March 15, 1932. F. MERK 1,849,986

AUTOMATIC TELEPHONE SWITCH

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Fig. 1.

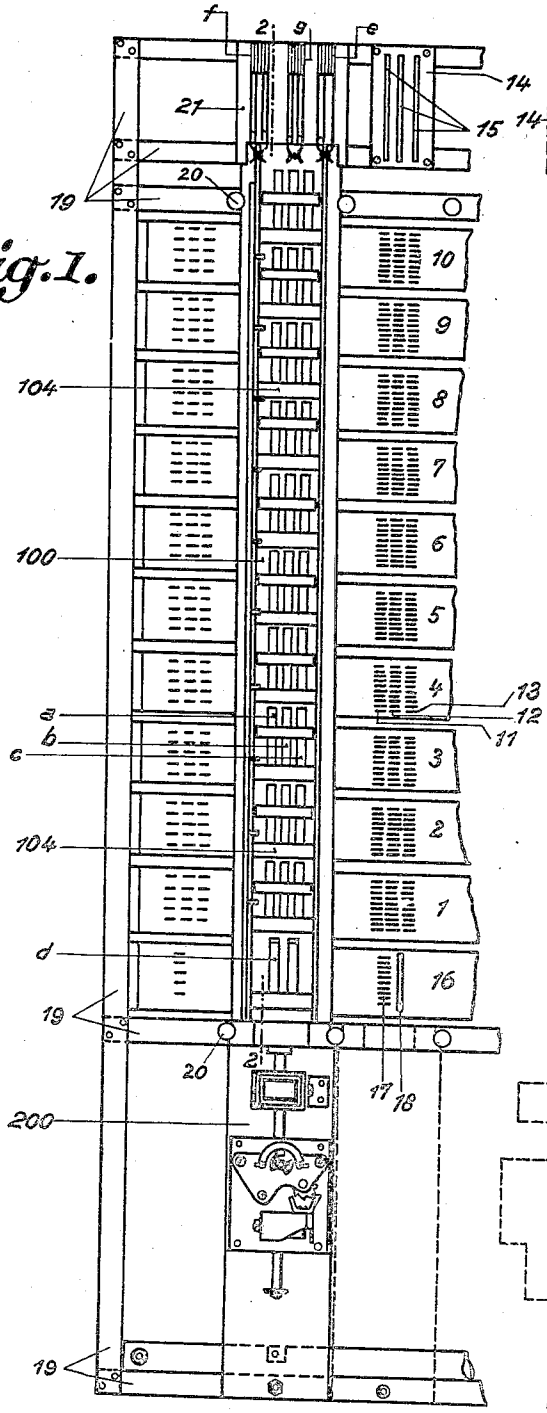
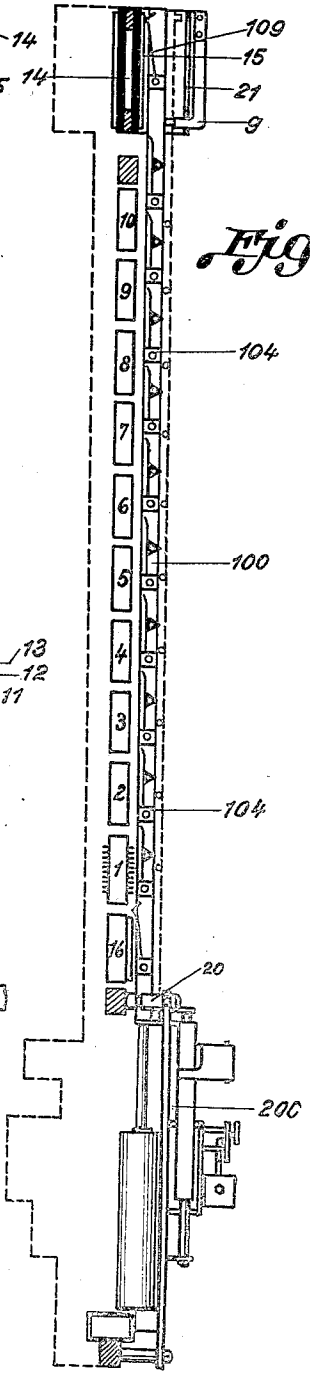


Fig. 2.



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AUTOMATIC TELEPHONE SWITCH

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Fig. 3.

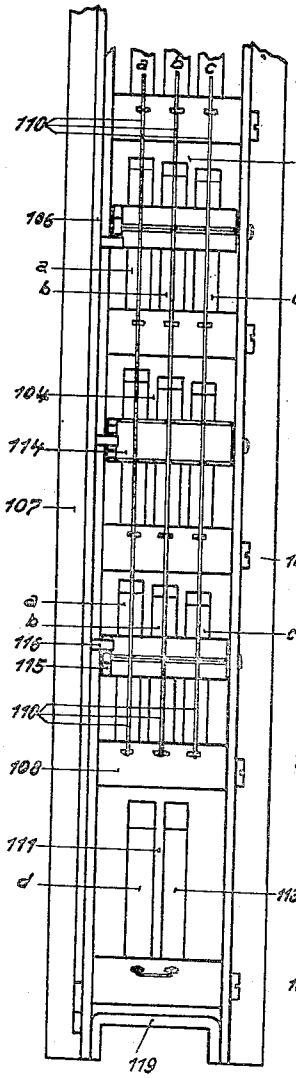


Fig. 4.

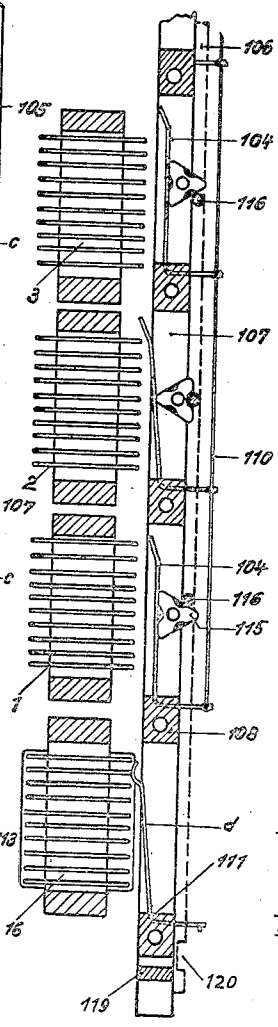
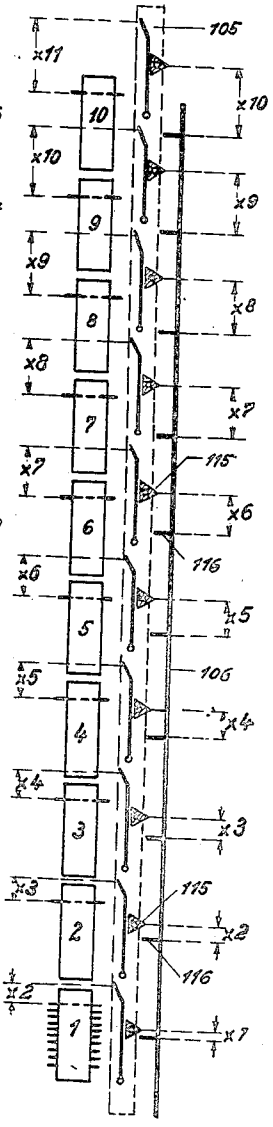


Fig. 5.



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AUTOMATIC TELEPHONE SWITCH

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Fig. 6.

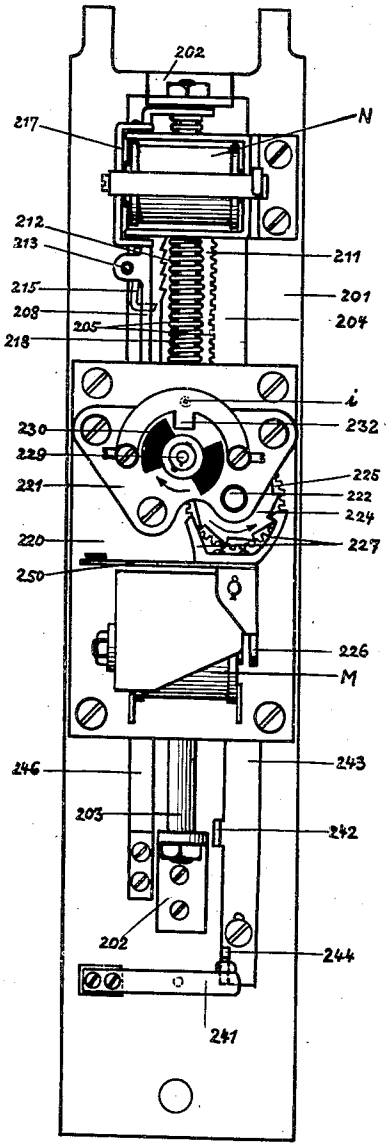
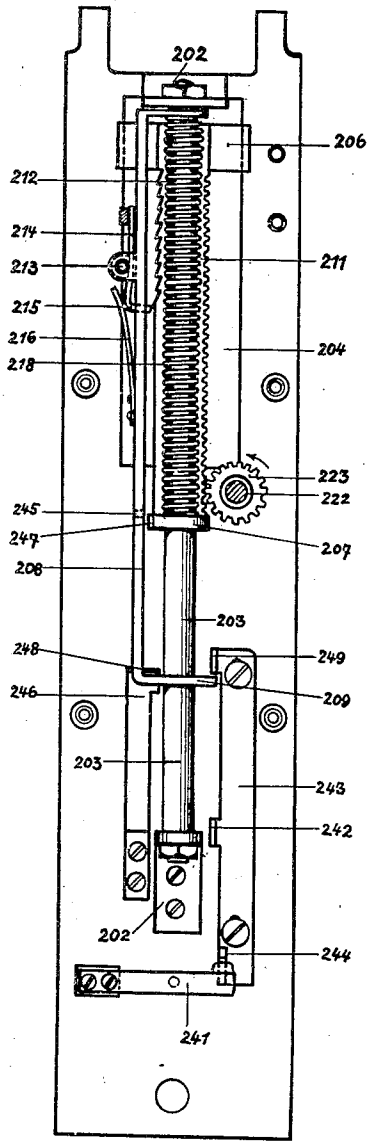


Fig. 7.



