Dec. 6, 1949 J. I. BELLAMY 2,490,665

AUTOMATIC TELEPHONE SWITCH

Filed March 1, 1944 6 Sheets-Sheet 1

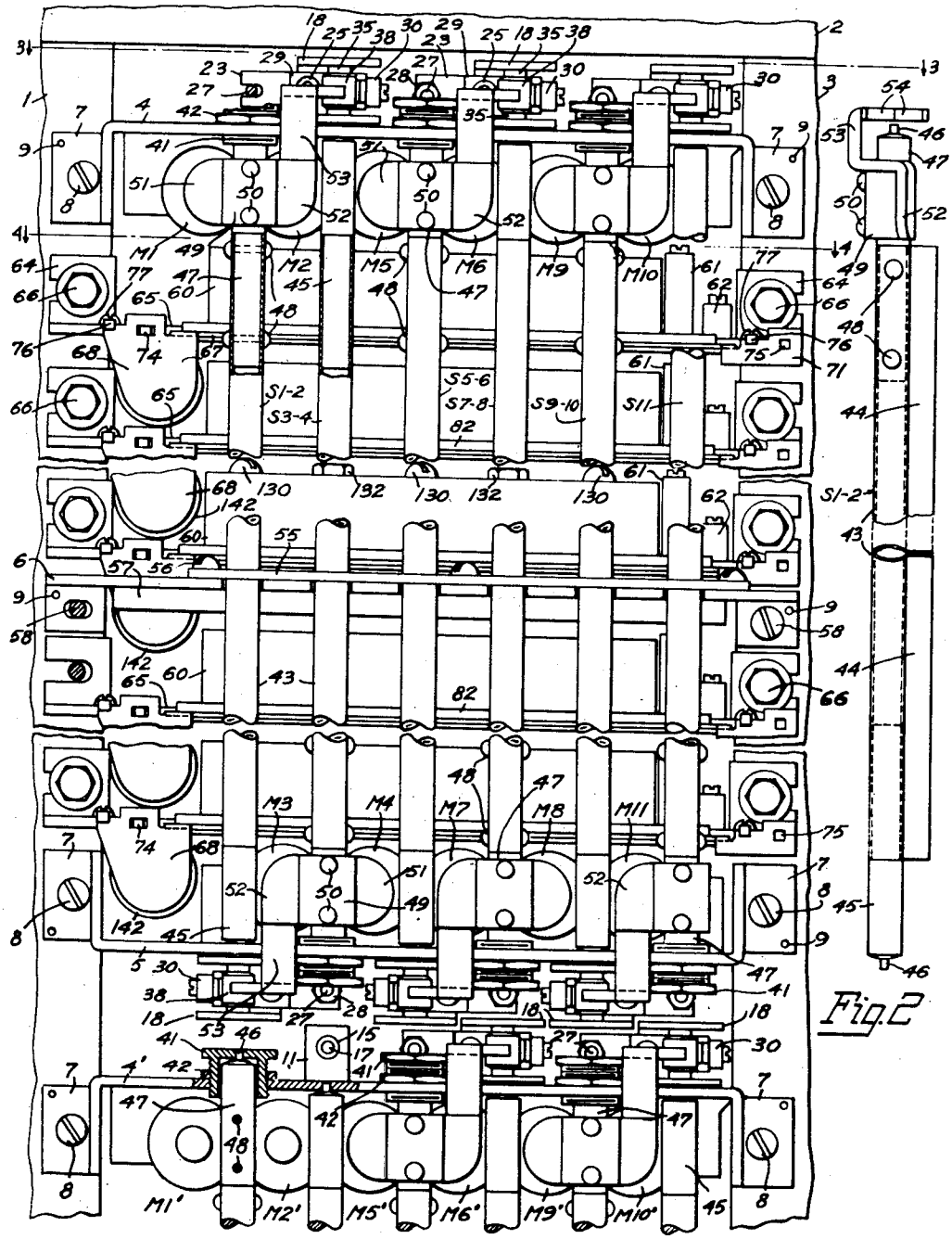


Fig. 1

Fig. 2

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Fig. 3

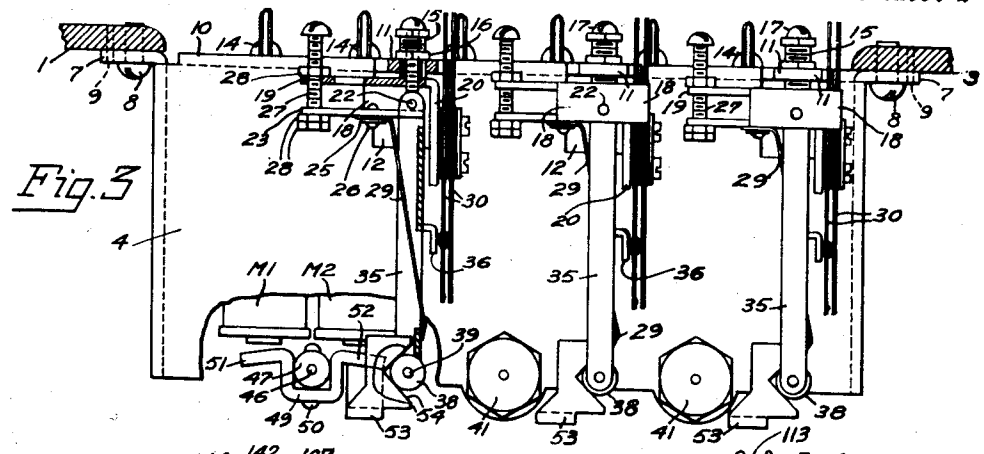


Fig. 4

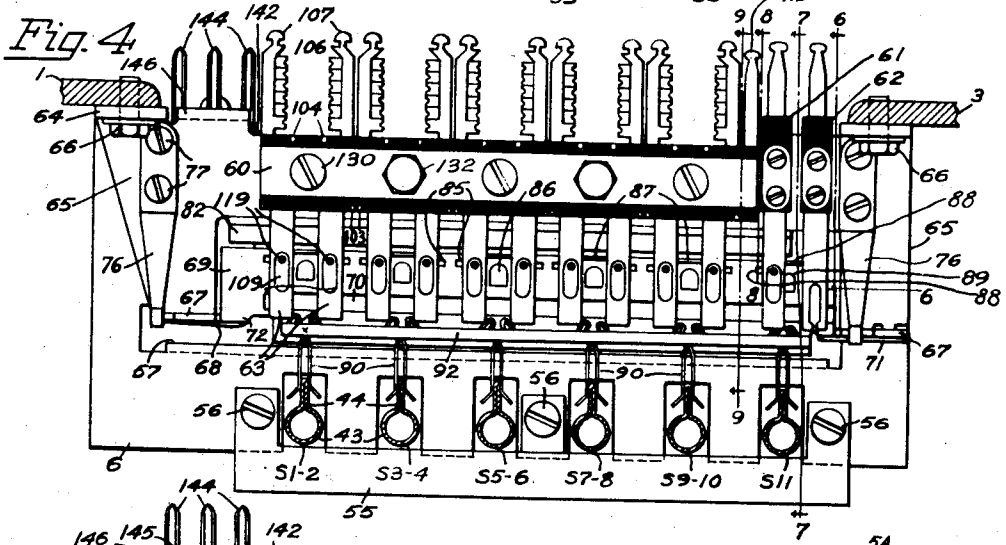


Fig. 5

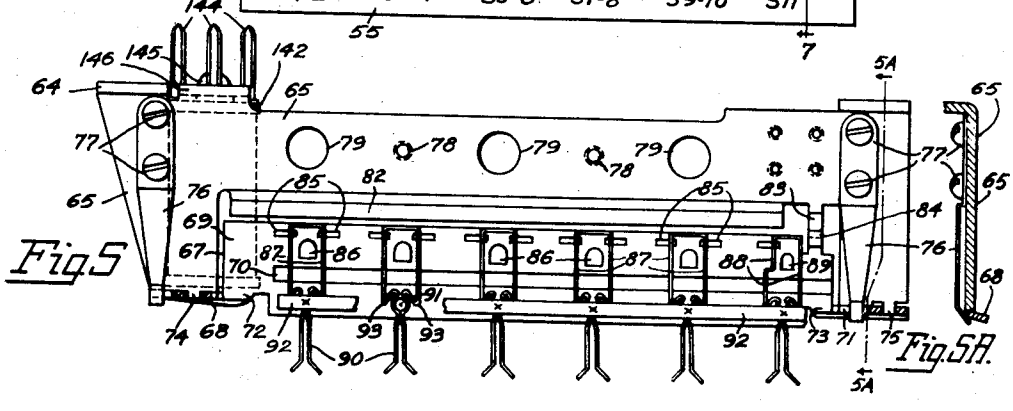


Fig. 5A

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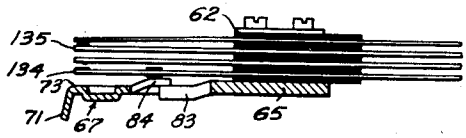


