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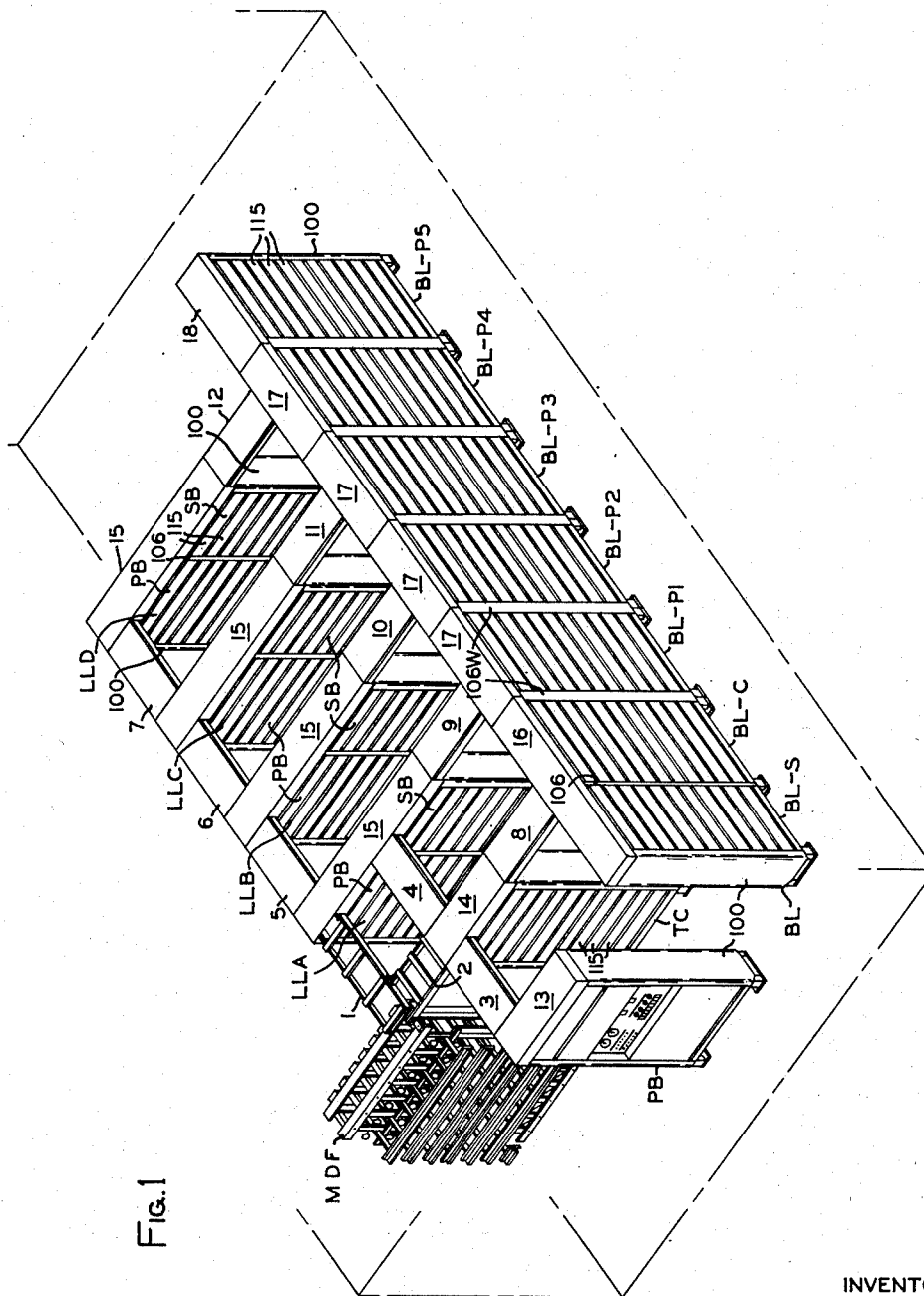
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2,627,554

CROSSBAR SYSTEM SWITCHBOARD CONSTRUCTION

Filed Oct. 25, 1949

11 Sheets-Sheet 1



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11 Sheets-Sheet 2

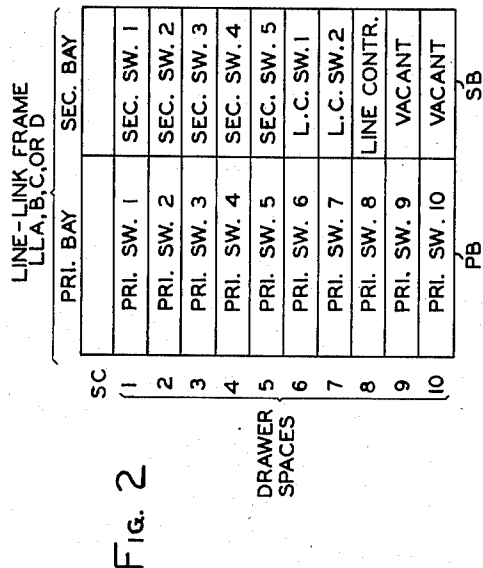
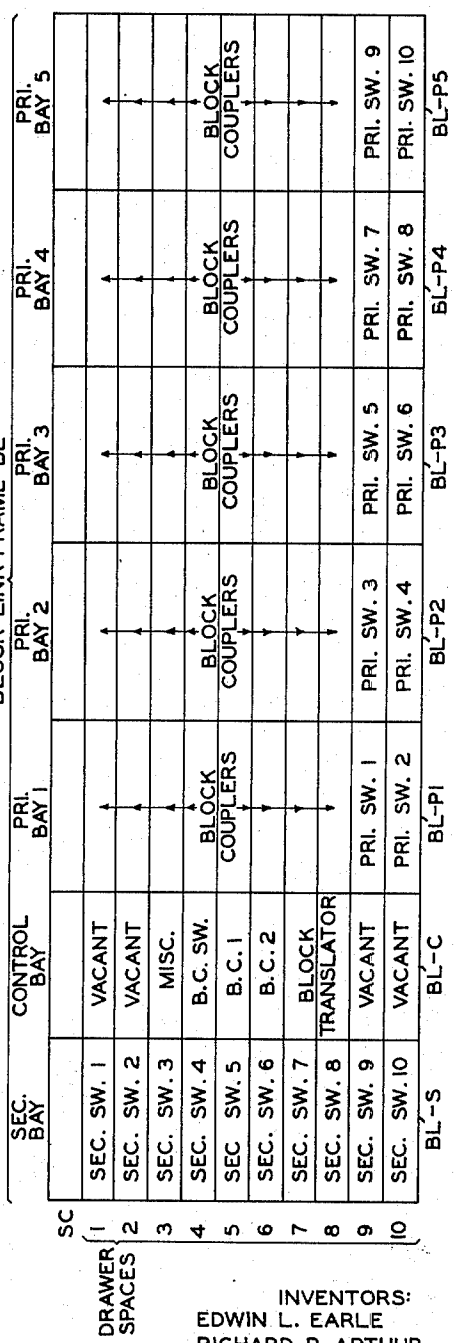


Fig. 2

Fig. 3



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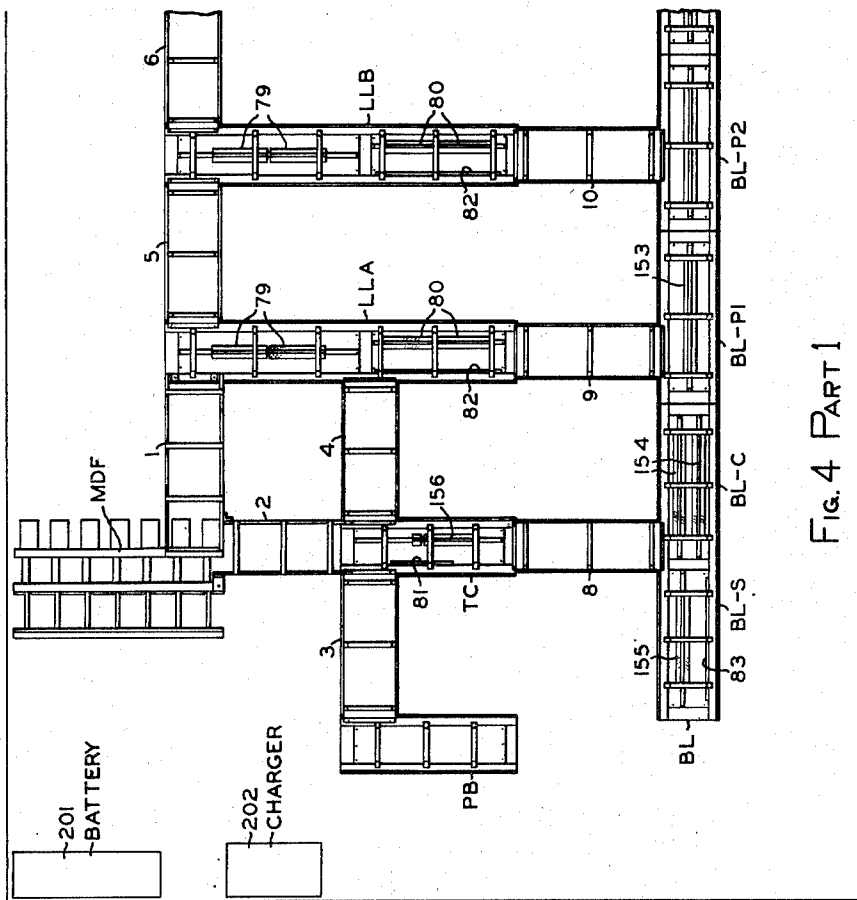
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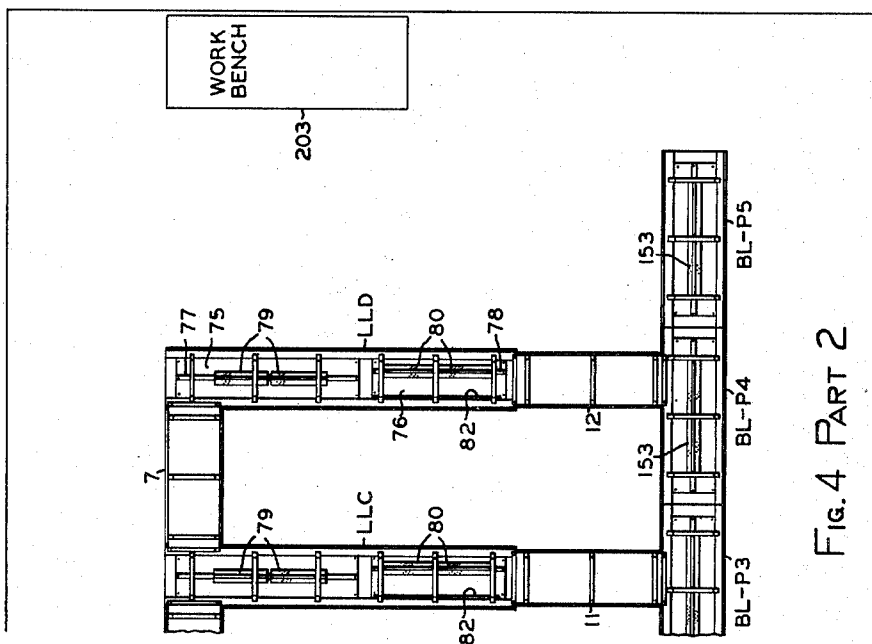