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AUTOMATIC TELEPHONE SWITCH

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Fig.8

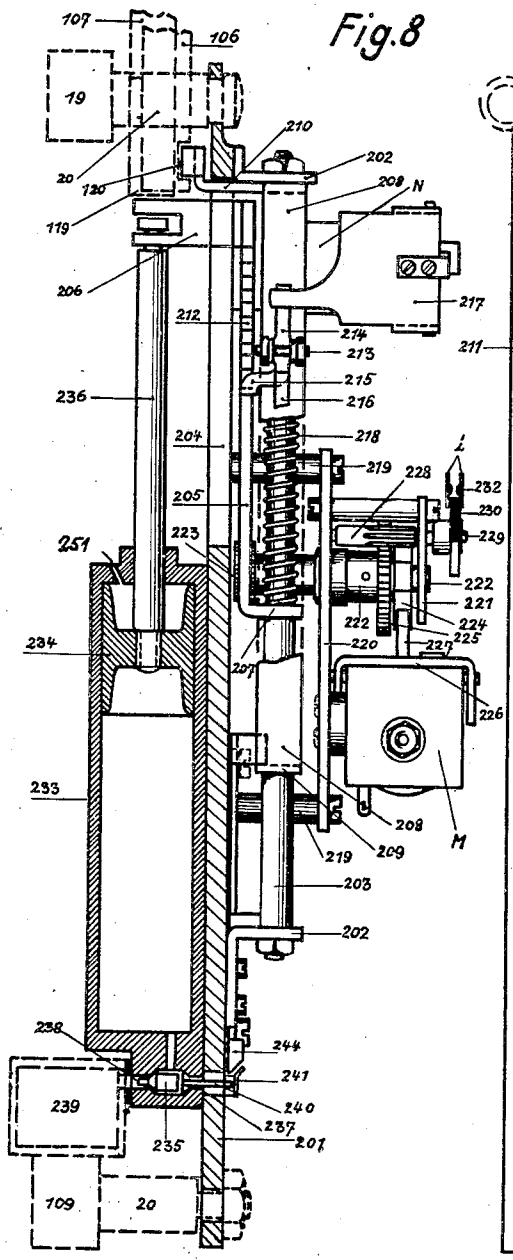
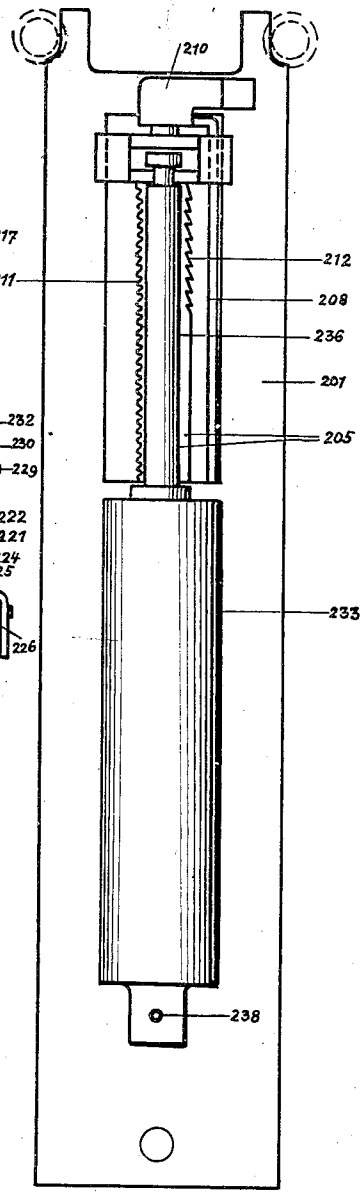


Fig.9



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AUTOMATIC TELEPHONE SWITCH

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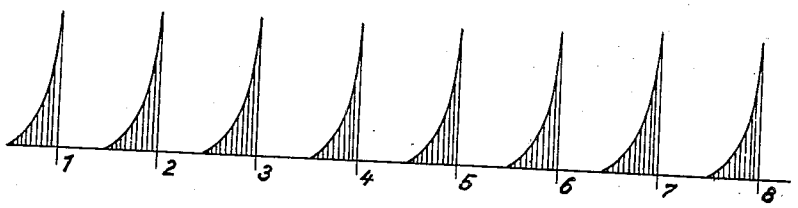


Fig. 10.

Fig. 11

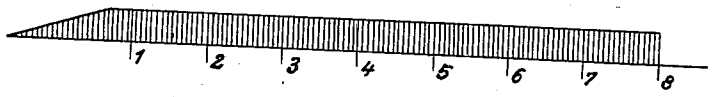


Fig. 12

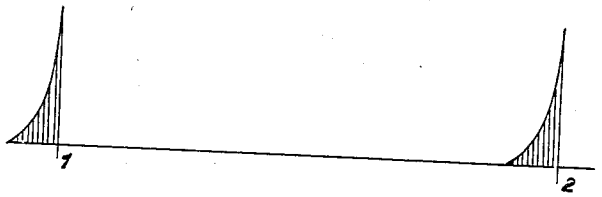


Fig. 13

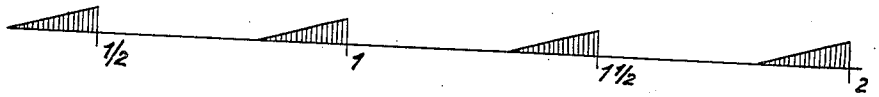
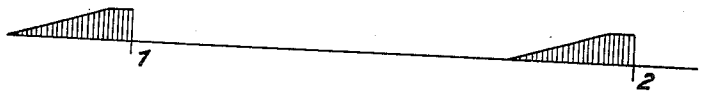


Fig. 14



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AUTOMATIC TELEPHONE SWITCH

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Fig. 15

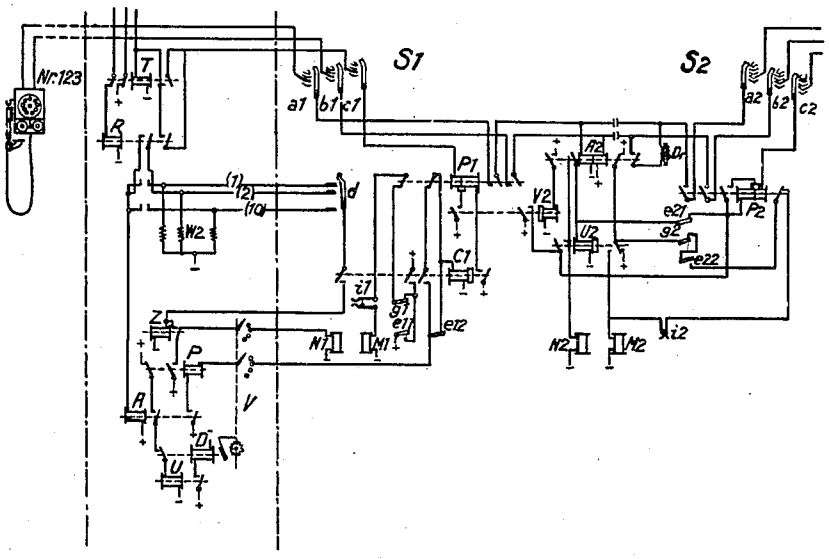
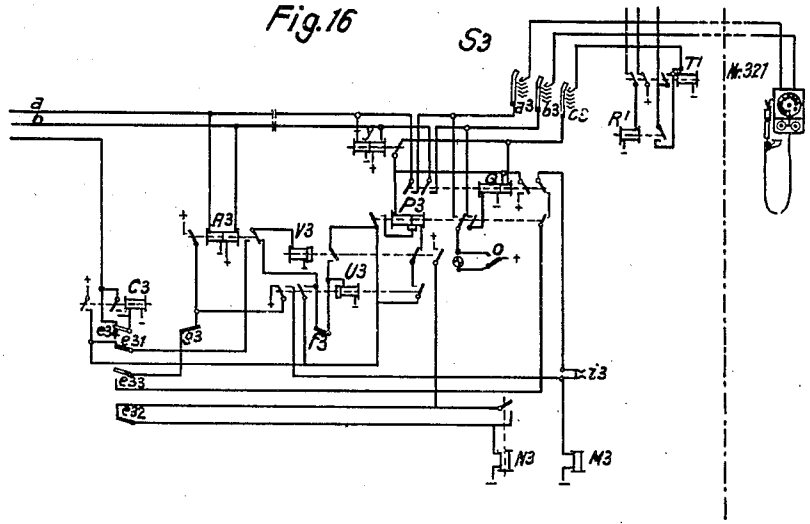


Fig. 16



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AUTOMATIC TELEPHONE SWITCH

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Fig. 17

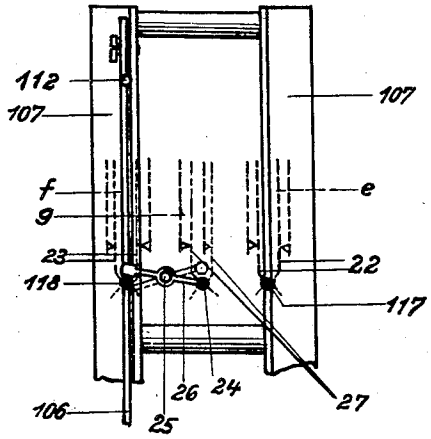
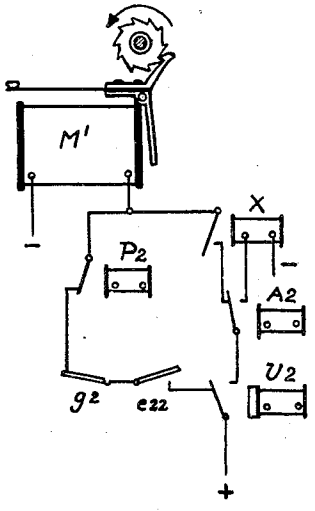


Fig. 18



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1,849,986

UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE SWITCH

Application filed May 25, 1929, Serial No. 365,950, and in Germany May 26, 1928.