Fig. 6

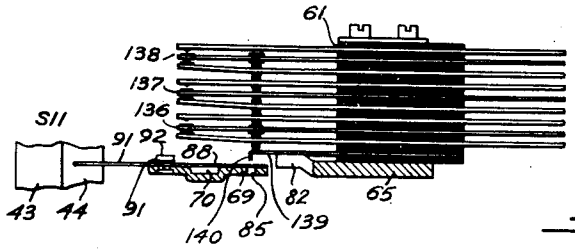


Fig. 7

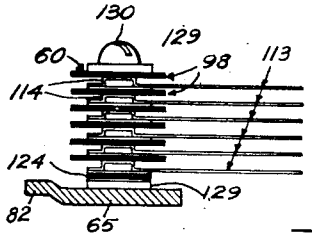


Fig. 8

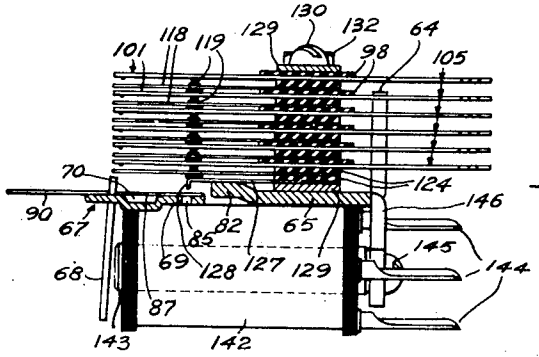


Fig. 9

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AUTOMATIC TELEPHONE SWITCH

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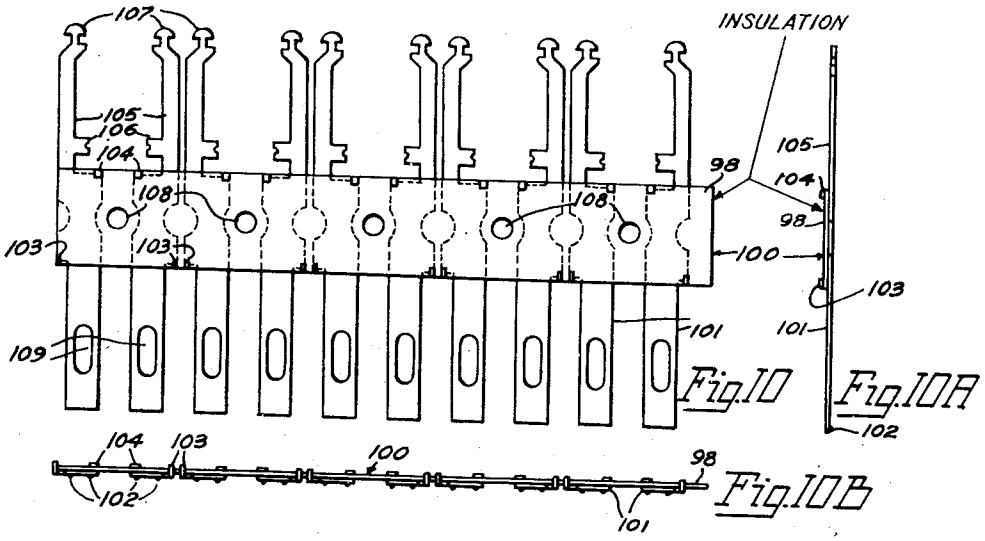


Fig.10 Fig.10A

Fig.10B

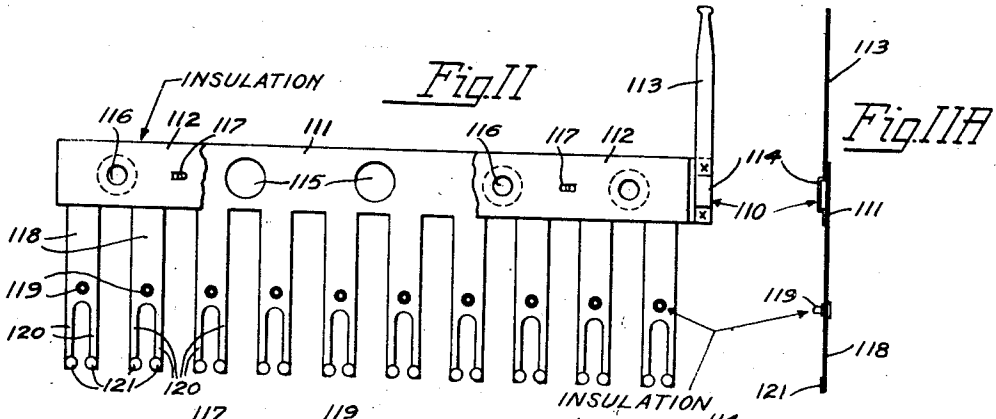


Fig.11 Fig.11A

Fig.11B

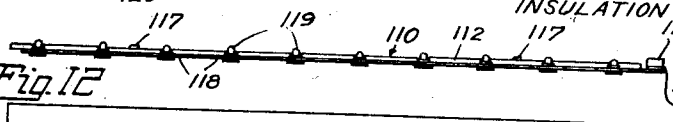


Fig.12

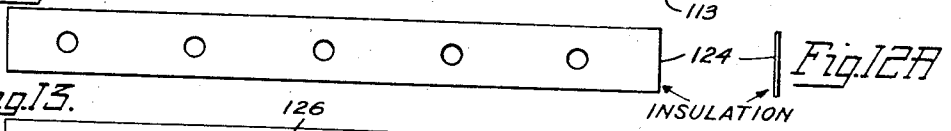


Fig.12A

Fig.13.

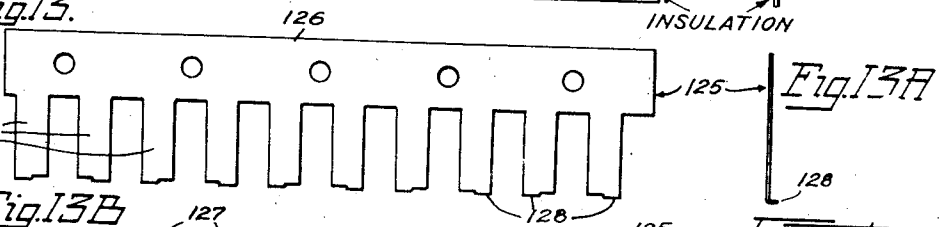


Fig.13A

Fig.13B



Fig.14

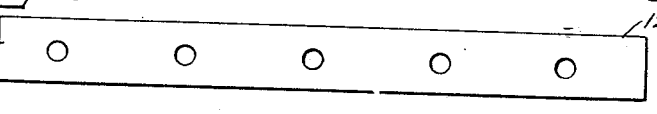


Fig.14A

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AUTOMATIC TELEPHONE SWITCH

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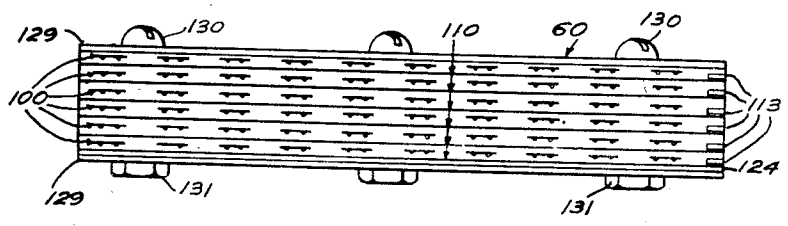


Fig. 15.

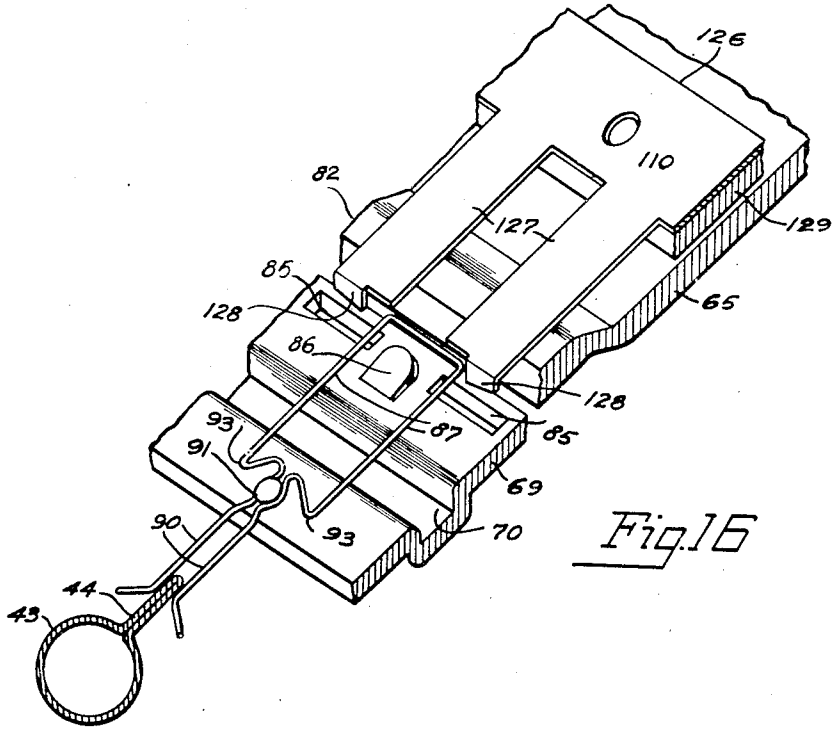


Fig. 16

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AUTOMATIC TELEPHONE SWITCH

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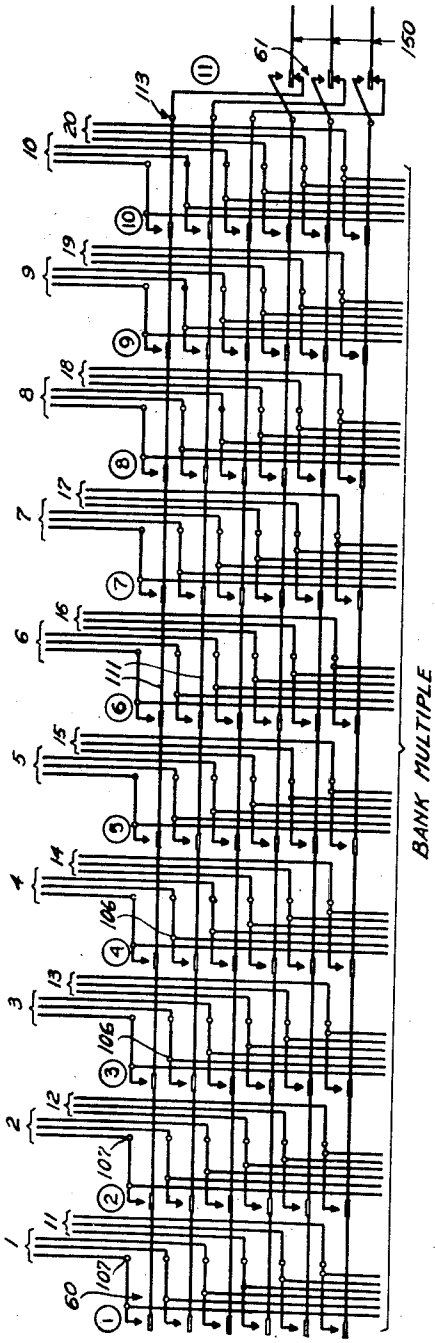


Fig. 17

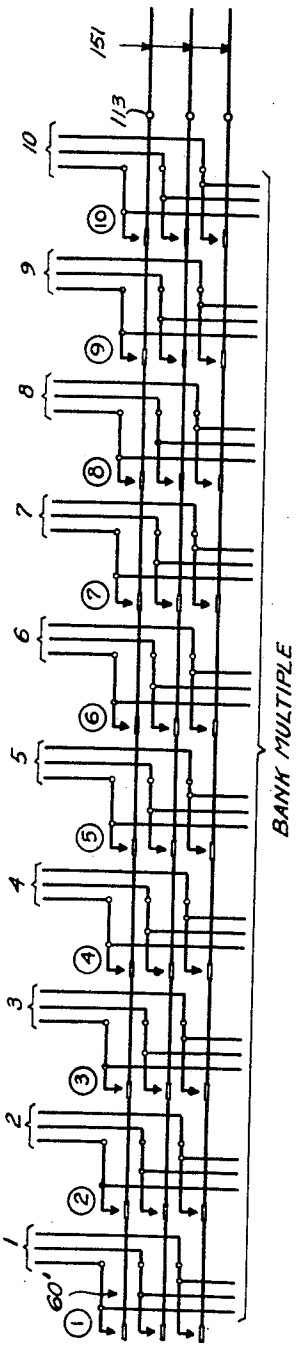


Fig. 18

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2,490,665

UNITED STATES PATENT OFFICE

2,490,665

AUTOMATIC TELEPHONE SWITCH

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Application March 1, 1944, Serial No. 524,816

20 Claims. (Cl. 179—27.54)

1

This invention relates to automatic telephone switches, although switches constructed in accordance therewith may have uses other than in automatic telephone systems.

