

May 25, 1943.

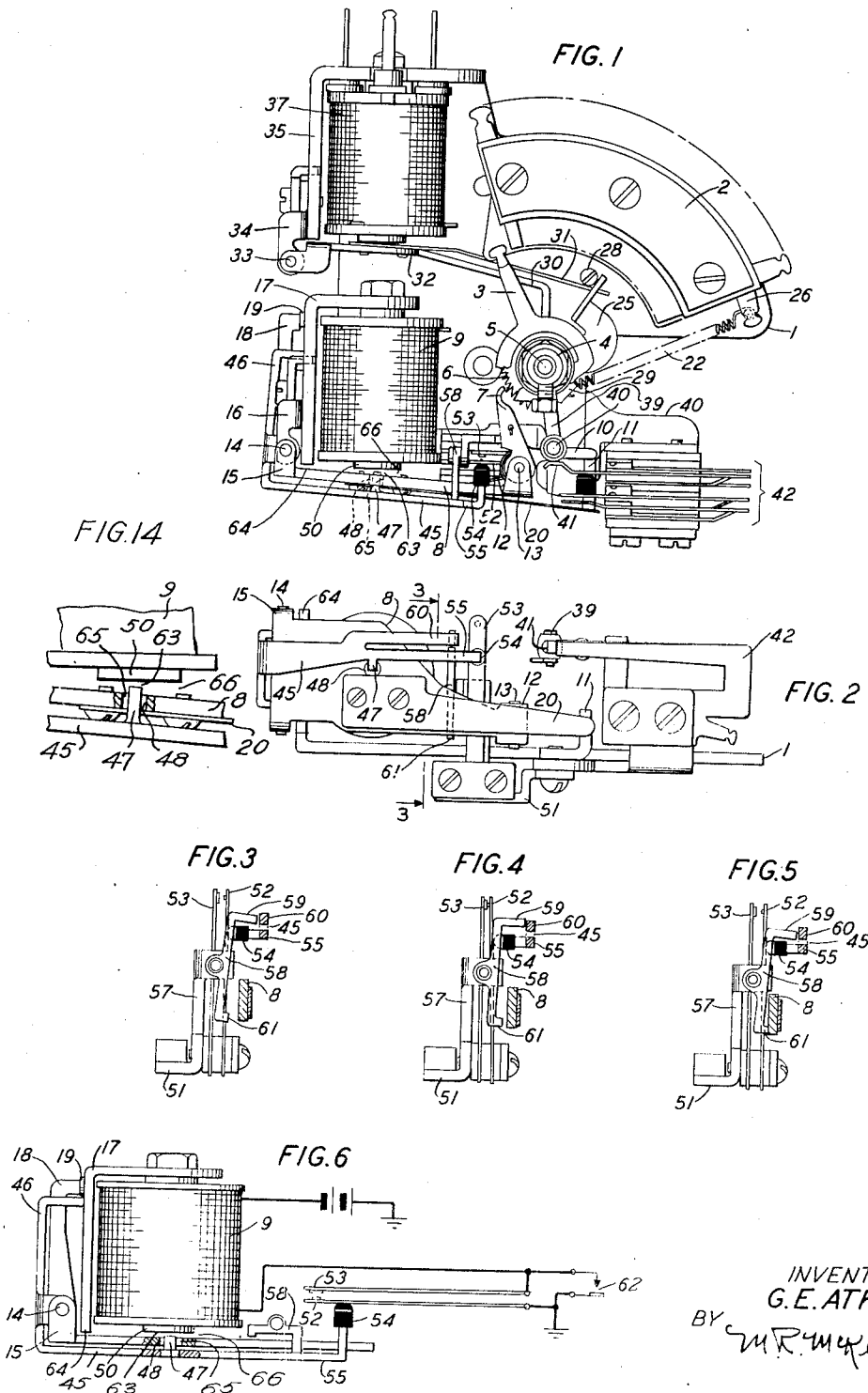
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2,320,254