The invention relates to selectors with a switching member which is driven by a constantly acting force and of which the operation is controlled through an intermittently acting device, by means of a pawl mechanism. Such selectors are well-known for step-by-step adjustment in several forms of construction. Generally, the switch member is driven by a spring or by its own weight, and is controlled by a pawl mechanism set into oscillation by an electromagnet, which, at each current impulse sent through the electromagnet, executes a to-and-fro movement which allows the switching member to move forward by one switching-step.

The invention has for its object an improvement of the above-mentioned selectors by permitting, whilst still retaining the step-by-step adjustment, the executing of a uniform movement (sliding movement) by the switching member. This dual adjustability deserves special consideration because, when the selector operates as a line finder, a sliding movement of the switching member is preferably to a step-by-step movement, whilst the step-by-step operation is, in any case, the operating form best suited for numerical selection.

The invention is distinguished from well-known proposals, which likewise may be operated, as desired, with a step-by-step or uniform movement of the selector switching member, by the special simplicity of the construction which, by the use of the controlling device indicated besides pawl mechanism, is applicable to both types of use.

The sliding movement of the switching member, according to the invention, is accomplished by the frequency and phase of the impulses transmitted to the controlling member being so adjusted with reference to the speed of the switching member that the pawl mechanism, set into oscillation by the control member, constantly avoids engagement with the switching member up to the moment of its stopping and thereby makes free the path of movement to the switching member for any length of switching step. A complete adjustment of the frequency and phase of the impulses of the control member to the speed of the switching member is obtained, in any case, by making the same dependent upon the switching member itself. The electromagnet, normally provided as the controlling device for the step-by-step operation, is quite suitable for executing the sliding operation. The transferring from the step-by-step operation to the sliding operation necessitates, in this case, merely transferring the conductors of the electromagnet from the circuit for the numerical current impulse reception, to a local circuit with an interrupter controlled by the switching member.

The advantage of the double kind of adjustability of the switching member becomes important particularly in the case of selectors adapted to perform different selecting operations, since, in this case, according to the manner of use of the selectors, either all the selectors or any individual ones may be supplied with step-by-step or sliding operation, as required. In the following description of a constructional example of the invention, it is assumed that the selector is for two-fold selection (group and individual line selection). Moreover, in the example described, both selections are in the same direction of movement and the arrangement for the group selection is made in such a manner that both adjusting movements of the selector are controlled with one single controlling and pawl device.

The general importance of the invention consists in that it balances the contrast between the modern existing types of main selectors with step-by-step and machine drive. Hitherto, there existed the conception that the step-by-step operation only comes into the question for lightly constructed selectors, in contradistinction to which selectors with a heavy switching member must have a machine drive. This view cannot be held against a selector arrangement which combines the step-by-step and sliding operation with one another in a simple and suitable manner for any desirable use. If, as in the following example for explaining the invention, care is taken that, with the group and individual line selection always small switching steps are used, then the limitation of the step-by-

step operation to the numerical selection makes possible a multiple decrease of the natural speed of the switching member in relation to known selectors with step-by-step drive, and thus a considerable increase in weight of the switching member without disadvantage to its operation is permissible. This theory is better explained in the following with the aid of several diagrams. In order, however, to prove the success of the method, it may be said that on selectors constructed according to the invention, with large switching output and steady working, a weight of 1 kilogram and more per switching member is permissible. Thus the invention is applicable to the use of the selectors with large contact fields particularly in the economical form of bar selectors with flat bank contact groups as were hitherto reserved for the machine drive, dispensing with the hitherto usual impulse storing register.

In the drawings Fig. 1 represents the front view of a complete selector for 100 lines.

Fig. 2 represents a section of the switch on the line 2—2 of Fig. 1.

Figs. 3–5 show the switching member in front view and section as well as in complete design.

Figs. 6–9 show various views of the driving mechanism.

Figs. 10–14 illustrate speed diagrams for explanation of the manner of action of the selector.

Figs. 15 and 16 show circuit arrangements for various uses of the selector.

Fig. 17 shows the constructional arrangement of the changeover contacts controlled by the selector.

Fig. 18 shows a special construction of the driving mechanism.

Referring to Figs. 1 and 2, the selector consists of a switching member 100 extending transversely across the ten groups of bank contacts 1—10, a driving mechanism 200 and three sets of contact springs *e*, *f*, *g*. The horizontally extending bank contact groups 1—10 are located at equal distances above one another and form the flat contact bank composed, in well-known manner, of groups of metal contacts and insulation, forming a plurality of similar switches. Each bank contact group contains the contacts of a group of ten lines, each comprising three contacts. The multiple contacts of the individual lines are arranged in three rows 11—13 extending in the direction of movement of the switching member. The numbering of the bank contact groups of lines proceeds, in the present case, from the bottom to the top; and the numbering of the lines of each group from the top to the bottom. The contacts of line No. 23, for example, are located in the third position from the top in the second bank contact group from the bottom.

Above the contact bank is provided a bar 14 with three current lead bars 15 for every three brushes *a*, *b*, *c* of the brush set 104 of the switching member 100. The numbering of brush sets corresponds to that of the bank contact groups and as usual all the brushes *a* are connected with one another in multiple, and also all the brushes *b* and *c* respectively.

When the switch is used as a call finder, as shown in the drawings, there is provided below the contact bank a special extra bank contact group 16, which contains the contacts of ten tens lines for determining, in the case of line finders, the group in which the calling subscriber's line is located. The ten individual contacts 17 of this bank contact group form a single row of contacts located above one another, and have a current introducing bar 18 extending adjacent thereto.

The bank contact groups 1—10 and 16, as well as the bars 14 with the current leads 15, are positioned in a frame 19 which also serves as a support for the remaining parts of the switch. The frame allows of the correct assembling of all parts of the switch to form a complete unit independent of the other devices, relays, and so on with which the switches are subsequently connected by connections on the frame.

The switching member 100 represented in Figs. 3, 4 and 5 is composed of two parts, namely a brush carrier 105 and a brush selector 106. The brush carrier 105 is located on four bolts 20 at the top and the bottom of the switch frame 19 (Fig. 2), and consists, of two angle irons 107 between which the brush sets 104 are secured so that they may be readily interchanged at definite distances apart.

For each bank contact group 1—10, a brush set 104, comprising three flat adjacent brushes for wiping over the contact rows 11, 12 and 13 embedded in insulating material 108, is fixed to the brush carrier. In addition, at the top of the brush carrier are provided three spring wipers 109 (Fig. 2), for wiping over the three abovementioned current lead bars 15. All the corresponding brushes *a*, *b*, *c* of the brush sets 104 are electrically connected together by wires 110 and also to the corresponding wiper 109 whereby all the brushes *a* are connected with the first bar 15, and correspondingly all the *b* and *c* brushes each with one of the other bars 15. If the switch is employed as a line finder, the brush carrier 105 carries at its lower end an extra two-part brush set 111 whose brushes *d* and 113 are electrically connected with one another. The brush *d* of this brush set 111 wipes the ten tens contacts 17 (Fig. 1) of the bank contact group 16, whilst the brush 113 always contacts with the current lead bar 18.

Whilst the brushes of the brush set 111 always rest on their associated contacts, the brush sets 104 are usually out of engagement

with their associated contacts, that is, the brushes *a*, *b*, *c* rest, in the normal position, some distance from the contacts, each resting against a rotatable and preferably triangular rod or prism 114 of insulating material arranged as shown.

The angular members or prisms 114 rotatably mounted upon the angle bars 107, control which individual brush set 104 shall make contact with its associated contacts. In the case of the triangular rod, for example, this is effected by rotating it through 60° so that its edge rests against the springs *a*, *b*, *c* of the desired brush set and makes them project from the space between the two angle plates 107 to engage with the desired bank contact group (see middle brush set of Figs. 3 and 4). The rotation of the prisms is effected by a small toothed wheel 115 arranged at the end of each prism (in the case of the triangular prism it has three teeth) and by pins 116 secured on the brush selector 106. The pins 116 are so displaced with reference to the prisms 114 that on the displacement of the brush carrier 105 with reference to the brush selector 106, each toothed wheel 115 of a prism successively engages with its individual operating pin 116 whereby the prisms are individually rotated in succession. In the case of the switch shown the brush carrier 105 moves downwards in both selecting operations, whilst the brush selector 106 is held during the first selecting operation and moves with the brush carrier during the second selecting operation. When the brush carrier 105 moves downwards with the brush selector 106 fixed, the prism 114 of the lowest brush set 104, is rotated step-by-step when it meets its associated pin 116; in the first switching step through 60° and in a second switching step through 120°, whereby it reaches a position corresponding to its initial position, whilst, by this second switching step, the prism of the brush set next above carries out its first rotary step. In Figs. 3 and 4, the brush carrier 105 has moved two switching steps so that the prism of the second brush set has been rotated through 60° and is thereby located in the operative position. The prism of the first brush set has, on the other hand, been rotated through 120° and back into its normal position, it having been set in the operative position by the first switching step. Should the brush carrier be lowered by a further switching stop, the third brush set will be located in the operative position, and the second brush set will have been returned to its normal position.

In order to effect this progressive changing over of the brush set, the successive distance between pins 116 on the brush selector 106 which cooperates with the toothed wheels 115 of the prisms 114, successively increase by one switching step. These spacing distances are indicated on the right of Fig. 5 by the reference characters $x1, x2 \ldots x10$, the index figure indicating the number of steps.

The changing over of a brush set 104, determined by the number of steps the brush carrier 105 has moved in the selection of the bank contact group, must always be effected when it is in a position one switching step in front of the first contact of its associated bank contact group. To this end the brush sets 104 are also displaced with reference to their associated bank contact groups 1—10, in a particular manner. Also in this case, the successive distances between the brushes, starting from the first brush, increase successively by one switching step. The reference characters $x2, x3 \ldots x11$ shown on the left of Fig. 5 indicate, by their index numbers, the spacing distances in switching steps of the brush sets from the actual first contact of each bank contact group.

