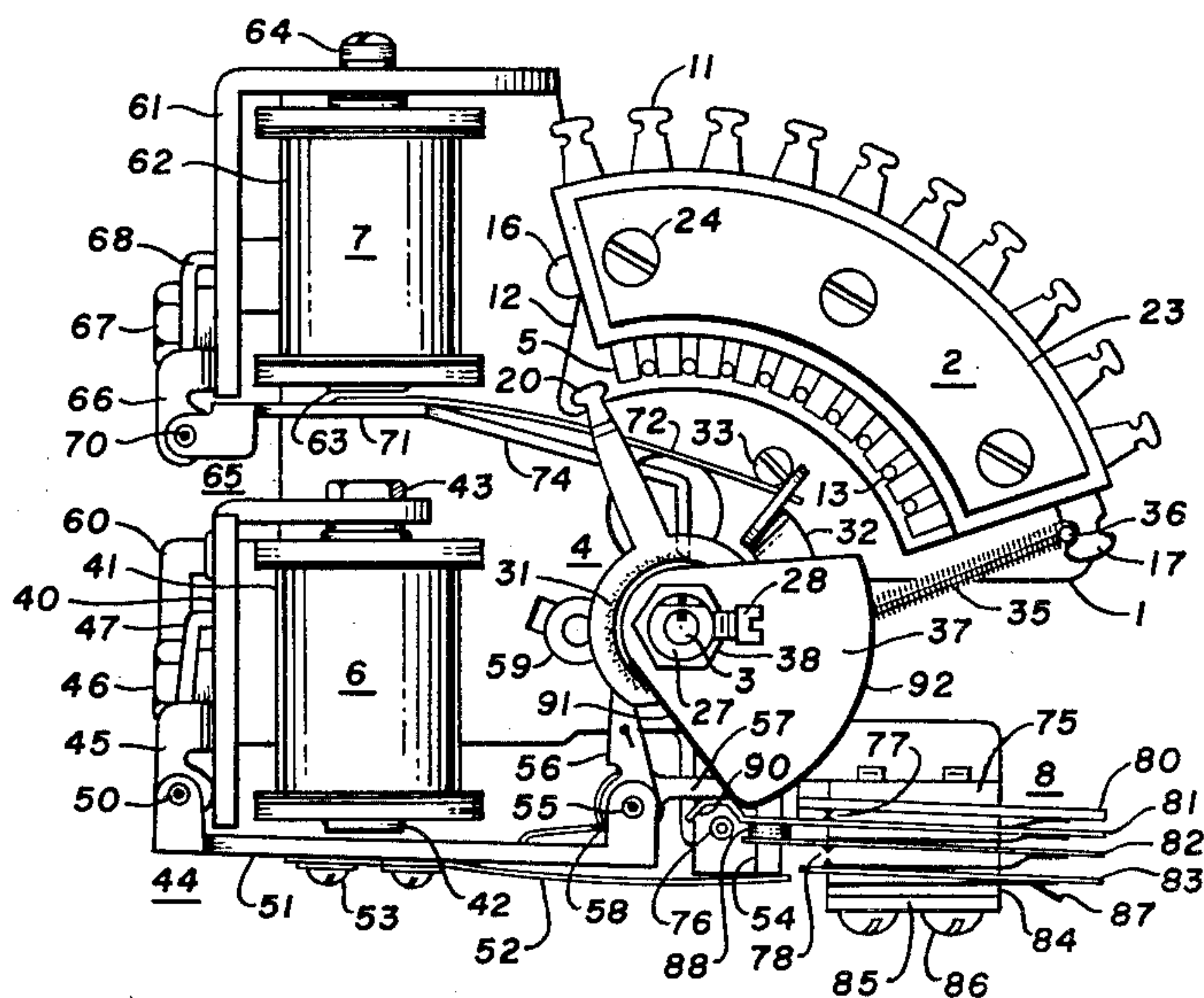


FIG. 1

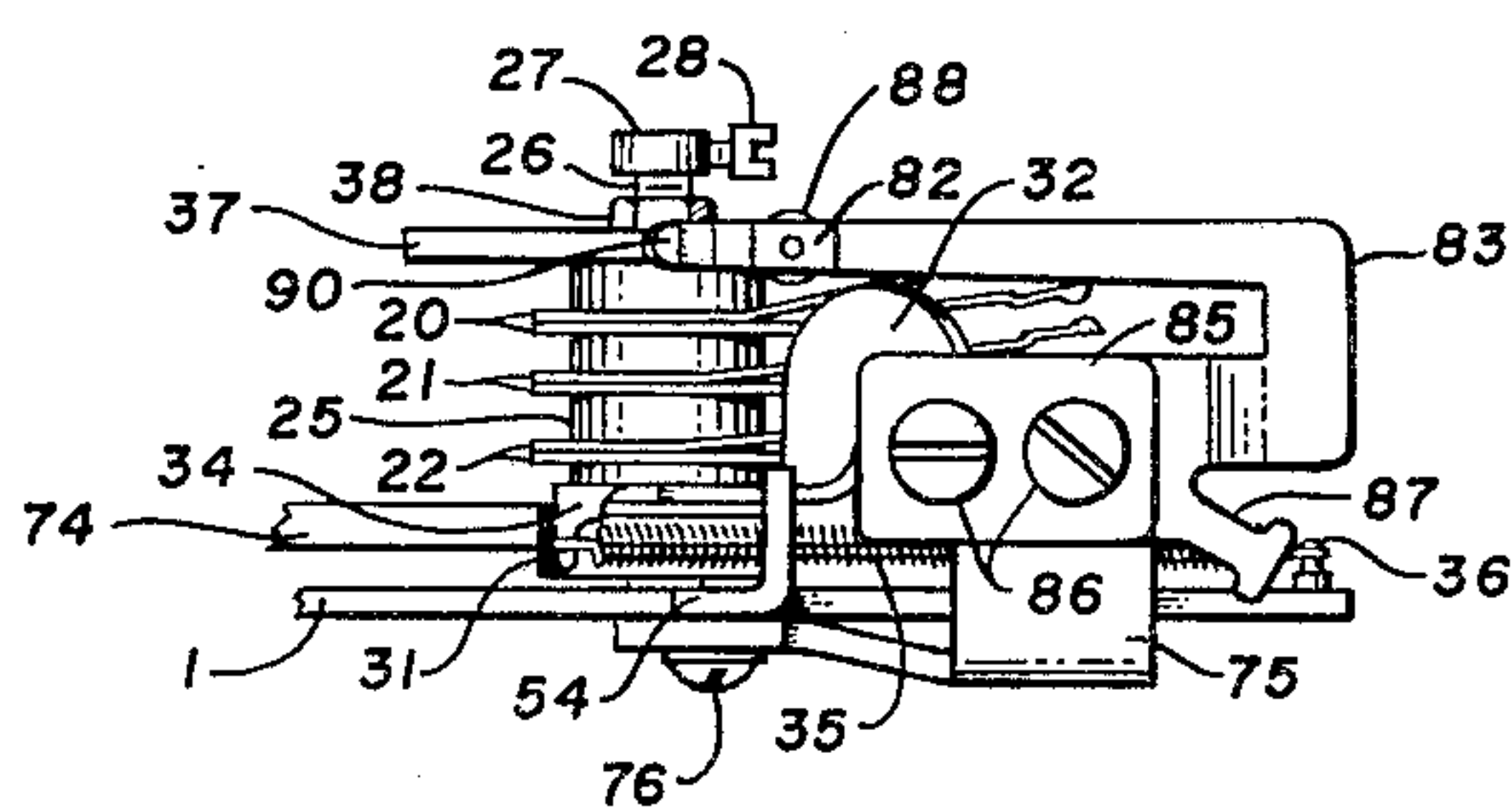


FIG. 2

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2,701,283

## STEPPING SWITCH

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6 Claims. (Cl. 200—105)

The invention relates to stepping switches and more particularly to stepping switches of the type or types used in automatic telephone systems.

Stepping switches of this kind generally have a contact bank, a set of wipers and an electromagnetically operated mechanism for stepping the wipers a given number of steps either directly or automatically, to set the wipers opposite a desired contact or group of contacts.

This stepping takes place against the action of a restoring force such as the tension of a retractile spring. If the switch is to be released, this force is made effective to return the wipers to normal. For this purpose a release magnet may be provided which, upon operation, withdraws a holding dog from engagement with a ratchet member of the stepping mechanism so that the restoring spring may pull the wiper assembly back against a stop provided in the normal position of the switch.

