Nov. 22, 1938. J. H. VOSS 2,137,514

SWITCHING APPARATUS

Filed Dec. 11, 1937 2 Sheets-Sheet 1

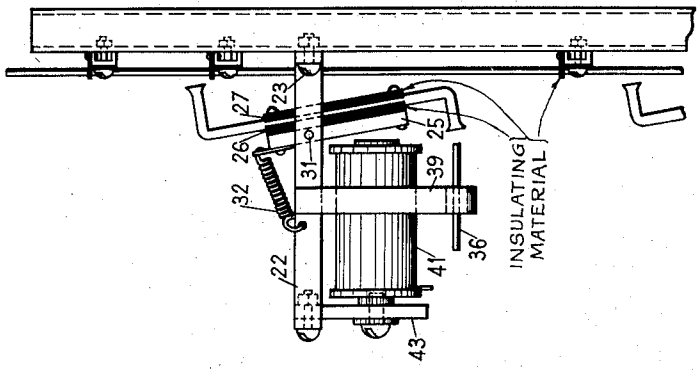


FIG. 2

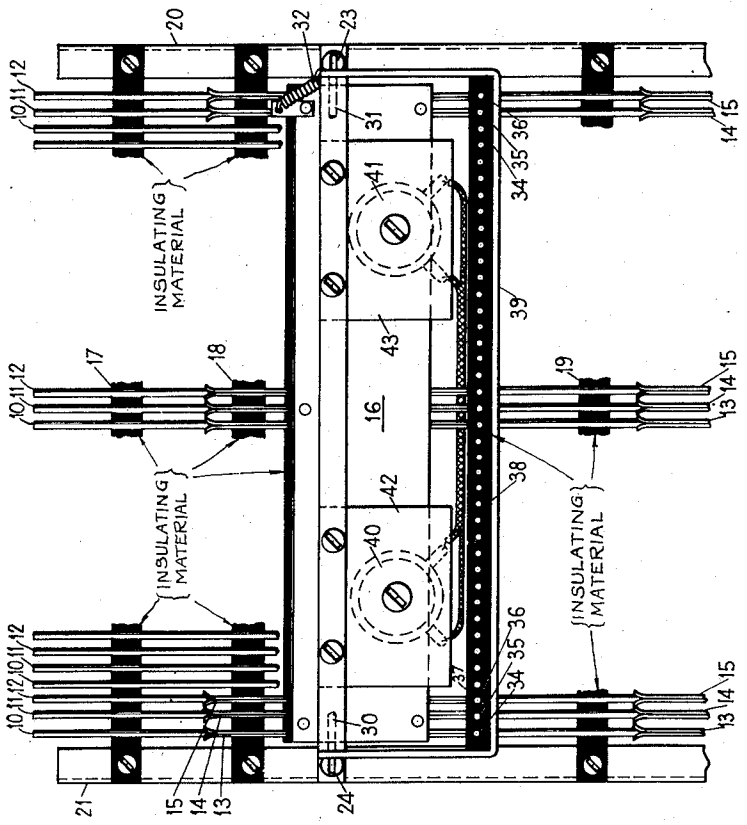


FIG. 1

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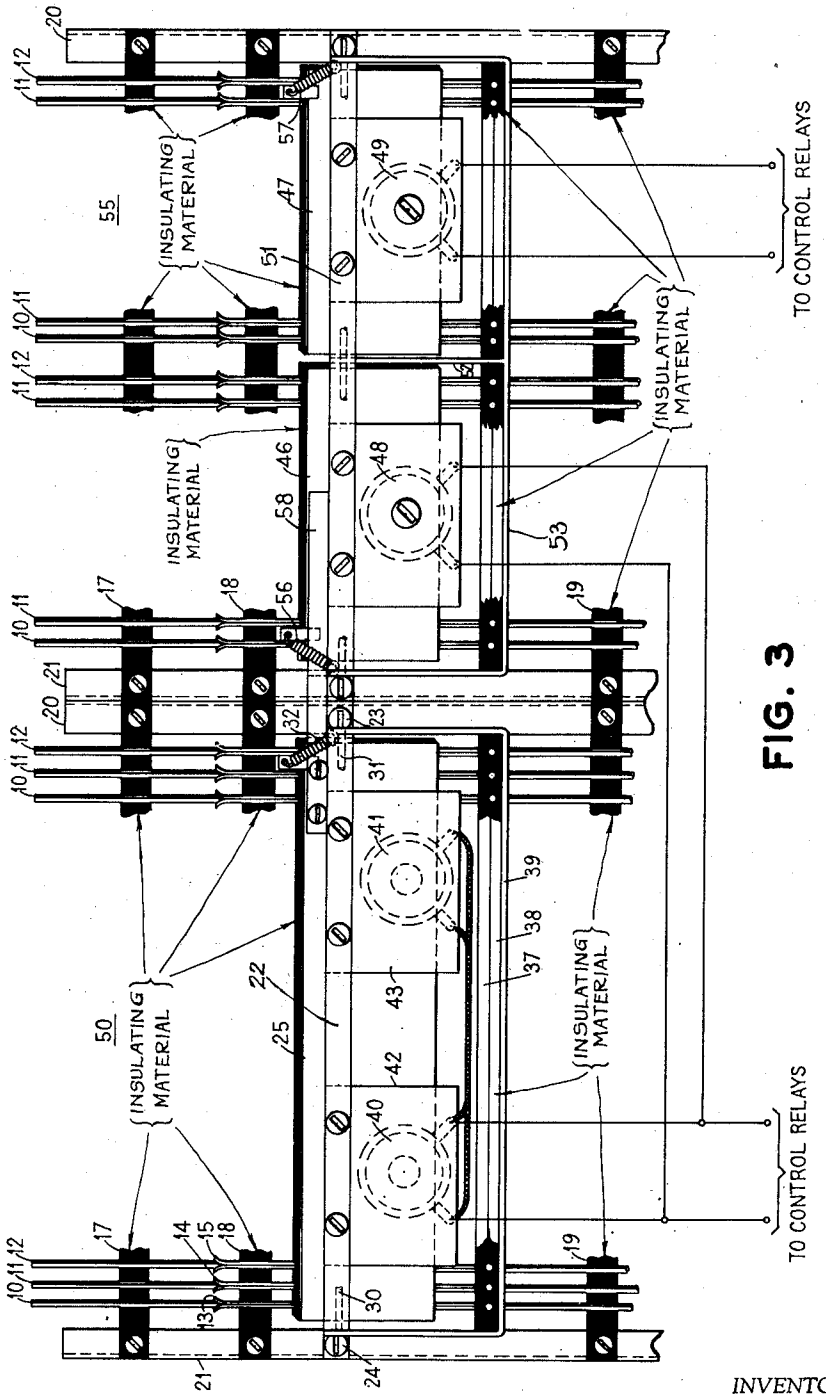


FIG. 3

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2,137,514

SWITCHING APPARATUS

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5 Claims. (Cl. 179—27.54)

The present invention relates to switching apparatus and more particularly to improvements in switching apparatus of the form suitable for use in automatic telephone exchanges.

As pointed out in the copending application, Serial No. 142,966—Clarence E. Lomax and John H. Voss, filed May 17, 1937, one of the major items of cost, as regards the construction and installation of an automatic telephone exchange, is that of constructing the multiples extending between the bank contacts of the various automatic switches. In accordance with conventional practice, this construction work is performed manually, each multiple conductor being soldered at several corresponding contacts respectively included in the switches of a particular group. By employing the improved arrangement disclosed in the above-mentioned copending application, the construction and installation costs are materially reduced through the expedient of using uninsulated conductors which serve both as multiple conductors between a plurality of switches and as wiper contacts for the wipers of the individual switches. In this improved arrangement, the line selecting mechanism employed is of the step-by-step type which utilizes a stepping magnet cooperating with a ratchet and pawl mechanism for imparting translatory movement to a shaft upon which the switch wipers are mounted. In this, as in other switches of the cross bar type, the nature of the line selecting mechanism limits the number of line grouping arrangements and, hence, detracts from economy in maintaining the number of switches in a given installation at a minimum.