FIG. 4 PART 2

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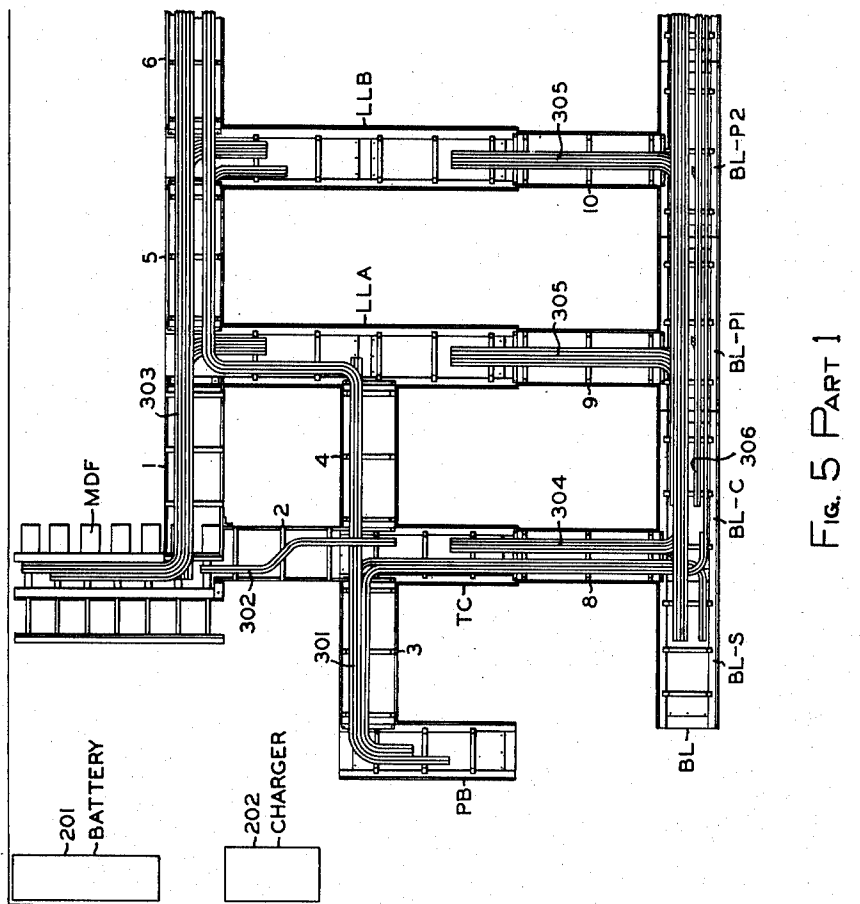
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11 Sheets-Sheet 5



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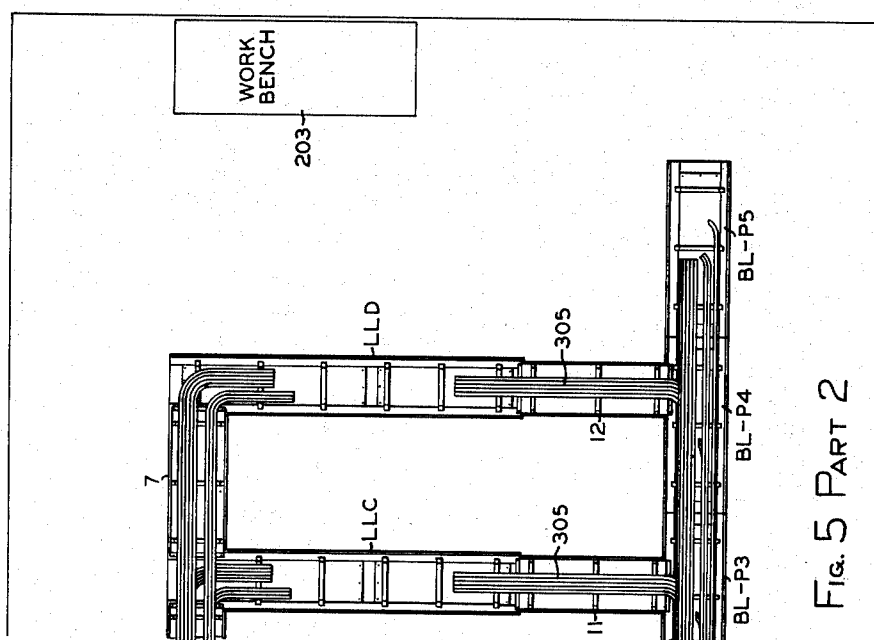
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CROSSBAR SYSTEM SWITCHBOARD CONSTRUCTION

Filed Oct. 25, 1949

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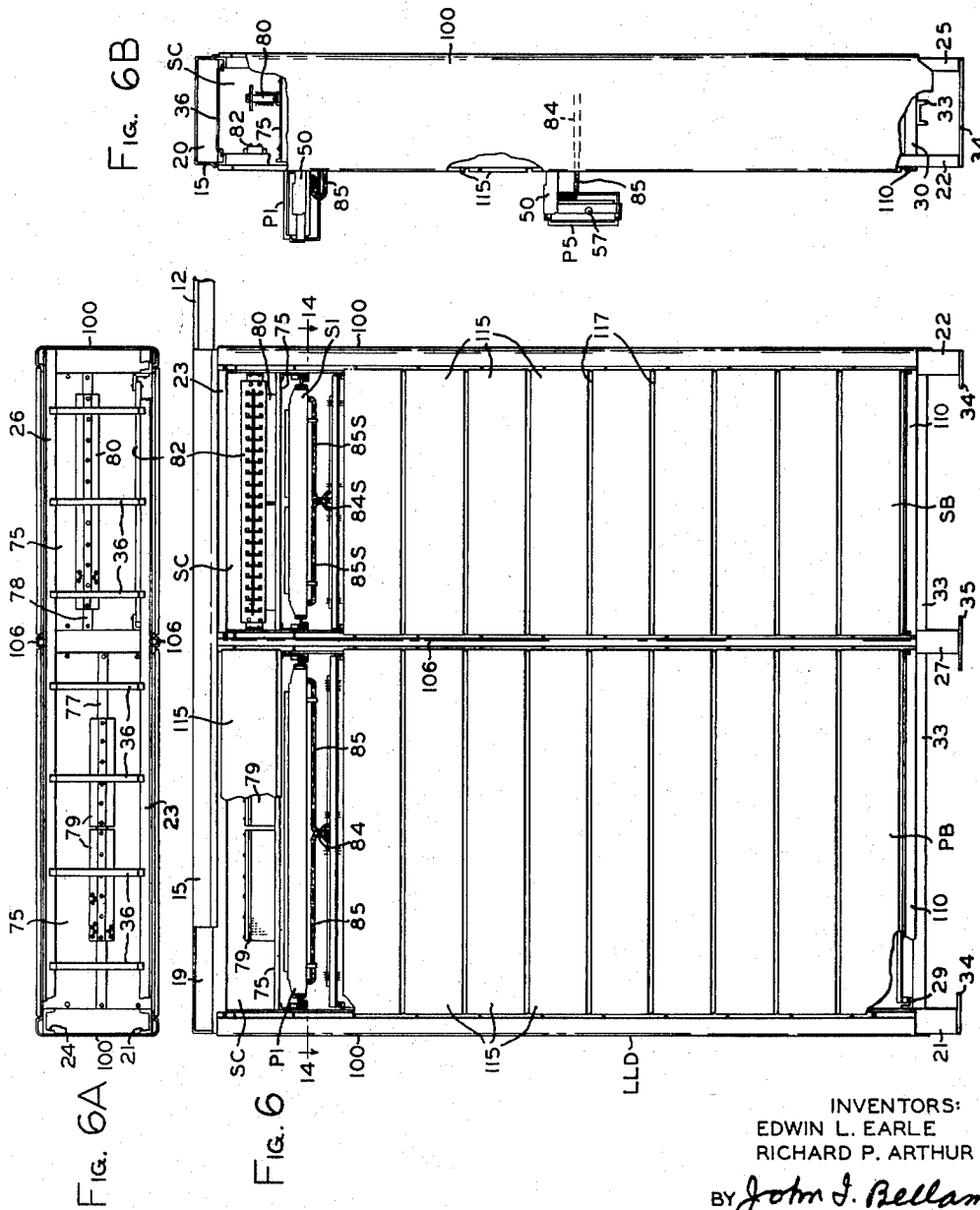
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CROSSBAR SYSTEM SWITCHBOARD CONSTRUCTION

Filed Oct. 25, 1949

11 Sheets-Sheet 7



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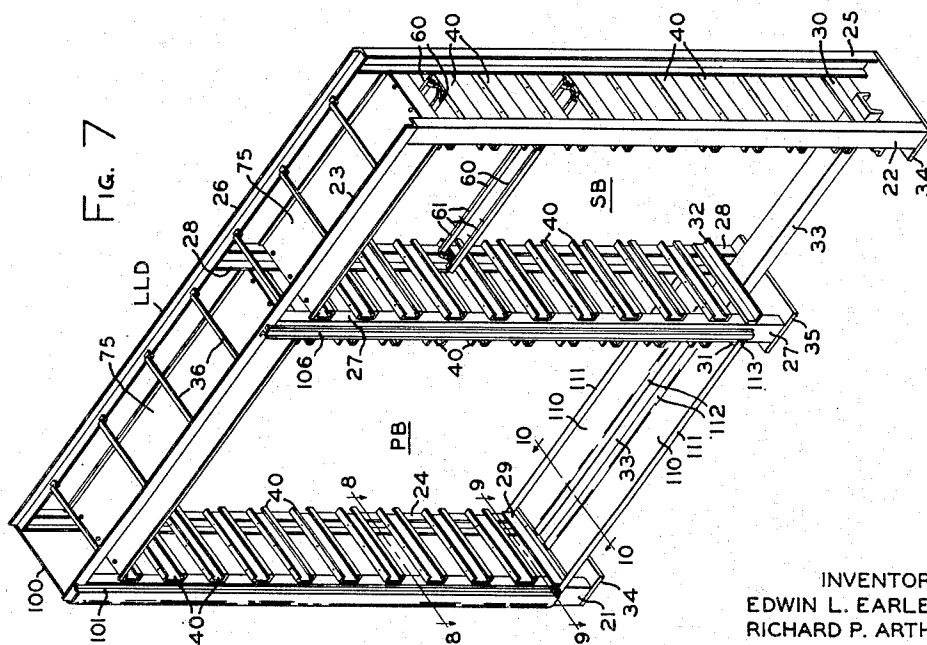
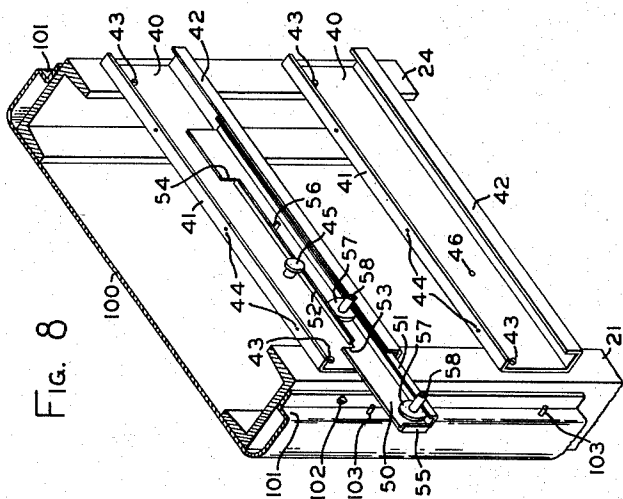
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CROSSBAR SYSTEM SWITCHBOARD CONSTRUCTION