The main object of the invention is the production of new and improved automatic switching apparatus of simple and reliable construction and which is economical to manufacture.

The switching structure disclosed herein is an improvement on that disclosed in applicant's copending application for Automatic telephone switches and systems, Serial No. 451,565, filed July 20, 1942, now Patent No. 2,354,660, dated Aug. 1, 1944.

GENERAL DESCRIPTION

As disclosed in the above-noted prior application, the switching apparatus under discussion includes similar individual switches arranged in a row, with each switch comprising a number of selectively operable stackups of contact members, and common selecting shafts extending along the row and arranged to cooperate with any switching device to select a contact stackup therein for operation.

Among the features of the present invention are the following:

1. The selective capacity of each individual switch in a group is doubled by providing an additional stackup, controlled by an additional common selecting shaft, which selects one or another of two groups of contact members in any selected stackup.

2. The stackups of contact members of a switch (excluding the additional stackup) take the form of a unitary contact bank which is readily attachable to and detachable from the individual switch to which it is assigned. In this bank construction, the parts comprise separate subassembly strips adapted to be secured together in superposed relationship, each such strip carrying a blade member for each of the several stackups provided by the bank, thereby facilitating production and assembly.

3. The contact blades forming the selective stackups of the contact bank have their rearwardly extending terminal portions laterally offset, whereby the forwardly extending stackups may be equally spaced to permit adjustment and inspection access from both sides, while the terminal portions are unequally spaced to provide ample room for attaching the vertically extending bank-multiple conductors to side tabs carried by the terminal portions.

4. A further feature relates to a simplified finger structure and a simplified arrangement for mounting and controlling the several selecting fingers of a switch. Each such simplified finger comprises a simple loop of spring material, of which the rear portion serves as the stackup-

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actuating portion; an intermediate portion cooperates with a fixed pivot; and the front portion serves as flexible arms controlled by a selecting shaft.

5. The stackup-actuating plate and the armature of the operating magnet of the switch comprise one piece which is readily mountable and demountable, being held in pivotal mounted position by retaining spring clips.

6. The parallel mounting rails on which a group of switches are mounted are permitted to be brought closer together, and the frame structure of the individual switches is simplified, by mounting the switches on the face of the mounting rails, rather than between them as in the prior arrangement.

7. Each of the common selecting shafts takes the form of a length of metal tubing having a finger-controlling web extension formed integrally therewith, a pair of insert members being provided at the ends for pivotally supporting the shaft for rotation.

8. Improved positioning mechanism renders the shafts more readily removable and replaceable, and the normal position of a shaft is readily adjustable, as is the tension of the shaft-restoring spring.

9. A still further feature relates to the provision of an improved arrangement for providing intermediate guide points for long controlling shafts, the construction being such that the lateral web portion of a shaft does not need to be cut away at the intermediate guide points.

Other objects and features of the invention will appear hereinafter.

The accompanying drawings, comprising Figs. 1 to 18, show a preferred embodiment of the invention:

Fig. 1 is a front view of a mounting rack on which two or more groups of switches constructed according to the invention are mounted;

Fig. 2 is a left-side view of one of the selecting shafts shown in Fig. 1;

Fig. 3 is a view taken along line 3—3 of Fig. 1, showing a top view of the upper shaft bracket 4 of the first group of switches;

Fig. 4 is a top view of the first individual switch of the first group, looking down along line 4—4 of Fig. 1;

Fig. 5 is a view similar to Fig. 4 with certain parts removed to permit a clearer view of the frame structure of the individual switch;

Figs. 6 to 9 are side sectional views along lines 6—6 to 9—9 respectively of Fig. 4, looking to the left as indicated by the arrowheads;

Figs. 10 to 14, together with their associated auxiliary views, show parts used in making up the contact bank 60 of an individual switch;

Fig. 15 show a partially diagrammatic front view of an assembled contact bank;

Fig. 16 is a perspective view showing the manner of selection of a stackup of contacts of an individual switch for operation;

Fig. 17 is a circuit diagram of the stackups of an individual switch provided with an additional, or switching, stackup enabling twenty selections to be made; and

Fig. 18 is a circuit diagram of the stackups of an individual switch arranged to make ten selections.

DETAILED DESCRIPTION

The invention having been described generally, a detailed description of the disclosure will now be given.

General arrangement

Referring particularly to Fig. 1, the general arrangement of the improved switching structure will first be described.

As previously noted, Fig. 1 illustrates two or more groups of automatic switches mounted on a vertically disposed mounting rack. The mounting rack, only fragmentarily shown, includes the parallel mounting rails 1 and 3, secured together at the top by cross member 2.

The first (uppermost) group of switches includes the switches mounted between the upper shaft bracket 4 and the lower shaft bracket 5 of the group, while the second group of switches includes switches (not shown) mounted below shaft bracket 4', being the upper shaft bracket of the second group, and being exactly similar to the upper shaft bracket 4 of the first group. The upper shaft bracket of the second group is shown principally to illustrate the relatively small amount of space required between adjacent switch groups on the same mounting rack.

Each of the individual switches mounted between shaft brackets such as 4 and 5 may be similar. Each such switch is secured to mounting rails 1 and 3 by screws or bolts 66, the illustrated washers being used if desired. Each individual switch includes a frame member 65 (see also Figs. 4 and 5) having a one-piece armature and actuating plate 67 mounted thereon for actuation by an operating magnet 142. Each individual switch also has a contact bank 60 mounted on the frame portion 65 and including ten stackups of contacts 63, as seen best in Fig. 4. Additionally, each switch has an eleventh, or switching, stackup of contacts 61, and a so-called off-normal stackup of contacts 62.

In the mounted position of the individual switches, the stackups of contacts thereof are respectively in alignment. The ten stackups 63 in bank 60 of any individual switch comprise five pairs of such stackups—1st and 2nd, 3rd and 4th, etc. Selecting shafts S1—2, S3—4, S5—6, S7—8, and S9—10 extend vertically across the front of the five pairs of stackups of bank 60 of each individual switch in the group. As will appear hereinafter, and as explained in the prior application previously referred to the arrangement is such that actuation of an armature of an individual switch effects the operation of a selective stackup of contacts of the switch only if such stackup of contacts has been selected by an appropriate movement of the associated one of the selecting shafts of such group of switches. Each shaft is arranged to be rotated slightly in either of two directions from its normal position in order to select one stackup or the other of the pair associated with such shaft in each of the switches of the group.

The eleventh stackup 61 of any individual switch is termed a switching stackup, for it is used as illustrated best in Fig. 17 to switch the common incoming conductors from in association with the upper group of contacts in all stackups of the associated bank 60 into an association with the lower group of contacts in such stackups, when connection is desired with one of the sets of outlet conductors 11 to 20 of Fig. 17 rather than with one of the sets of outlet conductors 1 to 10. An additional selecting shaft S11 is arranged to be rotated slightly from normal position to select the eleventh (switching) stackup 61 in all individual switches to thereby cause operation of the contacts in such stackup 61 to occur coincidental with the operation of any desired one of the ten stackups in the contact bank 60 of the switch, when the operating magnet of the desired individual switch is energized for this purpose.

The so-called off-normal stackup 62 of any individual switch is a non-selective stackup, in that the contact members thereof are operated responsive to each operation of the armature of the switch irrespective of the selecting shafts.

The selecting shafts

The selecting shafts shown in Fig. 1 are all of similar construction, a left-side view of shaft S1—2 being shown in Fig. 2. Each such shaft comprises essentially a metal tube 43 (Fig. 2) of appropriate length having an integrally formed web portion 44 (see also Fig. 4) through which the selective action of the shaft is performed incidental to rotation of the shaft about its longitudinal axis.

At the lower end of the shaft S1—2 a bearing rod 45 is provided. The lower part of rod 45 may have a diameter substantially equal to the outside diameter of tubular portion 43, followed by a reduced-diameter portion which may be retained within the hollow interior of portion 43 by friction. Bearing pin 46 may be provided by turning down the lower end of bearing rod 45, or may represent a pin of bearing material inserted into a suitable drilled hole in member 45. The abutting end portion adjacent pin 46 is preferably somewhat rounded, as illustrated, to provide a simple thrust bearing to sustain the weight of the shaft on the upper surface of lower shaft bracket 5 around a suitable opening for receiving pin 46.

An armature-end bearing rod 47 is provided, being generally similar to the lower bearing member 45. Rod 47 is preferably composed of annealed magnet iron, for a portion of it must serve as a magnetic return path, as will presently appear. Rotation of bearing member 47 with respect to tubular shaft 43 and its web portion 44 is prevented by rivets 48.

Rod 47 has armature 49 secured thereto as by rivets 50. Armature 49 has a pair of wing portions 51 and 52 formed integrally therewith, arranged to be acted upon by the respective associated select magnets M1 and M2. The normal relationship between wings 51 and 52 of any shaft and the associated select magnets (such as M1 and M2) is illustrated in Fig. 3 where a portion of the upper shaft bracket 4 is broken away for this purpose.

Wing 52 of each armature 49 is provided with an integral arm 53 through which the shaft is normally maintained in a desired normal position, and is returned to such normal position following temporary selectional rotation in either direction. As shown best in Fig. 2, arm 53 extends forward

from the top portion of wing 52 to a point which (in assembled position) is well in front of the adjacent front line of the upper bracket 4; thence extends vertically to a point well above the top line of bracket 4; and thence extends rearwardly to provide a horizontal portion into which the locating notch 54 (Fig. 3) is cut. At this point, it may be noted that yielding spring-driven rollers 38 are arranged to lie within the notches 54 to maintain the selecting shafts yieldingly in normal position, and to cause their return to such position following temporary rotation therefrom.

