Bulletin No. 215 September 30, 1925

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

Department of Development and Research

GN-801
(5-26)

STEP-BY-STEP MACHINE SWITCHING SYSTEM

DISTRIBUTING TERMINAL ASSEMBLY FCR SELECTOR BOARDS

Approved:

F. B. JEWETT,

Vice President

Bulletin No. 215

CONTENTS

Introduction

General

This bulletin describes a new terminal assembly for selector boards in step-by-step offices, which will be furnished in the future on boards rnounting selecturs which are associated with three-wire trunks. The new assembly offers important advantages in maintenance and simpler and more economical facilities for making changes in the grouping of selectors.

Functions

In general, the distributing terminal asssmbly provides means for performing the following functions:

(a) Terminating the terminal (bank multiple) cables from the selector banks,

(b) Terminating the long multiple (tie) and outgoing trunk cables.

(c) Multipling trunks through various numbers of selector divisions in accordance with traffic requirements.

(d) Cross-connecting the trunks from the various levels to the trunk cables to succeeding boards for equalizing the traffic to different sub-groups of switches.

Description

Outline

The distributing terminal assembly is essentially the same in framework construction as the present terminal assembly and will occupy the same space. Attached are two photographs of a selector board equipped with the new assembly and Drawing No, 707-119, shdwing the assembly and equipment. From these it will be seen that the assembly consists, in general, of three elements, as follows:

(a) 24 rows of 16-bank terminal strips each for terminating the bank multiple cables from the selector banks, the vertical strap wires for grouping the various divisions of selectors, and the distributing frame wire cross-connections for associating the selectors with the outgoing trunks or long multiple cables.

(b) A maximum of 5 rows of 5 distributing terminal strips each at the top of the assembly for terminating cables to and from other boards and the cross-connections from Che bank terminal strips.

(c) Distributing rings mounted on the vertical members through which the distributing frame wire cross-connections may be run between the distributing terminal strips and the bank terminal strips.

Bank Terminal Strips

The construction of the bank terminal strip is shown on Drawings Nos. 707-121 and 707-122. The 3 rows of terminals in order from the top down provide for the tip, ring anb sleeve conductors of one level of a half shelf of 10 selectors. Ten terminal strips are, therefore, required in each row for the 10 levels of a half shelf and 24 rows for the 12 shelves. The various levels of a selector division are thus terminated independently on individual terminal strips and the tip, ring and sleeve terminale of each circuit are kept adjacent instead of being in segregated terminal groups, as on the flat type terminal assembly.

It will be noted on Drawing No. 707-122, that the front end of the bank terminal is slotted. In general, the corresponding terminals in the successive rows of terminal strips, which are associated with a complete or partial group will be connected by means of vertical strap wires. Theee wires will be of No. 22-gauge tinned braided strap wire. They will be of sufficient length to connect as many successive rows of bank terminal strips as are required to be grouped without reversal. The slot in the terminal is large enough to accommodate two No. 22-gauge wires.

Where it is desirable to introduce a reversal between adjacent rows on certain levels, a small local form will be used in place of the vertical strap wires at the point where such reversal is desired. This form will be of tinned braided

strap wire. The construction and arrangement of the terminal strips provide for such a form.

There will be cases where one or more adjacent rows of bank terminal strips will be omitted, though the selectors associated with the rows of bank terminal strips immediately above and below the gap will be required to be grouped together. In such cases it is felt that the vertical strap wires can be used successfully across one or two blank bank terminal spaces but that jumpers should be used where three or more rows of bank terminal strips are omitted.

The bank multiple cable from the selector banks will be soldered to the bank terminal strips at the factory. There will be no slip or reversal in this cable. The wires will be attached to those notches on the terminals which are nearer the terminal strip block. The bank multiple cables from the two halves of each shelf to the associated bank terminal strips will be sewed into one cable form.

Distributing Terminal Strips

The method of mounting the distributing terminal strips at the top of the assembly is shown on Drawing No. 707-119. Mounting space is provided for a maximum of 25 three or six-point terminal strips as required.

In general, the top row of 5 terminal strips will be used for terminating long multiple (tie) cables to and from other boards and other miscellaneous circuits such as tone and intercepting trunks for vacant levels. With three-point terminal

strips, capacity is provided for 100 circuits. By the use of six-point strips this capacity may be doubled.

The four lower rows of terminal strips will be used for terminating outgoing trunk cables. With three-point strips throughout, capacity is provided for 400 outgoing trunk circuits. In case the ultimate requirements excsed this capacity, six-point strips will be required in some or all of the rows,

The uprights will be drilled so that three rows of equally spaced outgoing trunk distributing terminal strips can be mounted in the same vertical space as is required by the four rows cf terminal strips usually furnished. This will permit the use of wider vertical mounting centars and so facilitate maintenance in cases where six-point terminal strips are required, This arrangement can be used only where the ultimate number of outgoing trunks does not enceed 600.