Filed Oct. 25, 1949

11 Sheets-Sheet 8



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CROSSBAR SYSTEM SWITCHBOARD CONSTRUCTION

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FIG. 9

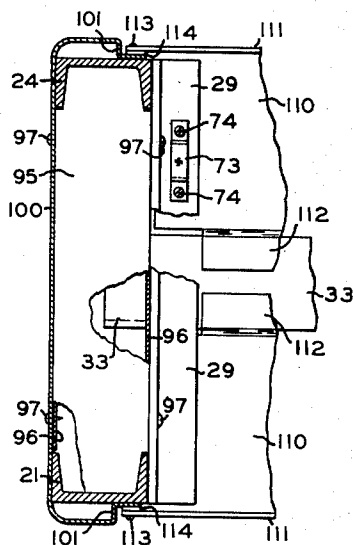


FIG. 10

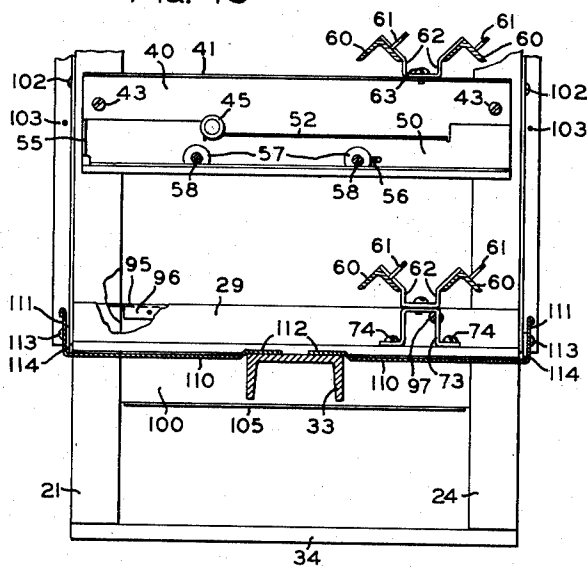


FIG. 11

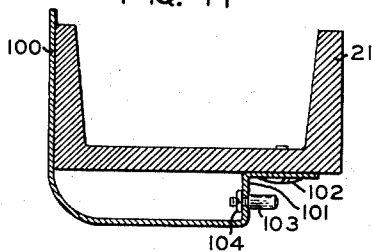
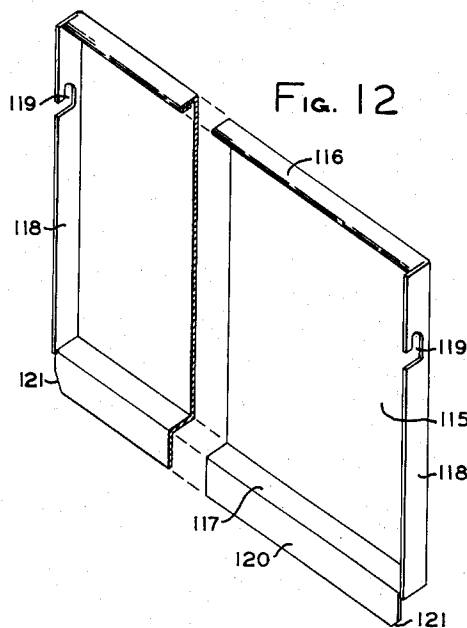


FIG. 12



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CROSSBAR SYSTEM SWITCHBOARD CONSTRUCTION

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FIG. 13

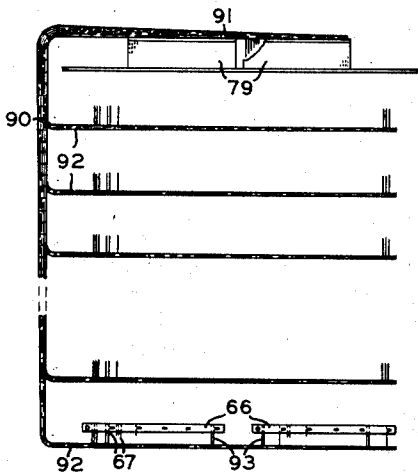


FIG. 14

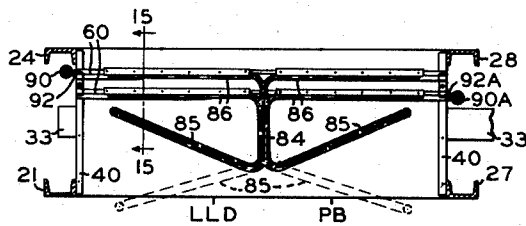


FIG. 15

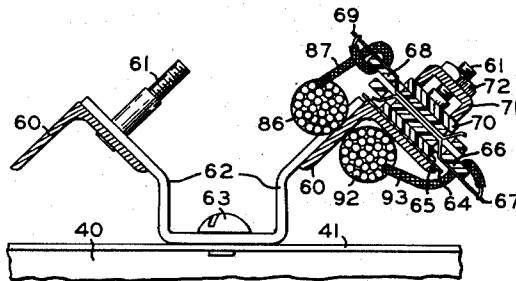


FIG. 16

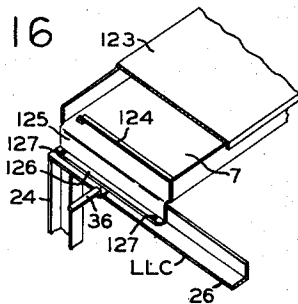
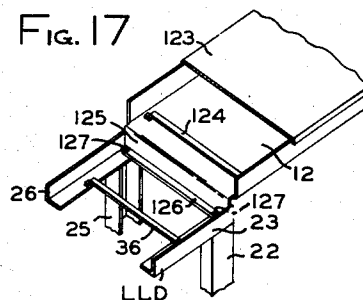


FIG. 17



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2,627,554

CROSSBAR SYSTEM SWITCHBOARD
CONSTRUCTION

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Ill., assignors, by mesne assignments, to Kellogg
Switchboard and Supply Company, a corpora-
tion of Delaware

Application October 25, 1949, Serial No. 123,431

15 Claims. (Cl. 179-98)

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This invention relates to a crossbar-system switchboard construction, but is not necessarily limited thereto. Its primary object is to provide a switchboard of new and improved construction on which the apparatus units required in a crossbar-switching system may be economically and efficiently mounted in a switchroom of a relatively small floor area and of a relatively low ceiling height.

A further object is to enhance the handling of the switchboard apparatus in transit to the site of installation. This object is attained by (1) providing a switchboard of the foregoing character which comprises separate frame uprights so constructed that they can be manufactured, fully wired, and shipped to the site of installation before the pertaining apparatus units are mounted thereon, and (2) by providing fully wired apparatus units which can be packed and shipped to the site of installation separately from the frame uprights and can be readily mounted thereon and connected to the frame wiring. These provisions operate to substantially lessen the weight of the items to be shipped and handled.

Additional objects are (1) to provide frame uprights of the foregoing character which, whether used singly or in groups to form a switching frame, may have suitable fully enclosing members attached thereto which include panels that are readily removable to give access to the apparatus units thereon, and (2) to provide standardized cable-runway parts to support the cables required to interconnect the several frames of the switchboard.

One feature of the invention is that the apparatus units are, for the most part, so mounted within the concerned frame uprights as to slide in and out in the manner of drawers. This arrangement permits efficient use to be made of frames which are relatively deep and which therefore are not required to be of great height to accommodate a desired amount of apparatus.

Further features are that (1) each drawer-mounted apparatus unit is provided with a flexible terminal cable connecting it to the frame wiring, permitting the unit to be slid out for inspection without disturbing its association with the frame wiring, and (2) each terminal cable connects to the frame wiring through readily detachable and detachable connecting members, permitting easy installation and removal of any such apparatus unit.

Other features are that (1) each frame uprights includes a built-in local cable runway at the top thereof, formed by cable slats attached at

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their ends to parallel structural members of the framework and (2) each frame upright has a service compartment (containing terminal blocks, fuse panels, and miscellaneous items) located between the local built-in runway and the uppermost drawer space, thereby enabling installers and service men to work on the inter-frame and power-supply connections without disturbing the apparatus units.

Still further features concern the enclosing panels and associated parts, including the use of an end enclosure which is formed around the front and rear corners to cooperate with front and rear enclosing panels, associated respectively with the service compartment and the individual drawer spaces.

Other objects and features will appear as the description progresses.

I. GENERAL DESCRIPTION

It has been chosen to illustrate the invention as applied to a switchboard serving a primary-secondary-spread crossbar telephone system specifically as disclosed in the application of Bellamy and Bowser Serial No. 85,292, filed April 4, 1949.

IA. THE DRAWINGS

The accompanying drawings comprising Figs. 1 to 21 show views of the chosen preferred embodiment of the invention as follows:

Fig. 1 is a general view of the switchboard, together with the associated powerboard PB and main distributing frame MDF;

Figs. 2 and 3 show the disposition of apparatus units within the drawer spaces in any line-link frame and in the block-link frame;

Fig. 4 is a plan view of a switchroom containing the apparatus of Fig. 1, with the covers removed from the cable runways which are shown empty;

Fig. 5 is a view similar to Fig. 4, but showing the runway cables in place;

Figs. 6, 6A, and 6B are respectively a front view, a plan view, and a right-end view of a fully equipped line-link frame;

Fig. 7 is a general view of a line-link frame only partially equipped, showing the basic construction;

Fig. 8 is a general sectional view of the apparatus immediately below line 8-8 of Fig. 7;

Fig. 9 is a fragmentary sectional plan view taken generally along line 9-9 of Fig. 7;

Fig. 10 is a fragmentary left sectional view taken generally along line 10-10 of Fig. 7;

Fig. 11 is a sectional view comprising an en-

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largement of the lower-left corner of Fig. 9 to show the construction of panel-retaining pins 103;

Fig. 12 is a general rear view of a cover panel 115;

Fig. 13 shows a typical frame cable;

Fig. 14 is a sectional plan view of the primary bay of a line-link taken along line 14—14 of Fig. 6, to show a typical flexible terminal cable;

Fig. 15 is an enlarged view taken along line 15—15 of Fig. 14;

Figs. 16 and 17 show constructional details of runway bridges used between frames;

Figs. 18 and 18A are respectively, a general rear view and an end view of a double-height drawer unit composed of relay equipment and terminal-pin blocks;

Fig. 19 is a perspective view of a single-height drawer of relay equipment;

Fig. 20 is an enlarged general view of a portion of the block-link frame of Fig. 1, but with parts of the enclosing panels broken away to show apparatus underneath; and

Fig. 21 is a fragmentary sectional view taken generally along line 21—21 of Fig. 20.

IB. GENERAL ARRANGEMENT (FIG. 1)

Referring generally to the drawings, and particularly to Fig. 1, the illustrated crossbar-system switchboard contains the switchboard apparatus required in the primary-secondary-spread crossbar telephone system, comprising a 1000-line telephone exchange, disclosed in the noted Bellamy and Bowser application. Such an exchange serves a maximum of one thousand local subscriber lines, and has provisions for forty incoming and forty outgoing tie trunks connecting with other points.