SWITCHING MECHANISM

Filed Nov. 26, 1941

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 7

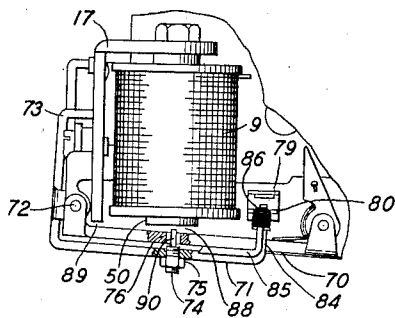


FIG. 8

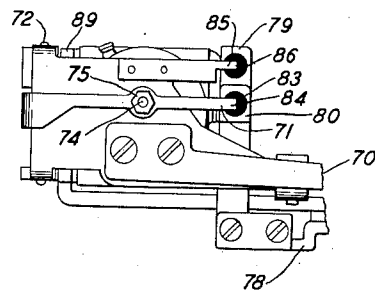


FIG. 9

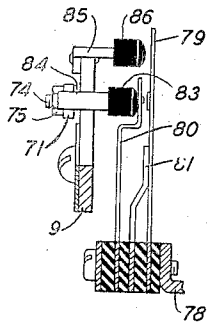


FIG. 10

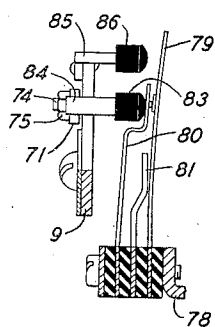


FIG. 11

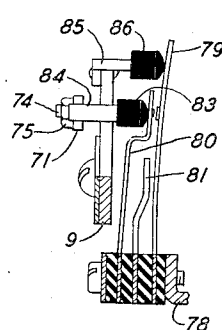


FIG. 12

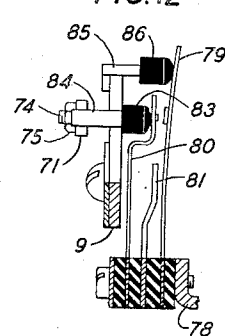
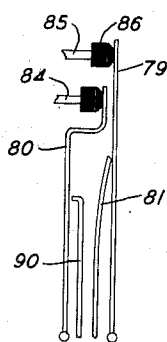


FIG. 13



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SWITCHING MECHANISM

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Application November 26, 1941, Serial No. 420,477

13 Claims. (Cl. 179—27.51)

This invention relates to switching mechanisms and particularly to such mechanisms when employed in telephone systems.

An object is to improve the operating characteristics of such switching mechanisms to insure more reliable operation in response to varying control conditions in regard to speed and duration of energizing impulses.

Heretofore driving mechanisms have been provided for contact selecting switches, for example, in which an electromagnet is employed to step the switch in a step-by-step manner by impulses of current through the magnet. Such switches may be provided with an armature that operates when energized by the magnet to act on a pawl and ratchet mechanism to control the rotary movement of wipers to travel over terminal banks. In these switches the magnet may be energized by impulses varying in duration and to aid in insuring that the magnet responds properly to insure a full operating step for each impulse received, so-called pulse-help mechanisms were provided. Such pulse-help mechanisms may include, in addition to the operating armature, an auxiliary armature. These armatures were arranged to control contacts for closing and opening an auxiliary pulse-aid circuit for the magnet to insure the proper functioning of the magnet regardless of the duration of the original operating impulse. In devices of this kind, the contacts for the pulse-aid circuit are closed by the auxiliary armature as it is attracted by the magnet and when the main armature is fully attracted it forces the auxiliary armature away from the magnet against the magnetic flux that tends to maintain it attracted so that the auxiliary armature will now open the pulse-aid circuit and thus cause the magnet to be deenergized to restore the main armature. An arrangement of this kind has been disclosed in the copending application of V. F. Bohman, filed November 26, 1941, Serial No. 420,449.

In the invention conceived by Bohman the auxiliary armature is in the form of a reed of magnetic material located near the core of the magnet so that it is attracted to the core by stray flux, while the main armature lies directly in the path of the magnetic flux circuit passing through the core, main armature and a return pole-piece.

The present invention relates to this general type of pulse-aid arrangement, and a feature thereof is a mechanism consisting of a main armature and an auxiliary armature controlled by a magnet and two contact springs normally opened for a pulse-aid circuit, in which both the

main armature and the auxiliary armature lie directly in the path of the magnetic flux circuit which passes through the core, the two armatures and a return pole-piece. To carry out this feature of the applicant's invention both armatures are closely associated with the return pole-piece of the magnet and the main armature is provided with an aperture and the auxiliary armature with a projection passing through this aperture so that this projection of the auxiliary lies conjunctively in front of the core directly in the path of the magnetic flux stream passing through the core, the armatures and the return pole-piece.