The designations which will be used on the distributing terminal strips are indicated on Drawing No, 707-136.

Cross-connection Facilities

Cross-connections are provided from the bank terminal strips to the distributing terminal strips.

(a) To connect trunks of complete or partial groups of selectors to outgoing trunk cables.

(b) To connect trunks of partial groups of selectors to long multiple (tie) cables to partial groups of selectors on cther boards of the same class or those having the same multiple.

(c) To connect vacant level trunks to vacant level tone or intercepting trunks, as required.

The cross-connecting wires are terminated on the bank terminal strips on the notch nearer the epd on the rear of the terminals. This notch is also used for terminating the straps for multipling unused with working trunks on levels where all ten trunks are not equipped,

Doors

Selector boards equipped with the distributing terminal assembly will ordinarily be furnished without doors. Guard rails will be added, however, to prevent damage to the terminals. Since the board is open on all sides, it is felt that the grotec-tion which the doors afford is too slight to warrant their use.

When a casing is specified for the selector board on account of severe humidity conditions or for other reasons, doors will be furnished for the terminal end of the board which will cover the bank terminals. A separate cover will also be provided for the projecting terminal strips at the top of the assembly.

Cross-Connection and Wiring Practices

The minimum length of distributing frame wire will, of course, be required if attachment is made to the highest bank terminal strip on which each trunk appears and this is the preferred practice. In some cases, however, it may be desirable to terminate the cross-connection at some other appearance of the trunk in order to avoid congestion of cross-connections,.

interference with the bank multiple cable form or to preserve regularity of numbering as noted hereafter.

The outgoing trunk and long multiple (tie) cables should be so located on the distributing terminal strips that crossing of the cross-connections between the bank terminal strips and distributing terminal strips will be eliminated. This will keep the congestion of wiring behind the assembly to a minimum and will facilitate the tracing of cross-connections. Thus, the trunks and long multiple cables associated with the higher numbered levels, which appear on the right-hand side of the rows of bank terminal strips, should be assigned as far as possible, to terminals in the right-hand half of the rows of distributing terminal strips, and similarly for the left-hand side. The assignment should be so made that approximately one-half of the cross-connections are run through the distributing rings on each side of the rear of the assembly.

Partial groups may sometimes divide between boards at the point where a reversal is indicated. In such cases it will be considered standard to make the reversal in the cross-connections to the long multiple (tie) cable on the lower numbered board,

In the case of graded multiple groups, it is preferable, in general, to take the outgoing trunks from the board on which the majority of trunks in an outgoing trunk cable appear before selectors.

In order to preserve regularity of numbering and

thus simplify the association of trunks on the bank and distributing terminal strips, jumpers should be terminated on bank terminal strips as follows:

(a) For groups complete on one board.
Jumpers to outgoing trunks should be terminated above the reversal form.

(b) For partial groups with reversal form on the originating or lower numbered bay.
On the lower numbered bay jumpers to outgoing trunks should be terminated on a bank terminal strip above the reversal form and jumpers to tie cables below the reversal form.

(c) For partial groups with reversal form on the succeeding or higher numbered bay.
On the lower numbered bay the jumpers to outgoing trunks should be terminated on a bank terminal strip above the one on which the jumpers to tie cables are terminated. On the higher numbered bay the tie cable jumpers should be taken from a bank terminal strip above the reversal form.

There will be a few conditions which will make it necessary or desirable to cross-connect between different distributing terminal strips, as follows:

(a) One or more trunks in a graded multiple partial group on board "A" but which do not appear

of the 100 row of [illegible] terminals for every selector

[illegible] distributing terminal assembly regardless

befose selectors on board "B" may be brought in a tie cable to board, "B" in order to be included in an outgoing cable from board "B."

(b) In case a group of 20 selectors is split between two boards it would be necessary, on one board, to jumper from one bank terminal strip to an outgoing trunk terminal strip and to a tie. cable terminal strip. It is felt, however, that two jumpers on one terminal can be accommodated on a Western Electric Company type distributing terminal strip better than on a bank terminal strip. It will, therefora, be considered standard, should this particular case arise, to jumper from the bank terminal strip to the outgoing terminal strip only and from there to the tie cable terminal strip and thus avoid double jumpers on the bank terminal strip.

Wiring for Vacant Level Tone and Intercepting Trunks

Five vacant level tone and two directory error intercepting trunks will be terminated on the middle terminal strip of the top row of distributing terminals on every selector board equipped with the dietributing terminal assembly regardless of whether or not there are any vacant levels at the time of installation.

These seven trunks will be multipled once on the

terminal strip in order to provide two appearances. The left-hand appearance will serve levels 1 to 5 inclusive and the set of jumpers will be run through the left-hand distributing rings and terminated on the lowest numbered vacant or intercepted level, Similarly, the right-hand appearance will serve levels 5 to 10 inclusive and the jumpers will be run through the right-hand distributing rings and terminated on the highest numbered vacant or intercepted level.