The main distributing frame MDF of Figs. 1, 4, and 5 is of well-known construction. The conductor pairs representing the subscriber lines and the noted tie trunks terminate on one side thereof, while the conductor pairs representing switchboard terminals terminate on the other side, and the terminals on the two sides are interconnected by two-wire jumpers as indicated in the noted prior application.

The apparatus for supplying the required direct-current and alternating-current power to the switchboard frames, and for supervising it, is mounted on powerboard PB, which may be of any desired construction, but preferably matches the switchboard apparatus in height and appearance, as shown.

Frame TC is the trunk-coupler frame of the noted application, having mounted thereon the trunk couplers required to be used in connection with the above-noted tie trunks.

Frames LLA to LLD are line-link frames A to D of the noted application, each terminating 250 subscriber lines. Frame BL, seen in the foreground in Fig. 1, is the block-link frame of the noted application. It is common to trunk-coupler frame TC and line-link frames LLA to LLD, as all calls handled by the switchboard pass therethrough.

The switchboard frames are preferably of a uniform height and depth. Each frame has such width (or running length) as is required according to the amount of apparatus to be mounted thereon. Each frame comprises one or more frame uprights having the type of construction shown in Fig. 7 for line-link frame LLD.

Each frame is surmounted by a local cable runway extending longitudinally thereof (parts 23,

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25, and 36 for frame LLD, Fig. 7). These runways are covered by sheet-metal covers 14 to 18, Fig. 1. The local runways are interconnected with each other and with powerboard PB by covered runway bridges 3 to 12 of Fig. 1.

Runway sections 1 and 2 interconnect main distributing frame MDF with frame LLA and frame TC respectively. These runway sections are left uncovered to match the open construction of frame MDF, whereat the necessity for making relatively frequent and extensive jumper changes renders the use of enclosing members undesirable.

The enclosing members for frames TC, LLA to LLD, and BL include eleven horizontal removable panels 115 front and rear for each frame or bay thereof. The eleven spaces respectively covered by these panels comprise a service compartment indicated at SC in Figs. 2, 3, 6, and 6B, followed by ten drawer spaces numbered 1 to 10 as indicated in Figs. 2 and 3. The service compartment SC at any frame is the space between the cable runway thereof and the baffle 75 thereof (Figs. 6, 6A, 6B, and 7), which act as protective covers for the underlying drawer spaces.

IC. DRAWER-SPACE ASSIGNMENT (FIGS. 2 AND 3)

Referring to Figs. 2 and 3, the assignment of apparatus units to locations in the ten drawer spaces of the switchboard frames will be described.

IC1. Line-link frames (Fig. 2)

The identity of the apparatus units mounted in the drawer spaces (1 to 10) of any line-link frame LLA to LLD is given in tabulated form in Fig. 2. Any such frame comprises a primary bay PB and a secondary bay SB. The uppermost compartment in either bay is the service compartment SC.

Ten primary crossbar switches occupy drawer spaces 1 to 10 respectively of the primary bay PB of any such frame. They are the line-link primary switches 800 of the Bellamy and Bowser application.

Five secondary switches occupy the drawer spaces 1 to 5 of the secondary bay SB. They are the line-link secondary switches 900 of the last-noted application.

Drawer spaces 6 and 7 of any bay SB are occupied respectively by line-controller switches 1 and 2. They are the line-controller switches 1000 and 1100 of the last-noted application.

Drawer space 8 of bay SB is occupied by a line controller, which is line-controller 1200 in the last-noted application.

Drawer spaces 9 and 10 of any secondary bay SB are vacant.

As pointed out in the Bellamy and Bowser application, each of the crossbar switches used in the system is preferably of the type disclosed in the pending application of R. F. Arthur for a Crossbar Switch, Serial No. 8,900, filed February 17, 1948. Each such switch has an overall appearance about as shown at P1, S1, and P5 of Figs. 6 and 6B, and each has a pair of rollers 57 (see Fig. 8) at each end thereof to facilitate its desired sliding operation as a drawer.

All control relay apparatus used on the disclosed switchboard is preferably of the type disclosed in the pending application of Bellamy and Arthur for Electromagnetic Relays, Serial No. 20,196, filed April 10, 1948. The noted line controllers (drawer space 8 in any secondary bay SB) each employ the noted relay apparatus

mounted to comprise a relay drawer as shown at RD in Fig. 19.

IC2. Block-link frame

Referring now to Fig. 3, the disposition of equipment on the block-link frame BL shown therein will now be described.

Block-link frame BL is composed of seven bays, secondary bay BL—S, control bay BL—C, and primary bays BL—P1 to BL—P5. The uppermost compartment in each bay of the block-link frame is the service compartment SC, as explained for the line-link frames.

IC2a. SECONDARY BAY

In secondary bay BL—S, the ten drawer spaces underneath the service compartment are occupied by secondary switches 1 to 10, each of which is a crossbar switch of the construction previously referred to. They are the block-link secondary switches 1400 of the noted Bellamy and Bowser application.

IC2b. CONTROL BAY

Referring to control bay BL—C, Fig. 3 shows that the first two drawer spaces are vacant, while the third drawer space is occupied by miscellaneous relay apparatus (Misc.). This apparatus is mounted on a relay drawer such as RD of Fig. 19, relay apparatus thereon comprises section-preference relays 1550 and the outgoing controller 1700 of the identified Bellamy and Bowser application.

Drawer space 4 is occupied by a crossbar switch serving as the block-controller switch 1500 of the Bellamy and Bowser application.

Drawer spaces 5 and 6 of the control bay are occupied respectively by duplicate block controllers (B. C. 1 and B. C. 2) each of which comprises a drawer of relay equipment such as is shown at RD in Fig. 19, and wired as shown for the block controller 1600 of the Bellamy and Bowser application.

Drawer spaces 7 and 8 of the control bay are occupied by equipment which is shown in circuit diagram in Figs. 18 and 19 of the Bellamy and Bowser application and identified as block translator 1800. Physically, this unit of equipment comprises apparatus mounted on the double-height drawer shown herein in Figs. 18 and 18A. The apparatus mounted on the front portion of the drawer comprises the relay apparatus of Fig. 18 of the Bellamy and Bowser application, while the apparatus mounted on the rear (at 137) comprises the terminal-pin blocks shown in Fig. 19 of the Bellamy and Bowser application.

Drawer spaces 9 and 10 of the control bay BL—C are vacant, as noted for drawer spaces 1 and 2 thereon.

IC2c. PRIMARY BAYS

Referring now to the five primary bays, BL—P1 to BL—P5 of the block-link frame BL, each has two sections of block couplers mounted thereon in drawer spaces 1 to 8 as shown in Figs. 20 and 21 for the final primary bay BL—P5. There is a section of twenty block couplers 150 mounted on the rear of each bay as shown in Fig. 20, and a similar section of twenty block couplers 150 mounted on the front of the bay as indicated in Fig. 21. Each block coupler includes a separate angularly shaped common magnetic return plate, together with relay apparatus mounted thereon, together with counting apparatus preferably of the general type dis-

closed in the application of Bellamy and Arthur for Electromagnetic Counting Devices, Serial No. 43,436, filed August 7, 1948. Any such block coupler has its relay and counting apparatus interconnected for operation as disclosed, for example, in Fig. 5 of the Bellamy and Bowser application.

Ten primary switches (PRI. SW1 to PRI. SW10) are mounted in pairs in drawer spaces 9 and 10 of the five primary bays BL—P1 to BL—P5. These are the block-link primary switches 1300 of the Bellamy and Bowser application. The section of block couplers mounted on the front of any primary bay is associated with the primary switch in drawer space 9, while the section of block couplers mounted on the rear of the bay is associated with the primary switch in drawer space 10 of the same bay.

ID. SERVICE COMPARTMENT EQUIPMENT (FIG. 4)

Fig. 4 shows the floor plan of a switch room containing the switchboard apparatus of Fig. 1 and associated powerboard and distributing frame, together with battery 201 for supplying direct current to the switchboard apparatus, charger 202 for charging the battery, and the customary workbench 203. The switchboard apparatus is illustrated in Fig. 4 as it appears with covers removed from the cable runways, and with the runway cables uninstalled to permit an unobstructed view of equipment in the service compartment of the switchboard frames.

In any line-link frame LLA to LLD, a fuse panel 82 is located in the service compartment of the secondary bay, as seen most clearly in Figs. 6, 6A, and 6B. Items 81 and 83 are similar fuse panels located in the service compartment of trunk-coupler frame TC, and secondary bay BL—S of the block-link frame BL, respectively.

Items 79 and 80 in Fig. 4 are terminal-pin blocks located in the service compartment of the primary and secondary bays respectively of any one of the line-link frames LLA to LLD, as seen most clearly in Figs. 6, 6A, and 6B. Items 153 in each of the primary bays BL—P1 to BL—P5, together with the two items 154 in control bay BL—C and item 155 in secondary bay BL—S, are similar terminal-pin blocks located in the service compartment of the bays of block-link frame BL.

When the usual connections (not shown) have been made and cables have been run as shown in Fig. 5, direct current from battery 201 is supplied through powerboard PB to the noted fuse panels located in the respective frames, and through separate fuses on the fuse panel of any such frame is supplied to respective apparatus units thereon.

Generally speaking, the control wires and talking-path wires which require to be connected externally at any switchboard frame are carried through frame cables to terminal pins in the associated one of the noted terminal-pin blocks 79, 80, and 153 to 155. Desired ones of the terminals in these pin blocks are interconnected with terminals on one or another of the switchboard frames, on the distributing frame MDF, or on powerboard PB, by cables installed in the cable runways as shown in Fig. 5.

IE. RUNWAY CABLES (FIG. 5)

Referring now to Fig. 5, the runway cables comprise groups 301 to 306 as follows:

The cables in group 301 extend from powerboard PB to each of the switchboard frames TC, LLA to LLD, and BL, carrying the necessary

direct-current and alternating-current and signal or supervisory wires to any such frame;

The cables in group 302 carry the conductor pairs between frames TC and MDF required for the noted two-conductor incoming and outgoing tie trunks;

The cables in group 303 extend between frame MDF and line-link frames LLA to LLD to carry the two-conductor subscriber lines between the frames;

The cables in group 304 contain the three-wire outgoing-trunk branches and the three-wire incoming-trunk branches between trunk-coupler frame TC and block-link frame BL;

The cables in any one of four groups 305 carry the originating and terminating trunks, along with associated control conductors between the concerned line-link frame LLA to LLD and the block-link frame BL; and

The cables in group 306 interconnect the control bay BL—C of the block link frame with the block-link primary switches mounted on primary bays BL—P1 to BL—P5.

For the most part, the wires in the foregoing cables connect to individual terminal pins in the pin blocks 79, 89 and 153 to 155 shown in Fig. 4 but omitted in Fig. 5 to avoid crowding and confusion.

II. DETAILED DESCRIPTION

A general description of the arrangement and function of the components of the improved crossbar-system switchboard disclosed herein having been given, the detailed description of the illustrated construction is as follows:

IIA. FRAME CONSTRUCTION (FIGS. 6 AND 7)

Referring particularly to Figs. 6, 6A, 6B, and 7, the construction of line-link frame LLD of Figs. 1, 3, 4, and 5 will be given, keeping in mind that frames LLA to LLD are all like in construction.

