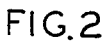


Filed May 29, 1958

DISTRIBUTION SWITCHBOARD

3 Sheets-Sheet 1



By *Brunniga and Sutherland*
ATTORNEYS.

Aug. 22, 1961

P. W. ELLEGOOD

2,997,627

DISTRIBUTION SWITCHBOARD

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FIG.3

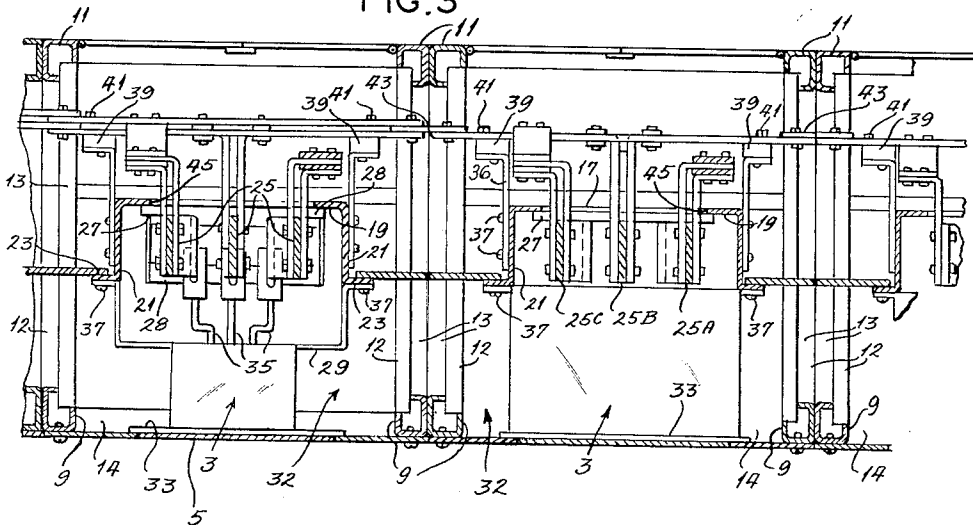
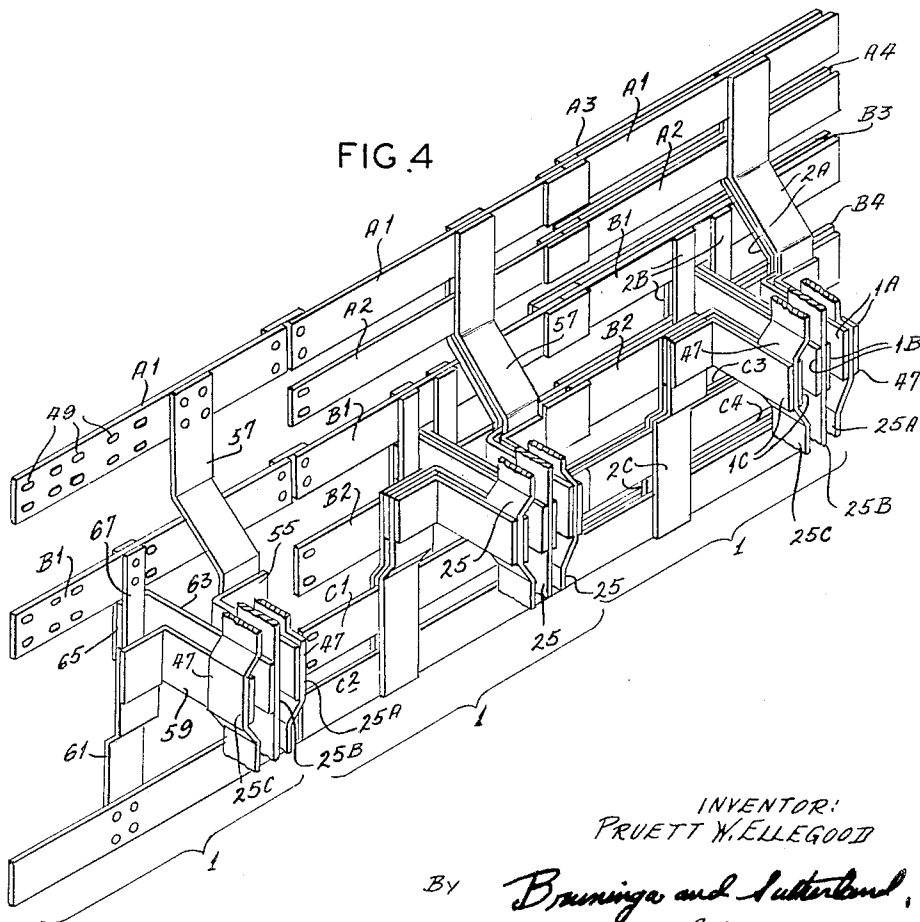