In case there are two or more vacant or intercepted levels in either half of the assembly, the additional levels will be connected to the one on which the jumpers from the distributing terminal strip are terminated, This connection will be made with distributing frame wire looped through the nearest distributing ring. For this connection, a location should be chosen which will result in the least interference with other jumpers.

With the arrangement outlined above there will never be more than two sets of jumpers between the bank terminals and the distributing terminals for vacant level purposes,

Advantages

When it becomes necessary to make changes in the grouping of selectors at the time of installing additional equipment or for other reasons, the distributing terminal assembly affords a simple means for accomplishing the desired

results. All minor changes can ordinarily be effected by rearrangement of the vertical strap wires and cross-connections and the necessity for distributing the switch-board cables should be infrequent.

The terminal assembly will be simple and substantial. Drawing No. 707-137 shows a form which may be used in making up the terminal assembly drawing. Methods of indicating certain typical connections on the frame are shown.

Maintenance advantages result from the regularity and accessibility of the arrangement and from the fact that the tip, ring and sleeve terminals of each circuit are adjacent. In general, the separation of the terminal strips for the switchboard sable and those for the bank multiple cable makes all terminals more accessible and their association with any particular circuit more evident.

With the present arrangernent, efforts to locate trouble by isolating certain switches may result in putting a large group of selectors oüt of service unless temporary wiring arrangements are used. On the distributing terminal assembly, the isolation of any particular trunk is easily accomplished by unsoldering the vertical strap wires from the proper bank terrninals. Other trunks in the group need not be disturbed.

On both the present and new type terminal assemblies the terminal stripe are soldered to the terminal

cables in the shop, The flat type strips of the present type must, however, be piled in proper order with the various other strips to which the long and short down multiple and other cables are soldered, whereas on the new type of placing of the bank terminal strips in regular order is a simple matter,

In addition to these installatfon and operating advantages there should be a substantial saving in the cost of engineering and drafting and of the rearrangement of trunk grouping, particularly at the time of installing additional equipment.

The distributing terminal assembly affords a simple means for employing graded multiple groups. With the cross-connection facilities provided by tne distributing terminal assembly, a fairly even distribution of traffic over succeeding sub-groups of switches is possible when graded multiple is used.

Limitations

Outgoing trunk circuits having four or more wires are not provided for in the design of the distributing terminal assembly as there is not sufficient space for bank terminal strips with more than three points, Terminal assemblies of the present type with flat type terminal strips will, therefore, continue to be furnished on frames in which such circuits appear. For this reason, it will be desirable to segregate, as far as possible, all selectors which are

associated with outgoing trunk circuits having more than three wires.

It is not convenient to arrange for multiple slips without sacrificing other advantages. The introduction of multiple slip would necessitate the use of special forms between each row of bank terminals, which would not only increase the first cost but nould also detract fram the regularity and conveniecce of arrangement of the assembly. A reversak in the middle of each group may be used, howeoer, without disadvantage.

Elimination of Divisions of Five Selectors

The distributing terminal assembly is not adapted to the use of divisions of five selectors because the bank terminal strip occupies a somewhat greater amount of vertical space than the flat type terminal strips which are required for the same purpose. Any convenient layout consequently provides for 24 rows of bank terminal strips only, which is just sufficient to serve divisions of ten selectors throughout. While this appears to be a limitation of the distributing terminal assembly, it does not seem to be a serious disadvantage since the flexibiiity of this frame permits the use of graded multiple arrangenents for those cases where divisions of five have been standard nith the present type terminal assembly.