Another feature of the applicant's invention is to so proportion the auxiliary armature that it will respond to a minimum amount of the available magnetic flux immediately this amount has been produced during the energization of the magnet so that the maximum amount of flux will remain for the attraction of the main armature and thus the auxiliary armature is quickly attracted by the core to act on the contact springs to close the pulse-aid circuit. To carry out this feature of the applicant's invention the cross section of the projection on the auxiliary armature is of such size that it will be saturated with magnetic flux of the desired minimum amount.

It is another feature of the applicant's invention to provide an arrangement such as a lever, for example, which when the main armature is fully attracted is acted upon by this armature to force the auxiliary armature away from the core back to its normal position to open the pulse-aid circuit, and it is at this time that the size of the extension of the auxiliary armature comes into play in maintaining the auxiliary armature in released position. The magnetic flux, as soon as it begins to die down sufficiently to permit the main armature to begin to release, will not be sufficient to again attract the auxiliary armature to cause a false reclosure of the pulse-aid circuit.

A modified form of the applicant's invention is an arrangement of the two armatures and the two control springs for the pulse-aid circuit in which, when a pulse of energizing current is passed through the magnet and the auxiliary armature is attracted, this auxiliary armature engages one of the springs to close with the other spring in the previously described arrangement, but, when the main armature is fully attracted by the magnet, instead of it operating on a lever to force the auxiliary armature away from the core, the main armature engages said other spring and opens the

pulse-aid circuit and thus permits the auxiliary armature to return to normal independently and quickly and prevent the pulse-aid circuit again closing during the slower return of the main armature. In this case, the first-mentioned spring may be arranged so that it offers a minimum amount of stiffness in flexing at the beginning of the operating stroke of the armature and as it is further flexed, this spring will increase in resistance rapidly to build up a maximum of tension when fully flexed so that when the pulse-aid circuit is opened by the main armature and the other spring this built-up tension of the first-mentioned spring and the size of the auxiliary armature will permit the auxiliary armature to release quickly after the magnetic flux begins to die out and consequently permit this spring to restore to normal well in advance of the return of the other spring to normal to prevent a connection from being made during the backward stroke of the main armature as it releases the said other spring.

Another modified form of the applicant's invention is an arrangement for causing the auxiliary armature to operate quickly and return quickly to normal by having the spring controlled by this armature comparatively flexible and having it associated with a stop member so that this spring may be advanced rapidly by the auxiliary armature at the beginning of its movement from normal position and when it encounters this stop, this spring will be considerably foreshortened and thus from this point on build up rapidly increasing tension towards the end of the stroke of the auxiliary armature. Thus a minimum amount of flux is required at the beginning of the stroke and then built up rapidly as the stroke is being completed and consequently a quick closure of the auxiliary pulse-aid circuit takes place and quick opening thereof on the release of the auxiliary armature.

This invention has been illustrated in the accompanying drawings in which:

Fig. 1 shows a top view of a single motion step-by-step switch in which one form of the applicant's invention has been incorporated;

Fig. 2 shows a partial front view of this switch;

Figs. 3, 4 and 5 illustrate the various steps of the pulse-aid contact springs and the two armatures embodying the applicant's invention as illustrated in Figs. 1 and 2;

Fig. 6 shows a diagrammatic view of this form of the applicant's invention including the two armatures and the pulse-aid contact springs as illustrated in Figs. 1 and 2;

Fig. 7 is a partial front view of a switch similar to the switch shown in Fig. 1 with a modified form of the pulse-aid contact springs;

Fig. 8 is a front view of the portion of the switch shown in Fig. 7;

Figs. 9, 10, 11 and 12 show the various steps of the pulse-aid contact springs and armatures of the modification in Figs. 7 and 8;

Fig. 13 shows another modified form of the pulse-aid contact springs; and

Fig. 14 is an enlarged fragmentary section showing the relationship of the armatures to the core of the operating magnet.