As seen best in Fig. 7, frame LLD includes three principal front members 21, 22, and 23, and three oppositely disposed principal rear members 24, 25, and 26. Considering the noted principal front members, 21 and 22 are upright channel bars on which member 23, a horizontal angle bar, is laid and welded to the ends thereof, providing a rigid inverted U-shaped configuration. Rear members 24 to 26 are similarly welded together to form a mirror image of the welded front member.

The noted front and rear U-shaped assemblies are placed in the relative locations shown in Fig. 7 and are welded to end floor plates 34 which hold the bottom of the assemblies at the desired distance from each other. Cable slats 36 are welded to the horizontal webs of top angle members 23 and 26 to hold the top of the assemblies at the desired distance from each other. Parts 34 and 36 combine the front and rear assemblies into a comparatively rigid frame.

Frame LLD is divided into the two bays, primary bay PB and secondary bay SB, by the intermediate upright channel members 27 and 28, which are welded to intermediate floor plate 35 and to the underside of horizontal top members 23 and 26.

The E-shaped frame structure thus far described is brought into a constructional four-sided shape by the addition of the centrally disposed longitudinal channel member 33, which is welded to cross angles 29 and 30, welded in turn to the left-end and right-end upright channels, respectively. Channel 33 is further welded to

cross angles 31 and 32, welded in turn to the intermediate upright channel members 27 and 28.

The foregoing welded frame construction provides an essentially four-posted arrangement which is used at all other frame uprights of the switchboard, with or without dividing channel members (such as 27, 28) as needed. That is, trunk-coupler frame TC is a single-bay frame upright; the starting section of block-link frame BL is a two-bay frame upright similar to any line-link frame; and each of the primary bays BL—P1 to BL—P5 is a single-bay frame upright.

The several frame uprights comprising frame BL are preferably bolted together, as by bolts passing through holes (not shown) in adjacent upright end members, similar to end channels 21, 22, 24, 25 of Fig. 7. This sectionalized construction of frame BL promotes handling and shipping, as well as permitting unneeded primary-bay sections to be omitted as in small initial installations.

IIB. SLIDE SUPPORTS

Ten pairs of slide supports 40, for drawer slides 50 (Fig. 8) are secured to the defining uprights (21, 24, 27, 28) of primary bay PB and ten similar pairs of slide supports 40 are installed in secondary bay SB, on its defining uprights, (27, 28, 22, 25). Slide supports 40 are secured to the upright members by screws 43 as shown best in Fig. 8. When installed, these slide supports add to the previously noted rigidity of the frame structure.

Any one of the first nine drawer spaces discussed hereinbefore is the space between the top of the concerned pair of slide supports 40 and the top of the next underlying pair of slide supports, while the tenth drawer space extends from the top of the lowermost pair of slide supports to the top of angle members such as 29 and 31.

IIC. BAFFLE PLATES

A sheet-metal baffle plate 75, having its front and rear edges turned up for rigidity, is laid on the two uppermost slide supports 40 in the primary bay PB, as a protective cover for the equipment units mounted in the underlying drawer spaces, and a similar baffle plate 75 is provided for the secondary bay SB. Baffle plates 75 may be secured in place by screws entering tapped openings 44 provided in each slide support 40, as seen best in Fig. 8.

Baffle plates 75 define the lower limit of the service compartment indicated at SC in Figs. 6 and 6B.

IID. DRAWER MOUNTINGS

As previously pointed out, each equipment unit is fitted into its assigned drawer space within the concerned switchboard frame so as to move in and out as a drawer. Most of the drawer-mounted equipment units are crossbar switches, and each is equipped with a pair of stud-supported rollers at each end. These rollers and studs are shown at 10 and 11 of Figs. 1 and 2 of the previously noted application of Arthur.

In Fig. 8 and in Fig. 10, the two rollers at one end (the left) of the eighth and tenth crossbar switches, respectively, of primary bay PB of frame LLD (Fig. 7) are shown at 57. Their supporting studs 58 are shown in section, as the noted switches are omitted from the drawings to permit an unobstructed view of the slide mechanism.

At any slide mechanism, rollers 57 are resting within a roller channel formed in drawer slide 50 by turning the lower portion thereof inward-

ly and turning the edge portion upwardly as shown at 51, Fig. 8.

In Fig. 10, the rollers 57 and slide 50 are shown in the position they occupy when the associated apparatus unit is entirely within the frame, while in Fig. 8, drawer slide 50 and rollers 57 are shown in the position they occupy when the concerned apparatus unit has been pulled part way out. Incident to this operation, each outward roller 57 has engaged outward stop 55 (a bent-over tongue attached to slide 50), and has pulled drawer slide 50 outwardly to the illustrated position. This movement of part 50 occurs within the slide-support channel formed within the lower portion of member 40 by a lateral and an upward forming operation to provide guide portion 42.

As seen best in Fig. 8, tipping of slide 50 within slide support 40 is limited by the shank and enlarged head of stud 45, rigidly secured to member 40 as by having a reduced portion of the stud passed through a hole 46 (see next underlying slide 40, Fig. 8) and riveted over on the other side. In the noted guiding action, the upper surface of the inwardly shear-formed portion 52 cooperates with the shank of the stud 45, while the inner edge thereof cooperates with the enlarged head of the stud.

Referring further to Fig. 8, when the apparatus unit in question is pulled further out, the limit is reached when the shank of stud 45 is encountered by the abutment 54 left in part 50 by shear-forming as noted to produce part 52. The unit then occupies a position as shown at P1, Fig. 6B.

When the fully withdrawn apparatus unit in question is pushed inwardly into place within the confines of the switchboard frame, its rollers 57 first rotate about studs 58 to allow the unit to roll inwardly a considerable distance before the part 50 is required to slide the remaining distance. The point of transition from rolling to sliding is reached when the inward roller 57 encounters inward stop 56, preferably produced by being struck up from the sidewall of part 50. The noted inward movement of slide 50 is arrested when abutment 53 (Fig. 8) thereon encounters the shank of stud 45 in Fig. 10.

Preferably, each slide mechanism 40, 45, 50 is first completely assembled, by telescoping parts 40 and 50 together and then riveting stud 45 in place, following which the assembled slide mechanisms are secured in place by screws 43, in readiness for the roller-equipped apparatus units to be installed. It should be noted that parts 45 and 50 are omitted from parts 40 in Fig. 7, and in one instance in Fig. 8, merely for clarity of illustration and to avoid crowding the drawing, rather than to indicate that parts 45 and 50 are applied after parts 40 are secured to the framework.

Keeping in mind that each drawer space is equipped with two slide mechanisms (a left-hand one as shown in Fig. 8), and a right-hand one (not shown in detail), when a roller-equipped apparatus unit is to be mounted within a drawer space the left and right slides 50 are first pulled out until each is stopped by contact between the associated stud 45 and surface 54. Then, the inward left and right rollers 57 of the apparatus unit are introduced into the portion of their slides 50 which lies outwardly from guide portion 52, as by tilting downwardly the inward portion of the otherwise horizontally held unit. The unit is then moved partially into its drawer space to

bring the two outward rollers inwardly beyond the front stops 55, whereupon the outward portion of the unit is allowed to descend to bring the remaining rollers into the roller channels in the slides 50. The drawer thereafter remains in place under the influence of gravity, and may be pushed into the frame and withdrawn as above explained.

When a drawer-mounted apparatus unit is pulled out to the position shown at P1, Fig. 6B, it may be inspected from above and below. If further access is desired, it may then be tilted upwardly to disengage its outward rollers 57 (Fig. 8) from their slides 50, following which the entire unit may be pulled forwardly until the inward rollers 57 thereof are stopped by outward stops 55. The apparatus unit may then be held firmly and rotated upwardly about its inward rollers until the under side of the unit is exposed to horizontal view, or it may be rotated downwardly to bring its top side into horizontal view when it reaches the pendant position shown at P5 in Fig. 6B. The pulled-out and partially detached apparatus unit may thus be rotated more than 180 degrees about the horizontal axis defined by its inward rollers. This may be done quite readily even with a comparatively heavy apparatus unit, as the weight of the unit, or a large part of it is borne by the inward rollers, which are left attached to their respective slide mechanisms. Keeping in mind that the slides 50 are in fully pulled-out position when the noted rotation of the apparatus unit occurs, the net external force applied to the apparatus unit should be outwardly, against outward stops 55, to avoid undesired drawer action.

Following its noted partial detachment from the slide mechanisms, the apparatus unit may be returned to its normal fully attached position by a reversal of the described partial detaching operations.

III. FRAME WIRING

Each switchboard frame (each frame upright in the case of sectionalized frame BL) contains frame wiring suitably related to the wiring represented by the described runway cables, groups 301 to 306, Fig. 5. In describing the frame wiring, line-link frame LLD of Figs. 1, 2, and 4 to 7 has been selected as typical, and the frame wiring required in the primary bay PB of this frame to connect the concerned subscriber lines to the ten primary switches thereof has been selected as a typical example. This latter frame wiring is contained in cable 90, Fig. 13, shown detached from the switchboard for clarity of illustration. Cable 90 extends from line-terminal blocks 79 in the service compartment of the primary bay to the respective drawer spaces of the primary bay, having a separate horizontal leg 92 for each drawer space.

When cable 90 is installed, the vertically disposed portion thereof lies in the space between the upright left-end members 21 and 24 of frame LLD as shown in section in Fig. 14. The main horizontal portion 91 of cable 90 lies within the service compartment SC (Fig. 6) of the frame, where the individual wires are connected to respective terminal pins in blocks 79.

Cable 90 and legs 92 thereof also may contain local wires extending between drawer spaces as desired. Frame cables interconnecting the units of bay PB with units of bay SB may have the vertically disposed portions thereof located in the space between intermediate vertical members 27

and 28 (as shown at 90a, Fig. 14), still further cables (not shown) may be located in the space between right-end vertical members 22 and 25 to serve the apparatus units of secondary bay SB of the frame.

IIF. CONNECTING STRIPS AND TERMINAL CABLES

Pursuant to (1) permitting the frames to be fully wired separate from the apparatus units, (2) permitting the fully wired units to be readily installed, and (3) permitting the installed drawer-mounted units to be withdrawn and returned as described while remaining operationally connected to the frame wiring, the individual wires (such as 93, Fig. 13) in any drawer leg such as 92 of cable 90 are connected to individual terminals 67 in a pair of aligned terminal strips 66, and each drawer-mounted apparatus unit is provided with a flexible terminal cable ending in one or more similar terminal strips having terminals which register respectively with the terminals in the first-noted strips when the strips are placed together.

The noted terminal strips are preferably compression-connecting strips of the type fully disclosed in the application of Earle et al. for Compression-Connecting Terminal Apparatus, filed December 20, 1948.

The compression-connecting terminal apparatus for any drawer space is carried on horizontal angle bars 60 of Figs. 7, 14, and 15. Those for any drawer space 1 to 9 in a bay are mounted on brackets 62 secured to the upper surface of slide supports 40 of the next underlying drawer space, while those of the tenth drawer space are mounted on brackets 73 and 62 (Fig. 10), secured to the underlying angle bars 29 to 32.