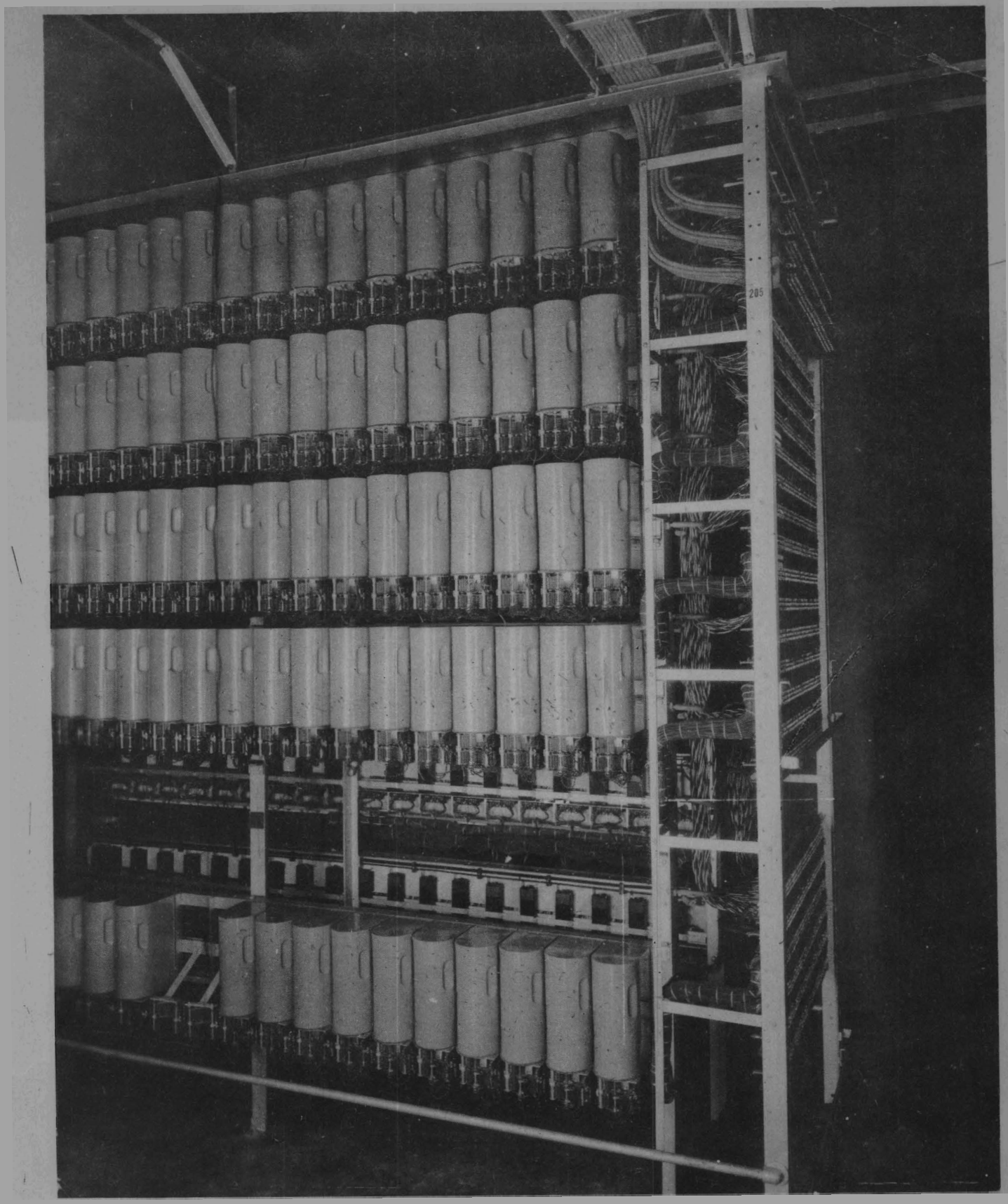
Furthermore, some saving in the cost of the bank equipment will be realized through the elimination of divisions