The above described brush selector arrangement also ensures the returning of the parts of the switch into their initial position when the switch is released after having established a talking connection, since on the raising of the brush carrier 105 at the termination of the connection, the pins 116 of the brush selector 106 rotate the prisms 114 in the reverse sequence and direction. In order that the brushes *a*, *b*, *c* which are inclined obliquely with reference to the contacts of the bank contact groups 1—10 do not catch on these contacts, their operation during this reverse movement is again effected, as is seen later, outside the contact groups and below the last contact of each bank contact group.

The total length of drop of the brush carrier 105 amounts to 22 switching steps, of which ten are employed for the selection of the bank contact group, and a further ten for the selection of the individual line in the group; whilst the two further steps are employed for initiating the return of the switch to normal. The length of drop of the brush selector 106 amounts only to half this number of switching steps, since, as mentioned, it moves with the brush carrier only during the second selecting operation. On the termination of a connection, the brush carrier and brush selector continue the falling movement until the brush selector reaches its lowest position. The brush selector has then travelled eleven steps in all. When this position is reached the restoration of the parts of the switch to normal begins; first only the brush carrier is raised, by the same distance which it travelled alone at first in selecting the group, whereupon it engages with and carries the brush selector with it, both parts together being finally restored to the initial position.

During these various movements of the brush carrier 105 and the brush selector 106, the contact spring sets *e*, *f*, *g* (Fig. 1) are op-

erated. These contact spring sets are secured to a frame 21 which engages with the upper end of the switching member 100. Their operation by the switching member will be described with reference to Fig. 17. The contact spring set *e* is operated by a projection 117 secured to one of the angle bars 107, and, in the normal position, stands between the two springs 22. If the brush carrier falls during the first selecting operation, then the projection 117 leaves, on the first step, the position indicated, and the contacts of the spring set *e* are changed over. The contact springs set *f* is operated in similar manner by a projection 118 which is secured to the brush selector 106 and which, in the normal position, stands between the two springs 23. The operation of contact spring *g* is effected by a projection 24 which is secured to the end of a lever 26, rotatably mounted on the shaft 25. The lever 26 ordinarily stands in the position shown, so that the projection 24 presses the springs 27 away from one another. Not until the brush selector 106 is brought into its lowest position after the termination of a connection, does the pin 112 secured on the brush selector 106 engage the top of the lever 26 and move it into the position indicated by dotted lines, whereby the projection 24 is ejected from between the springs 27. On the restoration of the switch to normal, the brush selector 106, during its last upward step and by means of the projection 118, engages with the underside of the lever 26 and rotates the latter back into the normal position. Thus the contact sets, after their first operation, are not operated again until the brush carrier 105 and the brush selector 106 are returned to the normal position. The driving mechanism 200 represented in Figs. 6 to 9 controls the movement of the switching member 100, that is, the dropping and raising of the brush carrier 105 and the brush selector 106. The driving apparatus is independently interchangeable and is secured to the switch frame 19 below the switching member.

To the front of a rectangular longitudinal base plate 201 is secured, by means of a bracket 202, a round guide rod 203. In the upper half of the base plate 201, behind the guide rod 203, a longitudinal opening 204 is located. Between the opening 204 and the guide rod 203 capable of being moved, is arranged a flat toothed rack 205, guided at its upper end by means of a crosspiece 206 riding in the opening 204 in the base plate, and at its lower end by means of a bent over limb 207, embracing the guide rod 203. On the back part of the crosspiece 206 of the rack 205, rests the stretcher 119 (Fig. 3) extending between the members 107 of the brush carrier 105. Thus the movement of the brush carrier 105 is controlled by the rack 205.

The guide rod 203 also guides a U-shaped member 208. The lower limb 209 of this member is, in the normal position as shown in Fig. 7, at a distance of eleven switching steps like eleven times the pitch of rack 205 below the limb 207 of the rack 205. The upper limb of this member carries towards the rear a projection 210 which engages in a slot 120 formed in the brush selector 106. Thus the member 208 controls the movement of the brush selector 106.

The two edges of the rack 205 have teeth of different form, formed thereon, the teeth 211 having the form of driving teeth and extending over the whole of 22 switching steps and the teeth 212 having a downwardly directed ratchet form and extending over a length of ten switching steps.

Upon the shaft 213, secured to the member 208, is rotatably mounted a locking pawl 215, constructed as a lever 214—215, which is pressed by a leaf spring 216 against the locking teeth 212. In the normal position of the driving mechanism (the drawings show the mechanisms in this position) the locking pawl 215 is at a distance of one switching step from the lowest locking tooth 212 and bears on the untoothed part of the rack. An electromagnet N secured to the base plate 201 engages, on energization, by its armature 217, (Fig. 8), the upper arm 214 of the locking pawl and thus holds it, against the action of the leaf spring 216, out of engagement with the locking teeth 212. When the locking pawl 215 is in this position, the rack 205 can move downwards, independent of the member 208 which is retained in its initial position by means of the spiral spring 218 surrounding the guide rod 203. The spring 218 is so highly compressed in the normal position of the driving mechanism that, on the independent downward movement of the rack 205, the decreased effort exerted, is always sufficient to hold the upper limb of the member 208 in position.

As soon as the armature 217 liberates the lever 214 on deenergization of the electromagnet N, and the locking pawl 215 is forced into engagement with the locking teeth 212 under the action of the leaf spring 216, the action of the spring 218 is stopped and the member 208 is positively carried along by the rack 205. The brush carrier 105 resting on the crosspiece 206 of the rack 205, then moves the brush selector 106 simultaneously with it, coupled by the projection 210 of the member 208.

If, on account of a failure of the electromagnet N, the locking pawl 215 does not engage the locking teeth 212, by the tenth switching step, the guide limb 207 of the rack 205 engages, on the eleventh step, with the lower limb 209 of the member 208 and carries this member along with it, providing the movement necessary to reach the end posi-

tion before the switch can be restored to normal.

The downward movement of the rack 205 is regulated by a locking device controlled by the release magnet M. The magnet is secured to the special base plate 220 mounted on four pillars 219, secured to the base plate 201, in front of the guide rod 203. A shaft 222 is rotatably mounted between the special base plate 220 and a bridge member 221 arranged parallel to and some distance from the base plate 220, and is provided with a driving wheel 223, a locking wheel 224 and a cooperating wheel 225. The driving wheel 223 engages with the driving teeth 211 of the rack 205 and transmits the weight of the switching member resting on the rack, together with the pressure exerted by the helical spring 218, to the locking wheel 224. This locking wheel cooperates with an escapement pawl 227 secured to the armature 226 of the release magnet M and thus only permits the rack 205 to move downwards in accordance with the oscillations of the escapement pawl, caused by the release magnet M. The release magnet M, on attraction and release of its armature 226, causes the escapement pawl 227 to be alternately moved into releasing and locking positions, so that the locking wheel 224, on each excitation and deenergization of the electromagnet, rotates through one tooth division. The teeth of the locking wheel 224, and the gear ratio between the driving wheel 223 and the driving teeth 211 of the rack 205, are so selected that each rotation of the locking wheel 224 through one tooth division advances the rack 205 and the brush carrier 105 by one switching step. Thus each current impulse acting on the release magnet M advances the brush carrier by one switching step.

The cooperating wheel 225 transmits this movement to a pinion 228, on whose shaft 229 is secured the interrupter disc 230. This interrupter disc 230, during its rotation, enters between the lugs 232 of the semi-circular contact spring *i*. The gear ratio between the pinion 228 and the cooperating wheel 225 is such that every switching step causes a contact opening and a contact closing of the switch *i*. The interrupter disc 230 is so adjusted on the shaft 229 that in the normal position of the driving mechanism the contact *i* is closed. The contact is, however, opened as soon as a release magnet M allows the locking wheel 224 to partially rotate, owing to the attraction of its armature, but is again temporarily closed when the magnet is deenergized and permits the locking wheel to complete the switching step.

The interrupting contact *i* regulates independently of the movement of the switching member, the transmission of current impulses to the release magnet M for producing a uniform motion of the switching member. If, for example, the magnet M is connected in well-known manner, explained later in detail, in a circuit extending through the contact *i*, then it is excited through this contact, which is closed in the normal position, and attracts its armature 226. The right arm of the escapement pawl 227 (Fig. 6) releases the locking wheel 224, which commences to rotate under the pressure exerted by the switching member, whilst the left arm of the escapement pawl 227 is moved into a position for engaging a tooth of the locking wheel. Before this tooth hits against the left arm of the escapement pawl 227, however, the disc 230, by opening the contact *i*, breaks the circuit, so that the armature 226 falls back under the action of the spring 250, removes the left arm of the escapement pawl 227 from in front of the tooth and moves the right arm into the locking position. Before, however, the tooth meets the right arm of the escapement pawl, the contact *i* is again closed by the further rotation of the interrupter disc 230, whereby the magnet M responds again and the operations are repeated. The transmission of current impulses to the release magnet M, thus controlled by the switching member, causes the escapement pawl to swing with such a period that it continuously avoids engaging with the teeth of the locking wheel 224. Thus the locking wheel can rotate continuously, unimpeded, so that the switching member moves with uniform motion.

For restoring the switching member to normal, an air driven device (Figs. 8 and 9) arranged on the back of the base plate 201, is employed, and consists of a cylinder 233 with a piston 234 and a valve 235. The piston rod 236 connects with the guide cross-piece 206 of the rack 205, upon which the stretcher 119 of the switching member rests. The valve 235 connects the lower cylinder space either by the passage 237 with the atmosphere, or by the passage 238 with a compressed air pipe 239. By means of the valve stem 240, the valve 235 is, in the normal position, pressed towards the left by a leaf spring 241 secured to the front of the base plate 201, whereby the cylinder chamber is connected with the atmosphere. The operation of the valve is effected mechanically by the member 208 of the driving mechanism. The latter, on approaching its lowermost position, engages, by its lower limb 209, with a projection 242 on a slide 243, also arranged on the front of the base plate 201, and moves the same downwards. The leaf spring 241 is released by the projection 244 on the slide, whereby the compressed air in the pipe 239 shifts the valve 235 towards the right and flows into the lower cylinder chamber. Since the piston rod 236 and the rack 205 are connected, the compressed air flowing in lifts the rack 205, together with the brush car-

rier 105. The member 208, together with the brush selector 106 of the switching member which is coupled with it, remains, however, at first, in its lowermost position, because it is held in this position by a locking pawl 246 engaging with a groove 245 formed therein. When the rack 205 has been raised so far that it assumes the same position relative to the member 208 as in the normal position, that is when the guide limb 207 of the rack 205 is at a distance of eleven steps from the lower limb 209 of the member, a projection 247 mounted on the limb 207, presses against the projection 248 on the locking pawl 246, thereby moving the latter out of the groove 245, and releasing the member 208 which then moves with the rack 205 into the initial position. On approaching the initial position, the lower limb 209 of the member 208 engages with the projection 249 on the slide 243 and moves it upwards. The leaf spring 241 then again presses upon valve stem, closing the passage 238 between the cylinder and the compressed air supply, and opening the passage 237 so that the air enclosed in the cylinder can escape to the atmosphere. The switching member and the driving mechanism parts have now been restored to the normal position.