It is an object of the present invention, therefore, to provide improved switching apparatus of the general form briefly described above which is of simple and economical construction and is susceptible of a wire variety of line grouping arrangements.

The improved apparatus as described in detail hereinafter is illustrated as including a plurality of spaced bank conductors which serve both as multiple conductors and as the bank contacts for a plurality of multiple contact relays, which relays individually include at least one armature, upon which are supported a plurality of circuit connecting elements comprising wipers for engaging the respective associated bank conductors. Means are provided in each relay for normally restraining the controlled wipers from engagement with their respective associated bank conductors, the wipers only being moved into engagement with the associated conductors when the operating magnet of the controlling relay is energized. In order to connect the conductors of the lines incoming to each relay to the armature controlled connecting elements, each of the latter elements is also provided with a wiper for engaging an associated contact during the movement of the connecting element into the contact-make position. For the purpose of enhancing the flexibility of the apparatus in regard to the trunking or line grouping arrangements possible, at least a portion of the relays are provided with split armatures so arranged that a portion of the wipers associated therewith are susceptible of being controlled through the operation of adjacently located relays. More specifically, a mechanical linkage arrangement is employed whereby the armature of one relay may control not only the wipers corresponding thereto but also a portion of the wipers controlled by the armature of an adjacently positioned relay.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings in which Figure 1 is a front view partially in section, illustrating one section of a switching unit constructed and arranged in accordance with the present invention; Fig. 2 is a side view of the apparatus illustrated in Fig. 1; and Fig. 3 is a front view partially in section, illustrating a further feature of the invention.