It will be observed that the first, third, and fifth of the selecting shafts of a group are all assembled in the same position with the armature 49 thereof at the top, while the second, fourth, and sixth shafts of the group are assembled in reverse position, the armatures 49 of the latter being at the bottom. Accordingly, the magnets M1 and M2, M5 and M6, and M9 and M10, for the first, third, and fifth shafts are located on the upper shaft bracket 4, while the magnets M3 and M4, M7 and M8, and M11, for the second, fourth, and sixth shafts, are located on the lower shaft bracket 5. This arrangement permits all shafts to be of exactly the same construction, any shaft turned so that the armature is at the top end, or reversed (armature at the bottom end) according to the position in the structure occupied by such shaft. It may be noted that the right wing (corresponding to wing 51 of any other shaft of the group) of shaft S11 is cut off. This wing of shaft S11 is not needed, for such shaft is associated with only one stackup (61) of any switch and accordingly needs to be rotated in only one direction from its normal position.

Shaft brackets and bearings

The shaft brackets 4 and 5 are generally similar to each other. Upper shaft bracket 4 comprises a flat plate-like portion, seen in top view in Fig. 3, having the ends thereof turned down to form stiffening supports. The rear portion of these down-turned ends is bent outwardly to form flat mounting portions 7 by which the bracket is held in engagement with the face of rack members 1 and 3 by screws 8. The rear portion 10 of bracket 4 is turned downwardly to form a vertical surface on which select magnets such as M1 and M2 are mounted by mounting screws 14 (Fig. 3). The front part of the main plate portion of bracket 4 is provided with vertical bearing openings for journally receiving the upper ends of the selecting shafts. The second, fourth, and sixth of these journal openings are comparatively small, as they directly receive the bearing-pin portion 46 of the concerned shafts. The first, third, and fifth of the bearing openings in shaft bracket 4 are comparatively large openings which threadedly receive adjustable bearing nuts 41. One of these bearing nuts 41 is shown in cross-section in upper shaft bracket 4' of the second group, whereat certain parts are omitted to give a clearer view of the underlying structure.

Each bearing nut 41 is preferably formed of magnetic material, and contains a cylindrical recess which receives bearing rod 47. A slight annular clearance (.015 inch, for example) between rod 47 and the inside surface of bearing nut 41 insures that no frictional engagement occurs between the concerned parts except where a bearing pin 46 extends through its opening in nut 41. Lock nuts 42 retain bearing nuts 41 in adjusted position.

When one of the magnets such as M1 or M2 (see Fig. 3) is energized, the magnetic flux passes from the front end of the magnet to the associated wing (51 or 52) of the concerned armature 49, passing thence to bearing rod 47, whence it traverses the small annular air gap between rod 47 and the inside surface of bearing nut 41, and returns through the bearing nut and the shaft bracket to the rear end of the energized magnet. The concerned armature wing, 51 or 52, is thereby attracted into engagement with the energized magnet, causing rotation of the concerned selecting shaft in one direction or the other.

The roller brackets

Each of the shaft brackets 4 and 5 has three roller brackets 18 (Figs. 1 and 3) mounted thereon. They carry the positioning rollers 38 and shaft-offnormal contact springs 30. Each of these roller brackets 18 is mounted on a vertical tab 11, being an extension of the portion 10 of brackets 4 and 5. One mounting tab 11 is seen in front view above the second shaft journalled in the upper bracket 4' of the second switch group (Fig. 1). Any such tab represents material cut out of the main horizontal portion of a bracket 4 or 5 (but left attached to portion 10), the resulting openings being indicated at 12 (Fig. 3).

Each roller bracket 18 includes a pair of opposed horizontal portions (interconnected by a rear vertical portion) containing an opening for vertical pivot pins indicated at 22 in Fig. 3. The upper horizontal portion of one of the roller brackets 18 is cut away in Fig. 3 to give a better view of the parts lying between the horizontal portions of a bracket 18. A tapped opening in the vertical rear portion of each roller bracket 18 (Fig. 3) receives a screw 17 which retains the bracket in assembled position. Each bracket has a roller arm 35 mounted therein and held pivotally in position by pivot pin 22. Each such roller arm generally resembles a U-shaped trough turned on its side. The upper side portion of one of the roller arms 35 is cut away in Fig. 3.

Each roller bracket 18 has a side extension 19 threaded at the end to receive tension-adjusting screw 27, and it has a forwardly extending arm 20 on which a pair of normally separated shaft-offnormal springs 30 are insulatedly mounted in the usual manner, as by a pair of screws whose heads are shown. The terminal portion of contact springs 30 extend to the rear to enable conductors to be attached thereto.

The front end of each roller arm 35 carries a roller 38 (rotatable around bearing pin 39) which engages notch 54 in the associated shaft-positioning arm 53 to retain the associated shaft normally in its desired normal position.

Each roller arm is provided with a tension spring 29, lying between the upper and lower side portions of the roller arm. The forward end of spring 29 rests on a vertical bridging portion of the roller arm near the front to urge the arm and its attached roller 38 toward the associated selecting shaft to resiliently retain such shaft in its desired normal position.

The rear portion of each spring 29 is formed at right angles to the roller arm and is held in engagement with a spring arm 23 by a rivet 26 which is passed through a washer 25, the rear part of spring 29, and spring arm 23. Spring arm 23 lies between the upper and lower horizontal portions of roller arm 35, and has rearwardly

extending ears through which pivot pin 22 passes to retain that end of the spring arm 23 pivotally in position. The free end of each spring arm 23 is slotted horizontally to loosely receive the forward portion of tension-adjusting screw 27. The front end of screw 27 is provided with a pair of lock nuts 28, preferably turned tightly together to act as a restraining shoulder for arm 23. A further lock nut 28 lies to the rear of arm 19, and is intended to be turned tightly against arm 19 to maintain screw 27 in any desired position of adjustment, such screw being threaded into an opening in arm 19. When the rear lock nut 28 is loosened and screw 27 is turned in one direction, the forward lock nuts 28 are drawn rearwardly to increase the tension which spring 29 exerts against the roller arm 35. Turning the screw in the opposite direction lessens this spring tension.

Each roller arm 35 has a tab-like extension 36 for acting upon the adjacent one of the shaft-offnormal springs 30 through an insulating bushing to cause the springs 30 to make electrical contact with each other when the roller arm 35 is rotated slightly about pivot pin 22 incidental to the associated switch shaft being rotated into one or another of its selective positions. The springs 30 may thus be used for "pilot" purposes to indicate to a control circuit that a shaft has been moved into a selecting position.

An arrangement is provided for adjusting the normal rotational position occupied by any selecting shaft. At each roller bracket 18, this arrangement includes the hollow machine screw (or thimble) 15 through which retaining screw 17 passes. Each such hollow screw 15 passes through a threaded opening in its respective tab 11, and protrudes slightly from the front side of such tab, thereby determining the location of the rear surface of the concerned roller bracket 18. The adjusted position of hollow screw 15 is maintained by lock nut 16.

When it is desired that a roller arm 35 be adjusted, forwardly or rearwardly, to thereby bring the roller 38 carried thereby toward the front or toward the rear, its lock nut 16 and the mounting screw 17 may both be loosened slightly to permit hollow screw 15 to be turned in the concerned direction. Roller bracket 18 is locked in the new position of adjustment by tightening lock nut 16 and screw 17. It should be noted that rotation of brackets 38 about retaining screw 17 as a pivot is prevented by contact between one main horizontal portion of any bracket 18 and the adjacent surface of the shaft bracket. For this purpose, the main horizontal portions of 18 are of sufficient length to bridge across the previously mentioned openings 12 in the shaft brackets, occasioned by the formation of mounting tabs 11.

Guide brackets

When there are a large number of switches in a group, guide brackets may be provided to maintain each of the then necessarily long selecting shafts (S1—2, S3—4, and so forth) substantially in alignment with respect to side-to-side deviations. Front-to-rear deviations are less likely to occur because of the strengthening effect of rearwardly projecting web portion 44. Moreover, a comparatively large front-to-rear misalignment can be tolerated, for the distance by which the finger arms 90 overlap a web portion 44 may vary a substantial fraction of an inch without adverse effect. Substantial lateral misalignment of a selecting shaft tends however to cause the concerned fingers 87 to stand too far to the right or to the left of the preferred normal (non-selecting) position.

One of the intermediate shaft-guide brackets is shown at 6 in Figs. 1 and 4. This bracket comprises essentially a horizontal plate-like member having down-turned tabs formed at the rear thereof by means of which it is held in engagement with mounting rails 1 and 3 by screws 58 passing through horizontally slotted openings to permit the guide bracket to be brought to the right or to the left into the desired position. The rear central portion of guide bracket 6 may be cut out to permit such bracket to be mounted closely below the adjacent individual switch mounted above it. Part 57 of bracket 6 may be bent down to form a vertical stiffening portion. Accurately sized and spaced notches are cut into the front portion of bracket 6 to freely receive the tubular portions 43 of the shafts. Each such notch is cut deep enough to accommodate the web portion 44 of the shaft. The width of each notch is preferably such that a shaft perfectly aligned from side to side is out of contact with the side walls defining the notch by a small amount, one sixty-fourth of an inch for example.

Each guide bracket 6 may have a front closure piece 55 mounted thereon and held in place by screws 56. These closure pieces, of course, may be left off indefinitely when desired, as during a period when the shafts need to be removed and subsequently replaced to permit repair or replacing of individual switches or to permit addition of individual switches to partially filled groups. It will be understood that a guide bracket is not intended to maintain front-to-rear alignment of the shafts. It does, however, serve to limit the extent to which a shaft may be freely flexed (accidentally or otherwise) to the front or to the rear, whereby the probability of permanent distortion of an installed shaft from this cause is greatly reduced.

Switch construction

The construction of the individual switches will now be described more in detail, reference being had particularly to Fig. 1 and Figs. 4 to 9. The frame portion 65 comprises a generally flat horizontal plate member having a pair of mounting tabs 64 turned up from the rear corner portions thereof through which the switch is mounted on the front face rails 1 and 3 by screws 66. Frame 65 also has a depending tab 146 (Figs. 4, 5, and 9) on which operating electromagnet 142, having rear terminals 144, is mounted by means of screw 145 threaded into the core portion 143 thereof. The three large openings 79 through the frame 65 serve to receive nuts 131 (Fig. 15) threaded onto the lower end of screws 130 which hold the parts of contact bank 60 in assembled relation, while tapped openings 78 receive intermediate bank screws 132 by means of which the assembled bank 60 is mounted on the switch in the position indicated in Figs. 1 and 4.