FIG. 4



Aug. 22, 1961

P. W. ELLEGOOD

2,997,627

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FIG. 5

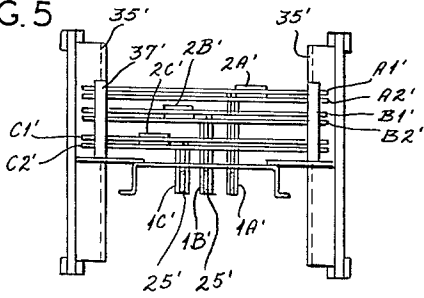


FIG. 6

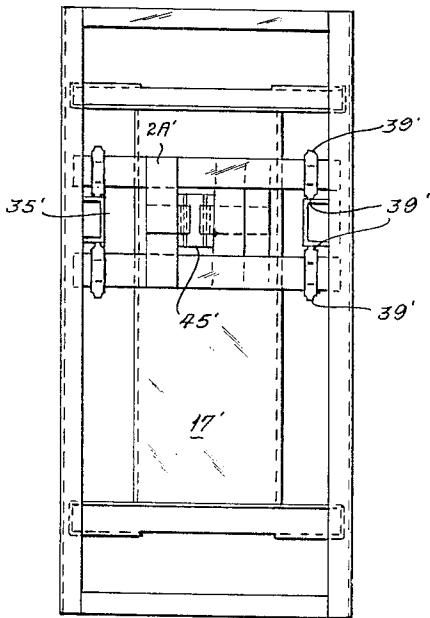


FIG. 7

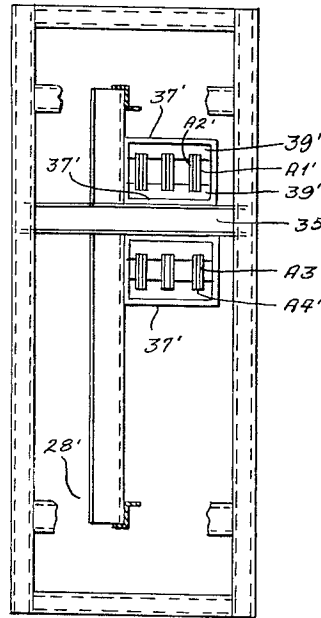


FIG. 8

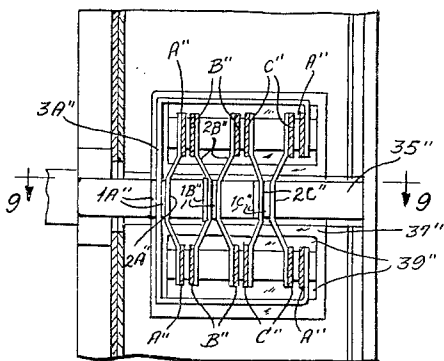
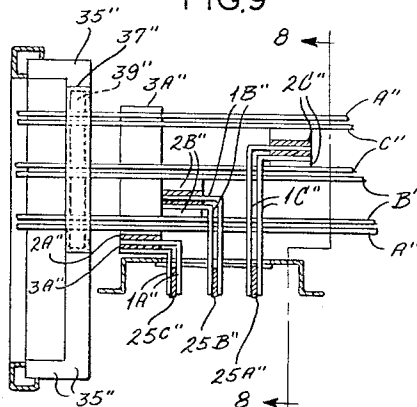


FIG. 9



INVENTOR:
PRUETT W. ELLEGOOD

By *Bruning and Sutherland*
ATTORNEYS.

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2,997,627

DISTRIBUTION SWITCHBOARD

Pruett W. Ellegood, St. Louis, Mo., assignor to Frank Adam Electric Company, St. Louis, Mo., a corporation of Missouri

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11 Claims. (Cl. 317—99)

This invention relates to switchboards, and more particularly to switchboards made up from interconnected sections assembled in adjoining relationship.