Referring now to Figs. 1 and 2 the frame mounting plate 1 has been shown on which the various parts of the switch are mounted; 2 shows a semicircular terminal bank containing terminals to which connections may be made by means of a set of brushes 3 assembled on a sleeve 4 mounted for rotation on a stationary shaft 5

secured to plate 1. On sleeve 4 is mounted a ratchet wheel 6 which may be engaged by an operating pawl 7 connected to a main armature 8 controlled by the stepping magnet 9. The pawl 7 is normally held away from the teeth on ratchet wheel 6 by an extension 10 engaging a stop 11 and a helical spring 12 surrounding the pawl mounting pin 13 urges pawl 7 against the teeth of ratchet wheel 6 when the armature 8 is attracted by magnet 9. The armature 8 is mounted on a pin 14 between ears 15 on the armature 8 and the pin 14 is mounted on a non-magnetic bracket 16 secured to the return pole-piece 17. The armature 8 is also provided with a backstop member 18 which normally engages a non-magnetic button 19 secured to the return pole-piece 17 on which the magnet 9 is mounted. This return pole-piece 17 forms part of the mounting plate 1. The armature 8 is held in normal position by the leaf spring 20 engaging the stop 11. The brushes 3 and the ratchet wheel 6 are held in a normal position as shown in this figure by means of a spring 22 attached at one end to a projection 26 forming part of a stop-plate 25 also mounted on the sleeve 4. The other end of the spring 22 is attached to a pin 26 secured to frame 1. The stop-plate 25 engages pin 28 on the frame 1 to locate the brushes in their normal position under tension of the spring 22. A holding pawl 30 normally engages the ratchet wheel 6 to maintain it in a position to which it has been advanced after each step taken by the operating pawl 7 when the armature 8 is attracted by the magnet 9. This pawl 30 is held against the teeth in the ratchet wheel 6 by means of a spring 31 attached thereto and engaging the pin 28. The holding pawl 30 forms part of an armature 32 pivoted at 33 to a bracket 34 secured to the return pole-piece 35 forming part of frame 1 for the release magnet 37 so that when the release magnet 37 is energized the holding pawl 30 disengages the ratchet wheel 6 to permit the brushes 3 to return to normal under tension of springs 22. Attached to the sleeve 4 is also a lever 39 having an insulating bushing 40 that normally engages a spring 41 of a spring pile-up 42 to normally maintain certain connections and when lever 39 and bushing 40 are moved by the rotation of the sleeve 4, the spring 41 closes other connections as shown in this figure for any suitable purpose when this switch is employed in telephone systems.

Mounted on the pin 14 on which the main armature 8 is mounted is also mounted an auxiliary armature 45 of magnetic material which is also provided with a backstop member 46 engaging the return pole-piece 17. The auxiliary armature is provided with an angular extension 47 and extends through an opening 48 of the main armature 8 towards the core 50 of the magnet 9. To frame 1 is secured a bracket 51 on which are mounted in a perpendicular direction two contact springs 52 and 53. Spring 52 is held tensioned normally against an insulation bushing 54 mounted on an extension 55 on armature 45. On an extension 57 of bracket 51 is mounted loosely a lever 58 having one arm 59 engaging an extension 60 on the armature 45 and another arm 61 in position to be engaged by the armature 8, the purpose of which will be described hereinafter.

The operation of the pulsing mechanism disclosed in the above-described Figs. 1 and 2 will now be disclosed in connection with these figures and Figs. 3 to 6. In the latter figure diagram-