During the downward movement of the rack 205, the piston 234 slows down the dropping speed since, in moving, it draws in air in the upper cylinder chamber through the small opening 251 and at the same time forces the air present in the lower cylinder chamber out through the relatively small valve passage 237. A suitable form of valve might in some instances be advantageously placed in said air inlet opening 251 for controlling the intake therethrough so as to regulate the rate of falling movement of the piston in the cylinder, although such is not here shown in this case as it is not required and would be an obvious addition.

The general method of operating the selector

For selecting the desired bank contact group, the electromagnet M receives current impulses which cause the escapement pawl 227 to release the locking wheel 224, and thus also the rack 205 on which the brush carrier 105 rests. The movement of the brush carrier and the rack is effected by the weight of the carrier in steps, or uniformly, according as the current impulses are generated by a numerical switch or the interrupter *i*. As soon as the brush carrier leaves the normal position, the set of contact springs *e* is operated. During this first movement of the selector, the magnet N is energized and holds the locking pawl 215 out of engagement with the locking teeth 212 of the rack 205. The member 208, and the brush selector 106 coupled with it by the projection 210, remain, therefore, under the influence of the spring 218, in the normal position. Consequently the brush carrier 105, with the brush sets 104 secured to it, moves relatively to the brush selector 106. The small toothed wheels 115 of the prisms 114 of the individual brush sets 104, engage in succession with the pins 116 on the stationary brush selector 106. With each switching step, one prism after the other, starting from the lowest brush set 104, is rotated, the brush sets being successively changed over into the operative position and, on the next switching step, being further rotated to the normal position.

When the desired bank contact group is selected, that is, when its corresponding brush set is in the operative position, the brushes *a*, *b*, *c* of this brush set then stand one switching step in front of the first contact of the corresponding bank contact group. The magnet N is now deenergized and releases the locking pawl 215 which falls into the teeth 212 and couples the member 208 with the rack 205. During the further movement of the brush carrier 105, the brush selector 106 is carried along with it and thereby the set of contact springs *f* is operated. The brushes of the operative brush set wipe over the contacts of the selected bank contact group. As soon as the desired individual line is reached, the movement of the brush carrier is stopped by the stopping of the escapement pawl 227 at final deenergization of the electromagnet M.

To restore the selector to the normal position, new current impulses are sent through the magnet M so that the brush carrier 105 and the brush selector 106 continue moving until the brush selector 106 has reached its lowest position. In this position the contact spring set *g* is operated by pin 112 and lever 26 (Fig. 17) and the circuit for the magnet M interrupted. The lower limb 209 of the member 208 moves the slide 243 which lifts the spring 241 and releases the valve 235. Compressed air then flows into the cylinder 233 from the supply pipe 239 and moves the piston 234, together with the rack 205 and the brush carrier 105, upwards. The brush selector 106 and the member 208 are, at first, held by the locking pawl 246. Consequently the small toothed wheels 115 of the prisms, which had been changed over in the group selecting operation, successively engage the pins 116 on the brush selector 106, and are rotated in reverse direction. This operation is performed upon each successive brush set as each successively approaches the lowest contact of its associated bank contact group. When the lowest brush set, which is the last to be operated, is changed over, the limb 207 of the rack 205 releases the locking pawl 246 from the member 208, so that the brush selector 106 and the brush carrier 105 return together to the normal position. The contact sets *e*, *f*, *g* are then restored to their nor-

mal positions. Further, the member 208 operates the slide 243 whereby the leaf spring 241 again closes the valve 235.

Figs. 10 to 14 represent different speed diagrams for the switching member, which show the diminution in the speed of the switching member itself, permissible in switches according to the invention, whilst still increasing the operating speed of the switch. On the abscissæ is plotted the time and on the ordinates the natural speed of the setting member.

Fig. 10 is a speed diagram of a selector with electromagnetic step-by-step drive, used as a line finder. The maximum practical stepping speed amounts to about 50 steps per second, since for each attraction and release of the armature, about 1/50 of a second is required. In this case during only half the time of each switching step is the switching member in motion, the other half being lost by the release of the armature to overstep the next notch between the individual switch movements. The movements in themselves rapidly accelerate and the speed curve is therefore very steep.

Fig. 11 shows the condition for the case in which the switching member traverses the same switching distance with uniform speed, for example, in a braked falling movement in accordance with the above description. The initial oblique slope of the curve corresponds to the starting. The figures annexed underneath indicate, as in the case of Fig. 10, the individual switching steps, and the times for traversing these successive steps may be read from the diagram. The equality of the sections and the whole switching distance appears from the comparison of the corresponding graphs of Figs. 10 and 11. A comparison shows that in Fig. 10 the maximum speed of the switching member with each switching step is 4½ times as great as in Fig. 11, although the operating time in the latter case is shorter by a time period.

Fig. 12 is a speed diagram of a selector with electromagnetic step-by-step drive, used as a numerical selector. The usual number of steps amounts, in this case, only to 10 steps per second. The difference with respect to Fig. 10 is expressed merely by the inactive periods between the switch movements, which are, in this case, nine times as long as the periods of motion of the switching member. These periods of motion of the switching member last exactly as long as in Fig. 10, because, with selectors with exclusive electromagnetic step-by-step drive, the natural speed of the switching member must be adapted to the quickest connecting speed (Fig. 10) and is invariable. The speed attained is obviously unnecessarily large for the purpose of a numerical selection.

Fig. 13 shows, in contra-distinction to Fig. 12, the conditions for the case in which a selector according to the invention is operated by numerical current impulses. In this case the maximum speed of the switching member with each switching step is, in comparison with the previous case, 5 to 6 times smaller, because, firstly, the escapement divides each switching step into two half steps, and secondly the drive is effected by a continuously acting force (gravity) which produces a uniformly accelerated motion. The shaded surfaces of every two half steps (Fig. 13) correspond to each shaded surface of Fig. 12.

The movements of the switching member when controlled by means of the escapement, are less dependent upon the accuracy of the numerical selecting current impulses than in the case of electromagnetic stepping. Short current impulses suffice to operate the switching member according to Fig. 13. Even with quite short current impulses, no failure takes place since in this case the two half steps are combined into one step according to Fig. 14. In this case the air piston brakes the speed towards the end of the motion and holds it constant at the highest desired speed. This braking is permissible in numerical selection since the time periods between the individual switching steps are still sufficiently large to ensure perfect operation.

The limitation of the maximum natural speed of the switching member to a considerable lower value than with electromagnetic stepping, permits the switching member and other moving parts to be more massively constructed since the kinetic energy liberated on the stopping of these members is only directly proportioned to the mass of the members whereas it is proportional to the square of their speed. The switching member can therefore be strongly constructed and rigid in itself, thereby eliminating several guiding members, which were previously necessary to guide the switching member along the contact bank. The guiding is effected in the constructional example shown (Fig. 1) merely by the bolts 20 at the top and bottom end of the contact bank. Any frictional resistance occurring during the motion of the switching member may be neglected on account of the large force exerted in driving the switching member by its own weight. This simplification of the guiding arrangements and the fact that no limitation in the weight of the switching member is necessary, makes the construction of the selector cheaper and more economical in use than hitherto.

The method of operation of the switching acting as a call finder, group selector and connector will now be explained with reference to the following circuit diagrams, Figs. 15 and 16, which show an exchange of 1000 subscribers. Each 100 subscribers form a group with about ten line finders, group selectors and connectors associated therewith. In Fig. 15, S1 shows the switch acting as a line

finder, S2 as a group selector and S3 (Fig. 16) as a connector with the necessary control relays.

If a subscriber, for example, No. 123, wishes to call another subscriber, say No. 321, the method of operation is as follows.

The call of the subscriber No. 123 is transferred, by a distributor V in the exchange (Fig. 15) to a free line finder S1 of the first one hundred group. The brush carrier of this line finder is released and moves downwards at a uniform speed whilst the brush selector is at first held. By this means the tens group in which the calling subscriber's line is located, is selected. On testing every tens group, the corresponding brush set of the line finder is, at that time, temporarily in the operative position. On finding the calling tens group, that is in the present case the second group, the brush selector is released to move with the brush carrier. Consequently the second brush set remains in the operative position for the individual testing of the lines of the second tens group during the uninterrupted continuous uniform downward motion of the brush carrier. On reaching the third line in this group, which is the calling line, the brush carrier is stopped. The calling subscriber's line is then extended to the group selector S2 associated with the line finder S1, and the distributor V, up till then connected with the line finder, is released.

The operation of the group selector is different insofar as, during the group selection, the brush carrier is moved downwards with a step-by-step instead of uniform motion. In accordance with the three current impulses sent out by the subscriber, the brush carrier moves downwards, again free from the brush selector, by three switching steps. The brush selector is then released for the associated movement and since, at the same time, the release magnet of the group selector is connected, by the current impulse relay, to the local circuit of the automatic interrupter, the brush carrier and brush selector move downwards at a uniform speed, the third brush set wiping over the lines leading to the connectors of the selected third hundred group. On finding a line leading to a free connector, the brush carrier is stopped and the calling subscriber is extended to this particular connector.