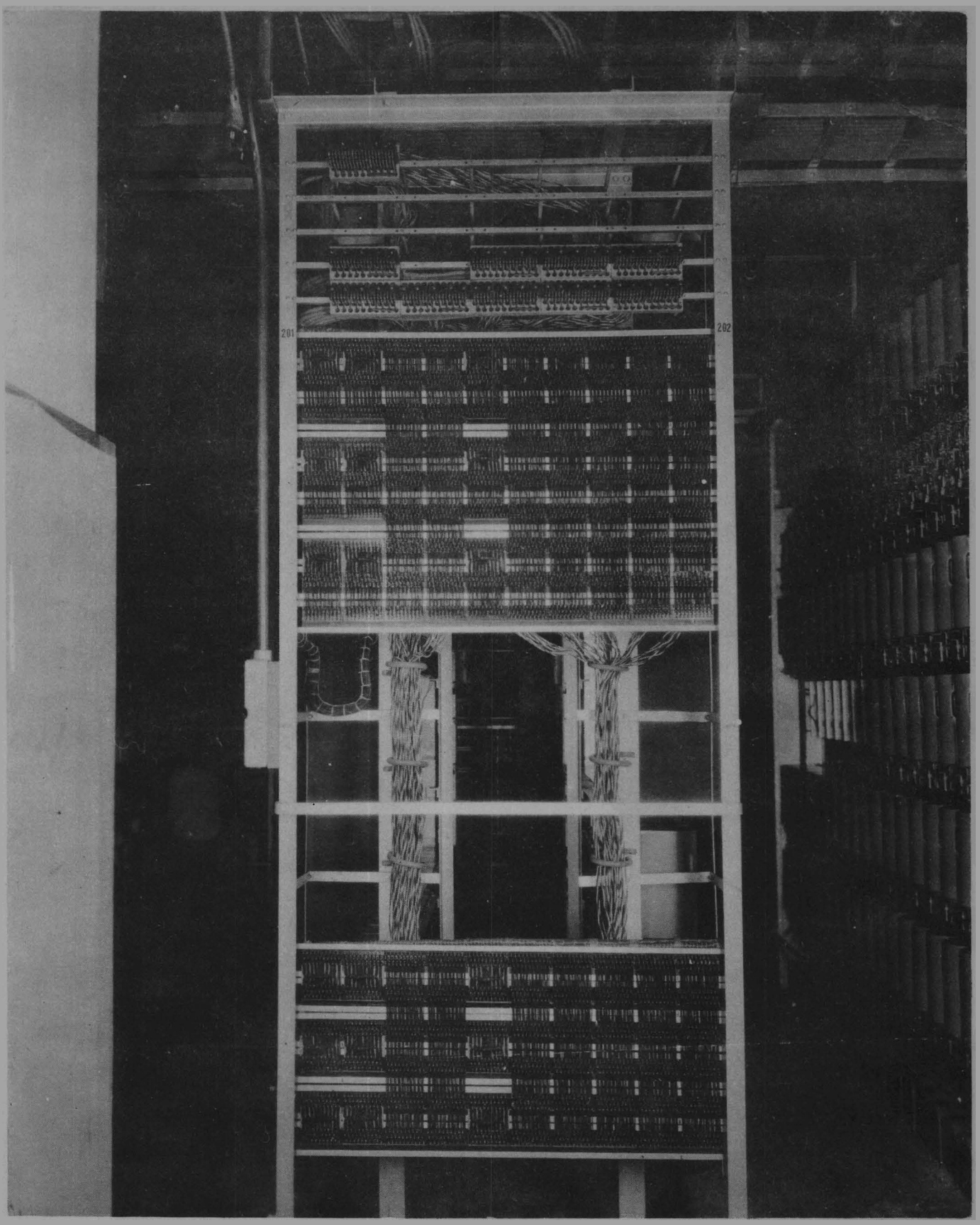
of five, since these are proportionately more expensive than divisions of ten.

With divisions of ten a regular arrangement of the frame is made possible in which the terminals for any particular half-shelf of selectors will be in the same definite location on all frames,

A variety of special terminal cable forms is required with the present arrangement. The elimination of divisions of five will reduce the number of forms required.

WGF/RE





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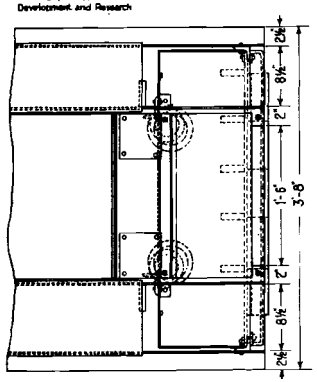
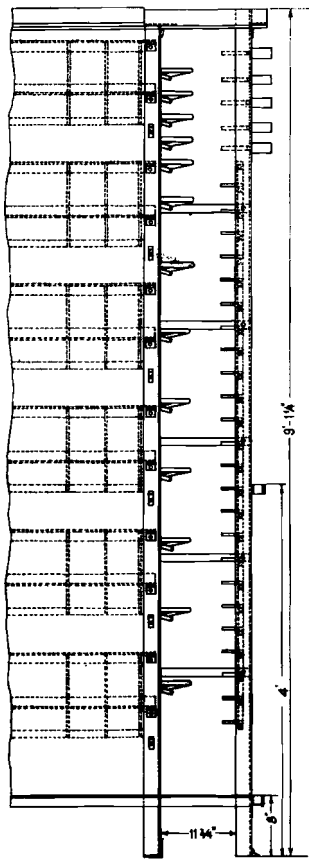
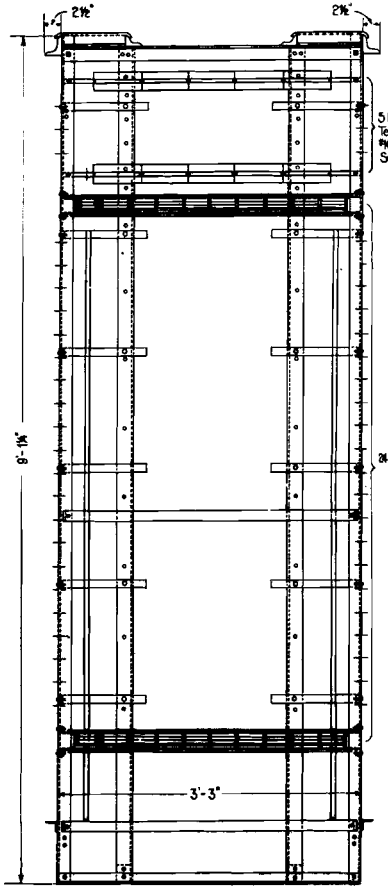
STEP BY STEP MACHINE SWITCHING SYSTEM
DISTRIBUTING TERMINAL ASSEMBLY