It will be understood that a switchboard is usually arranged to stand on a floor and afford access to both the switching device at the front and the main busses at the back. In a multiple-section switchboard, each section has a series of switching devices disposed vertically one above the other, and the several sections are assembled side by side, this arrangement being desirable since it permits the sections to be built and shipped separately and then assembled at the point of use. The input cables enter the switchboard at the back and the power is distributed to the switching units through main bus bars also disposed in the back.

Heretofore, the practice in making multiple-section switchboards has generally been one of custom design and manufacture, i.e., a workman would cut, bend, punch and build up the assembly of main bus bars in accordance with his own tastes, after assembling the desired switching units at the front of the section. With this custom-built approach, drawings were seldom made, and if a customer desired to add a section to his existing installation, there was no way of knowing, short of inspecting the particular job, how to arrange the bus bars of the new section so that they can be readily connected with the old system. Also, the lack of standardization often resulted in excessively high labor costs (perhaps through a misguided desire to save copper) or excessive use of copper. In fact, it is not uncommon to find a very elaborate and extensive maze of bus bars in the back of a switchboard. The tendency is for the bars which are installed first to be short and conveniently manufactured, whereas the subsequently added bars (as the job proceeds) become increasingly complex and more difficult to fit into the system while maintaining adequate air gaps therebetween.

Accordingly, one of the objects of the present invention is to provide a neat standardized switchboard section, which may be manufactured utilizing assembly-line techniques and which may be readily assembled with similar sections, thereby minimizing the amount of copper required for the bus bars, simplifying the assembly operation and facilitating subsequent expansion.

Although other features of the invention will be in part apparent in the detailed description, briefly, each section comprises an open frame including corner posts connected together with top and bottom bracing members at the sides, front and back. An elongate panelback is secured within the frame of the section in spaced relationship from both the front and back, the panelback serving as the support for a column of switching units at the front and as the support for a set of bus bars extending vertically in the center of the section and to which the switching units are connected.

Preferably, the panelback is in the form of a vertical trough, the bus bars being mounted on edge adjacent the back of the trough and the sides thereof forming means for attaching the switching units. The invention contemplates that most of the switching units will have plug-on stab connections with the vertical bars, above or below center portions of the bars. The central parts of the outer vertical bars are than stepped outwardly, in order to accommodate certain bus connecting bars, which pro-

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ject rearwardly from the vertical bars for connection to a set of horizontal bus bars disposed behind the panelback.

The front faces of the switching units may, in part, define the front of the switchboard section, there further being gutter spaces between the sides of the frame and sides of the switching units for branch circuit or feeder distribution cables. Gutter cover strips are removably secured to front corner posts to cover the gutter spaces.

Where the panelback is a trough, a center opening is cut in its back wall for the bus connecting bars, and the panelback may be narrower than the frame to permit front removal. Also, there may be barriers projecting from the sides of the panelback, thereby to isolate the front gutter spaces and branch circuit conductors from the main input busses at the back of the switchboard.

Each section of the switchboard carries its own set of main horizontal bus bars, which are of a length approximately equal to the width of the frame and which are supported on insulators from either the panelback or frame. These horizontal bars may be arranged in different ways, depending upon the particular desires. For example, there may be from one to four (or more) separate bars for each phase, the number and size of the horizontal bars for each phase being determined by the capacity requirements for the associated section and following sections of the switchboard. In one arrangement, the three phases are spaced vertically from one another in substantially the same common plane. Another system involves spacing the several phases horizontally from one another. The bus-connecting bars may vary also, although the preferred arrangement contemplates two separate connecting bars for each vertical bar, each connecting bar thereby providing capacity for one-half of a vertical bar, as will be more apparent.

It will be understood that several such sections are readily assembled side by side and the horizontal bars thereof conveniently connected together by short overlapping pieces of copper. The invention contemplates, however, that each of the horizontal bars may be prepunched with a number of apertures, not only at their ends but also in the center, so as to permit connection with input cables and facilitate assembly of the bus-connecting members.

Other features of the invention will be in part apparent from and in part pointed out in the following detailed description, taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view illustrating the front of a switchboard having a main service disconnect switch at one end and three adjoining sections of distribution switching devices;

FIG. 2 is a perspective view of the back of this switchboard, parts being omitted for purposes of illustration;

FIG. 3 is a relatively enlarged section taken horizontally through the distribution sections of the switchboard;

FIG. 4 is a diagrammatic perspective of the main or horizontal bus system, as if viewed from the front of the switchboard, the vertical bus bars being broken away for purposes of clarity;

FIG. 5 is a horizontal cross section taken through a switchboard section, but illustrating an alternative embodiment of the invention;

FIG. 6 is a rear elevation of the switchboard shown in FIG. 5;

FIG. 7 is a side elevation of the switchboard shown in FIG. 6;

FIG. 8 is a vertical section taken generally on the line 8—8 of FIG. 9 and showing another embodiment of the invention; and

FIG. 9 is a horizontal cross section taken on the line 9—9 of FIG. 8.