It is to be noted that the front central portion of frame 65 is cut out, as seen in Figs. 4 and 5 to permit actuating plate 69 of armature 67 to lie within the confines of the frame.

Armature 67 comprises two principal portions—the horizontal actuating plate 69, underlying all stackups, and portion 68, the armature proper. Armature 67 has a second generally vertical portion 71, located at the right end thereof, to complete the knife-edge pivoting and returning portion of the armature. The arma-

ture is pivotally suspended on a pair of lugs 74 and 75 (Figs. 1 and 5), extending forwardly from the principal front surface of frame 65 a distance about equal to the thickness of the material from which the armature is made.

The armature is held in assembled position by armature-retaining springs 76, shown in profile in Fig. 5A. They are secured to frame 65 by screws 77. These springs are tensioned downwardly at the front to engage the upper forward edge of parts 68 and 71 of the armature. Since the forward ends of springs 76 are bent downwardly at an angle as indicated in Fig. 5A, the retaining force applied by spring 76 to armature 67 is rearwardly and downwardly. The armature can be removed from assembled position by merely drawing it forwardly until the lugs 74 and 75 are cleared, springs 76 yielding for this purpose. To replace the armature, it suffices to raise the forward end of springs 76 while the armature is being placed in position. It may be noted that the horizontal line along which retaining springs 76 contact parts 68 and 71 of the armature is in horizontal alignment with the top surface of frame 65, and consequently with the top surface of lugs 74 and 75 formed integrally therewith. Accordingly, there is a minimum of sliding between the armature and springs 76 as the armature is pivotally operated and restored under control of magnet 142.

It may be noted that the generally vertical attractable portion 68 of the armature is connected with the horizontal actuating portion 69 by a relatively narrow neck 72, rendering it comparatively easy to adjust the angle between parts 68 and 69, to thereby adjust the stroke or angular movement of the armature incidental to an energization of magnet 142. A similar neck portion 73 interconnects actuating part 69 and the right-hand support part 71. It is preferable that part 71 slant outwardly and downwardly at a slightly greater angle from vertical than is normally required for part 68 in order that part 71 shall not require angular adjustment (incidental to adjustment of the angle between parts 68 and 69) to maintain the pivotal contact between part 71 and upper front edge of frame 65 along the desired knife-edge line.

As best seen in Figs. 5, 7, and 9, actuating portion 69 of armature 67 has a stiffening depressed rib portion formed therein at 70. This rib portion stops short of the left end of actuating portion 69 to avoid undesired contact with operating magnet 142, which partially underlies the left end of portion 69. In this connection it should be noted that the armature is illustrated as formed of material of about half of the thickness of the material from which the frame is formed, and is so formed that the lower surface of actuating part 69 (exclusive of strengthening rib 70) lies flush with the lower surface of main horizontal portion of frame 65.

In order to maintain actuating part 69 of the armature against dropping below its normal horizontal position, the armature is provided with a rearwardly extending, upwardly offset, part 84 (Figs. 5 and 6) which overlies forwardly extending, downwardly offset, portion 83 of frame 65. The location of parts 83 and 84 along the structure is such that the top surface of part 84 of the armature underlies the insulating actuating bushing affixed to the lower one of the contact springs 134, which are thereby brought into engagement with each other each time the armature 67 is operated. At this point, it may be

noted that normally closed contact blades 135 (Fig. 6) are assembled in stackup 62 merely for convenience, as they are not controlled by armature operation. They may be separated when desired, and are used in certain system arrangements to impose an artificial busy condition on the individual switch.

A row of eleven slots 85 (one for each of the eleven selective stackups of the switch) lies along the rear portion of actuating plate 69. Each such slot underlies the actuating portion of its associated stackup, and serves normally to receive the depending actuating tab of the stackup when armature operation occurs whereby a stackup of contacts normally does not respond to an operation of the armature. Fingers 87 are provided to bridge the middle portion of any of the slots 85 to thereby block the depending actuating portion of the concerned stackup from passing through the slot, whereby the concerned stackup is actuated responsive to armature operation. Considering the first finger 87, for example, the left portion of this finger is associated with the first and second stackups of bank 60, but normally does not overlie either of the associated openings 85 sufficiently to cause operation of either of the concerned stackups. This finger is pivoted at an intermediate portion, as illustrated in Fig. 5 for the second finger. When turned counterclockwise about this intermediate pivot point, the left side of the first finger 87 bridges the central portion of the first slot 85, whereby the first stackup is selected for operation, subject to armature 67 operating to raise plate 69. On the other hand, if the first finger 87 is turned in a clockwise direction from its normal position illustrated in Fig. 5, the right-hand portion thereof comes over the middle part of the second slot 85, effecting selection of the second stackup of contacts for operation along with the armature.

Finger stops 86 may comprise portions punched up (as by shear forming) from the material of actuating plate 69, having the form illustrated best in Fig. 16. Each such part 86 is preferably of such a width that it stops the movement of the associated finger 87 in either direction from normal position when the forward portion of the finger is approximately under the center of the stickup into association with which it is brought by the movement.

Each of the five fingers 87 (see Fig. 5) of an individual switch may comprise a length of spring material (such as round wire) of a suitable diameter formed to the indicated configuration, which may be described as of a modified hairpin shape. The intermediate portion of the finger provides a pair of opposed nearly semi-circular portions which do not quite define a circle. This pivot portion of the finger fits comparatively snugly around the associated pivot 91.

Each pivot 91 may be formed by a process known as semi-perforating; that is, a circular section of the sheet material is punched partway through to raise the cyclindrical pivot portion 91 a desired distance above the surrounding flat surface. This distance is preferably slightly in excess of the diameter of the wire of which fingers 87 are formed, whereby a slight operating clearance remains when the finger-retaining strip 92 is placed in position, supported by the top surface of pivots 91. Strip 92 may be spot-welded to the top of each pivot portion 91 as is indicated by the x marks in Fig. 5.

The sixth finger 88 (the one cooperating with the eleventh, or switching, stackup 61) is of the same construction as the five fingers 87, except that the rear left portion is offset inwardly, as shown in Fig. 5, to displace the left stackup-selecting and actuating portion of such finger to the right. This expedient is adopted because switching stackup 61 is spaced an additional distance to the right of the tenth stackup in bank 60 to provide room for the common inlet terminals 113, as shown best in Fig. 4, while selecting shaft S11 is spaced only a normal distance (one inch, for example) from the preceding selecting shaft, S9—10. Stop member 89, associated with the sixth finger 88, is similar to stop members 86, but is of reduced width because of the narrowed space between the side portions of finger 88 produced by the above-mentioned offset on one side of finger 88.

With further reference to the construction of the fingers, it will be noted that "corner" portions 93 are so located as to lie underneath retaining strip 92 in all rotational positions of the finger, whereby any tendency of a finger to tip (rotate about its longitudinal axis) is avoided.

The one-piece armature 67, with its principal parts 68 and 69, is preferably formed complete with its slots 85, stops 86 and 89, strengthening rib 70, pivots 91, and finger-retaining strip 92, following which the five fingers 87 and the sixth finger 88 may be placed in assembled position by inserting each such finger from the rear beneath the retaining strip 92 and straddling its pivot 91. The arm portions 90 of the finger spread apart for this purpose, responsive to the forward assembly pressure, again snapping together around pivot 91 when the desired position of assembly is reached. It is to be noted that the illustrated finger construction and finger-pivoting and retaining construction, besides providing a one-piece finger, spring, and control arms (90), permits the use of a very simple and economical arrangement for removably pivoting the fingers in place.

Bank construction

Referring now particularly to Fig. 1 and Figs. 4 to 16, the construction of the contact bank 60 of any individual switch will be explained more in detail.

The completed contact bank 60 is shown in top view in Fig. 4, in cross-sectional view in Fig. 9 (taken along line 9—9 of Fig. 4), and is shown partially diagrammatically in front view in Fig. 15. Each individual switch is provided with one of these banks 60, as is shown in Fig. 1, where each such contact bank is indicated for convenience merely as a rectangle.

Each bank 60 comprises a number of layers or strips held together between the upper and lower clamp strips 129 (shown in Figs. 14 and 14A) by screws 130, passing through the bank and threaded into bank nuts 131.

Besides the upper and lower clamp strips 129, bank 60 includes six pairs of contact strips, the uppermost strip of each pair having a construction as shown in Figs. 10, 10A, and 10B, the lower strip of such pair having a construction as shown in Figs. 11, 11A, and 11B. Below the lowermost pair of contact strips, there is assembled next an insulating strip shown in Figs. 12 and 12A, followed by the actuating strip shown in Figs. 13, 13A, and 13B, the latter strip lying directly on the lower clamp strip 129.

Referring now particularly to Figs. 10, 10A, and 10B, the upper-contact strip shown therein is indicated generally by the reference character 100. It comprises essentially an insulating strip 98 having ten contact blades 101 underlying it and extending across it to form a row. The form of the section of each contact blade 101 overlaid by the common insulator strip 98 is shown in dotted outline. All the contact blades 101 of the strip may be similar, as indicated. They comprise five pairs, with the first blade of each pair being assembled in what may be termed a normal way, while the second blade of each pair is assembled reversed, in that it is rotated 180 degrees about its longest axis. This reversal is effected in order to bring the rear terminal extensions 105 of the two blades of a pair some distance apart (with the member 105 being offset laterally from the contact-blade portion 101) to provide a wider field between the terminal members 105 of a pair to permit ready access to the side tabs 106 which are provided with notches as indicated, into which vertically extending inter-bank multipling wires may be soldered. Such vertically extending soldered wires are herein termed the bank multiple.

Strip 98 is preferably provided with retaining notches in its front and rear edges in which front tabs 103 and rear tabs 104 (formed integrally with the blade members) lie in the assembled position of the strip. These tabs are preferably clinched inwardly as indicated to retain the respective parts in the illustrated assembled position.

The extreme rear portion of each of the terminal extensions 105 is shaped as shown at 107 to permit conductors (usually the outlet conductors common to all switches of a multipled group or subgroup) to be attached to these terminals at any desired one, or more, of the switches of a group connected together by the same bank multiple.

Insulating strip 98 of the strip assembly 100 is provided with five holes 108 for receiving bank screws 130 (Figs. 4, 9 and 15) and bank attaching screws or bolts 132 (Fig. 4). The contact blades are spaced a substantial lateral distance away from the holes 108 to avoid electrical connection between the blades and the screws passing through the bank. Since the blades are assembled beneath insulating strip 98, the upper clamp member 129 of bank 60 may be assembled directly on the uppermost strip 100 of the bank.