Engineer
Draftsman
Checked by
Log No. PHM7 9-25-58
ISSUE 1
Changed back cable guiding and panel legs
Log No. PHM4 4-29-59
ISSUE 2







TERMINAL END VIEW
(WITH DOORS OMITTED)

5 Rows Distributing Terminal Strips #100 D W.E.Co. See Fig. 1 and Fig. 3

26 Rows-Bank Terminal Strips See Fig. 2 and Fig. 3

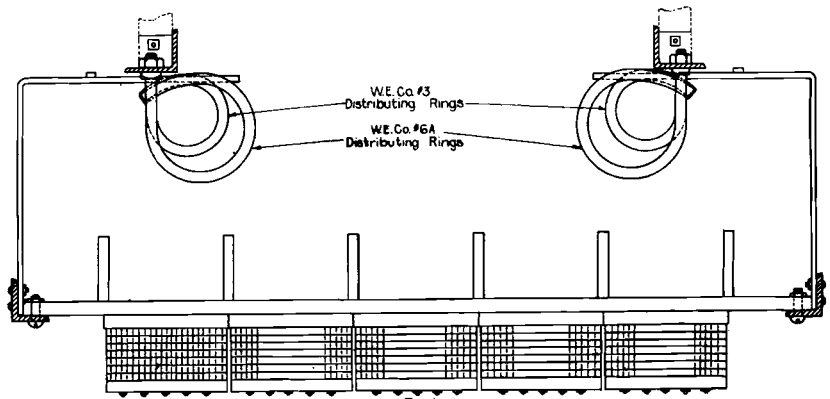


FIG. 1
#100-DW. E. Co. TERMINAL STRIPS
Distributing Terminal Strips

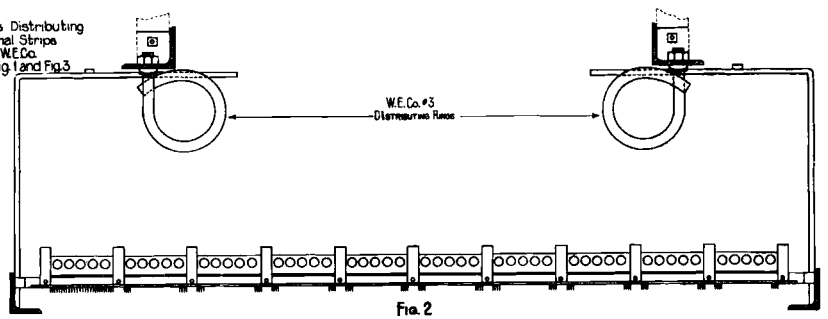


FIG. 2
BANK TERMINAL STRIPS

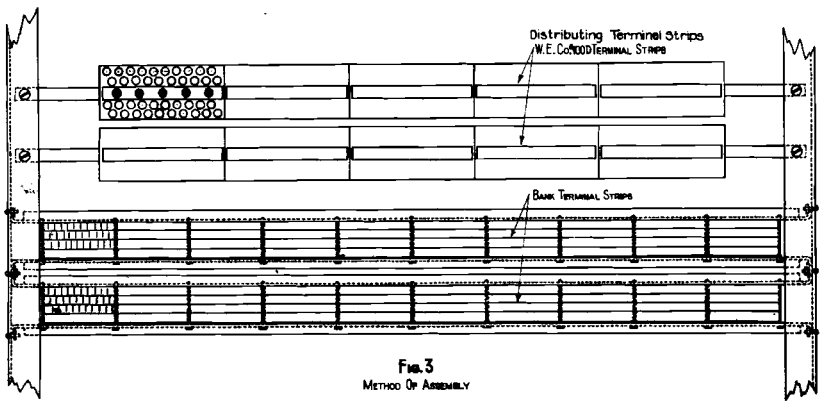


FIG. 3
METHOD OF ASSEMBLY

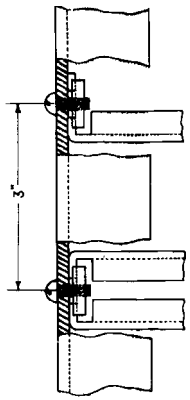


FIG. 4
SHOWING METHOD OF MTG.
BANK TERMINAL STRIPS

—NOTE—
Where 3 Pt. Terminal Strips are desired use #100A W.E. Co. Terminal Strip.