Referring to the drawings, FIG. 1 illustrates a switchboard having a main service disconnect section (which might contain a large-capacity switch S or circuit breaker, main feeder, metering transformer, etc.) and three adjoining sections or bays containing feeder-distribution switching devices, the feeder sections being designated 1. Each section 1 contains a vertical row of switching units 3, which may be of the same or varied size and capacity, the size normally increasing with the capacity. For example, the switching units at the bottom of the sections are of relatively high capacity in comparison with those at the top. The vertical row of units is interrupted, however, by a center cover plate 5, whose purpose will be more apparent. Also, space cover panels 7 may be provided where there is no switching unit, thereby facilitating the addition of switching units upon subsequent expansion of this system. With the arrangement herein disclosed, switching units are readily added by removing the space covers 7.

Each section of the switchboard is made up as a vertical frame from front corner posts 9 and back corner posts 11 extending the full height of the switchboard. The corner posts are connected together by top and bottom side rails 12 and cross rails 14. In addition, there are side rails 13 and transverse bridging rails 15 which support a panelback generally designated 17 (FIG. 3). The panelback extends vertically within the frame and is somewhat smaller so as to provide space in the front, sides and back thereof.

The panelback is adapted for mass production to standardized dimensions and may comprise a depressed trough having a back wall 19 (FIG. 3), side walls 21 and front apertured flanges 23. Bus bars 25A, B and C are secured against insulating layers 27 at the back of the trough to extend longitudinally thereof, the bus bars being mounted on edge for plug-on cooperation with the switching unit and being supported by insulators 28 at the ends thereof.

The switching units (or branch-circuit control devices) 3 are similarly adapted for manufacture by assembly-line techniques to standardized dimensions, and are adapted for attachment to the side flanges 23 of the panelback, as by screw connections. Where a relatively large switching mechanism is required for high capacity, the mechanism itself might extend the full width of the panelback. Switching mechanisms of somewhat smaller size will require a supporting bracket, such as shown at 29 in FIG. 3, the bracket 29 being of a width and depth such as to properly position the mechanism relative to the panelback. In some instances, a pair of even smaller control devices might be mounted side by side on a common supporting bracket, but all of the "switching units" preferably include rearwardly extending stabs 35 for plug-on cooperation with the bus bars 25. Accordingly, "switching units" so manufactured to standardized dimensions are quickly and conveniently assembled on the panelback of the switchboard section.

The branch circuit feeders (not shown) are front connected at the sides of the switching units and extend vertically along the sides of the section, there being sufficient gutter space 32 provided for this purpose. While the front surfaces of the switching units may lie substantially flush with the front of the switchboard, the units with the smaller mechanism should be provided with lateral extensions 33, whose purpose is to bring the side edges of all "units" (regardless of size of the mechanism) out to the same vertical lines. Accordingly, an assembly of switching units presents a front surface of a predetermined standardized width.

The gutter space 32 left between the sides of the switching units and the corner posts is then enclosed with removable gutter-cover strips 31. The latter are removable in order to permit connection of the branch circuit feeders to the switching units, and in this sense, the switchboard is of a front-connected type but the front is fully enclosed. It will be understood that the top and back of each sec-

tion would also be enclosed by suitable panels or doors secured on the framework. Also, the ends of the completed switchboard are closed by side panels, but the sides of adjoining sections are left open.

The space behind the back 19 of the panelback accommodates the main busses A, B, C and N for distributing power to the several sections of the switchboard. The horizontal busses are made up from bus bars of a length but slightly less than the width of a section, each section having its own set of horizontal bars supported on insulators from the panelback or frame. For example, FIG. 3 illustrates supporting brackets 36 secured to the side walls 21 of the panelback by screws 37, so as to project rearwardly therefrom. Insulators 39 are fastened to the angled ends of these brackets and the horizontal bars are then secured on studs 41 embedded in the insulators, there being an insulator at both ends of each vertically spaced horizontal bar. The brackets 36 may be made adjustable within limits, as by enlarged holes for the screws 37, in order to facilitate the fitting together of the sections which make up the switchboard. The frames of adjoining sections are bolted together at the corner posts, and the horizontal bars of adjoining sections are connected together by overlapping bus pieces 43, which may be secured by bolts or other clamping means.