matic representation has been made of this mechanism to illustrate circuits that may be supplied and the relation of the parts to each other without regard to the actual structural details. However, in Fig. 3 the exact position of the springs, armatures and lever 58 have been shown as in normal position and as actually constructed. In general therefore, if a connection at 62 is closed, a pulsing circuit is closed from battery through the winding of magnet 9, contacts 62 to ground to energize the magnet 9. It will be noted now that when the magnet begins to energize and build up a magnetic flux, the size of the extension 47 on armatures 45 is such that only a small amount of magnetic lines of force may pass through it. These magnetic lines of force may originally pass from the return pole-piece 17, backstop 46, armature 45, extension 47 and across the air-gap 63 to core 50 back to pole-piece 17 as this is the line of least resistance. This air-gap 63 is comparatively small and the armature 45 and extension 47 are quite light having small cross sections so that the armature 45 is quickly attracted to the core 50 before the magnetic flux in magnet 9 has built up to any appreciable extent. As the backstop 46 leaves the pole-piece 17, the magnetic lines of force will then pass through the air-gap 64 between the pole-piece 17 and armature 8, through this armature and the air-gap 65 between armature 8 and extension 47, air-gap 63, core 50, back to pole-piece 17. However, this latter path does not increase the magnetic lines of force beyond the amount possible for the extension 47 to absorb. If attention is now directed to the spring 52, it will be observed that this spring is quite light and that it normally has practically no back tension against the bushing 54 mounted on extension 55 on armature 45 so that at the beginning of the stroke of the armature 45, practically no resistance will be exerted by the spring 52. The only work that the magnetic lines of force have to do is to overcome the inertia of the light armature 45 and the slight build-up of tension in the spring 52. This will aid in the quick operation of the armature 45. When the armature 45 is fully attracted and spring 52 contacts with spring 53 the pulse-aid circuit is closed from battery, winding of magnet 9, springs 53 and 52 to ground. This circuit therefore permits the building up of the magnetic flux of magnet 9 even though the original pulse circuit may be opened at contacts 62. This increased magnetic flux will now be passed through the pole-piece 17, air-gap 64, armature 8, air-gap 66 and core 50 back to pole-piece 17 and the magnet 9 will begin to attract armature 8. The position taken by the armature 45 after closure of the connection between springs 52 and 53 is shown in Fig. 4. This indicates that the lever 58 has been slightly rotated in a counter-clockwise direction by the extension 60 acting on arm 59 of lever 58 which has brought the arm 61 nearer to armature 8 and when the armature 8 now moves toward the core 50 it will, as it is about to complete its stroke, engage arm 61 and move the lever 58 in a clockwise direction so as to cause arm 59 to move extension 60 and through it the armature 45 back to normal and thus allow the spring 52 to leave spring 53 to open the pulse-aid circuit at the time the armature 8 is fully attracted. This condition is illustrated in Fig. 5. The armature 8 will then return to normal as it is released due to the dying down of the magnetic flux in magnet 9. Thus with this arrangement of the applicant's

invention, a quick operation of the armature 45 is obtained to quickly close the pulse-aid circuit and this circuit will be opened at the proper moment to release the armature 8 as soon as it has completed its forward stroke. The extensions 55 and 60 may, by bending them by hand be adjusted so that the normal contact gap between the springs 52 and 53 will be maintained the same when the main armature 8 moves into attracted position to rotate lever 58 to return the auxiliary armature to normal position, that is, the contact gap shown in Fig. 3 between the springs 52 and 53 will be the same as the contact gap shown in Fig. 5.

The modified form of the applicant's invention, as disclosed in Figs. 7 to 12 is similar to the form disclosed in the preceding figures as far as the general structure of the switching mechanism and the pulsing and pulse-aid circuits are concerned. However, the arrangement of the two armatures for the pulse-aid circuit is somewhat different from that shown in Figs. 1 to 6. The main armature has been marked 70 in these latter figures and the auxiliary armature 71 which is mounted on pin 72 is provided with a backstop 73 engaging the pole-piece 17. This armature 71 is provided with a screw 74 of magnetic material that may be screwed into the armature 71 and held in place by a nut 75 and extends through the opening 76 of armature 70 toward the core 50. On the bracket 78 of frame 1 is mounted in a perpendicular direction two springs 79 and 80, spring 79 is tensioned normally against the backstop spring 81 mounted with springs 79 and 80 on bracket 78 to hold the spring 79 in a certain fixed position in relation to spring 80. The spring 80 on the other hand as shown in Fig. 9, in particular, is bent with an offset to normally engage the insulation bushing 83 on an angular projection 84 of armature 71. On an angular extension 85 connected to armature 9 is mounted an insulation bushing 85 which bushing, however, does not normally touch the spring 79 but is located a certain fixed distance therefrom.

The operation of the pulse-aid mechanism shown in Figs. 7 to 12 comprising the contact springs 79 and 80, and the auxiliary armature 71, the main armature 9 and the operating bushings 83 and 86 and their supports is as follows: In general if pulsing and pulse-aid circuits are associated with the magnet and contact springs as disclosed and described in connection with Fig. 6 it will be noted that when the pulsing circuit is closed and the magnet begins to energize and build up a magnetic flux the size of the screw 74 is such that only a certain amount of magnetic flux may pass through it. These magnetic lines of force may originally extend from the return pole-piece 17 through the backstop 73, armature 71, screw 74 and across the air-gap 88 between screw 74 and the core 50, as this is the line of least resistance. This air-gap 88 is comparatively small and the armature 71 is quite light, having a small cross section, but this cross section and air-gap 88 and the size of the screw 74 are such that a sufficient number of magnetic lines of force will be passed through these elements across the air-gap 88 to quickly attract the armature 71 towards the core 50 before the magnetic flux in coil 8 has built up to an appreciable extent. As the backstop 73 of the armature 71 leaves the return pole-piece 17 the magnetic lines of force will then pass through the air-gap 89 between the

return pole-piece 17 and the armature 9 through this armature 9, the air-gap 90 to the core 50. However, this latter path for the magnetic lines of force does not increase the magnetic lines of force beyond the amount possible for the screw 74 to absorb.