Associated with stepping switches of the kind referred to there is generally a set of contacts commonly known as off-normal contacts which change their condition when the stepping mechanism leaves its normal position and resume their original condition upon return of the stepping mechanism to normal. These off-normal contacts may be used for a number of control purposes such as preparing a circuit for the release magnet of the switch by which the switch may later be restored to normal.

In the known stepping switches of the above kind, the spring or springs actuating the off-normal contacts are normally deflected and held in their deflected or operated position by an arm secured to the wiper assembly. When the switch leaves its normal position this arm is disengaged from the off-normal springs so that these springs are allowed to assume their substantially straightened position and thereby actuate the associated contacts. When upon operation of the release magnet the wiper assembly is returned to normal under the action of the switch restoring spring, the aforementioned arm upon leaving the first operative position of the switch again engages and deflects the off-normal springs so that the set of off-normal contacts resumes its original actuated condition. This means that during the final portion of the return travel of the wiper assembly the tension of the switch restoring spring which is then in a largely relaxed condition is opposed by the tension of the off-normal springs.

As a result there is a tendency for the wiper assembly to be arrested in its return movement before it reaches the normal stop or to be bounced off this stop after this end position has been reached, whereby the off-normal contacts in turn may become subject to bouncing so that the reliability of operation of the switch is adversely affected. While it would be possible to increase the tension of the restoring spring, this would add to the wear of the stepping mechanism and for a given design reduce the operating safety of the stepping magnet.

It is an object of the invention to avoid the difficulties encountered in the operation of prior art stepping switches due to off-normal contact actuation.

Another object of the invention is to provide a stepping switch in which the spring tension of the off-normal springs is utilized to aid the switch restoring spring in returning the wiper assembly to normal.

In accordance with the preferred form of my invention, the foregoing and other objects are carried out by providing a cam moving with the wiper assembly which deflects the actuating spring of the set of off-normal contacts when the switch moves into its first operative position thereby to actuate the off-normal contacts. This cam has a cam

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surface extending over all operative positions of the switch so that the off-normal contacts are positively maintained in actuated condition irrespective of the position to which the switch has been stepped. Upon release of the switch the above actuating spring rides off that cam surface when the switch moves from its first operative position to its normal position and by thus bearing against the end of that cam surface aids the switch restoring spring in completing the return movement of the wiper assembly.

In the preferred embodiment described hereinafter with reference to the accompanying drawing, the invention is applied to a so-called minor switch, that is, a returnable stepping switch of the rotary type having an operating and a release magnet.

In the drawing,

Fig. 1 is a top view of a 10-point minor switch in its normal position, this switch having an off-normal contact actuating mechanism according to the invention.

Fig. 2 is a front view of this minor switch in its tenth position; in this view all parts except the wiper assembly, the off-normal spring assembly, the switch restoring spring and a portion of the switch base and the ratchet holding dog have been omitted.

Referring now to Figs. 1 and 2 of the drawing, reference numeral 1 represents the switch base on which there are mounted a three-level contact bank assembly designated as a whole by reference character 2 and a wiper assembly 4 which is rotatably mounted on a stud 3 riveted to base 1 to selectively engage the contacts 5 of contact bank assembly 2. Also mounted on switch base 1 are a rotary magnet assembly 6, a release magnet assembly 7 and an off-normal spring assembly 8.

For the insulation of bank contacts 5 which are provided with soldering lugs 11, there are provided bank insulators 12 having flat pins 13 formed thereon between the individual bank contacts of each row to prevent bouncing of the wipers. On the bottom side of each bank insulator 12 there is provided a common contact segment having at one end a protruding lug 16 and at the other end a soldering lug 17, three of these pairs of contact rows and contact segments being provided in the case of the minor switch illustrated in the drawing. These three contact levels are respectively engaged by three pairs of wipers 20, 21, 22. When in the operation of the switch the upper wiper of a given pair has been brought into engagement with an individual contact 5 of a contact row and the lower wiper of this pair into engagement with the common contact segment associated with this row, an electrical connection is established between the bank contact and the common segment through both wipers of the pair in series, viz. by virtue of the fact that the two wipers of each pair are mounted with their rear ends in contact with each other as shown in Fig. 2. The whole contact bank assembly is held together by means of clamping plates 23 and clamping screws 24.