FIG. 2 illustrates an arrangement wherein each phase A, B and C has a pair of bus bars A1, A2, B1, B2, C1 and C2 plus a neutral bus bar N. The several bars are disposed in substantially the same vertical plane, being spaced one above the other. The system of two bars per phase extends through all of the sections which make up the board.

FIG. 3 and FIG. 4 show a somewhat different system of main busses, each phase of one section having four separate bus bars A1-4, B1-4, C1-4 (the neutral bar being omitted). The next section of the switchboard has only two bars per phase (A1-2, B1-2, C1-2), and the final section only one bar per phase (A1, B1, C1). The additional bars A3-4, B3-4, C3-4 are disposed in slightly spaced relationship opposite bars A1-2, B1-2, C1-2, hence are readily accommodated. In fact, such additional bars may be conveniently added to the other sections, should it subsequently prove desirable to expand the capacity of the switchboard, either by adding sections or replacing switching units. The bus arrangement shown in FIG. 4 has the advantage of conserving copper, assuming the input is connected to the section with four bars per phase. It will be understood the vertical bars normally extend the height of the board, but are broken away in FIG. 4 for purposes of clarity. In stepping down or tapering the busses, bus bars A4, B4, C4 are first omitted, bus bars A3, B3, C3 are next dropped and A2, B2, C2 are omitted last. Of course, the bus system may taper in both directions where the input is at a center section.

FIGS. 3 and 4 further illustrate how the vertical bus bars 25A, B, C are connected to the horizontal bus bars through an opening 45 cut in the back wall 19 of the panelback half-way between the ends thereof. It will be noted that the center portions of the outer vertical bus bars 25A and 25C are stepped or bent outwardly at 47, so as to provide a wider separation from the center bar 25B. These bent portions 47 are located behind the center cover panels 5 (FIG. 1) where no switching unit is connected. Rather the load represented by the switching units is divided between the top and bottom halves of the vertical bars, hence with an input to the center thereof, the total load for the vertical bus bars may be twice as great as would be the case if the input to the vertical bars were at an end thereof.

On the other hand, the center feeder or connecting bars or straps must have twice as much carrying capacity, hence two connecting straps 1A, 1B, 1C are used for each of the respective vertical bars 25A, B and C. The connecting straps 1A are disposed on opposite sides of the bar 25A, and the same practice is followed for connecting 1B to 25B; and 1C to 25C.

In the embodiment of FIGS. 3 and 4, the connecting pieces 1A project rearward to a point between the back wall 19 and the horizontal bus bars, whereupon they turn to the side for connection to straps 2A, which angle up for connection to the horizontal bars of phase A, which are uppermost. Straps 1B extend straight back through the space between the bus bars B1 and B2 and then turn to opposite sides, the turned portions then being connected to the horizontal bars of phase B by four narrow straps 2B. Straps 1C are similar to 1A, except the associated straps 2C angle down for connection to the horizontal bars of phase C, which are lowermost. Accordingly, the bus-connecting straps or bars connect with the horizontal busses at points offset longitudinally of the horizontal bars. Although each vertical bar preferably has a pair of connecting straps, a single connecting strap may be sufficient when the load on the particular bay is not excessive.

One of the important advantages of the system disclosed is that it uses standardized parts, thereby achieving substantial economies in labor cost as well as copper cost. A further reduction in labor may be achieved by pre-punching all of the horizontal bus bars to a standard pattern of holes 49, such as shown on one of the bars of FIG. 4. Such a bar pre-punched with a full pattern of holes will fit with all of the bus-connecting straps, and since only a few of the holes will be occupied in connecting the straps to the bar, other holes will be available for attaching input feeder cables and the like.

Referring to FIGS. 5-7, the invention contemplates an alternative arrangement wherein the horizontal bus bars are grouped so that six bars are supported on edge in front-to-back spaced relationship. The bars are supported at the ends thereof on upper and lower insulator bars 39', which are notched to accommodate the edges of the bars. Each pair of insulators is confined within a frame 37' of the channel cross section, the frames, in turn, being secured to rails 35' extending inwardly along the sides of the frame. The rails 35' are secured to the corner posts and extend beneath the upper frames and above the lower frames.