While Fig. 7 shows support bars 60 installed for only one drawer space (#4 in bay SB), it will be understood that each drawer space in each bay of the frame (excepting the two labelled "vacant" in Fig. 2) is equipped with a set of bars 60. Each bar 60 has a number of studs 61 disposed therealong to locate and clamp the terminal strips to be placed thereon. Referring to Fig. 10, two support angles 63, extending across the lower portion of the tenth drawer space of bay PB, Fig. 7, are welded at their left end to the two arms of bracket 62, and are similarly secured at the other end (not shown). Bracket 62 is secured to the upper face of adapting bracket 73, secured to the lower web of angle bar 29 by screws 74.

As shown in Figs. 10 and 15, the bracket 62 at either end angle bars 60 for any any drawer space 1 to 9 of bay PB (Fig. 7) is secured by a screw 63 to the upper flange 41 of the next underlying slide support 40.

As shown best in Fig. 15, the compression-connecting terminal assembly for any angle bar 60 is applied to the rear sloping surface thereof, the one to which studs 61 (Figs. 7, 10, 15) are attached, as by spot welding.

Thin insulator strip 64 is first applied to bar 60, studs 61 being received by location holes (not shown) in strip 64. Spacing insulator strip 65 is next applied, followed by a terminal strip 66 (see Fig. 13) to the terminals 67 of which respective wires 93 of the concerned leg 92 of cable 90 have been secured. The cable leg 92 is conveniently sheltered within the confines of the associated angle bar 60. The noted parts 64, 65, 66, and 67 correspond respectively to parts 5, 2, 4, and 16 of Figs. 1 to 10, in the noted application of Earle et al.

During manufacture and assembly of the

switchboard frame under discussion, the noted assembly of the wired terminal strips 66 on support bars 60 is followed by the assembly of insulating strips 70, bars 71, and clamp nuts 72, which are tightened for shipment. The parts may remain so assembled until the frame wiring has been tested; the frame has been shipped and installed; the switchboard frames have been connected together by the described runway cables; and the drawer-mounted apparatus units have been installed and are ready for connection to the frame wiring.

As shown in Figs. 6, 6B, 14, and 15, each drawer-mounted apparatus unit is provided with a terminal cable 84 having flexible forward branches 85 connected to the unit, and having fixed rearward branches 86 which afford connections to the frame wiring. When such a unit is undergoing the manufacturing operations, the wires in branches 85 of its terminal cable are connected to respective terminal members (not shown) of the apparatus unit, and the wires in fixed branches 86 of the cable are connected to respective terminal members 69 contained in terminal strips 68 (Fig. 15), which are reversed in position to adapt them to cooperatively overlay the respective strips 66 at which the frame wiring has been terminated.

When the terminal wiring of an installed drawer-mounted apparatus unit is to be connected to the frame wiring, the nuts 72, clamp strips 71, and outer insulator strips 70 (Fig. 15) are removed from the concerned terminal-assembly groups, following which the terminal strips 68 to which the terminal-cable wires 87 have been attached are laid upon respective frame strips 66 in the relative positions shown in Fig. 15. Parts 70 and 71 are reapplied to studs 61 and nuts 72 are reapplied and are tightened securely. The wires 87 in the terminal cable are thereby connected respectively to the frame wires 93 through terminals 69 and 67, which are in contact with each other in overlying registry in the strips 68 and 66 by being "woven" through the openings in the strips, as clearly disclosed in the noted Earle et al. application. Preferably the main part of cable 84 is fixed rigidly with the support bars 60, as by lashing the butt ends of cable legs 86 thereto by lacing twine.

Fig. 14 shows a cable 90a lying between intermediate vertical channels 27 and 28 in association with the forward support bar 60 at the indicated drawer space, while cable 90 of Fig. 16 is shown associated with the rearward support bar 63. The portion of the terminal assembly associated with cable 90a has been omitted from Fig. 15 as unnecessary duplication of the assembly shown therein.

Referring further to Fig. 14, the apparatus unit served by the illustrated terminal cable 84 does not show because of the level (see Fig. 6) at which the view was taken. It has been found desirable to locate each terminal cable 84 along the center of the drawer space as seen best in Fig. 14. This leads naturally to a symmetrical construction providing two smaller flexible legs 85. The central location of cable 84 is rendered feasible by providing two similar terminal assemblies on each support bar 60, a left assembly and a right one as seen best in Fig. 14.

The outer ends of flexible legs 85 are attached to the apparatus unit as shown at P1 and P5 (Fig. 6B). Legs 85 are shown by the full lines in Fig. 14 in the approximate position they occupy when the apparatus unit is in its normal po-

sition within the frames. The dotted lines show the approximate position to which cable legs 85 flex when the unit is fully withdrawn to the position shown at P1, Fig. 6B. Parts 85 flex the required further amount when the apparatus unit is manipulated as hereinbefore explained to detach the outward rollers thereof and is then pulled clear and rotated upwardly, or downwardly as at P5, Fig. 6B.

III. ENCLOSING MEMBERS

The enclosing members employed will now be described with particular reference to line-link frame LLD, chosen as typical. The enclosing members at this frame are (1) two end panels 100 (Figs. 6 to 10), (2) two mullions 106 (Figs. 1, 6, and 7), (3) forty-four removable door panels 115, eleven front and eleven rear for each of the bays PB and SB (Figs. 1, 6, and 12), and (4) four bottom panels 110 (Figs. 6, 6B, 7, 9, and 10). All of the noted parts bearing the same reference character may be identical except that the greater width of primary bay PB requires longer bottom and door panels 110 and 115 than for the corresponding parts used at secondary bay SB.

As shown in Figs. 6A, and 9, each end panel 100 is of channel-like construction, and encloses the end and a small portion of the front and rear faces of the frame. The width of a member 100 is sufficiently greater than the depth of the frame that it may be offset inwardly to form corners 101 to receive the ends of door panels 115 flush with the end panels (Figs. 1 and 6B).

End panels 100 are secured to the end members (21, 24; 22, 25) of frame LLD by a suitable number of oven-headed screws 102, Fig. 11. Each panel 100 is preferably cut square at the top (Figs. 1 and 7) at the level of the upper edge of the uppermost door panels 116, while the lower end of each may have the tongue-like central portion shown in 6B which extends down sufficiently to conceal the ends of longitudinal bar 33, while the front and rear portions of the end panels preferably terminate on the same level as the lower line of bottom enclosures 110.

Each end panel 100 is provided with twenty-two inwardly extending pins 103 (Fig. 11), eleven front and eleven rear for supporting cover panels 115 in cooperation with notches 119 (Fig. 12) in the cover panels. Each pin 103 has a threaded portion of reduced diameter passing through a hole in panel 100 and held by a nut 104.

Each mullion 106 of frame LLD has a narrow finish portion flush with the covers 115. The finish portion lies between two portions of the mullion which are inwardly offset to provide corners such as corners 101 in end panels 100. The mullions are secured to the framework as described for end panels 100, and are similarly provided with pins such as 103, Fig. 11, for supporting the inside ends of cover panels 115.

As shown in general rear view in Fig. 12, each door panel 115 has top, bottom, and side flanges 116, 117, and 118 turned up for rigidity. These flanges may be tack-welded at their intersection points if added rigidity is desired. A depending flange 120, of slightly reduced width and having the tapered corner portions indicated at 121, extends downwardly from the inner edge of bottom flange 117. When a door panel 115 is installed, the tapered tip of its depending flange 120 is behind the upper part of the next underlying cover panel 115. Flange 120 thus closes the rear of the horizontal inter-panel opening

left between adjacent door panels to permit the hereinafter described vertical sliding action required to engage and disengage the door panels incidental to installing and removing them.

Each of the two bottom panels 110 for primary bay PB, for example, closely underlies angle bars 29 and 31 (Figs. 7 and 10), and each has an inner portion 112 of a reduced width which will pass between the angle bars 29 and 31. Portion 112 is upwardly offset to overlap the upper surface of channel bar 33. The outward edge of each panel 110 is turned upwardly to provide a strengthening finish flange 111. Two screws 113 (Figs. 7 and 10) pass through each flange 111 to hold the panel 110 to the frame members such as 21 and 24. Spacers 114, which may be bent-over end tabs of flange 111, hold the flange spaced outwardly a sufficient distance to permit the tip of the depending flange 120 of the lowermost door panel 115 to slide down behind it when the door panel is installed.

With the end panels 100, mullions 106, and bottom panels 110 installed on frame LLD as described, the forty-four door panels 115 may be installed, eleven for the front and eleven for the rear in each bay PB and SB. During installation, any cover panel 115 is held opposite its opening at a point slightly higher than its final position, and is then moved bodily to the rear whereupon its flanges 118 enter a corner 101 in panel 100 and the opposed similar corner in mullion 106. During this movement, the tip of depending flange 120 clears the top of the next underlying cover panel 115, if installed, and the top of the panel being installed clears the bottom flange 117 of the next overlying panel 115, if installed. At the same time, the horizontal leg of each L-shaped notch 119 receives the associated support pin 103 (Fig. 11), carried by end panel 100 and mullion 106, permitting the cover panel to move inwardly to the desired flush position. Then the panel 115 is allowed to drop bodily to its final position wherein the top part thereof is held against outward movement by the noted pins 103 being received in the vertical portion of notches 119, and the bottom part of the panel is held against outward movement by the tip of depending flange 120, which has slid behind the upper portion of the next underlying cover panel, or behind the upstanding flange 111 (Figs. 7, 9, 10) of the associated bottom panel 110.

An installed cover panel 115 may be removed by lifting it to clear the pins from the vertical portion of notches 119 and to clear the tip of depending flange 120 for outward movement. This lifting may be accomplished by inserting the fingers in the horizontal space between the main portion of the concerned cover panel and the one below it. When so lifted, the panel may be bodily moved outwardly from the frame.

The foregoing describes the enclosing of the principal portion of the bottom of the equipment space within frame LLD, together with the ends and the front and rear faces thereof. The top of the service compartment in the frame is left open except for the runway covers hereinafter described. The top of the uppermost drawer space in each bay is closed by the previously described baffle plates 75 (Fig. 7), which act as a cover for the ten underlying drawer spaces as a whole. If desired, similar baffle plates may be applied as individual covers for the respective underlying drawer spaces.

The three cable wells between the upright structural members of frame LLD are preferably en-

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closed at the top and bottom to complete the enclosing of the switchboard space in which apparatus units are mounted. These cable wells comprise the one between members 21 and 24, and the ones between members 27 and 28, and members 22 and 25.

As shown in Figs. 9 and 10, the bottom of the cable well between members 21 and 24 is closed by well panel 95, sized to match the outline of the well. Two flanges 96, of a length of fit between members 21 and 24, are turned down at the sides. Screws 97 enter these flanges to secure the well panel to end panel 100 and to angle bar 23.

A similar well panel (not shown) may be used at the top of the well, on a level with the baffle plates 75 and secured between the associated slide support 40 and end panel 100. The top well panel, suitably slotted to accommodate cables such as 99 (Figs. 13 and 14), which may be suitably grommeted to fill the cable-receiving notch (not shown) without chafing the cable.

The remaining cable wells of the frame are similarly enclosed at the top and bottom.

III. FRAME BL

From the foregoing detailed description of line-link frame LLD, which applies to any of the three similar two-bay, single-upright frames LLA to LLD, the construction of the single-bay frames PB and TC will be apparent. The construction of the multi-upright block-link frame BL, however, may require some additional explanation.