The method of operation of the connector differs from those of the previous cases insofar as the brush carrier is moved step-by-step in the selection of tens and units corresponding to the numerical current impulses 2 and 1 sent by the calling subscriber. Since, as previously, the brush selector only moves during the second selecting operation, the second brush set is set in the operative position and stops when it reaches the first contact of its associated bank contact group.

The restoration of the brush carrier and the brush selector to normal, at the close of a talking connection, is effected by the uniform further downward motion of the switching member until the brush selector reaches its lowest position. The slide then operates the compressed air device and the switch is restored to normal in the aforedescribed manner.

The switching operations will now be described in detail.

1. The operation of the line finder S1

On lifting the receiver at the calling subscriber's station No. 123, a current flows through the calling subscriber's line group and the associated calling relay R, at the exchange, responds. Relay R excites relay A:

Positive, relay A, right inner contact of relay R, resistance W2, negative.

Relay A excites with its inner contact, a relay U, which by operating the rotary magnet D of a distributor V, causes a free line finder to be selected. At the same time the relay A connects with its outer contact, the test relay P of the distributor V to the positive pole. As soon as the lower switch arm of the distributor meets a free line finder, the following circuit is closed:

Positive, right outer contact of relay A, relay P, switch arm on the distributor V, contact *e*12 of a line finder S1, relay C1, negative.

The relays P and C1 respond to this current. Relay P, by opening its outer contact, stops the distributor V, and, by closing its inner contact, excites the magnet N1, which uncouples the brush selector from the brush carrier of the line finder. Relay C1 closes a circuit for the magnet M1, and by closing its left outer contact and its right contact, prepares a test circuit for the group selector *d* and the test relay P1. The magnet M1 releases the brush carrier having responded to the following circuit:

Positive, left middle contact of relay C1, contact *g*1, left outer contact of relay P1, interrupter contact *i*1, magnet M1, negative.

Through the interrupter contact *i*1 the circuit for the magnet M1 is so interrupted that the escapement moved by it never engages with the locking wheel teeth. As soon as the brush *d* of the line finder makes contact with the tens line (2) to which positive pole is applied by relay R, relay Z is excited:

Positive, relay A, right inner contact of relay R, line 2, brush *d*, left outer contact of the relay C1, relay Z, negative.

By changing over its contact, relay Z interrupts the excitation of the magnet N1 which lets its armature drop back and couple the brush selector to the brush carrier. Since the brush carrier, up to the deenergization of the magnet N1, has travelled a distance of two switching steps, the brush set of the

second tens group is then set in the operative position for the selection of the individual line in the second tens group. When the brush $c1$ of the second brush set engages with the contact of the calling subscriber, a circuit arises for the test relay P1 as follows:

Positive, right contact of relay C1, both windings of relay P1, brush $c1$, test line, right outer contact of the relay R, relay T, negative.

With this circuit the relays T and P1 are energized. Relay T, by opening its left contact, opens the circuit of relay R and, by closing its right contact, connects itself to the test line. Relay P1, by opening its left outer contact, opens the circuit of the magnet M1 and, by opening its left inner contact, opens the circuit of the relays C1 and P, the contact $e12$ having been opened when switching member commenced its falling movement. The disconnection of the magnet M1 results in the immediate stopping of the line finder on the calling line. Relay P deenergizes and releases the distributor V for further calls. The slow acting relay C1 falls off somewhat later. In the meantime the relay P1, by closing its right contacts, has extended the talking line to the relay A2 of the group selector S2. Relay A2 responds over the subscriber's line, and, with its outer left contact, excites the slow-acting relay V2. Relay V2, by its left outer contact, short-circuits the right winding of the test relay P1, whereby the calling subscriber's line is blocked against further calls.

2. Operation of the group selector S2

The relay V2, operated by the current impulse relay A2, excites, by closing its inner contact, a further slow-acting relay U2 as follows:

Positive, inner contact of the relay V2, contact $e21$, relay U2, negative.

Relay U2, by closing its left contact, excites the magnet N2, which effects the uncoupling of the brush selector, and, by changing over its right contact, prepares a circuit for the magnet M2 for operation by numerical current impulses.

Since the subscriber No. 321 is wanted, the calling subscriber interrupts the line circuit three times so that relay A2 falls off three times. On each falling off of the relay A2, the magnet M2 is excited.

Positive, right inner contact of the relay A2, right inner contact of relay U2, magnet M2, negative.

The brush carrier falls three switching steps. On the first step the contacts $e21$ and $e22$ are changed over. $e21$ interrupts the exciting circuit of the slow-acting relay U2 which, however, remains energized during these three releases of the relay A2 by a circuit extending through the left inner contact of relay A2 and its own left contact. After these impulses have been sent the relay U2 slowly falls off. Relay U2, by opening its left contact, deenergizes the magnet N2, whereby the brush selector, after having set the third brush set in the operative position, is coupled with the brush carrier.

The right contact of the relay U2 closes, for the further selection, the following local circuit for the magnet M2:

Positive, right contact of the relay U2, contacts $g2$ and $e22$, right contact of the relay P2, interrupter $i2$, magnet M2, negative.

The magnet M2 responds and releases the brush carrier with the brush selector coupled thereto, and is excited by the interrupter $i2$ in such a way that the escapement pawl never engages with the teeth of the locking wheel and thus the brush carrier and brush selector continue the downward movement with uniform motion. As soon as the brush $c2$ of the group selector reaches the contacts of a free connector, the relays P2 (Fig. 15) and C3 (Fig. 16) are energized:

Positive, inner contact of the relay V2, both windings of the relay P2, brush $c2$, test line contact $e34$ of connector S3, relay C3, negative.

Relay P2 by opening its right contact interrupts the circuit of the magnet M2. The group selector is thereby stopped. Relay P2 further short-circuits, with its left inner contact, its left winding, so that the connector is blocked. At the same time relay P2, by closing its left outer contacts, extends the talking line to the connector S3.

3. Operation of the connector S3

When the group selector is extended to the connector, relay A3 is energized:

Positive, right winding of the relay A3, b-branch of the connecting line, brush $b2$ in the group selector, middle left contact of the relay P2, outer right contact of the relay A2, choke coil Dr, outer left contact of the relay P2, brush $a2$, a-Branch of the connecting line, left winding of relay A3, negative.

Relay A3 and the relay C3, already mentioned, together close the following circuit for the slow-acting relay V3:

Positive, outer contact of the relay C3, contact $e31$, right contact of relay A3, relay V3, negative.

Relay V3 responds and excites the coupling magnet N3 and the slow-acting relay U3. Circuit for the magnet N3:

Positive, outer contact of the relay V3, contact $e32$, magnet N3, negative.

Circuit for the relay U3:

Positive, outer contact of relay C3, inner contact of relay V3, relay U3, negative.

Relay U3, by closing its outer contact, prepares a circuit for the magnet M3 for its operation by numerical impulses.

To select the desired number, the calling subscriber interrupts his line loop twice. On

each of these interruptions, the armature of the relays A2, in the group selector, and A3, in the connector, fall off abruptly. Relay A3 closes a circuit for the release magnet M3:

Positive, left contact of the relay A3, outer left contact of the relay U3, magnet M3, negative.

Magnet M3 lets the brush carrier fall two switching steps. After the second step, the second brush set is in the operative position.

On the first switching step, the contacts *e*31 to *e*34 are changed over. Contact *e*31 interrupts the energizing circuit of the relay V3; but this relay is kept energized during the sending of the impulses, through the right contact of the relay A3, left inner contact of the relay U3, and the left outer contact of the relay C3, until after the transmission of impulses when relay A3 opens the right contact for a longer period. Relay V3, on de-energization, opens the circuit of the coupling magnet N3, which up till now has remained energized, after the opening of the contact *e*32, through its own contact and the right contact of the relay V3. Magnet N3, on its deenergization, liberates the brush selector for its subsequent motion.

The calling subscriber, for the purpose of further selection, now interrupts his line loop once, the armatures of the relays A2 and A3 again fall off and send an impulse, as previously, to the release magnet M3. The brush carrier now makes, together with the brush selector, a further switching step. The operative second brush set thus contacts with the called subscriber's line.

Relay A3, on its last deenergization, energizes the relay V3:

Positive, outer contact of the relay C3, left inner contact of the relay U3, right contact of relay A3, relay V3, negative.

Relay V3 temporarily operates again, therefore, on the last switching step and, with its inner contact, holds the relay U3 excited after its exciting circuit has been interrupted by the brush selector moving out of the normal position and opening contact *f*3. The relays V3 and U3 successively fall off slowly after the last switching step.

On deenergizing, relay V3 closes, whilst relay U3 is still excited, the following testing circuit over the selected line:

Positive, outer contact of the relay C3, right contact of the relay U3, right contact of the relay V3, both windings of the test relay P3, contact of the relay Y, brush *c*3, test line, test relay T′ of the called subscriber, negative.

If the called subscriber is free, then the relays P3 and T′ are energized. Relay T′ disconnects the calling relay R′ of the subscriber. Relay P3, by its left contact, short-circuits its right winding and thereby renders the called subscriber's line engaged. Also relay P3, with its two inner right contacts, connects the automatic calling signal to the called subscriber's line as follows:

Positive, contact *o* of periodical interrupter right inner contact of the relay P3, brush *a*3, line loop of the subscriber No. 321, brush *b*3, outer right contact of relay P3, left winding of relay Q, negative.

Alternating current is automatically sent, in definite time intervals, over this circuit to the bell of the called subscriber's station. Relay Q does not respond to alternating current since its right winding is short-circuited. Only when the called subscriber answers does direct current flow through this circuit. The relay Q then responds and, with its left contacts, extends the called subscriber's line to the relay Y. Relay Y opens, with its contact, the short-circuit of the right winding of the relay Q so that this winding is also energized. Relay Q, with its right inner contact, short-circuits the left winding of the relay P3, up to then energized, and thereby takes over the blocking of the called subscriber's line in place of the relay P3 which, on account of the short-circuiting, deenergizes and interrupts the alarm circuit.

The desired connection is then completed.

4. Restoration of the selector

is effected by inserting its release magnet M in the circuit of the interrupter when the calling subscriber hangs up the receiver and opens the circuit of the relay A2, so that the latter deenergizes. Relay A2, with its left outer contact, opens the circuit of the relay V2 which falls off and, with its outer contact opens the circuit of the relays P1 and T and, with its inner contact, opens the circuit of the relays P2 and C3. These relays are thus deenergized and their armatures fall off.