Each contact blade 101 may be provided with a pair of depending contact points 102 in Figs. 10A and 10B, and secured to the blades in any desired manner, as by welding. They cooperate with the twin contacts 121 of the adjacent lower-contact strip 110 (Fig. 11).

It may be noted that the blades 101 of the strip 100 are formed of comparatively thick sheet material in order that the contacts 102 carried thereby shall be comparatively rigidly supported to thereby serve substantially as fixed contact points, against which the respective underlying blades in the adjacent lower-contact strip (Fig. 11) may be brought firmly into engagement.

Referring now particularly to Figs. 11, 11A, and 11B, the lower-contact strip shown therein is indicated generally by the reference character 110. It comprises essentially a comb-like strip of spring material underlying insulating strip 112 and secured to the latter by integral tabs 117 extending up through openings in the insulator strip and clinched over the top of the tabs 117,

as shown in Figs. 11 and 11B. Insulating strip 112 has five holes 116 therethrough of a size and spacing to align with the screw holes 108 in upper-contact strip 100, while the underlying conducting back portion 111 of the comb structure has larger concentric clearance holes 115 therethrough to maintain the comb structure well out of electrical contact with the bank screws and the bank mounting screws.

The comb structure of contact strip 110 carries ten flexible blades 118, serving as flexible movable-contact springs for cooperation respectively with the ten fixed-contact blades 101. Since blades 118 are interconnected electrically by the back portion 111 of the comb structure, such back portion may serve as a common conductor for the ten contact pairs represented by one upper-contact strip 100 and one underlying lower-contact strip 110. For this purpose, insulating strip 112 stops short of the right-hand end of back portion 111 of the comb, leaving a clear space at the right-hand end of part 111 for the attachment of the relatively rigid terminal blade 113, as by spot-welding at points *x* in Fig. 11. Each terminal blade 113 is provided with a raised portion 114 extending across the longitudinal center line of common portion 111 to provide a clamping action in the complete assembly to render the terminal blades 113 more rigid than if held merely by virtue of being secured to the rather flexible extended right-end portion of back 111 of the comb structure. This rigidifying clamping action, involving raised portion 114 of terminal blade 113 is apparent upon reference to Fig. 8.

Each flexible contact blade 118 carries a bushing 119 at about its midpoint. This bushing has a head portion lying underneath its blade 118. Each such bushing 119 also has an upwardly extending part. This upwardly extending part of the bushing is intended to pass through the rear portion of openings 109 (Fig. 10) in the overlying contact blades 101 to engage the depending head portion of bushings 119 of any strip 110 which may be assembled above the one in question in the bank assembly. This column-like cooperation of bushings 119 is shown best in Fig. 9, where one stackup of bank 60 is shown in sectional view.

Contact blades 118 are bifurcated from a point just forward of bushings 119 to the front end, forming twin arms 120 for each blade 118. A contact disc 121 is secured to the front end of each contact arm 120. Twin points of contact are thus provided between each movable-contact blade 118 and its respective overlying fixed-contact blade 101, through cooperation of the twin contact discs 121 of such blade 118 and the twin contact points 102 of such blade 101. Preferably, the material of which the comb structure of strip 110 is formed is comparatively thin to render the blades 118 flexible to permit bending thereof between the front edge of the common portion 111 and the actuating bushing 119, and to render the twin arms of any such blade 118 individually flexible to insure that each exerts contact pressure substantially independent of the other when any contact blade 118 is raised by force exerted from below on its bushing 119.

As previously noted, contact bank 60 comprises six pairs of contact blade strips, each such pair being made up of a strip 100 and an underlying strip 110. All strips 110 may be of identical construction, and all strips 100 may be of identical construction, except that each strip 100 in the bank has its side lugs 106 (Figs. 10 and 4) located at a different distance from the end of the rear terminal extensions 105, so as to space the vertical wires of the bank multiple along planes parallel to the direction of extension of the contact blades.

The lowermost one of the six strips 110 in the illustrated bank 60 is underlaid by an insulating strip 124 (Figs. 12 and 12A) which keeps back portion 111 of the comb structure of the lowermost strip 110 out of electrical engagement with the frame portion of the individual switch.

Actuating comb 125 (Figs. 13, 13A, and 13B) directly underlies insulator strip 124, and directly overlies the lower clamp strip 129 (Fig. 14). Actuating comb 125 comprises a common back portion 126 having flexible fingers 127 formed integrally therewith. Each finger 127 is of such a length that, when assembled in the bank 60, it ends just forward of the center of the contact bushing 119 of the immediately overlying contact blade 118, the lower or head portion of such bushing 119 lying on the underlying finger 127 near the forward end thereof, as shown in Fig. 9.

As clearly seen in Figs. 13 and 13B, and as shown in the perspective view (Fig. 16), the front end of each flexible blade 127 of the actuating comb is provided with a down-turned actuating tab 128 through which the front end of the actuating spring may be raised subject to the adjacent side of the associated finger 87 having been rotated underneath such actuating portion 128 to bridge the underlying slot 85. The bottom surface of any actuating portion 128 slopes slightly upwardly away from the normal position of the associated actuating finger 87 to insure that the finger which has selected and brought about the operation of the stackup of contacts will remain in its off-normal selective position so long as the actuating plate 69 of the armature remains raised, to thereby maintain the selected stackup in operated position.

In the assembled position, blades 127 of the actuating comb are supported on the upper surface of the upwardly offset part 82 of switch frame 65, as shown in Figs. 9 and 16, whereby the depending portions 128 are maintained above the level of selecting fingers 87. Preferably, each of the contact blades 118 is tensioned downwardly slightly to insure that it is normally out of contact with its overlying contact blade 101. The total light downward tension of all of the flexible blades 118 in a stackup is imparted to the forward end of the underlying actuating blade 127 through the medium of bushings 119. This downward pressure is resisted by blade 127 by virtue of its support at 82, near the front end thereof.

The eleventh stackup

The eleventh, or switching, stackup 61 shown in Figs. 1 and 4, is shown in profile view in Fig. 7, taken along section line 7—7 of Fig. 4. Generally, switching stackup 61 comprises three sets of contact blades 136, 137, and 138, each such set including three contact blades arranged in transfer, or break-make, assembly. The lower and upper blades of any such set of three are preferably of comparatively rigid construction, similar to blades 101 (Figs. 10 and 10A), while the intermediate blade of any such set is preferably a relatively thin and flexible blade, similar to blades 118 (Figs. 11 and 11A). Each such intermediate blade of the set of three is tensioned downwardly to maintain the lower twin contacts carried there-

by normally in engagement with those carried on the upper side of the front end of the underlying rigid contact blade. Bushings are carried by the upper and lower flexible blades in stackup 61 through which the intermediate portion of the flexible blades may be raised by pressure exerted upwardly on the depending portion of the insulating bushing carried by the lowermost flexible blade. When this upward movement occurs, the flexible blades are raised upwardly together. Each thereupon moves out of contact with the underlying fixed-contact blade and into contact with its overlying fixed-contact blade.

Below the three sets of transfer, or switching, blades in stackup 61, there is assembled an actuating blade 139 similar to actuating blades 127 (Fig. 13). This actuating blade is also supported on the upwardly offset portion 82 of switch frame 65 to maintain its depending portion 140 normally above the level of the associated selecting finger 88.

Basic alignment provisions

Referring again to Fig. 1, basic alignment provisions illustrated therein will now be described.

The openings in mounting portions 7 (of shaft brackets 4 and 5) through which mounting screws 8 pass may be slotted laterally (as shown for the left-hand opening for mounting screw 58 of shaft-guide bracket 6). Accordingly, the upper and lower shaft brackets 4 and 5, and the shaft-guide brackets such as 6, may be adjusted laterally to the desired position of alignment on the rack before the mounting screws 8 and 58 are drawn up tight.

When the shaft brackets and shaft-guide brackets have been tightened in aligned position, holes 9 may be drilled through the mounting portions of the brackets, and through the underlying side rails 1 and 3 of the mounting rack, following which a locating pin may be driven into each such hole 9. With these brackets thus permanently mounted and aligned, the removal and replacement of the selecting shafts such as S1—2 to S11 does not operate to disturb the alignment of the shafts.

Each individual switch, with the shafts installed and adjusted to the desired neutral, or normal, position (by parts 15 to 17, Fig. 3), may be adjusted laterally into aligned position by virtue of the lateral slots through which mounting screws 66 pass.

Figure 17

Fig. 17 is a diagrammatic showing of electrical connections which may be made through bank 60 of any individual switch by way of its eleventh, or switching, stackup 61. In this drawing, the encircled numbers 1 to 11 represent the first eleven selective stackups of an individual switch, the upper switch of a group for example. The twenty sets of upwardly extending conductors labeled 1 to 20 respectively represent the twenty three-conductor outlet paths to which the three common inlet conductors 150 can be selectively connected. With stackup 61 in its illustrated normal position, the inlet conductors 150 are connected through the normal contacts in stackup 61 to the three upper horizontal conductors in the bank common to the ten stackups of the bank, by way of the upper three of the six terminal blades 113 shown in Figs. 4, 8, and 11. It will be understood that the horizontal common conductors indicated in Fig. 17 are the back portions 111 of the comb structures illustrated in Fig. 11. When the inlet conductors 150 are to be connected with the respective conductors of any one of the outlet groups 1 to 10 of Fig. 17, it suffices simply to close all six contact pairs in any one of the stackups 1 to 10 of bank 60. The closure of the upper three contact pairs in such stackup is effective for the purpose stated, while the closure of the lower three contact pairs of such stackup is at that time a mere ineffective operation because the lower three horizontal conductors in the bank are normally open at the alternate contacts of the unactuated eleventh stackup 61.

When the inlet conductors 150 are to be connected with one of the outlet groups 11 to 20, the concerned one of the stackups 1 to 10 of bank 60 is actuated along with the eleventh stackup 61. In this operation, the lower three contact pairs of the actuated stackup 1 to 10 are effective to complete the desired connection through the now effective alternate contacts of the actuated stackup 61, while the closure of the upper three contact pairs of the actuated stackup 1 to 10 are ineffective because the normal contacts in stackup 61 are then in open condition.