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FORM FOR TERMINAL ASSEMBLY DRAWING

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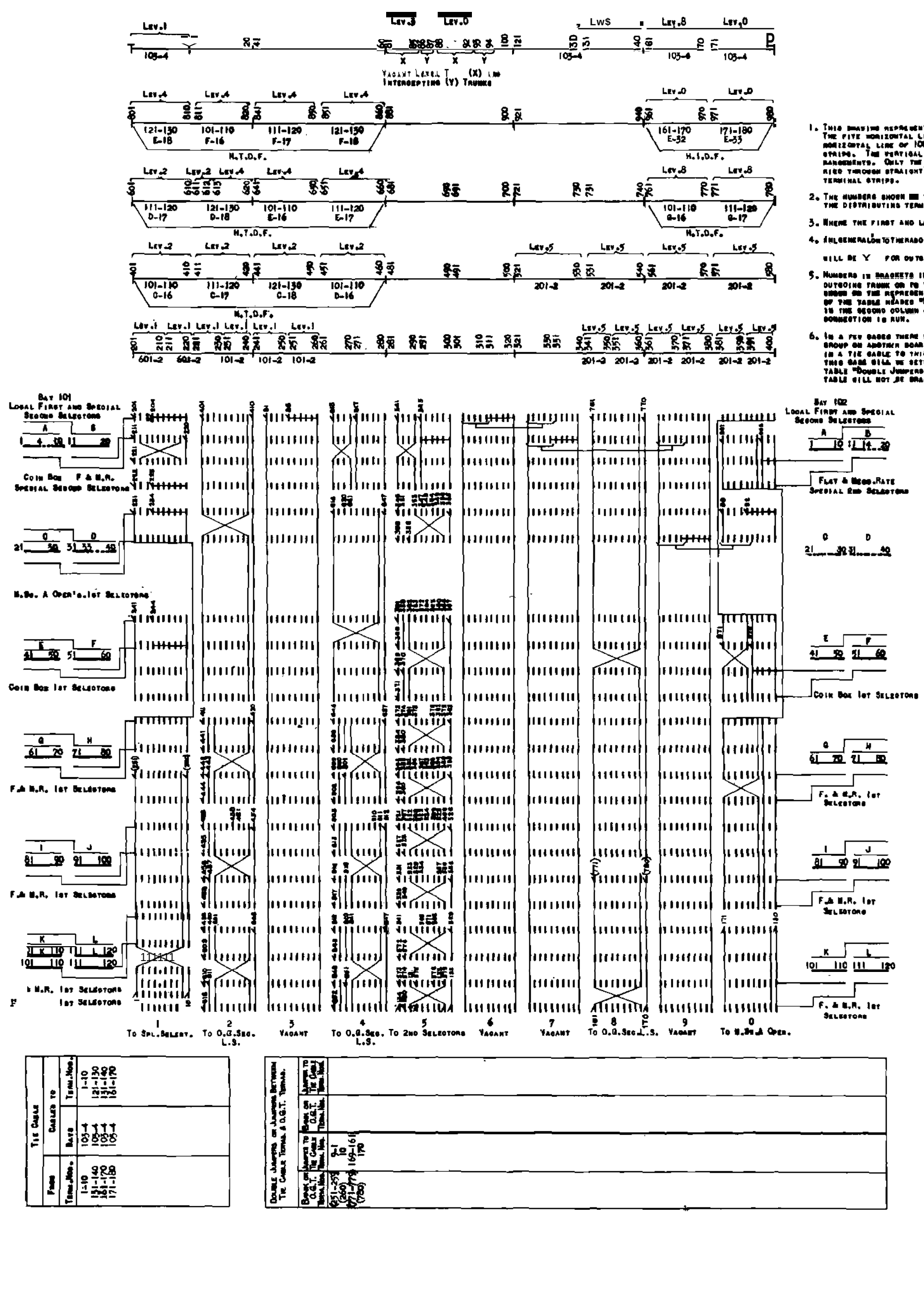
INFORMATION



- NOTES -

1. This drawing represents the distributing terminal assembly and indicates the multipling arrangements. The five horizontal lines at the top represent the 100 type W.E.Co. distributing terminal strips. Each horizontal line of 100 dashes represents the 100 trunks appearing on each horizontal row of bank terminal strips. The vertical lines connecting the dashes represent the strap wires and show the multipling arrangements. Only the first and last strap wire of a group to be reversed (and the 10th wire which is carried through straight) are shown. The horizontal lines connecting dashes represent strapping on the bank terminal strips.

2. The numbers shown on the representation of the bank terminal strips are the numbers of the terminals on the distributing terminal strips to which the trunks are cross-connected.

3. Where the first and last numbers are shown on a trunk group, the numbering is consecutive

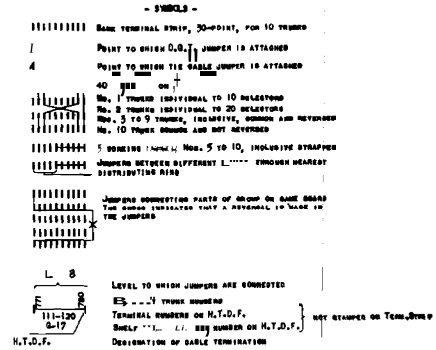
4. In general, on the ... Nos. 1-200 ... 201-1000 will be Y for outgoing trunks.