If now attention is directed to the spring 80, it will be noted that this spring is quite light and that it normally has practically no back tension against the bushing 83 so that at the beginning of the stroke of the armature 71 practically no resistance will be exerted by spring 80. The only work that the magnetic lines of force, passing through the air-gap between screw 74 and core 50 has to do is to overcome the inertia of the light armature 71 and the slight build-up tension of spring 80. However, as the magnetic lines of force are gradually increasing, the tension of spring 80 will, of course, increase more and more as it flexes towards spring 79. When connection is made between springs 80 and 79, the pulse-aid circuit is closed. This circuit therefore will permit the building up of the magnetic flux through the core 50 of coil 9 even though the original pulsing circuit may now be opened. This increasing magnetic flux will now be diverted through the return pole-piece 17, the air-gap 89, the armature 70 and the air-gap 80 between the armature 70 and the core 50 and will begin to attract the armature 70 towards the coil. The position taken by the armature 71 after it has closed the connection between springs 80 and 79 is shown in Fig. 10. This indicates that the spring 79 has been slightly moved towards the right further away from the bushing 86 at this time. This will permit the main armature 70 to be moved for quite some distance before the bushing 86 reaches the spring 79, that is, it will have practically completed its forward stroke. When the main armature 70 is finally fully attracted, the bushing 86 will engage spring 79 and move it further towards the right as shown in Fig. 11 and thereby break the connection between springs 80 and 79. When this takes place the pulse-aid circuit through these two springs will be opened and the magnet will begin to deenergize. Thus during the forward attractive motions of the two armatures, the pulse-aid circuit will be closed quickly and open only at the end of the stroke of the main armature.

Now it will be noted that as soon as the magnetic lines of force begin to decrease, it is evident that due to the tension built up in the spring 80 by the armature 71, this armature will be released quickly before the magnetic lines of force have decreased to any appreciable amount and thus return quickly with spring 80 to normal position. This condition is shown in Fig. 12. As the magnetic lines of force decrease further, the main armature 70 will begin to return to normal but as the armature 71 is already returned to normal, the spring 79 will never succeed in catching up with spring 80 during its return stroke to normal and therefore prevents the connection between springs 80 and 79 from being closed during the return stroke of the armatures. These elements therefore function to establish the pulse-aid circuit at the earliest possible moment on the energization of the magnet 9 and open it quickly at the beginning of the deenergization of the magnet and thus the original pulse-aid circuit may remain closed for a very short interval without affecting

the proper functioning of armature 70 to take a complete step.

Referring now to the modified form of the spring contacts as shown in Fig. 13 in addition to the springs 80 and 79 and the backstop 81, there is also another spring or stop member 90 which normally does not touch the spring 80 and is somewhat stiffer than spring 80. The purpose of this arrangement is such that when the spring 80 is first moved to make contact with spring 79, it will begin to move immediately and rapidly, in response to a very small amount of flux as produced by the magnetic lines passing through the air-gap between screw 74 and core 50, due to it not being tensioned against stop 90 and due to it being very flexible. However, as the magnetic lines increase and the spring 80 has moved a certain distance, it will come in contact with spring 90 and from this point on towards the end of the stroke, a greater power will be required to flex the springs 80 and 90 further to complete the stroke of the armature 71 as the spring 80 is now effectively stiffer due to its contacting with stop 90. The purpose of this is so that when the magnetic lines decrease at the opening of the connection between springs 80 and 79, the tension built up in springs 80 will at the beginning of the back stroke be larger than at the beginning of the forward stroke and consequently aiding in restoring the armature 71 to normal quickly and thus insuring that the spring 80 will be released well in advance of the return of the main armature and that under no circumstances will the spring 79 be able to catch up with spring 80 on the return stroke of the two armatures to establish a false connection between these springs.