Frame BL comprises six frame uprights placed end to end as shown in Figs. 1, 4, and 5. The starting section of frame BL is the two-bay upright which contains secondary bay BL—S and control bay BL—C. Except for the somewhat different bay widths ordinarily required, this upright is similar to any one of the line-link frames LLA to LLD.

The noted two-bay starting section of frame BL is succeeded by five similar frame uprights (or frame sections) comprising primary bays BL—P1 to BL—P5, respectively. The adjacent ends of the uprights comprising frame BL may be bolted together as desired to maintain them in alignment, as by bolts passing through holes in the outside webs of the corner members corresponding to parts 21, 24, 22, 25 of Fig. 7.

The enclosing members for frame BL include end panels 100 attached to the end uprights of the frame together with bottom enclosures, baffle plates, and cable-well enclosures as described for frame BL, and door panels 115. The door panels are removably mounted on the frame by pins supported on end panels 100 (see Figs. 8 and 11) and on mullions 106 and 106W. Mullion 106 of frame BL is similar to mullion 106 of frame LLD, and mullions 106W are similar to mullions 106 except that they are wider in that each covers a portion of two adjacent frame uprights, being secured to each.

III. CABLE RUNWAYS

As noted, each frame upright includes a local cable runway extending along the top thereof. As seen best in Figs. 6, 6A, and 7, the local runway of frame LLD comprises the horizontal structural bars 23 and 26, together with the slats 36 extending between them and welded thereto. The slats 36 support the cables shown in Fig. 5, which are preferably laced or otherwise secured to the slats 36 in the desired groups and layers.

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The described local runway of frame LLD is typical of the local runway at the other frames, as seen best in Fig. 4.

As before explained, the runways local to the several frames are interconnected by runway bridges 3 to 12 as shown best in Fig. 4. With inter-frame aisles of uniform width (Figs. 1, 4, 5) all of the runway bridges 3 to 12 are similar and interchangeable.

It will be noted that each bridge 3 to 7 terminates at the side of each of the two frames which it interconnects, while each bridge 8 to 12 terminates at the end of the frame to which one end of it connects, and is at the side of the frame to which the other end connects. The bridges 7 and 12, which connect with line-link frame LLD have been chosen to illustrate the two noted relationships, and are therefore illustrated in some detail in Figs. 16 and 17, respectively.

Each cable bridge 7 and 12 is a trough-like sheet-metal member having its width dimension about the same as the depth dimension of the switchboard frames. Cable slats 124 are secured to each bridge as by welding. They correspond to slats 36 (Fig. 7) of the local runways of the frames, and are upwardly offset to facilitate lacing the cables thereto.

At each end of either bridge, there is a vertical leg 125, comprising a downwardly bent extension of the bottom flange of the bridge. Leg 125 ends in a foot 126.

At frame LLD of Fig. 1 (similar to the described frame LLD) foot 126 of bridge 7 (Fig. 16) rests on the bottom flange of structural angle bar 26, and is secured thereto by screws 127, and the other end of the bridge (not shown in Fig. 16) terminates similarly at frame LLD.

At frame LLD (see Fig. 17) leg 125 of bridge 12 stands between the side flanges of structural members 23 and 26, and foot 126 rests on the bottom flanges of these members and is secured thereto by screws 127.

Each runway bridge is provided with a sheet-metal cover 123, shown broken away in Figs. 16 and 17 to expose the interior of the bridges, but shown in full in Fig. 1.

As noted hereinbefore, runway sections 1 and 2 (Fig. 1), which connect frame MDF with frames TC and LLA, are of the usual open construction. They may be secured to the frames in any desired manner, as by bolts (not shown).

As shown in Fig. 1, the local runways on the several frames are provided with box-like sheet-metal covers 13 to 17, which have portions of their sidewalls and endwalls removed as required for communication with runway sections 1 and 2 and covered runway bridges 3 to 12.

At the single-upright frames PB, TC, and LLA to LLD, single-piece runway covers 13, 14, and 15 are used. They are similar except for length variations.

At the multi-upright frame BL, a separate section of runway cover (starting section 16, four intermediate sections 17, and final section 18) is used at each frame upright. Starting and final sections 16 and 18 each have one end closed and one end open, while each intermediate section 17 has both ends open. Each section 16 and 17 may have the forward end portion expanded to telescopically receive the adjacent end portion of the next succeeding section, as is common practice in sheet-metal work.

Referring again to Figs. 6 and 6B, the cover 15 for frame LLD has side opening 19 for receiving one end of bridge 7 (Fig. 1) and end opening 20

to receive one end of bridge 12 (Figs. 1 and 6). The other covers and cover sections have similar bridge-receiving openings as required.

Each runway cover preferably has a sidewall configuration as shown best in Fig. 6B for cover 15. The sidewall is offset outwardly near the bottom thereof to provide a widened portion which receives the top structural members of the frame, while the widened portion ends in a shoulder on which the weight of the cover rests.

IIK. MULTI-SPACE DRAWER UNIT (FIG. 18)

Figs. 18 and 18A show an apparatus unit (block translator BT) which occupies more than one drawer space within the frame upright on which it is mounted. As indicated in Fig. 3, the block translator occupies drawer spaces 7 and 8 in control bay BL—C of frame BL.

The unit BT includes two end plates 130, secured together by the underlying longitudinal tie bar 131, preferably welded to each. Upright angle bars 132 are secured, as by welding, to the front end of plates 130 to provide a mounting location for L-shaped members 133, detachably secured thereto as by screws (not shown).

Members 133 are magnetic return members for relay apparatus as disclosed in the noted Bellamy et al. application for Electromagnetic Relays. This apparatus includes electromagnets 139 and contact assemblies 140 controlled thereby to provide the relay apparatus of the block translator as shown in Fig. 18 of the noted Bellamy and Bowser application.

The apparatus at the rear of unit BT includes groups of terminal pins 137 assembled in blocks to provide the translator terminal pins shown in Fig. 19 of the identified Bellamy and Bowser application. The pins 137 extend through their mounting blocks as shown in Fig. 18A to permit local cable wire (not shown) to be attached thereto on the inside face of the rear assembly, and to permit local jumper wires (not shown) to be attached to pins 137 on the exposed rear face of the unit.

The blocks in which pins 137 are secured are maintained in their illustrated assembled position by clamp bolts 139, extending between lower and upper clamp bars 134 and 135.

The pin-block assembly is secured to end members 130 by hinge pins 136 which pass through the down-turned ends of the lower clamp bar 134, thereby enabling the pin-block assembly to be rotated outwardly when access to the local wiring between the relay and pin-block assemblies is desired. Latch bars 138, detachably secured between the front and rear assemblies as by bolts, normally maintain the illustrated upright position of the hinged pin-block assembly.

End plates 130 are each provided with a pair of rollers 57 through which the unit BT is mounted in slide mechanisms to operate as a drawer, as described in connection with Figs. 6 to 8. Rollers 57 are so placed on unit BT that, when mounted to slide within a given drawer space, the lower part of the unit occupies that drawer space, while the upper part of the unit occupies the next overlying drawer space, but makes no use of the drawer-slide mechanism thereof. Such slide mechanism may, therefore, be omitted from the last-noted drawer space.

It is contemplated that, when required, the unit BT may be extended downward (as by longer vertical bars 132) to accommodate depending equipment which will be accommodated in a third drawer space, the one immediately under-

lying the one containing the slide mechanism in which the rollers 57 of the unit are received. Such an extended three-space unit will thus be drawer-mounted in the intermediate one of the three drawer spaces which it occupies within the switchboard.

III. RELAY-DRAWER UNIT (FIG. 19)

Fig. 19 shows relay drawer RD, an apparatus unit for mounting a large amount of relays, and related equipment within a single drawer space of the switchboard. The apparatus on such a unit may be the previously noted miscellaneous relay equipment of frame BL (see Fig. 3) or may be any one of the items referred to hereinbefore as a line controller or a block controller.

Structurally, relay drawer RD is composed of similar L-shaped end plates 145 and L-shaped magnet relay bars 146 connecting the end plates and removably secured thereto, as by screws (not shown) entering the intumed flanges of the end plates. Each end plate 147 is provided with a pair of rollers 57 for cooperation with slide mechanisms as hereinbefore described for the crossbar switches.

Relay apparatus (including electromagnets 147) may be mounted on bars 146 as described for bars 133 of Figs. 18 and 18A.

IIIM. BLOCK-COUPLER MOUNTING (FIGS. 20, 21)

As described, each primary bay GL—P1 to BL—P5 of frame BL, has mounting locations for two drawer-mounted primary cross-bar switches in its drawer spaces 9 and 10, and has mounting locations in its drawer spaces 1 to 8 for respectively associated sections of block couplers, one section at the front of the bay and the other at the rear. Each section includes twenty block couplers associated respectively with the verticals of the associated one of the crossbar switches, as disclosed in the noted Bellamy and Bowser application.

Twenty block couplers 150, comprising the section at the rear of the final bay BL—P5, are shown in part in Fig. 20 where the concerned door panels 115 are broken away. Each coupler 150 is an L-shaped magnetic bar, such as parts 133 and 146 of Figs. 18 and 19, together with relay apparatus and counting apparatus mounted thereon as disclosed in the two noted Bellamy and Arthur applications. Such apparatus wired as shown, for example, in Fig. 5 of the Bellamy and Bowser application. The relay and counter apparatus has not been shown in Figs. 20 and 21 to avoid crowding the lines on the drawings.

As shown in Fig. 21 for a portion of the left-hand end of bay BL—P5, the block couplers 150 of any primary bay are supported at each end on support angle bars 151 welded to the upright structural members, which correspond to 21, 24, and 22, 25 of Fig. 7. The horizontal web of each support bar 151 is notched at points 152 to receive the depending web of two block-coupler angle bars 150, one for the front section and one for the rear section. The end portion of the horizontal web of each bar 150 rests on the portion of the horizontal web of its support bar 151 which extends outwardly from the concerned notch 152, and the two webs may be fastened together, as by screws (not shown).

Terminal pins 154 are mounted in blocks supported on bars 155 which lie centrally between the two front and rear couplers 150 on the same level. Pins 154 serve to terminate the switch-

board wires (not shown) relating to the several block couplers 150.

Terminal pins 153 of Fig. 21 are those which lie in the service compartment of the bay as shown also in Fig. 4.

III. QUANTITY VARIATIONS

Quantity variation in the equipment and apparatus units contained in the switchboard of Fig. 1 may be made (1) to accommodate fewer than the maximum number of lines, and (2) to provide less than the maximum number of block couplers and related block-link primary switches according to the traffic demands.

IIIA. LINE-LINK FRAME VARIATIONS

Major variations in the number of lines served give rise to corresponding variations in the number of line-link frames installed. If, for example, no more than 250 lines are to be served initially, line-link frames LLB, LLC, and LLD may be omitted. Of course, the omitted line-link frames may be added later, one or more at a time as required. Moreover, when the number of lines to be served is not an even multiple of 250 (the capacity in lines of a line-link frame) primary switches may be omitted as desired from the primary bay PB of any line-link frame, reducing the equipped capacity of the switchboard by twenty-five lines for each such omitted switch. Any such omitted switch may be later installed when required for expansion, thereby permitting expansion of the facilities in blocks of twenty-five lines by the simple process of installing initially unneeded primary switches on the line-link frames.