Referring now more particularly to Figs. 1 and 2 of the drawings, there is illustrated one frame or section of the improved switching apparatus as comprising a plurality of uninsulated bank conductors 10, 11, and 12, which comprise a common contact field for a plurality of relays, one of which is indicated generally at 16, each including a plurality of circuit connecting elements 13, 14 and 15 respectively associated with the bank conductors. The bank conductors are arranged in evenly spaced apart relation in the same vertical plane and are supported by insulating members 17, 18, 19, etc., which extend between and are secured to oppositely disposed frame members 20 and 21 in the manner indicated. Although the bank conductors may be secured to the insulating members 17, 18 and 19 in any desired manner, the conductor field is preferably preformed by slotting the horizontally extending ridge portion of each insulating

member at the correct intervals and by forcing the conductors into the slots so that the sides of each slot tightly grip the accommodated conductor. The various relay structures are spaced vertically along the frame and, if desired, alternate ones of the relays may be disposed on opposite sides of the conductor field for the purpose of best utilizing the conductor field, thereby to minimize the height of a given size unit. Since the relays may be of identical construction, only that indicated at 10 has been shown in detail. This relay is mounted on the frame members 20 and 21 by means comprising a U-shaped cross member 22 having its two legs bolted, respectively, to the frame members 20 and 21 by two bolts 23 and 24, respectively. The connecting elements embodied in this relay structure are mounted upon an armature piece 25 between two insulating members 26 and 27. These insulating members are provided along their opposed surfaces with spaced grooves within which the connecting elements nest so that, when the assembly is completed by bolting or riveting the three elements 25, 26 and 27 together, the elements are rigidly held in position. It will be understood that the spacing of the grooves corresponds to the spacing between the various bank conductors so that, when the relay structure is mounted on the frame members 20 and 21, the wipers are positioned to be moved into engagement with their respective associated bank conductors. The armature piece 25 is provided at its respective ends with pivot studs 30 and 31, the free extremities of which are journaled in bearings formed by apertures drilled in the legs of the cross member 22 at oppositely spaced points. By this arrangement, the armature assembly is mounted so that it may be rotated to bring the wipers included therein into engagement with their respective oppositely disposed bank conductors. Normally this assembly is restrained in the position indicated in Fig. 2 of the drawings, wherein the wipers are disengaged from the bank conductors, by means comprising a coil spring 32 secured at one end to one of the legs of the cross member 22 and, at the opposite end, to the upper portion of the armature piece 25.

Each of the connecting elements is substantially Z-shaped in outline and is composed of two adjacently positioned flat spring members preferably stamped from a resilient material of high electrical conductivity such, for example, as brass. The wiper ends of the connecting elements formed at the extremities of the upper legs thereof are flared, to facilitate their engagement with the bank conductors, by bending in opposite directions the end portions of the two spring members comprising the same. As indicated in Fig. 2, the extremities of the upper legs of the Z-shaped connecting elements form the wipers for engaging the oppositely disposed bank conductors, each of these wipers being arranged to straddle and make contact at two points with its associated conductor when the armature assembly is rotated to cause engagement between the wipers and the bank conductors.

In order to connect the conductors of the lines incoming to the relay to the connecting elements embodied in the armature assembly, the extremities of the lower legs of the connecting elements are arranged to engage associated contact elements 34, 35 and 36 during rotation of the armature assembly to its contact-make position. These contact elements are clamped between a pair of insulating members 37 and 38 which are, in turn, mounted upon a U-shaped member 39 depending from the legs of the cross member 22.

For the purpose of rotating the armature assembly into its contact-make position, two electromagnets 40 and 41 are provided, which magnets are mounted upon the cross member 22 by means of heel pieces 42 and 43, respectively. Since the cross member 22, the heel pieces 42 and 43, and the armature piece 25 constitute a part of the magnetic circuits for the two magnets 40 and 41, all of these elements are constructed of a material, such, for example, as iron, having a low reluctance characteristic.