The three pairs of wipers 20, 21 and 22 are mounted by way of insulating bushings 25 on a mounting sleeve 26 which is rotatably mounted on mounting stud 3. A bushing 27 and an associated set screw 28 engaging mounting stud 3 serve to hold mounting sleeve 26 in place on the mounting stud.

Also secured to mounting sleeve 26 and thereby forming a part of wiper assembly 4 are a ratchet wheel 31 and a stop member 32 cooperating with a stop pin 33 mounted on switch base 1. On this stop member 32 there is formed a lug 34, Fig. 2, to which is attached one end of a coil spring 35 serving as the restoring spring of the switch. The other end of this coil spring is secured to a pin 36 mounted on switch base 1.

The wiper assembly is completed by an off-normal cam segment 37 of insulating material, and a clamping nut 38 holding the various components of wiper assembly 4 in place on mounting sleeve 26.

The rotary magnet assembly of the minor switch illustrated in the drawing comprises a heel piece or yoke 40 formed on switch base 1, a coil 41 mounted on a core 42 secured to yoke 40 by means of a mounting screw 43, and an armature assembly 44. This armature assembly in turn includes an armature mounting member 45 adjustably secured to yoke 40 by means of mounting screw 46



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and washer 47 and a rotary armature 51 pivotally mounted on member 45 by means of bearing pin 50. A leaf-type restoring spring 52 is attached to armature 51 by means of screws 53, this leaf spring bearing at its free end against the lower end, Fig. 1, of a lug 54 formed on switch base 1.

Pivoted to the free end of rotary armature 51 by means of bearing pin 55 is a rotary pawl 56 having integrally formed therewith a guide arm 57 cooperating with the upper end, Fig. 1, of the aforementioned lug 54 on switch base 1. A coil spring 58 serves to urge rotary pawl 56 into engagement with the teeth of ratchet wheel 31 upon attraction of rotary armature 51. Upon release of this armature under the influence of spring 52, guide arm 57 withdraws rotary pawl 56 from engagement with ratchet wheel 31. Pawl stop 59 is adjustably mounted on switch base 1 to limit the stroke of rotary armature 51. At the other end the stroke of this armature is limited by a back stop extension 60 thereof engaging yoke 40.

It will readily be seen that by intermittent energization of coil 41, for example under the control of the dial at a calling telephone subscriber's station, the switch may, by way of armature 51, pawl 56 and ratchet wheel 31, be stepped in a clockwise direction, Fig. 1, into any one of its ten operative positions to cause wipers 20, 21, 22 to be set on the corresponding set of bank contacts 5. With each such step the tension in switch restoring spring 35 is increased.

Release magnet assembly 7 is in some respects similar to the rotary magnet assembly 6 just described. The release magnet assembly comprises a yoke 61 which is formed as an integral part of switch base 1, and a coil 62 mounted on a core 63 fixed to yoke 61 by means of a mounting screw 64. The release armature assembly 65 consists of an armature mounting member 66 similar to armature mounting member 45 and adjustably mounted on yoke 61 by way of screw 67 and washer 68. Pivotally mounted on mounting member 66 by means of bearing pin 70 is release armature 71 which has fixedly attached thereto a restoring spring 72 bearing against the above-mentioned stop pin 33. At the free end of release armature 71 there is formed a holding dog 74 which normally engages the teeth of ratchet wheel 31 to retain the wipers in any operative position and may be withdrawn from such engagement upon energization of coil 62 of the release magnet to bring about the release of the switch under the influence of switch restoring spring 35.

Referring now to off-normal spring assembly 8, there is provided a mounting bracket 75 for this assembly which is secured to switch base 1 by means of mounting screws 76. This spring assembly further comprises generally U-shaped contact springs 80-83 which are insulated against each other and against mounting bracket 75 by insulators such as 84. A clamping plate 85 and clamping screws 86 serve to hold the contact springs and the spring insulators in place on mounting bracket 75.