What is claimed is:

1. In a stepping mechanism, a magnet having, a winding, a core and a return pole-piece, a circuit for momentarily energizing said winding, a heavy armature having an aperture, a light armature having an extension located in the center of said aperture so that the magnetic flux produced between said core and pole-piece when the winding is energized by said circuit will be concentrated in a single stream through said armatures, a second circuit for said winding, contact springs for said second circuit and means controlled by said armatures arranged so that when the light armature is attracted by said core, said contact springs are actuated to close said second circuit to continue the energization of said winding and when the heavy armature is fully attracted by said core, said contact springs are separated to open said second circuit to discontinue the energization of said winding.

2. In a stepping mechanism, a magnet having a winding, a core and a return pole-piece, a circuit for momentarily energizing said winding, a heavy armature having an aperture, a light armature having an extension located in the center of said aperture so that the magnetic flux produced between said core and pole-piece when the winding is energized by said circuit, will be concentrated in a single stream through said armatures lying directly in the path of said flux, a second circuit for said winding, contact springs for said second circuit, and associated with said light armature so that when said latter armature is attracted by said core, said contact springs are actuated thereby to close said second circuit to continue the energization of said winding, and means controlled by said heavy armature when fully attracted by said core for

releasing said light armature to separate said contact springs to open said second circuit to discontinue the energization of said winding.

3. In a stepping mechanism, a magnet having a winding, a core and a return pole-piece, a circuit for momentarily energizing said winding, a heavy armature lying directly in the path of the magnetic flux produced between said core and pole-piece when the winding is energized by said circuit, a light armature located coextensively with said heavy armature in the same flux path and capable of absorbing only a small amount of the totally available magnetic flux produced by the energization of said magnet, a second circuit for said winding, contact springs for said second circuit and associated with said light armature so that when said light armature is first attracted by said core, said contact springs are actuated thereby to close said second circuit to continue the energization of said winding, and means controlled by said heavy armature when later fully attracted by said core for releasing said light armature to separate said contact springs to open said second circuit for discontinuing the energization of said winding.

4. In a stepping mechanism, a magnet having a winding, a core and a return pole-piece, a circuit for momentarily energizing said winding, a heavy armature located in the magnetic flux stream produced between said core and pole-piece when said winding is energized by said circuit, a light armature located coextensively with said main armature in said flux stream, a second circuit for said winding, contact springs for said second circuit and associated with said light armature so that when said light armature is moved by said flux stream from a normal position to an actuated position, said contact springs are moved thereby to close said second circuit to continue the energization of said winding, and means controlled by said heavy armature when fully attracted by said flux stream, for restoring said light armature to its normal position to separate said contact springs to open said second circuit for the discontinuing of the energization of said winding.

5. In a stepping mechanism, a magnet having a winding, a circuit for momentarily energizing said winding, a heavy armature located in the path of the magnetic flux produced by said winding when energized by said circuit, a light armature having a projection extending through an aperture in said heavy armature, a second circuit for said winding, contact springs for said second circuit and associated with said light armature so that when said light armature is attracted by said winding said contact springs are closed thereby to close said second circuit to continue the energization of said winding, and means controlled by said heavy armature when fully attracted by said winding for releasing said light armature to separate said contact springs to open said second circuit.

6. In a stepping mechanism, a magnet having a core, a circuit for momentarily energizing said magnet, a heavy armature having an aperture and located with a certain air-gap between it and the core of said magnet, a light armature having an extension located in the center of said aperture, said extension being further located in relation to the core so that it forms an air-gap between itself and the core which is smaller than the air-gap between the heavy armature and the core, a second circuit for said magnet, contact springs having a certain contact gap be-

tween them for said second circuit and associated with said light armature so that when said light armature is attracted by said core, said contact springs will close said contact gap to close said second circuit and continue the energization of said magnet, and means controlled by said heavy armature when fully attracted by said core to release said light armature to separate said contact springs until the contact gap between them is restored to normal condition to open said second circuit to discontinue the energization of said magnet.

7. In a stepping mechanism, a magnet, a circuit for momentarily energizing said magnet, two armatures both located in relation to said magnet and in relation to each other so that when said magnet is energized the magnetic flux produced thereby flows through said armatures independently and from one armature to the other armature, normally opened contact springs controlled by said armatures, a second circuit for energizing said magnet and controlled by said contact springs, said armatures being so proportioned that one of them is attracted prior to the other, said armatures being associated with the contact springs so that when the magnet is energized by said first circuit, the first attracted armature when fully attracted closes said second circuit and the other armature when fully attracted opens said second circuit.