Although it is believed that the operation of the apparatus as described above will be apparent from the preceding description, it is noted that, when the two electromagnets 40 and 41 are energized, the armature assembly is rotated in a clockwise direction from the position indicated in Fig. 2 of the drawings to move the connecting elements 13, 14 and 15 into engagement with their oppositely disposed bank conductors 10, 11 and 12 and their respective associated contact elements 34, 35 and 36. As a result, the lines terminating at the indicated bank conductors are connected by way of the connecting elements to the lines terminating at the associated contact elements. Assuming that the size of the bank conductor field is such that ten three-conductor lines are terminated thereat, this group of lines is selected upon energization of the two magnets 40 and 41. In accordance with well-understood telephone practice, further selection of a particular line in this group may be attained by terminating the contact elements 34, 35 and 36 in the contact springs of a group of line selecting relays arranged in a conventional manner.

As indicated in the introductory portion of the specification, prior switching arrangements are not particularly flexible as regards the line grouping arrangements possible. To illustrate this point, the requirements of a one hundred line connector switchboard designed to serve eighty-five subscribers' lines and fifteen outgoing trunk lines may be considered. Normally, and for reasons of construction economy, the switchboard bank is constructed in ten-line sections, or, sections designed to terminate integer multiples of ten lines. Hence, if standard equipment is to be used in terminating the eighty-five subscribers' lines and the fifteen trunk lines, nine sections for the subscribers' lines and two sections for the trunk lines, or a total of eleven sections, will be required, together with the associated relay equipment. Of the available bank conductors, ten sets, or five sets in each of two sections, will necessarily be left blank. It will readily be seen that the provision of the extra switch section represents a considerable item of cost which it is desirable to eliminate.

Referring now more particularly to Fig. 3 of the drawings, there is illustrated an improved arrangement devised to overcome the problem as outlined above. To this end, a portion of the connecting elements, which would normally be controlled by one relay structure in the arrangement of Fig. 1, are arranged to be independently controlled or to be controlled by the armature of the adjacently positioned relay. Two bank conductor frames or sections, generally indicated at 50 and 55 and in all respects similar to that described above with reference to Fig. 1, are utilized, these frames being positioned side by side in the conventional manner. Due to the identity of con-

struction between each of these frames and that shown in Fig. 1, similar reference characters have been used to indicate corresponding parts. The bank conductors of each section may be regarded as an independent group, but, by the particular construction and arrangement of the relays associated with the bank conductor section 55, both subscribers' lines and trunk lines may be terminated at the conductors of this frame. Since the relays associated with the bank conductors making up the frame 50 are each identical in construction with that depicted in Fig. 1, similar reference characters have been used to indicate the corresponding elements. The relays for controlling the wipers associated with the bank conductors of the section 55 are, however, of different construction, in that the armature assembly is split into two component parts 46 and 47, which may be independently controlled by the operating magnets 48 and 49. Thus, the armature assembly 46 is pivotally mounted between the left leg of the U-shaped cross member 51, corresponding to the cross member 22, and an intermediate leg thereof, not shown, extending horizontally therefrom and attached to an intermediate leg 52 projecting upwardly from a member 53, which latter member corresponds to the member 39. Similarly, the armature assembly 47 is pivotally mounted between the right leg of the cross member 51 and the intermediate leg of this cross member. The two armature assemblies 46 and 47 are respectively restrained in the contact-break position by suitable coil springs 56 and 57 arranged in the manner shown. The remaining portions of the relay are quite similar to the relay 16, and, hence, no further description is deemed necessary to a ready understanding of the operation thereof.

By dividing the connecting elements associated with the conductors of the frame 55 into two small subgroups, respectively, controlled by independent operating magnets, it is possible more fully to utilize the available line capacity. Thus, if an odd number group of trunks as, for example, fifteen, and an odd number of subscribers' lines as, for example, eighty-four, are required in a particular installation and the sections 59 and 55 are each of ten lines capacity, the fifteen trunks may be terminated at the conductors of the section 50 and the five sets of bank conductors associated with the connecting elements supported by the armature assembly 46. The remaining five conductor sets associated with the connecting elements carried by the armature assembly 47 are still available for the four odd subscribers' lines. With this line grouping arrangement two alternative arrangements for actuating the wipers associated with the trunk terminating bank conductors into engagement with their respective associated conductors are disclosed.

The first arrangement, as shown, comprises circuit connections for energizing the operating magnets 40, 41 and 48 in parallel when it is desired to select an idle one of the trunks. Since the operating circuit of the magnet 49 is independent of this parallel circuit and the armature assembly 47 is entirely independent of the assembly 46, the resulting trunk selecting operation of the apparatus in no way affects the position of the armature assembly 47.