It will be noted in FIGS. 5-7, that the two groups of horizontal bars are spaced above and below a center opening 45' in the panelback 17', thereby to accommodate bus-connecting straps 1A', 1B', 1C'. The latter are L-shaped members, which project rearwardly from the vertical bars 25' between the two groups of horizontal bars and have ends bent to extend coextensively with the proper horizontal bars in the space between the groups, these ends then being connected to the horizontal bars by flat vertical straps 2A', 2B', 2C', which overlap the straps 1A' and bars A1-4', etc. Otherwise, the system is substantially the same as that described in connection with the previous embodiment. If only two horizontal bars per phase are required, the lower group may be omitted. Similarly, a group may consist of only three horizontal bars corresponding to the three phases.

Referring to FIGS. 8-9, there is shown a system identical to that of FIGS. 5-7, but for a different pattern of connections from the vertical bus bars 25'' to the horizontal main busses A'', B'', C''. There are identical upper and lower groups of six horizontal bars, but in each group the pattern is A'', C'', C'', B'', B'', A''. Connections are then made from the vertical bar 25A'' to the four bars A'', etc.

The bus-connecting bars or straps 1B'' extend rearwardly from 25B'' between the two groups to a point between the two horizontal bars B'' of a group, where they are bent to one side and connect with straps 2B''. The latter extend vertically and are bent so as to connect with the opposed faces of the four B'' bus bars. The same arrangement is utilized to connect the vertical bar 25C'' to the horizontal bars C''. The connection between 25A'' includes bent straps 1A'', a vertical strap 2A'' and a C-shaped strap 3A'', the latter connecting the

two outer A'' bars to one another, as shown in FIG. 9.

Among the advantages of the disclosed switchboard may be noted a compact arrangement of the components; thus permitting a large capacity system in relatively close quarters. This is significant in modernizing old switchboard installations, since many old buildings have only limited space set aside for this purpose, whereas present day and future electrical load requirements call for doubling or quadrupling the capacity of many old switchboards.

Although there is a center space which cannot accommodate a switching unit, the height of this space is kept to a minimum by using two narrow bus-connecting straps rather than one wide strap.

The individual sections can be shipped in completed condition, or can be broken down for partial shipment at different times. Partial shipment permits the main frame and enclosure to be shipped early so that it can be fitted in during the heavy construction work. The panelback and more expensive switching units can be shipped later when there is less likelihood of loss or damage. If the main busses are supported from the frame, the panelback is conveniently installed by pushing it in from the front (after removal of the gutter cover strips), the bus-connecting straps on the horizontal busses having a plug-on type of connection with the vertical bars on the panelback. The connecting straps need then only be bolted or otherwise clamped to the vertical bars.

This front installation or removal of the panelback and switching units is also a considerable convenience during the installation and connection of the feeder cables to the switching units. Accordingly, there are savings in space, materials and labor, during initial manufacture, installation and subsequent expansion.

The systems disclosed in FIGS. 5-9 require a deeper enclosure frame, but do not tend to create as much eddy-current heating in the back wall or doors of a section or in the back wall of the panelback. While the detailed disclosure is particularly directed to a system wherein the main busses extend horizontally at the rear of a panelback, it will be apparent they might also be located forwardly of the panelback behind the center cover panels shown at 5 in FIG. 1. Also, a neutral-phase bar or bars may be readily incorporated in any of the several embodiments disclosed, there being space at the front top or bottom or at the rear top or bottom. Moreover, while the illustrated embodiments have only one row of switching units in a section of the switchboard, there may be twin units or even a double row condition (with two sets of vertical bars) in a single frame or section. Numerous other modifications and variations will occur to those skilled in the art, without departing from the spirit of this invention, or the scope thereof, as set forth in the appended claims.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In a switchboard of the character disclosed, the improvement that comprises a plurality of switching units arranged in vertical rows at the front of the switchboard, the rows of switching units being discontinuous to provide spaces in the centers thereof, removable cover panel means mounted at the front of the switchboard opposite said center spaces, separate sets of bus bars extending vertically behind the several rows of switching units, said vertical bus bars lying in planes perpendicular to the front of the switchboard and each row of switching units being separately connected to an adjacent set of vertical bars disposed therebehind, additional bus bars mounted horizontally to define a bus extending substantially the width of the switchboard generally adjacent the center level of the vertical bars, and means separately connecting the several sets of vertical bars to said horizontal bus, said bus-connecting means being connected with the center portions of the vertical bars in the spaces behind said center cover panel means.