IIIB. BLOCK-LINK FRAME VARIATIONS

Major variations in the number of trunk paths needed through frame BL give rise to corresponding variations in the number of primary bays installed at frame BL. For example, if no more than forty block couplers 150 (Figs. 3, 20, and 21) are required for an initial installation, only one primary bay (BL—P1) is required at block-link frame BL. Bays BL—P2 to BL—P5 are therefore omitted. If the installation in question includes only line-link frame A, then no special runway provision is necessary, as runway bridge 9 (Figs. 1, 4, and 5) carries the necessary cables 305 (Fig. 5) between frame uprights LLA and BL—P1. But, if the noted installation includes two line-link frames (LLA and LLB) cable bridge 10 of Fig. 1 is relocated to join line-link frames LLA and LLB at their secondary end in the manner of bridge 5 at the primary end of the frames. The cables 305 (Fig. 5) of frame LLB then traverse bridges 10 and 9 in succession, reaching frame upright BL—P1 over bridge 9, along with cables 305 of frame LLA.

When the amount of traffic being handled through frame BL requires more than the forty trunk paths which can be provided through bay BL—P1 (by its primary switches and forty block couplers 150), one or more of the omitted bays BL—P2 to BL—P5 may be added as required. Such additions usually (but not necessarily) occur along with the addition of one or more initially omitted line-link frames LLA to LLD. The runway bridges such as 10 to 12 are added as needed incidental to the addition of the initially omitted line-link frames and the addition of initially omitted primary-bay sections of frame BL.

Referring to any installed primary bay BL—P1 to BL—P5, either of the two primary switches normally mounted in the two lowermost drawer

spaces therein may be omitted along with the twenty block couplers 150 associated therewith.

Moreover, any desired number of block couplers less than twenty may be installed initially in any section. The two noted provisions leave room for expansion within the installed primary bays whenever the number of block couplers required initially, or at the time of a later switchboard addition, is not an even multiple of twenty or forty.

It may be pointed out that a group of sets of terminal pins in the blocks 153 in any primary bay BL—P1 to BL—P5 is assigned to sets of wires leading to the respective block coupler positions on the bay, and that additional sets of the noted terminal pins are assigned to originating trunks incoming from at least one line-link frame. The pins in the blocks 153 thus serve as an intermediate distributing frame extending along the service compartments of bays BL—P1 to BL—P5, which are in end-to-end communication. That is, connecting jumpers may be run in the service compartment between the noted terminal sets of the same bay, or between bays as desired. Examples of such jumpers are shown at 204 and 204' in Fig. 5 of the identified Bellamy and Bowser application.

Additional explanation

In further explanation, it is pointed out that the stated object of providing a switchboard requiring only a relatively small volume of switchroom space is attained in the disclosed switchboard construction by provisions including (1) giving suitable portions of the switchboard apparatus the form of generally oblong apparatus units (crossbar switches and relay drawers) of a greater width than thickness and providing frame uprights having bays of a width and depth corresponding to the length and width of the units, each bay having facilities for receiving a number of superposed units each disposed with its shortest dimension (thickness) vertical, and (2) giving other portions of the switchboard apparatus (the block couplers) the form of individual bay-width strips, and mounting two groups of them on a frame upright, one group facing front and one facing rear. As a result, the height of the frame required for a given amount of apparatus, such as ten crossbar switches or crossbar switches and relay drawers, is considerably reduced, while only a relatively small increase in frame depth is required for the purpose. Stated alternatively, if a certain frame height is desired, the described mounting arrangement enables a substantially increased number of units of apparatus to be mounted in a bay thereof, reducing the number of bays to thereby reduce the floor space required.

It may be noted that the volume of any frame upright of the disclosed improved construction may be nearly as great as the volume of a frame upright of conventional construction having an equivalent capacity in switchboard apparatus, for the decrease in frame volume otherwise resulting from the noted reduction in height is at least partially offset by the increased frame depth required. A great reduction in the required volume of the switchroom nevertheless occurs, for the disclosed switchboard construction permits a great reduction in the volume of space represented by the illustrated aisles (Figs. 1, 4, 5) which are required to give free access to the switchboard frames. For example, when the noted reduction permitted in switchboard height is

availed of, a lowered ceiling height results, but no increase is thereby required in the aisle width normally employed. The reduction in height of the aisle spaces therefore represents a net decrease in the required volume of switchboard space. In fact, the aisle width required may often be reduced when the frame height is reduced, for the rolling ladders ordinarily employed for very high frames are not then required, in which case the reduction in aisle-space volume results both from width reduction and from height reduction.

We claim:

1. In a switchboard, a mounting frame defining an upright mounting space having a generally oblong horizontal cross-sectional configuration, apparatus units each having a generally similar horizontal configuration, means for supporting said units horizontally in superposed relationship within said space on vertical centres sufficiently great to leave substantial free spaces between adjacent units, groups of wiring terminals located in said free spaces respectively, frame wiring including groups of wires supported by the frame and attached to said terminal groups respectively, and groups of terminal wires extending from respective apparatus units to terminal groups in respectively adjacent ones of said inter-unit spaces.

2. In a switchboard frame as set forth in claim 1, the said means for supporting the units including superposed pairs of support brackets attached to the frame at the left and right ends of the said mounting space, and support bars mounted on the brackets of any desired pair and extending across the frame between them to support a group of said terminals disposed in a row extending therealong, the column of interspersed units and terminal groups beginning at one end with a said unit and ending at the other end with a said group of terminals.

3. In a switchboard frame as set forth in claim 1, the said terminal wires for any apparatus unit underlying its unit and comprising a cable extending therefrom to the said group of terminals which immediately underlies the unit, said cable being flexible and of sufficient length to permit the unit to be withdrawn from the space while remaining connected to its said terminals through the wires in its said cable, one said group of terminals underlying the lowermost unit.

4. A switchboard including a mounting frame enclosing and defining an upright switchboard space comprising superposed sections of space, the uppermost said section comprising a service compartment, the remaining said sections comprising apparatus spaces, apparatus units and means for supporting them in said apparatus spaces respectively, individual terminal groups fixed with the mounting frame in said apparatus spaces respectively, groups of terminal wires extending from the apparatus units to said individual terminal groups respectively, a common terminal group mounted in the service compartment, and frame wires interconnecting the common terminal groups with all said individual terminal groups.

5. A switchboard including a mounting frame enclosing and defining an upright switchboard space comprising superposed sections of space, the uppermost said sections comprising a service compartment, the remaining said sections comprising apparatus spaces, apparatus units and means for supporting them in said apparatus spaces respectively, individual terminal groups

fixed with the mounting frame in said apparatus spaces respectively, terminal wires extending from the apparatus units to said individual terminal groups respectively, a common terminal group mounted in the service compartment, frame wires interconnecting the common terminal groups with all said individual terminal groups, and a horizontal baffle plate disposed across said space at the lower limit of the service compartment to protect the said apparatus units in the underlying said spaces from injury incidental to the performance of operations in the service compartment.

6. A generally rectangular switchboard frame upright having a thickness less than either its height or its length, two similar three-member assemblies defining respective opposed faces of the upright, each assembly including a top member and two supporting end members, cross members joining the assemblies to maintain the said thickness of the upright, said cross members including a pair joining respective end members of the two assemblies at a location near the bottom of the upright, and a longitudinal structural member joining the last-named cross members along the centre line thereof to rigidify the lower part of the upright longitudinally.

7. A switchboard frame upright having a thickness materially less than either its height or its length, two opposed structural angle members defining the longitudinal top edges of the upright, each said member having vertical and horizontal webs extending upwardly and inwardly respectively from the junction line thereof, upright corner posts respectively supporting the edges of the upright, cross members connecting the corner posts together to constitute a unitary structure, and cable slats secured between the said horizontal webs to support cables extending longitudinally of the upright in the space above said horizontal webs and between said vertical webs, said cable slats serving to rigidify the structure.

8. A switchboard frame upright having a thickness materially less than either its height or its length, two horizontal structural members defining the opposed longitudinal top edges of the upright, upright corner posts respectively supporting the ends of said horizontal members and defining the four vertical edges of the upright, horizontal cross members joining the corner posts together at the ends of the upright to combine the parts as a unitary structure, said cross members including slide-support brackets opposing each other in superposed pairs, and longitudinally disposed apparatus units each slidably mounted at its ends on and between the brackets of a separate one of said pairs for movement out of and into an assigned space within the upright.

9. In a switchboard frame upright as set forth in claim 8, separate terminal-support means supported on and extending between the brackets of each of said pairs, and terminal groups supported respectively on said terminal-support means, certain of said terminal groups being specific respectively to corresponding apparatus units, another of said terminal groups being common to all said apparatus units.

10. An apparatus unit for use in a switchboard frame providing superposed spaces for receiving respective horizontally disposed apparatus units, said unit comprising a pair of opposed horizontally disposed end angle bars each having an upwardly extending vertical web and having a horizontal web extending inwardly toward the other end bar, a series of relay mounting strips extend-

ing between the end bars and lying on the horizontal webs thereof, the strips and bars being rigidly secured together, and members attached to the said vertical webs and extending outwardly therefrom to support the unit in its said space.

11. In an apparatus unit as set forth in claim 10, each said relay mounting strip comprising an angle bar having one web disposed horizontally and resting at its ends on the horizontal webs of the end bars, the vertical webs of the mounting strips extending upwardly and lying between the vertical webs of the end bars.

12. An apparatus unit including a pair of opposed upright end plates and upright mounting bars secured respectively thereto at the front end thereof, a series of relay mounting strips extending between the mounting bars and secured overlappingly thereto, a tie bar joining the end plates at a location to the rear of the mounting bars to rigidify the structure, and an upright assembly of apparatus disposed at the rear of the unit and means securing it to the end plates.

13. In an apparatus unit as set forth in claim 12, said securing means comprising means pivotally securing the upright assembly of apparatus to the end plates for rotation about an axis passing through the end plates along the lower edge of the said assembly, and transverse arms detachably securing the upper corner portions of the said assembly to the said upright mounting bars.

14. In combination, an upright switchboard frame including means defining and enclosing all sides of an upright rectangular space, a column of apparatus units mounted within said space, the enclosing means for one side of said space including removable door panels disposed opposite said apparatus units respectively, means for holding each panel to the frame at two points located at the left and right ends thereof above the horizontal centre line of the panel, each panel including a depending flange extending substantially the full width of the opening to be covered by the door panels, the depending flange

of each said panel above the lowermost one extending behind the next lower panel into overlapping relationship therewith, the depending flange of the lowermost said panel extending similarly behind and in overlapping relationship with an enclosing part fixed with the frame.

15. In combination a switchboard frame defining a generally rectangular upright mounting space having a thickness between the front and rear faces of the frame which is small compared to the height and length of the frame and defined space, and two groups of apparatus units mounted in said space, one group above the other, each of said apparatus units of each group extending substantially the full length of said space, the units of one group being disposed in a single column and each unit thereof occupying substantially the entire thickness of said space, the units of the other group being disposed in two columns, each unit of such group occupying no more than half the thickness of said space, the units of one of the last said two columns being accessible from the front of the frame, the units of the other column of the two being accessible from the rear of the frame.

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