As an alternative arrangement for simultaneously operating the connecting elements normally controlled by the armature 25 and the assembly 46, there may be provided a cross bar 58 which is secured to the armature piece 25 and extends into engagement with the armature piece of the assembly 46. With this arrangement and when the magnets 40 and 41 are energized to attract the armature piece 25, both the assembly including this armature piece and the assembly 46 are rotated to move their controlled wipers into the contact-make position. It will be understood that when this arrangement for controlling the connecting elements is employed the magnet 48 may be entirely omitted or disconnected.

Although only one specific line grouping arrangement for the apparatus of Fig. 3 is described, it will readily be apparent that many other arrangements designed fully to utilize the available line capacity are possible through the provision of the split armatures of the relays associated with the bank conductor section 55. For example, the armature assembly may be controlled independently of any of the other assemblies by providing a separate and independent operating circuit for the magnet 48.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made in the structure thereof, and it is contemplated in the appended claims to cover all such modifications as fall within the true spirit and scope of the invention.

I claim:

1. Switching apparatus comprising, in combination, a plurality of bank conductors arranged in two groups, circuit connecting elements respectively associated with the conductors of each group, means normally restraining said elements from engagement with their respective associated bank conductors, a pair of operating magnets, means responsive to the energization of one of said magnets for operating only a portion of the connecting elements corresponding to one group of conductors into engagement with their respective associated conductors, means responsive to the energization of the other of said magnets for operating the connecting elements corresponding to the other group of conductors into engagement with their respective associated conductors, and means also responsive to the energization of the other of said magnets for operating a portion of the connecting elements corresponding to said one group of conductors into engagement with their respective associated conductors.

2. Switching apparatus comprising, in combination, a plurality of bank conductors arranged in two groups, circuit connecting elements respectively associated with the conductors of each of said groups, means normally restraining said elements from engagement with their respective associated conductors, a pair of operating magnets, means comprising a member controlled by one of said magnets for operating at least a portion of the connecting elements corresponding to one of said groups of conductors into engagement with their respective associated conductors, means comprising a pair of members controlled by the other of said magnets for operating the connecting elements corresponding to the other of said groups of conductors into engagement with their respective associated conductors, and means comprising a link carried by said first-named member and cooperating with one of said pair of members for operating a portion of the connecting elements controlled by said pair of members into engagement with their respective

associated conductors simultaneously with the operation of said first-named means.

3. Switching apparatus comprising, in combination, a plurality of bank conductors arranged in two groups, a plurality of contacts arranged in two groups, circuit connecting elements respectively associated with the conductors and contacts of the respective groups, each of said elements including a wiper for engaging the associated conductor and a contact point for engaging the associated contact, means normally restraining said elements from engagement with their respective associated conductors and contacts, a pair of operating magnets, means comprising an armature controlled by one of said magnets for operating the connecting elements corresponding to one of said groups of conductors into engagement with their respective associated conductors and contacts, means comprising a pair of armatures, one of which is controlled by the other of said magnets, for operating the connecting elements corresponding to the other of said groups of conductors into engagement with their respective associated contacts and conductors, and means comprising a link carried by said first-named armature and cooperating with the other of said pair of armatures for operating a portion of the connecting elements controlled by said pair of armatures into engagement with their respective associated contacts and conductors simultaneously with the operation of said first-named means.

4. Switching apparatus comprising, in combination, a pair of bank conductor frames, groups of bare bank conductors respectively supported by said frames, said frames and the conductors carried thereby being of a standardized size and construction, a plurality of relays supported on each of said frames, each of said relays including connecting elements adapted to be moved into engagement with oppositely disposed ones of said bank conductors, and the relays associated with the group of conductors supported by one of said frames each including two independently controllable armature assemblies for actuating independent portions of the connecting elements included in the corresponding relay.

5. Switching apparatus comprising, in combination, a plurality of spaced bare bank conductors adapted to serve both as multiple conductors and as wiper contacts, a plurality of contacts, an electromagnet, an armature for said magnet, a plurality of substantially Z-shaped circuit connecting elements supported on said armature and insulated from each other, said circuit elements corresponding respectively to said contacts and conductors and each thereof including as one arm a wiper for engaging its associated conductor and as the other arm a wiper for engaging its associated contact, said armature being arranged to pivot said circuit connectors and bring the wipers thereof into engagement with their respective associated conductors and contacts, and means normally restraining said armature in a position such that said wipers are disengaged from their associated contacts and conductors.

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