Relay P1 of the line finder closes, for the operation magnet M1, the following circuit:

Positive, contacts *e*11 and *g*1, left outer contact of relay P1, interrupter *i*1, magnet M1, negative.

The magnet M1 is energized by interrupted current impulses, so that the line finder falls until the brush selector on reaching its lowest position, opens the contact *g*1 and thus opens the circuit of the magnet M1. The brush carrier and brush selector are now raised to the normal position, the latter having operated the compressed air device.

Relay P2 of the group selector closes, for the operation magnet M2, the circuit:

Positive, right contact of the relay U2, contacts *g*2 and *e*22, right contact of the relay P2, interrupter *i*2, magnet M2, negative.

The magnet M2 operates like M1, until the brush selector on reaching its lowest position, opens the contact *g*2, and thus the circuit of the magnet M2, and operates the compressed air device.

Relay C3 of the connector, with its outer contact, opens the circuits of the relays V3,

U3 and P3 so that these drop their armatures provided they were still energized and close or prepare the following circuit for the release magnet M3.

Positive, outer left contact of the relay U3, contacts *g*3 and *c*33, outer right contact of the relay P3, outer right contact of relay Q, interrupter *i*3, magnet M3, negative.

This circuit is only closed when the relay Q is deenergized. The relay Q is, as indicated, energized when the called subscriber is at the apparatus. Consequently, after a conversation, the restoration of the connector is, in given cases, delayed until the called subscriber also hangs up the receiver and thus deenergized the relays Y and Q. The circuit for the magnet M3 acts as in the case of M2 and M1. When the brush selector reaches its lowest position it opens the contact *g*3 and operates the compressed air device.

Finally, it may be mentioned, that the production of the desired step-by-step or uniform motion of the switching member is not limited to the use of a double acting locking member (escapement pawl). Fig. 18 shows a construction with only a simple locking pawl secured to the armature of the magnet M′, in combination with a circuit arrangement which provides a modification of the diagram for the group selector shown in Fig. 15. For the group selecting operation, which is effected by numerical impulses, a special relay X is provided which, during the excitation of the relays U2 and A2, is also excited, and, during the transmission of impulses through relay A2, allows its armature to fall off quickly after each of the same have been sent. Thus the magnet M′ receives periodical current impulses, so limited that the locking pawl, before the next switching position has been reached, again returns into the locking position. After the changeover to the selection of the free connector, relay U2 then deenergizes, magnet M′ is still remaining energized through the contact of relay U2, contact *c*2, already closed on the first switching step, contact *g*2 and the contact of the relay P2, and completely releases the switching member until, on its finding a free connector, relay P2 opens the circuit. The switching member remains in this position until, at the end of the conversation, the relay P2 deenergizes and again energizes the magnet M′. The switching member then continues to fall until contact *g*2 is opened when it reaches its lowest position.

I claim:—

1. A switching device for automatic telephone systems comprising a contact field with a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a constant force acting individually on said movable switching member to move the same along the contacts of said contact field, means for locking the switching member against the action of said force, means for releasing the locking means and causing a movement until the operative brush set reaches the desired contacts and means for returning the switching member to initial position in a continuous movement at the end of a conversation.

2. A switching device for automatic telephone systems comprising a contact field with a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a constantly acting driving force acting individually on said movable switching member to move the same along the contacts of the contact field, a pawl mechanism for locking the switching member against the action of said force, means for releasing the locking means and causing a movement until the operative brush set reaches the desired contacts, and means for returning the switching member to its initial position in a continuous movement at the end of a conversation.

3. A switching device for automatic telephone systems comprising a contact field with a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a constant driving force acting individually on said movable switching member to move the same along the contacts of the contact field, a pawl mechanism for locking the switching member against the action of said force, another pawl mechanism for releasing the lock and for performing a movement until the operative brush set reaches the desired contact, and means for returning the switching member to its initial position in a continuous movement at the end of breaking of connection.

4. A switching device for automatic telephone systems comprising a contact field with a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a constantly acting driving force acting individually on said movable switching member to move the same along the contacts of the contact field, a pawl mechanism for locking the switching member against the action of said force and for releasing it to movement until the desired contact is reached by said operative set of brushes, and means for returning the switch-

ing member to its initial position by a continuous movement at the end of the conversation.

5. A switching device for automatic telephone systems comprising a contact field with a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a constantly acting driving force acting individually on said movable switching member to move the same along the contacts of the said field, a pawl mechanism for locking the switching member against the action of said force and for releasing the switching member to movement; said pawl mechanism embodying a two-armed escapement and a magnet controlling the escapement so as upon energization and de-energization to free the switching member for movement for one half of the distance of two contacts of the field and then stop the same, and means for returning the switching member to its initial position.

6. A switching device for automatic telephone systems comprising a contact field with a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a constantly acting driving force acting on said movable switching member to move the same along the contacts of said field, a pawl mechanism for locking the switching member against the action of said force and for releasing said member to movement; said pawl mechanism embodying a two-armed escapement and a magnet controlling the escapement, an impulse transmitter for controlling the magnet dependent on the movement of the switching member for creating an oscillating movement of the escapement so as to retire the pawl from locking position before the switching member reaches it, means for bringing into circuit the impulse transmitter so as to cause an uninterrupted movement of the switching member over a plurality of contacts, means for disconnecting the impulse transmitter so as to cause a stopping of the switching member, and means for returning the switching member to its initial position.

7. A switching device for automatic telephone systems comprising a contact field with a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a constantly acting driving force operable individually on said switching member to move the same along the contacts of the field, a pawl mechanism for locking the switching member against the action of said force and for releasing said member to movement; said pawl mechanism embodying a one-armed operating pawl, an electromagnet for controlling said operating pawl, and means for energizing the electromagnet so as upon energization to move the pawl to free the switching member for continuous movement along a plurality of contacts, means for de-energizing the electromagnet so as to lock the switching member, and means for returning the switching member to its initial position.

8. A switching device for automatic telephone systems comprising a contact field with a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a constantly acting driving force operable individually on the switching member so as to move the same along the contacts of the field, a pawl mechanism for locking the switching member against the action of said force and for releasing the switching member to movement; said pawl mechanism embodying a one-armed operating pawl, an electromagnet for controlling said operating pawl, means for energizing the electromagnet so as upon energization to move the pawl to free the switching member for continuous movement along a plurality of contacts, means for de-energizing the electromagnet so as to lock the switching member, a transmitter for numerical impulses, means controlled by said transmitter for creating a to-and-fro movement of the pawl, temporarily acting switching means controlling the to-and-fro movement of the pawl in such manner that the pawl returns to the locking position before the switching member reaches said position, and means for returning the switching member to its initial position.

9. A switching device for automatic telephone systems comprising a contact field with a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a constantly acting driving force operating individually on said movable switching member so as to move the same along the contacts of said field, a pawl mechanism for locking the switching member against the action of said force and for releasing said member to movement, means for operating the pawl mechanism to allow movement of the switching member until a position corresponding with the predetermined set of contacts is reached, means for making operative a set of brushes corresponding to

said set of contacts, means for actuating the pawl mechanism again to permit a continued movement of the switching member until the desired contact is reached by the set of brushes made operative, and means for returning the switching member to its initial position.

10. A line finder in automatic telephone systems including a contact field having a plurality of contact groups, comprising a movable switching member having a plurality of sets of brushes cooperable with said groups of contacts, means for making operative one set of brushes corresponding to a predetermined group of contacts, a constantly operative driving force acting individually on said switching member so as to move the same along the contacts of said field, a pawl mechanism for locking the switching member against the action of said force and for releasing the same again to movement, means dependent on the contacts of the field for controlling the pawl mechanism to allow a continuous movement of the switching member until the desired group of contacts is reached by the corresponding set of brushes, means also dependent on the contacts of the field for controlling the pawl mechanism to creating a continued and continuous movement of the switching member until the desired contact is reached within the desired contact group by a set of brushes made operative, and means for returning the switching member to its initial position.

11. A selector for automatic telephone systems including a contact field having a plurality of groups of contacts, comprising a movable switching member carrying a plurality of sets of brushes and cooperating with said groups of contacts, means for making operative one set of brushes corresponding to a predetermined group of contacts, a constantly acting driving force operating individually on said switching member to move the same along the contacts of said field, a pawl mechanism for locking the switching member against the action of said force and for allowing movement thereof respectively, a numerical impulse transmitter, means dependent on said transmitter for controlling the pawl mechanism to create a step-by-step movement of the switching member until the desired group of contacts is reached by the corresponding brush set, means dependent on the contacts of the contact field for controlling the pawl mechanism to create a further continuous movement of the switching member until the contact connected with an idle line of the desired contact group is reached by the set of brushes made operative, and means for returning the switching member to its initial position.

12. A connector in automatic telephone systems including a contact field having a plurality of groups of contacts, comprising a movable switching member carrying a number of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes corresponding to a predetermined group of contacts, a constantly acting driving force operating individually on said switching member to move the same along the contacts of said field, a pawl mechanism for locking the switching member against the action of said force and for permitting movement thereof respectively, a numerical impulse transmitter, means dependent on said transmitter for controlling the pawl mechanism to create a step-by-step movement of the switching member until the desired group of contacts is reached by the corresponding set of brushes and until the desired contact within such group is reached by the set of brushes made operative, and means for returning the switching member to initial position.

13. In an automatic telephone system including a contact field having a plurality of groups of contacts and a row of contacts corresponding to said groups of contacts, a line finder comprising a movable switching member carrying a plurality of sets of brushes cooperating with contacts within said groups and a set of brushes cooperating with said row of contacts, a constantly acting driving force operating individually on said movable switching member to move the same along the contacts of said field, means for selecting one set of brushes during a partial movement of the switching member until a predetermined group of contacts is reached, means for making operative the selected set of brushes at the end of such partial movement of the switching member, a pawl mechanism for locking the member against the action of said force and for permitting movement thereof respectively, switching means in connection with the set of brushes cooperating with said row of contacts and dependent on said row for controlling the pawl mechanism to create a continuous movement of the switching member until the desired group of contacts is reached by the corresponding set of brushes, means dependent on the contacts of the field for controlling said pawl mechanism to create a continued and continuous movement of the switching member until the desired contact is reached within the desired group of contacts by the set of brushes made operative, and means for returning the switching member to initial position.