It should be noted that the outlet conductors forming groups 1 to 20 in Fig. 17 are attached to the rearmost terminals 107 (Figs. 4 and 10). The vertical conductors shown extending downwardly from bank 60 in Fig. 17 and labeled "bank multiple" represent conductors attached to the side tabs 106 (Figs. 4 and 10). These vertical conductors comprising the bank multiple may extend to and connect to the side tabs 106 of any desired number of individual switches, enabling the illustrated conductor groups 1 to 20 to serve as the common outlet paths for all the switches in the group.

Figure 18

Fig. 18 is illustrative of electrical connections involving a modified bank structure 60', which is similar to the bank structure 60 except that a fewer number of the strips of Figs. 10 and 11 are employed where only ten selections are to be made by the individual switch to which the bank is applied. Accordingly, in Fig. 18, each of the ten stackups has only three contact pairs, for making only a single three-wire connection. In Fig. 18, the three inlet conductors 151 are attached directly to the common bank terminals 113, no eleventh stackup 61 being required.

When conductors 151 are to be connected with any one of the ten sets of outlet conductors, shown in Fig. 18 as extending upwardly from the fixed contacts in the several stackups of bank 60', it suffices to close the three contact pairs of the concerned stackup. The bank multiple indicated in Fig. 18 is for the purpose noted above in connection with the bank multiple shown in Fig. 17.

It will be understood of course that the bank construction herein disclosed is applicable to any number of contact pairs in the individual stackups.

When the ten-selection arrangement of Fig. 18 is employed, the tapped holes 80 of Fig. 5 are obviously unused, for no stackup 61 is required. Additionally, finger 88 may be omitted from each individual switch, and shaft S11 (used only to control the eleventh or switching stackups 61) may be omitted from the concerned group of switches.

OPERATION

Operation of the disclosed switching arrangement will now be described.

(a) Stackup selection

When any selective stackup of an individual switch is to be operated, such stackup must first be selected by a rotation of the concerned selecting shaft in the concerned direction. Selection of the first stackup of all unoperated individual switches of the group occurs responsive to an energization of select magnet M1 (Figs. 1 and 2). Left wing 51 of the associated armature 49 is thereby attracted into engagement with magnet M1 whereby the first shaft S1—2 is rotated in a clockwise direction. Thereupon, web 44 of the shaft S1—2 acts through arms 90 to rotate its associated fingers 87 counterclockwise about their pivots 91 (Figs. 5 and 16) until their respective associated finger stops 86 are engaged. The selecting shaft is preferably arranged to rotate through a slightly larger angle than the fingers, to insure that all fingers rotate a sufficient amount. This excess shaft rotation is permitted by virtue of the inherent flexibility of the disclosed finger construction. The concerned arm 90 of each finger merely yields as soon as the finger engages its stop 86.

With the fingers associated with stackups 1 and 2 of all unoperated individual switches of the group rotated counterclockwise into engagement with their respective stops 86, as above outlined, the first stackup of bank 60 is selected in each unoperated individual switch of the group.

If any individual switch of the group is in operated condition when the selective action just described occurs, the raised condition of the actuating plate 69 of such switch causes the concerned (first) finger 87 of such switch to strike the side of the concerned depending actuating finger 128 (see Fig. 16 for example) before the finger stop 86 of such finger is engaged. This action results merely in a slight additional flexing of the concerned arm 90 of such finger.

The above-described selective counterclockwise rotation of shaft S1—2 is accompanied by a forward rotational movement of arm 53 attached to the right wing 52 of the armature 49 of such shaft. The rear defining wall of the notch 54 of such arm 53 thereupon acts to move the associated roller 38 to the right, along with the associated roller arm 29. Roller 38 revolves about its bearing pin 39, and arm 35 pivots counterclockwise about pin 22, for this purpose. This action is performed against the tension of restoring spring 29.

When the shaft movement is nearly completed, shaft off-normal springs 30 are brought into engagement by tab 36 carried by roller arm 35.

(b) Switch operation

Following the above described selecting action, and while the concerned magnet M1 is maintained energized, the operating magnet 142 of any desired unoperated one of the individual switches is energized. The depending portion 68 (see Fig. 9) of such armature 67 is thereupon attracted rearwardly into engagement with the protruding end portion of core 143, rotating the armature structure about the knife-edge mounting arrangement hereinbefore described. This action rotates and raises actuating plate 69, together with all its fingers 87. Slots 85 in such actuating plate 69 pass around the depending actuating tabs 128 of all selective stackups of the concerned bank 60 without affecting such stackups, except in the case of the selected first stackup, where the slot 85 is bridged by the left side of the first finger 87, which has been placed below its actuating tab 128. The actuating tab 128 in the first stackup of this switch is raised by the now bridging portion of the left side of the first finger 87, thereby raising the forward end of its actuating blade 127, causing the overlying column of bushings 119 (see Fig. 9) of this stackup to be raised, carrying with it the intermediate portion of all movable contact blades 118 of the stackup.

When the armature stroke is only partially completed, the contacts carried on the forward end of the six flexible contact blades 118 of the stackup encounter those depending from the forward end of the respective associated fixed contact blades 101. The further movement of the armature causes flexing of the individual contact arms 120 (Fig. 11) of blades 118, keeping in mind that contact blades 101 are constructed of relatively heavy rigid material, while contact blades 118 are made from relatively thin flexible material.

The lower contact pair 134 in off-normal stackup 62 (see Fig. 6) is closed responsive to the armature movement irrespective of which stackup in bank 60 is selected and operated.

Operating magnet 142 of the individual switch is maintained energized for so long a time as the connection established by the individual switch is to remain intact.

(c) Shaft restoration

The energized selecting magnet (M1 in the assumed example) may be deenergized immediately following the operation of the individual switch. When this occurs, the associated restoring spring 29 acts to restore roller arm 35 and roller 38 to normal position, along with armature 49 and the shaft S1—2 to which it is attached. Roller 38 acts reversely in its roller notch 54 for this purpose. The normal position is reached when roller 38 strikes its lowest point in notch 54. The concerned contact springs 30 are now again in their separated condition illustrated in Fig. 3.

When the selecting shaft is returned to normal position, the finger 87 through which the selected stackup in the concerned individual switch was operated is held in selecting position by the downward pressure exerted by the flexible blades in the actuated stackup. The holding of the finger is assisted by the previously mentioned bias cut of the lower face of tabs 128 as illustrated in Fig. 16. The concerned (left) arm 90 of the first finger of the operated switch flexes to the left as the selecting shaft S1—2 returns to normal position.

(d) Switch restoration

When the operating magnet 142 (of the switch operated as previously described) is subsequently deenergized, the armature thereof rotates back to it normal position by virtue of the weight of the actuating plate 69 thereof, assisted by the downwardly exerted spring tension in off-normal stackup 62 and in the operated selective stackup (stackup 1 in bank 60 in the assumed example).

When the descending actuating plate 69 lowers the first selecting finger 87 of the switch out of engagement with the depending actuating tab 128 of the previously actuated first stackup, such selecting finger is thereupon released, whereupon the spring action exerted through its two arms 90 causes the finger to realign itself with web portion 44 of the associated shaft S1—2, to the position shown in Figs. 4 and 16.

Selecting other stackups

From the foregoing description it is clear how other stackups of the same switch, or any other switch of the group, may be accomplished. For example, if stackup 2 in bank 60 of any idle (unoperated) switch of the group is to be operated, the same shaft (S1—2) is rotated in the opposite direction responsive to an energization of selecting magnet M2, causing the fingers 87 controlled by such shaft to be rotated in a clockwise direction, to bring the right side of such selecting fingers beneath the actuating tab 128 of stackup 2 of each idle switch in the group. Then, when the operating magnet 142 of a desired idle switch is energized, stackup 2 of such switch is operated in place of stackup 1. At this point, it may be noted that roller 38 and roller arm 39 associated with shaft S1—2 act as previously described except that the front defining wall of notch 54 in arm 53 operates at this time to move the roller and roller arm, as the shaft moves in its counterclockwise selecting direction.

In a similar manner, the remaining stackups of the switches may be selected for operation—the second and third stackups by rotation of shafts S3—4, the third and fourth stackups by shaft S5—6, and so forth.

Selecting stackup 61

It will be understood that the stackup selection and switch operation such as considered in the immediately foregoing discussion (with the eleventh stackup 61 of the concerned switch not being affected) makes effective connection only through the upper three contact pairs of the concerned stackups 1 to 10, as hereinbefore described in connection with Fig. 17.

When the lower three contact pairs of any one of the ten stackups in bank 60 of any switch is to be rendered effective for purposes discussed in connection with Fig. 17, the previously described selection of the concerned one of stackups 1 to 10 is accompanied by selection of the eleventh or switching stackup 61. This selection is accomplished by energizing the eleventh selecting magnet M11. Wing 52 (the only wing) of armature 49 of shaft S11 is thereby attracted rearwardly, causing shaft S11 to be rotated in a clockwise direction to thereby rotate the associated fingers 88 (Figs. 4 and 5) in a counter-clockwise direction about their pivots. The offset left-side portion of each such finger 88 is thereupon brought effectively beneath the depending actuating tab 149 (Fig. 7) of stackup 61 of each idle switch in the group. As a result, when the operating magnet of a desired idle switch is then energized, stackup 61 of such switch is operated along with the selected one of stackups 1 to 10 in bank 60 of such switch. The operation of stackup 61 renders effective the lower three contact pairs of the operated one of stackups 1 to 10, as previously described in connection with Fig. 17.

By the herein described provision of a sixth shaft S11 for a group of switches, and the provision of the eleventh (or switching) stackup 61 for each switch of the group, the number of selections which can be made by the switch is doubled. In the illustrated embodiment, the number of selections is increased from ten to twenty.

Although it is considered preferable that the disclosed switching devices be mounted in superposed relationship as shown and described, it will be understood that a group of switches may be mounted in any desired other position. For clarity and convenience, the following claims generally refer to the parts enumerated therein by expressions such as vertical, horizontal, front, rear, and so forth. It will be understood, of course, that such expressions are merely relative and are not to be construed as limiting.

A portion of the novel subject matter disclosed herein is claimed in my divisional application for Selecting and actuating mechanism for a crossbar switch, Serial No. 88,274, filed April 19, 1949.

I claim:

1. In combination, stackups of contact blades arranged side by side, a common actuating member underlying said stackups, stackup-selecting means operable to preselect any said stackup for operation, means for subsequently moving the actuating member toward all said stackups, means responsive to such movement for actuating any preselected one of said stackups, and conductors so interlinking said stackups that actuation of any one of a plurality of said stackups completes one corresponding connection or another, depending upon whether one of said stackups not included in said plurality is actuated or not.