2. A switchboard as set forth in claim 1, wherein bus-connecting means is, at least in part, constituted by pairs of bus-bar straps, each of a width approximately equal to the width of the associated vertical bar, each pair of straps being clamped against opposite faces of a vertical bus bar.

3. A switchboard as set forth in claim 2, wherein the vertical bars are in part bowed outwardly at their centers to facilitate connection of said bus-connecting straps thereto.

4. In a switchboard of the character disclosed, the improvement that comprises a plurality of vertically elongate panelbacks mounted in laterally spaced relationship from one another rearwardly of the front of the switchboard, each panelback carrying a set of vertical bus bars disposed to lie in planes perpendicular to the front of the switchboard, a plurality of switching units mounted on the upper and lower portions of each panelback at the front thereof and separately connected to the associated vertical bars, said switching units defining a row which is discontinuous in the center, said discontinuity defining a space opposite the vertical bus bars which space is covered by panel means at the front of the switchboard, additional bus bars mounted horizontally to extend parallel to the front but clear of said panelbacks, said horizontal bars defining a continuous bus to which the several sets of vertical bars are separately connected, and bus-connecting straps extending from the center portions of said vertical bars to said horizontal bars.

5. A switchboard as set forth in claim 4, wherein said panelbacks are trough-like, the vertical bus bars being mounted adjacent the back of the trough and the sides thereof projecting forwardly as means for supporting the switching units.

6. A switchboard as set forth in claim 4, wherein said horizontal bars are mounted behind said panelbacks, the several panelbacks defining a barrier between the horizontal bus and the front switching units.

7. A switchboard as set forth in claim 4, wherein said horizontal bus bars are disposed behind the panelbacks and are supported independently of the panelbacks, said panelbacks being separately removable through the front of the switchboard.

8. A switchboard comprising a plurality of sections and each section comprising a frame having front and back corner posts, an elongate panelback secured vertically within said frame in rearwardly spaced relation from the front thereof, a plurality of switching units secured to the upper and lower portions of said panelback at the sides thereof, a first set of bus bars mounted on said panelback to extend longitudinally thereof, said switching units hav-

ing plug-on electrical connections with the upper and lower portions of said vertical bus bars, a set of bus-connecting straps secured to the center portions of said vertical bars to project horizontally therefrom clear of the panelback, and a second set of bus bars extending horizontally clear of the panelback adjacent said projecting ends of the bus-connecting straps, said horizontal bars of a length equal to the width of the frame, said bus-connecting straps being connected to said horizontal bus bars, and the horizontal bus bars of adjoining sections being connected together at their ends.

9. A switchboard section comprising an outer frame having front and back corner posts, an elongate panelback mounted vertically within said frame in spaced relationship from the front, back and sides thereof, a set of vertical bus bars carried by said panelback so as to lie in planes parallel to the sides of the frame, the sides of the panelback having means for attaching a series of switching units over the upper and lower portions thereof forwardly of said vertical bus bars, a series of horizontal bus bars supported rearwardly of the panelback to lie in planes parallel to the back of the frame, each horizontal bar extending substantially from side to side of the frame forwardly of the back corner posts, and bus-connecting straps extending from the vertical bus bars at points intermediate their ends to said horizontal bus bars.

10. A switchboard section as set forth in claim 9, wherein there are three vertical bus bars disposed side by side, the portions of the two outer vertical bars to which the bus-connecting straps are connected being bowed outwardly.

11. A switchboard as set forth in claim 1, wherein the horizontal bus is formed by a plurality of bus bars connected end-to-end, there being a separate set of horizontal bars for each set of vertical bars, thereby to provide for a readily modified tapering horizontal bus.

References Cited in the file of this patent

UNITED STATES PATENTS

760,077	Muller	May 17, 1904
1,162,553	Bergmann	Nov. 30, 1915
1,955,287	Graves	Apr. 17, 1934
1,958,916	Hammerly	May 15, 1934
2,319,415	Lightfoot	May 18, 1943
2,359,247	Rowe	Sept. 26, 1944
2,363,364	Rugg	Nov. 21, 1944
2,424,345	West	July 22, 1947
2,441,485	Graves	May 11, 1948
2,648,032	Mekelburg	Aug. 4, 1953