As will be seen from Fig. 1 there are provided a break contact 77 and a make contact 78, the break contact being formed by a back spring 80 and an actuating spring 81 and the make contact being formed by an actuating spring 82 and a front spring 83, each of these springs being provided with a soldering lug 87 at its rear end. Spring 81 serves as the main actuating spring of the off-normal spring assembly and is connected with make contact actuating spring 82 by means of an insulating bushing 88.

At the free end of main actuating spring 81 there is formed by bending a cam surface 90 which cooperates with the aforementioned cam 37 mounted on wiper assembly 4. In the normal condition of the minor switch cam surface 90 at the end of actuating spring 81 is under stress so that it bears with a light pressure against side face 91, Fig. 1, of cam 37. When the switch takes its first step, that is, when it is moved under the control of rotary magnet 6 from its normal position to its first operative position to cause the wipers to engage the first set of bank contacts, cam surface 90 on spring 81 rides up on the left-hand corner, Fig. 1, of off-normal cam 37 so that actuating spring 81 is further stressed by being moved from its normal or substantially straightened position to its deflected or actuated position in which break contact 77 is opened and make contact 78 closed. Due to the arcuate extent of the circumferential surface 92 of cam 37, the actuated condition of the off-normal

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springs is maintained during subsequent steps of the switch. More particularly, if the wiper assembly of the minor switch in response to ten impulses is set on its tenth operative position as shown in Fig. 2, the right end of cam surface 92 of segment 37 will still be in effective engagement with cam surface 90 on actuating spring 81 and thereby maintain the set of off-normal springs fully actuated even in this last position of the switch.

The release of the switch from any of its operative positions, is brought about by energization of coil 62 of the release magnet which as mentioned above, attracts release armature 71 in response to such energization. Consequently holding dog 74 is withdrawn from engagement with the teeth of ratchet wheel 31 and coil spring 35 in contracting acts to restore the wiper assembly 4 back to normal in a counter-clockwise direction. As cam end 90 of actuating spring 81 during this return movement of the switch rides off the left end of cam surface 92 of off-normal cam 37, the above referred to further stress stored in spring 81 and also the stress in springs 82 and 83 upon actuation of the off-normal springs bears against side surface 91 of a cam 37 and thereby aids coil spring 35 in completing the movement of the wiper assembly from its first operative position into its normal position in which stop member 32 contacts stop pin 33. In this way the wiper assembly is positively returned to its normal position without the danger of bouncing and therefore without faulty reactivation of the off-normal contacts during this last portion of the return movement of the switch.

It will readily be seen that these results may be obtained without an increase in the tension of switch restoring spring 35. Moreover, tests have shown that the operation of the off-normal springs by means of cam 37 on the first step of the switch does not increase the load on the rotary armature over what is required to step the switch from the ninth to the tenth position in which the tension of coil spring 35 is at its maximum. The off-normal mechanism according to the present invention therefore lends itself to replacement of the conventional off-normal mechanism on existing switches, in which an arm mounted on the wiper assembly holds an actuating spring similar to spring 81 in its operated position with the minor switch at normal and becomes disengaged from this actuating spring when the switch takes its first step.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects. For example, it is possible to apply the invention to stepping switches other than minor switches. Thus, the off-normal mechanism according to my invention may advantageously be used to actuate the off-normal contacts associated with the secondary direction of flat type two-motion switch such as described in the copending application of Frank A. Morris, Serial No. 743,415, filed April 23, 1947, now Patent No. 2,567,650, Sept. 11, 1951. I therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim is:

1. In a stepping switch having a set of wipers, an electromagnetic stepping mechanism for stepping said set of wipers to any one of a plurality of operated positions against the action of a restoring force, means for making said restoring force effective to return said mechanism to its non-operated position for releasing said switch, and a set of off-normal contacts having an actuating spring; the improvement comprising inter-engaging cam means operatively connected with said mechanism and said actuating spring, respectively, means engaging said cam maintaining said actuating spring under stress at all times, said cam means having a cam surface disposed so as to deflect said spring for actuating said contacts as said mechanism is stepped to the first of said operated positions and extending over all of said operated positions to keep said spring so deflected irrespective of the operated position on which said mechanism is set, and means effective upon the release of said switch for utilizing the stress in the deflected actuating spring in cooperation with said restoring force for returning said mechanism from said first operated position to said non-operated position.