8. In a stepping mechanism, a magnet, a circuit for momentarily energizing said magnet, an armature having an aperture located in the magnetic flux stream produced by said magnet when energized by said circuit, said armature being of such size as to be fully attracted by said flux stream when of a certain density, a second armature having a portion concentrically located in said aperture, contact springs, said second armature being of such size and so located as to be attracted by said flux stream when of a less density and prior to the attraction of the other armature, a second circuit for said magnet controlled by said contact springs and means associated with said armatures for controlling said contact springs to close them when said second armature is fully attracted and open them when said first armature is fully attracted.

9. A motor magnet, a circuit therefor, means for closing said circuit at intervals, a main armature for said magnet, an auxiliary armature for said magnet, a second circuit for said magnet, contact springs for closing said second circuit, said armatures and contact springs cooperating so that when said first circuit is closed, the energization of said magnet attracts said auxiliary armature quickly to close said contact springs for continuing the energization of said magnet through said second circuit to attract said main armature to open said contact springs at the end of the stroke of said main armature and so that on the deenergization of said magnet, said auxiliary armature is released quickly to maintain said contact springs open during the subsequent restoring of said main armature.

10. In a stepping mechanism, a motor magnet having a core, a circuit therefor, means for closing said circuit at intervals, a main armature, an auxiliary armature, a second circuit for said magnet, contact springs for closing said second circuit, said armatures being arranged to control said contacts in a certain sequence, the auxiliary armature being for that purpose of small mass as compared with the mass of the main armature and so located in relation to one of the contact

springs and to the core of the magnet that when the first circuit is closed, a comparatively small amount of flux is required for the attraction of the auxiliary armature to the core to overcome the tension on said one contact spring and to cause said armature to act on said contact spring to establish a connection with the other contact spring, said connection being thus established before the main armature is fully attracted and when the main armature is fully attracted it will act on the other contact spring to open said connection and when the magnet is deenergized a comparatively small decrease in flux will permit the auxiliary armature to release and prevent said contacts from closing during the return movement of said armatures.

11. In a stepping mechanism, a motor magnet, a circuit therefor, means for closing said circuit at intervals, a main armature, an auxiliary armature, a second circuit for said magnet, contact springs for closing said second circuit, the mass of said two armatures and their relationship to said contact springs, the tension of said contact springs and the magnetic path of the flux for controlling said armatures are such that the auxiliary armature completes its forward and its backward strokes independent of the main armature before the main armature completes its forward and backward strokes and so that said contacts are closed by the auxiliary armature at the beginning of its forward stroke and are opened by the main armature at the end of its forward stroke and are not again closed by said armatures on their backward stroke.

12. In a stepping mechanism, a motor magnet having a core, a circuit therefor, means for closing said circuit at intervals, a main armature and an auxiliary armature, a second circuit for said magnet, contact springs for closing said second circuit, the auxiliary armature comprising a comparatively light main portion and a light extension portion, the latter portion being

located in close proximity to the core of the magnet to form a comparatively small air-gap and of such size that only a small portion of the available magnetic flux can pass through said extension but sufficient to attract said auxiliary member to said core at said air-gap before the remaining flux is built up sufficiently to attract said main armature to permit the closure of said contacts by said auxiliary armature when attracted and to allow the opening of said contacts by said main armature when fully attracted to start the deenergization of the magnet and thereby cause said auxiliary armature to release when said small portion of flux is dissipated on the deenergization of the magnet before the main armature is released by the final dissipation of said flux and thereby preventing the contacts from closing during the return movements of the armatures.

13. In a stepping mechanism, a motor magnet having a core, a circuit therefor, means for closing said circuit at intervals, a main armature, an auxiliary armature, a second circuit for said magnet, contact springs for closing said second circuit, the mass of said armatures, their relationship to said contacts and to the core of magnet, the tension of said contacts and the magnetic flux distribution through said armatures being such that the auxiliary armature operates quicker than the main armature during its forward stroke due to a path of least resistance being available for the flux through said auxiliary armature and restores quicker than the main armature due to the tension built up in one of said springs during the forward movement of the auxiliary armature so that the contacts are closed by the auxiliary armature during its forward stroke and are opened by the main armature at the end of its forward stroke and are maintained opened during the return strokes of said armatures.

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