2. In combination, groups of contact members, means operable to preselect any one of said groups, an actuating member common to all said groups and movable to actuate any preselected group, and conductors so interlinking said groups that actuation of any one of a plurality of said groups completes one corresponding connection or another, depending upon whether one of said groups not included in said plurality is actuated or not.

3. In combination, a plurality of connecting groups of contact members, each such group being divided into two subgroups, a switching group of contact members, means operable to preselect any connecting group alone, and to preselect any connecting group along with the switching group, an actuating member common to all said groups and movable to actuate any preselected one, and conductors so interlinking the connecting groups with the switching group that actuation of any connecting group completes an effective connection through one subgroup or the other subgroup thereof, depending upon whether the switching group is actuated or not.

4. In combination, a group of switches, each switch having groups of contacts individual thereto, said contact groups being arranged in pairs, group-selecting shafts common to all said switches and equal in number to the said pairs of contact groups of a switch, each such shaft being associated with corresponding pairs of contact groups in all said switches, each such shaft having an inactive normal position, and being movable therefrom alternatively in two directions to preselect the two contact groups respectively of the associated pair in any switch, each said contact group including two subgroups of contacts, a subgroup-selecting shaft common to all said switches and having an inactive normal position from which it is movable to an active selective position, such positions corresponding respectively to the two subgroups in any contact group, each switch having an actuating member operable to actuate any currently preselected contact group thereof, and means dependent upon which of its said positions is currently occupied by the common subgroup-selecting shaft, when the actuating member of any switch is operated, for rendering the corresponding subgroup of the actuated contact group effective to the exclusion of the other subgroup thereof.

5. In combination, a group of switches, each switch being operable to any one of a plurality of circuit-closing positions, each such switch preparing two circuit connections when so operated, each switch including a switching group of contact elements having alternative positions, and operable to complete one prepared circuit or the other according to which of its alternative positions it assumes, and means including a movable selecting shaft common to and selectively associated with all said switching groups for causing the switching group of any operated switch to assume either desired one of its alternative positions.

6. In combination, a switch including a mounting frame, a contact bank built up of superposed horizontal strips to provide columns of contact members through which desired connections may be made upon operation of the switch, said bank including upper and lower clamp strips, aligned openings being provided through all said strips, clamp members passing through certain of such openings and effective to exert inward pressure on the clamp strips to hold the several strips together as a preassembled contact bank, and mounting members passing through the remaining openings to secure the preassembled bank to the frame in operative relation to the remaining components of the switch.

7. In combination, a switch including a mounting frame, a contact bank built up of superposed horizontal strips to provide columns of contact members through which desired connections may be made upon operation of the switch, said bank including upper and lower clamp strips, aligned openings being provided through the strips, clamp screws passing down through certain of such openings and threadedly entering nuts lying below the lower clamp strip to exert inward pressure on the clamp strips to hold the several parts together as a preassembled contact bank, said frame having openings aligned respectively with said openings in the bank, the frame openings aligned with the clamp nuts being enlarged sufficiently to receive the clamp nuts of the bank, the remaining frame openings being tapped to receive bank-mounting screws, and mounting screws passing down through the remaining openings and threadedly entering said tapped openings in the frame to secure the preassembled bank to the frame in operative relation to the remaining components of the switch.

8. A switch bank including contact blades arranged in similar stackups lying side by side, each stackup including rigid contact blades interspersed with flexible contact blades, each rigid blade being comparatively thick to enhance its rigidity, each flexible blade being comparatively thin to enhance its flexibility, a body portion extending continuously across the rear of said stackups and serving to hold the blades in assembled position, comparatively thin lateral conducting strips in said body portion providing common connections for the respectively corresponding flexible blades in all stackups, each such strip being formed integrally with the flexible blades to which it is common, individual terminals for the rigid blades extending to the rear of the body portion, each such terminal being an integrally formed portion extending rearwardly from the concerned rigid blade, and comparatively thick terminal strips connected to said conducting strips, respectively, said terminal strips being held in assembled position by said body portion and extending laterally therefrom.

9. In a switch bank wherein a body portion holds in assembled position contact blades arranged in stackups lying side by side, and wherein the body portion is built up of strips including strips of insulated contact blades, all such strips being held together in aligned assembled position by retaining members passing therethrough, one such strip being a composite strip including an insulating strip and a conducting strip, said conducting strip having a contact blade for each stackup formed integrally therewith, said insulating strip having openings for receiving said retaining members, said conducting strip having respectively corresponding enlarged openings, said retaining members securing the last-named strips together in aligned superposed relationship as a composite subassembly strip.

10. In a switch bank wherein a body portion holds in assembled position contact blades arranged in stackups lying side by side, and wherein the body portion is built up of strips including strips of insulated contact blades held together in aligned assembled position by retaining members passing therethrough, one such strip being a composite strip including an insulating strip and a conducting strip, said conducting strip having a forwardly extending contact blade for each stackup formed integrally therewith, a rearwardly extending terminal blade secured to said conducting strip, said insulating strip having openings for receiving said retaining members, said conducting strip having respectively corresponding enlarged openings, said retaining members securing said strips together in aligned superposed relationship as a composite subassembly strip.

11. In combination, a mounting plate comprising side arms interconnected by a rear bridge arm, contact stackups mounted side by side on said bridge arm and extending above the open space between said side arms, each side arm having a lug extending forward therefrom, a combined armature and actuating plate having apertures through which it is loosely suspended on said lugs, said combined structure including an intermediately located generally horizontal actuating plate lying in said open space between said side arms, generally vertical end portions containing said apertures, and bent neck portions connecting said end portions respectively with said actuating plate, one of said end portions being extended downwardly to serve as an armature, an electromagnet mounted below the frame and arranged to operatively attract the armature rearwardly to rotate the actuating plate into operative association with said stackups, and means flexibly retaining said combined structure from sliding forward off said lugs.

12. In combination, a mounting plate comprising side arms interconnected by a rear bridge arm, contact stackups mounted side by side on said bridge arm and extending above the open space between said side arms, a combined armature and actuating plate including an intermediately located generally horizontal actuating plate lying in said open space between said side arms, generally vertical end portions at the front end of said side arms, and bent neck portions connecting said end portions respectively with said actuating plate, means pivotally retaining said end portions on said side arms, one of said end portions being extended downwardly to serve as an armature, and an electromagnet mounted below the frame and arranged to operatively attract the armature rearwardly to rotate the actuating plate into operative association with said stackups.

13. A switching device adapted to be mounted on the forward face of a pair of upright mounting rails, said device including a horizontal mounting plate of such a width that it overlaps both rails in mounted position of the device, integrally formed mounting feet turned over at the rear of the plate, forwardly extending stackups of contact blades mounted side by side on the plate at the rear thereof, a forwardly extending electromagnet mounted below the plate on a tab depending from the rear thereof, an armature for the electromagnet pivoted on the front of the plate to actuate the stackups, said armature being of such a width that it overlaps said rails, armature-retaining means located in overlapping relation with said rails, and terminals for the electromagnet and stackups extending rearwardly between the rails in mounted position of the device.

14. A composite selecting shaft for a row of shaft-controlled switches aligned with a shaft-controlling electro-magnet, said shaft comprising a principal section having an end section fixed and aligned therewith, the principal section comprising a hollow tube having an integral side vane extending the full length thereof and forming the selective portion of the shaft, the inner end portion of said end section lying within the hollow principal section to hold the sections together, the ends of the composite shaft being so formed as to cooperate with fixed bearings limiting endwise movement of the shaft while permitting rotation thereof; in the mounted position of the shaft, said end section extending across, and lying close to, the plane defined by the face of said electromagnet, the said principal section stopping short of said electromagnet, the side vane extending laterally through said plane, and an armature fixed to said end section and extending laterally across the face of said electromagnet.

15. In combination, a selecting shaft adapted to be journalled for rotation between a pair of mounting plates, a control arm fixed with said shaft adjacent to one end thereof, said arm extending laterally sufficiently to clear the edge of the adjacent plate, then extending axially to a point beyond the plate, and finally extending laterally to a location opposed to a section of such plate, and restoring means adapted to act upon said arm at said location to restore the shaft to normal position following a limited rotational movement therefrom.

16. In combination, a group of selective switches mounted in superposed relationship, a bracket mounted at each end of the group, a selecting shaft extending across the group and journalled in said brackets for rotation, said shaft having an armature fixed therewith near one end thereof between the brackets, an electromagnet mounted on the associated bracket for rotating the shaft a limited amount, said shaft having an offset side arm fixed therewith near one end thereof between the brackets and extending vertically to a point beyond the associated bracket, such arm then extending horizontally to a location vertically aligned with a section of such bracket, and means at said location cooperating with said side arm to return the shaft to normal position following rotation.

17. In combination, a group of selective switches mounted in superposed relationship, a bracket mounted at each end of the group, each bracket having a row of bearings along the front edge thereof, selecting shafts extending across the group between said brackets and journalled

in said bearings for rotation, each shaft having an armature fixed therewith near one end thereof between the brackets, electromagnets mounted in association with said armatures for rotating the respective shafts a limited amount, each shaft having an offset side arm fixed therewith near one end thereof between the brackets and extending along the axis of the shaft in front of the associated bracket to a point beyond such bracket, each such arm then extending horizontally to a location vertically aligned with said row of bearings in such bracket, and means at said location cooperating with said side arm to return the shaft to normal position following rotation.

18. In combination, a shaft journalled for rotation, an armature fixed therewith, an electromagnet having one pole associated with said armature to rotate said shaft, and structure providing a magnetic return path from said armature to the other pole of said magnet including a portion of the shaft and an annular gap surrounding the shaft and defined by a portion of said structure and the surrounded portion of the shaft.

19. In combination, a selective shaft journalled between a pair of brackets for rotation, an armature fixed therewith, an electromagnet having one pole associated with said armature to rotate said shaft, structure providing a magnetic return path from said armature to the other pole of said magnet including a portion of the shaft and an annular gap surrounding the shaft and defined by a portion of said structure and the surrounded portion of the shaft, and a cup member fixed with one bracket and freely receiving one end of the shaft, the bottom of said member containing one bearing for the shaft, the side walls of said cup being said portion of the structure which cooperates with the surrounded portion of the shaft to define said air gap.

20. In combination, a shaft journalled for rotation between a normal position and an operated position, a first cam member mounted for movement generally radially of said shaft, a second cam member fixed with said shaft in cooperative relationship with the first, spring means normally urging the first cam into engagement with the second to maintain the shaft in normal position and to return it to normal position following rotation to operated position, and means for adjusting the first cam tangentially of the shaft to change said normal position.

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