2. In a stepping switch having a set of wipers, a restoring spring, an electromagnetic stepping mechanism for



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stepping said set of wipers to any one of a plurality of operated positions against the action of said restoring spring, means for making said restoring spring effective to return said mechanism to its non-operated position for releasing said switch, and a set of off-normal contacts having an actuating spring; the improvement comprising a cam operatively connected with said mechanism, means engaging said cam maintaining said actuating spring under stress at all times, said cam having a cam surface disposed so as to deflect said actuating spring for actuating said contacts as said mechanism is stepped to the first of said operated positions and extending over all of said operated positions to keep said spring so deflected irrespective of the operated position on which said mechanism is set, and means effective upon the release of said switch for utilizing the stress in the deflected actuating spring in cooperation with said restoring spring for returning said mechanism from said first operated position to said non-operated position as said actuating spring returns to its undeflected position.

3. In a stepping switch having a set of wipers, an operating magnet, a restoring spring, a rotary stepping mechanism for stepping said set of wipers under the control of said operating magnet to any one of a plurality of operated positions against the action of said restoring spring, a release magnet for making said restoring spring effective to return said rotary mechanism to its normal rotary position for releasing said switch, and a set of off-normal contacts having an actuating spring; the improvement comprising a cam segment operatively connected with said rotary mechanism, means engaging said segment maintaining said actuating spring under stress at all times, said segment having an arcuate cam surface disposed so as to deflect said actuating spring for actuating said contacts as said mechanism is stepped to the first of said operated positions and extending over all of said operated positions to keep said spring so deflected irrespective of the operated position on which said rotary mechanism is set, and means effective upon the release of said switch for utilizing the stress in the deflected actuating spring in cooperation with said restoring spring for returning said rotary mechanism from said first operated position to its normal rotary position as said actuating spring returns to its undeflected position.

4. In a rotary stepping switch having a set of wipers, an operating magnet, a restoring spring, a rotary stepping mechanism for stepping said set of wipers under the control of said operating magnet to any one of a plurality of operated rotary positions against the action of said restoring spring, a release magnet for making said restoring spring effective to return said set of wipers to its normal position for releasing said switch, and a set of off-normal contacts having an actuating spring; the improvement comprising a cam segment operatively connected with said set of wipers, means engaging said segment maintaining said actuating spring under stress at all times, said segment having an arcuate cam surface disposed so as to deflect said actuating spring for actuating said contacts upon the first step of said switch and extending over all of said operated positions to keep said spring so deflected irrespective of the operated position on which the switch is set, and means effective upon the release of said switch for utilizing the stress in the de-

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flected actuating spring in cooperation with said restoring spring for returning said set of wipers from its first operated position to its normal position as said actuating spring returns to its undeflected position.

5. In a stepping switch having a set of wipers, an electromagnetic stepping mechanism for stepping said wipers to any one of a plurality of operated positions, means for restoring said switch to its non-operated position, a set of off-normal contacts having an actuating spring; the improvement comprising cam means operatively connected with said mechanism and maintaining said spring under stress at all times, said cam having a first surface for holding said actuating spring deflected after said mechanism has been stepped from its non-operated position to any one of its operated positions, said cam means also having a second surface so disposed that said actuating spring bears in stressed condition against said second surface in the non-operated position of said mechanism whereby upon the release of said switch said actuating spring aids said restoring means in returning said mechanism from the first of the operated positions to the non-operated position.

6. In a stepping switch having a set of wipers, an electromagnetic stepping mechanism for stepping said wipers to any one of a plurality of operated positions, a restoring spring for urging said switch to return to its non-operated position, said restoring spring being so arranged that the tension in said spring increases as said mechanism is stepped away from its normal position, a set of off-normal contacts having an actuating spring; the improvement comprising cam means operatively connected with said mechanism and maintaining said actuating spring under stress at all times, said cam having an arcuate surface, a follower on said actuating spring engageable with said surface, said surface being disposed so as to deflect said actuating spring for actuating said contacts as said mechanism is stepped from its non-operated position to any of said operated positions, said cam having a surface with a radial component engageable with said follower between the non-operated and first operated positions of said switch, said actuating spring co-operating with said radial component surface to bias said mechanism from said first operated position to said non-operated position and to maintain said mechanism in said non-operated position.

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