14. A switching device for automatic telephone systems having a contact field with a plurality of groups of contacts, comprising a movable switching member embodying two parts movable one against the other in the direction of the switch movement, one of said parts being constructed as a brush support carrying a plurality of sets of brushes co-

operating with the groups of contacts, a constantly acting driving force operating individually on said switching member to move the same along the contacts of said field, means for locking the brush support part of the switching member against the action of said force, means for locking the other part of said member against the action of said force, means for releasing the brush supporting part to movement along the other part for selection of the set of brushes corresponding to the desired group of contacts, means for releasing both of the switching member parts to common movement until the desired contact is reached by the selected set of brushes, and means for returning both parts to their initial position.

15. A switching device for automatic telephone systems having a contact field with a plurality of groups of contacts, comprising a movable switching member embodying two parts movable one against the other in the direction of the switch movement, one of said parts being formed as a brush support carrying a plurality of sets of brushes cooperating with the groups of contacts, a constantly acting driving force operating individually on said switching member to move the same along the contacts of said field, means for locking the brush support part of the member against the action of said force, means for locking the other part of said member against the action of said force, means for releasing the brush carrying part of the switching member along the other part for selection of the set of brushes corresponding to the desired group of contacts, intermediate means attributed to each set of brushes on said supporting part of the switching member and moved by gear mechanism on said part in turn moved by the other part of the switching member; said other part being formed as a slide with driving pins corresponding to and cooperating with the gear drives, means for releasing the two parts of said switching member to common movement until the desired contact is reached by the selected set of brushes, and means for returning both parts to initial position.

16. In a switching device for automatic telephone systems having a contact field with a plurality of groups of contacts, a movable switching member embodying two parts movable one against the other in the direction of switch movement, one of said parts being formed as a brush support carrying a plurality of sets of brushes cooperating with the groups of contacts; said brushes comprising a plurality of contact springs arranged in one plane, a constantly acting driving force operating individually on said switching member to move the same along the contacts of said field, means for locking the brush support part of the switching member against the action of said force, means for locking the other of said parts against the action of said force, means for releasing the brush supporting part of the member to movement along the other part for selection of the set of brushes corresponding to the desired group of contacts, intermediate means attributed to each set of brushes on the supporting part arranged cross-wise to the contact springs of the corresponding set of brushes and moved by a gear drive on said supporting part in turn moved by the other part of the switching member; said other part being formed as a slide with driving pins corresponding to and cooperating with the gear drive, means for releasing the two of said switching member parts to common movement until the desired contact is reached by the selected set of brushes, and means for returning both parts to initial position.

17. In a switching device for automatic telephone systems having a contact field with a plurality of groups of contacts, a movable switching member embodying two parts movable one against the other in the direction of switch movement, one of said parts being formed as a brush support carrying a plurality of sets of brushes cooperating with the groups of contacts and said brushes comprising a plurality of contact springs arranged in one plane, a constantly acting driving force operating individually on said switching member to move the same along the contacts of said field, means for locking the brush support part of the switching member against the action of said force, means for locking the other part of said member against the action of said force, means for releasing the brush supporting part of the member to movement along the other part for selection of the set of brushes corresponding to the desired group of contacts, intermediate means attributed to each set of brushes on the supporting part of the switching member and arranged cross-wise to the contact springs of the corresponding set of brushes for pressing said springs out of normal position against the contact field, a gear drive on the supporting part of the switching member for rotating said intermediate means to a predetermined angle acting on said contact springs and returning said means to normal position by further rotation, means for moving the supporting part of the switching member by the other part thereof; said other part being formed as a slide with driving pins corresponding to and cooperating with the gear drive, means for releasing the two parts of said switching member to common movement until the desired contact is reached by the selected set of brushes, and means for returning both of said parts to initial position.

18. In an automatic telephone system, a selector comprising a contact field having a plurality of line groups, a movable switching

member embodying two parts movable with respect to each other, one of said parts being constructed as a brush carrier having a number of brush sets corresponding to said line groups of the contact field and the other part of said member being constructed as a slider, intermediate means having toothed wheel drives arranged on said brush-carrier part, driving pins on said slider part, the latter and said intermediate means being so arranged upon the slider and brush-carrier parts respectively that during movement of the brush-carrier part along the slider part the brush sets are brought into their active position individually and one after another, whereas the brush set made active by further common movement of both the switching member parts makes contacting possible with the contacts of its group.

19. In an automatic telephone system, a selector comprising a contact field having a plurality of line groups, a movable switching member embodying two parts movable with respect to each other; one of said parts being constructed as a brush carrier and the other part being constructed as a sliding bar, means for coupling the sliding bar part which remains stationary during the first switching movement with the brush carrier part for a portion of its movement and an electromagnet for actuating said coupling means when deenergized.

20. In an automatic telephone system, a selector comprising a contact field having a plurality of line groups, a movable switching member embodying two parts movable with respect to each other; one of said parts being constructed as a sliding bar and being stationary during the first switching movement and the other part being constructed as a brush carrier, means for coupling the sliding bar with the brush carrier, and a spring between the two parts of said member for retaining the sliding bar in the initial position until it and the brush carrier are coupled whereupon they carry the spring along together.

21. In an automatic telephone system, a selector comprising a contact field having a plurality of line groups, a movable switching member embodying two parts movable with respect to each other; one of said parts being constructed as a sliding bar and being stationary during the first switching movement and the other part being constructed as a brush carrier, means for coupling the sliding bar with the brush carrier, a spring arranged between the two parts of the member for retaining the said sliding bar in the initial position until it and the brush carrier are coupled to then carry along the spring together, means for moving the brush carrier along the sliding bar for selecting the brush set corresponding to the desired group of lines, means for commonly moving the two parts of the switching member for adjusting the brush set onto the desired contacts of said line group, means for commonly moving both parts further until the sliding bar reaches a predetermined final position for restoring the switching member, means for resetting the brush carrier at its initial position relative to the sliding bar, and means for commonly returning both parts to initial position.

22. In an automatic telephone system, a selector comprising a contact field having a plurality of line groups, a movable switching member embodying two parts movable with respect to each other; one of said parts being constructed as a sliding bar and being stationary during the first switching movement and the other part being constructed as a brush carrier, means for coupling the sliding bar with the brush carrier, a spring arranged between the two parts for retaining the sliding bar in its initial position until it and the brush carrier are coupled to then carry along the spring together, means for moving the brush carrier along the sliding bar for selecting the brush set corresponding to the desired group, means for commonly moving the two parts for adjusting said brush set onto the desired contacts of the line group, means for commonly moving both parts further until the sliding bar reaches a predetermined final position for restoring the switching member, means for resetting the brush carrier at its initial position relative to the sliding bar, and means for commonly returning both parts to the initial starting position, said means for resetting the brush carrier and return both parts of the switching member together being actuated by the sliding bar after reaching its predetermined final position, and being stopped by said bar after returning it to its initial position.

23. A switching device for automatic telephone systems comprising a contact field having a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a force acting constantly on said switching member to move the same along the contacts of said field, a pawl mechanism for locking the switching member in a lifted position against the action of said force and for releasing said member to movement, means for actuating the pawl mechanism to permit falling movement of the switching member until it reaches a position corresponding to the predetermined set of contacts, means for making operative a set of brushes corresponding to said set of contacts, means for actuating the pawl mechanism again to create a continued movement until the desired contact is reached by the set of brushes made operative, and means for

returning the switching member to its initial position.

24. A switching device for automatic telephone systems comprising a contact field having a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, means applying gravity as a driving force acting constantly on said switching member to move the same along the contacts of said field, a pawl mechanism for locking the switching member in a lifted position against the action of gravity and for releasing said member to movement, means for actuating the pawl mechanism to permit falling movement of the switching member until it reaches a position corresponding to the predetermined set of contacts, means for making operative a set of brushes corresponding to said set of contacts, means for actuating the pawl mechanism again to permit continued movement of the member until the desired contact is reached by the set of brushes made operative, and a compressed-air piston for returning the switching member to the initial lifted position.

25. A switching device for automatic telephone systems comprising a contact field having a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a driving force acting constantly in a downward direction on said switching member to move the same along the contacts of said field, a pawl mechanism for locking the switching member in a lifted position against the action of said force and for releasing said member to movement, means for actuating the pawl mechanism to permit downward movement of the switching member until it reaches a position corresponding to the predetermined set of contacts, means for making operative a set of brushes corresponding to said set of contacts, means for actuating the pawl mechanism again to allow continued movement of the switching member until the desired contact is reached by the set of brushes made operative, means for operating the pawl mechanism still again to permit continued downward movement of said member until a final position is reached, and a compressed-air piston for returning the switching member to the initial lifted position.

26. A switching device for automatic telephone systems comprising a contact field having a plurality of groups of contacts, a movable switching member having a plurality of sets of brushes cooperating with said groups of contacts, means for making operative one set of brushes in accordance with a predetermined group of contacts, a constantly acting driving force operating individually on said switching member to move the same along the contacts of said field, means for locking the member against the action of said force, means for releasing the member to cause movement thereof until the desired contact is reached by the set of brushes made operative, and means for returning the switching member against said force to its initial position in a continuous movement when the effected connection is broken and thereby re-applying the force thereon.

27. In an automatic telephone system, a combined selector, line finder and connecter adapted to be connected as either one of the three, comprising a contact field, a movable switching member formed in two parts, means for moving the switching member along the contacts of said field continuously, means for stopping one of the switching member parts during the continuous movement thereof, means at the contacts of the field passed by the switching member during its movement for actuating said stopping means, and means for causing a step-by-step movement of the other part of said switching member in the same direction as the continuous movement for equal small distances, the last named means being independent of the fields of said contacts passed during the step-by-step movement.

In testimony whereof I affix my signature.

FRIEDRICH MERK.