5. Numbers in brackets indicate that the associated trunk is cross-connected to a tie cable as well as to an outgoing trunk or to two tie cables. The outgoing trunk number or one of the tie cable numbers only is shown on the representation of the bank terminal strips. The same number is also shown in the first column of the table headed "Double Jumpers or Jumpers Bet. Tie Cbl. Term. & O.G.T. Term." The corresponding number in the second column of the table indicates the tie cable terminal strip terminal to which the second cross-connection is run.

6. In a few cases there will be one or more trunks (in a graded multiple group) which will appear in a partial group on another board but which will not appear before selectors on this board but which will be brought in a tie cable to this board to reach an O.G.T. cable outgoing from this board. The cross-connection in this case will be between a tie cable terminal and an O.G.T. terminal only. Such cases are shown in the table "Double Jumpers or Jumpers Bet. Tie Cblj. Term. & O.G.T. Term." The numbers in the first column of the table will not be bracketed.

7. The table headed "Tie Cable" shows in the first column the terminals on this board on which the tie cables terminate in the second column the other board and in the third column the terminals on that board on which the tie cable terminate.

- SYMBOLS -



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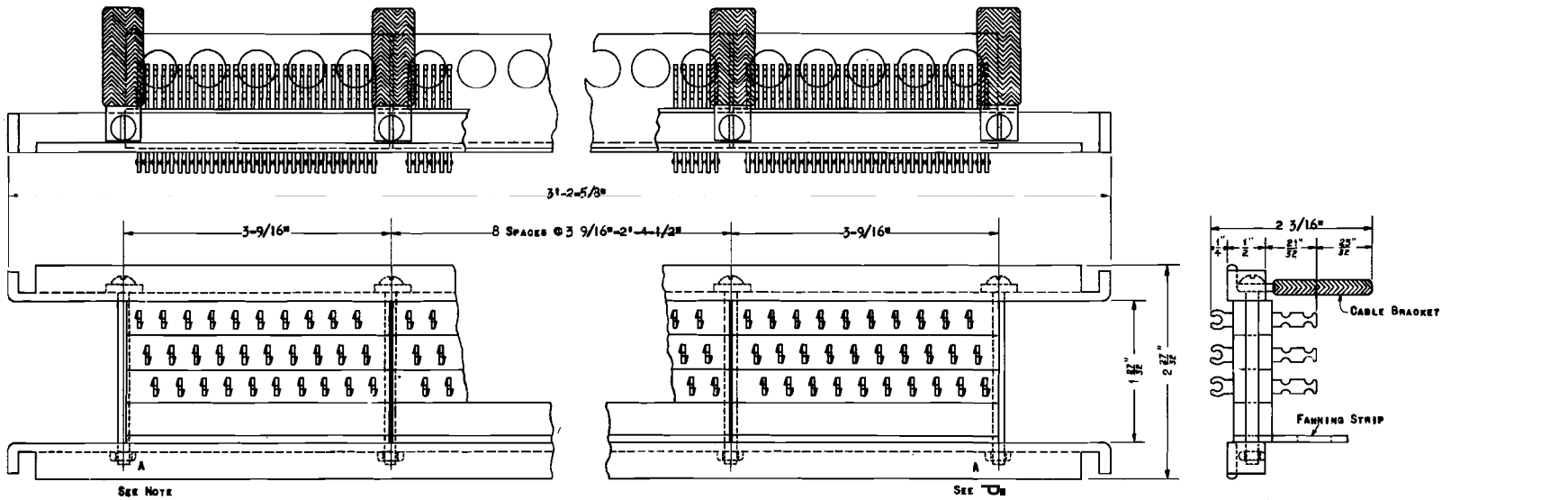
DEPARTMENT OF
DEVELOPMENT AND RESEARCH

DISTRIBUTING TERMINAL ASSEMBLY

BANK TERMINAL STRIP ASSEMBLY

707 - 121
INFORMATION

ENGINEER
DRAFTSMAN
CHECKED BY
L #P-11165, 9/20/23
ISSUE 1



- NOTES -

SELF DESIGNATION LETTERS STAMPED IN BLACK, 3/8 HIGH, AT HALF OPEN OF ROW SERVING SELVES IN LEFT HAND SIDE OF FRAME AND IN RED AT HAND END OF EVERY FOURTH SELVES IN RIGHT HAND SIDE OF FRAME.

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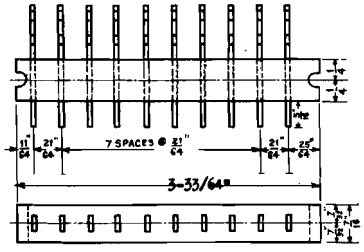
DISTRIBUTING TERMINAL ASSEMBLY

BANK TERMINAL STRIP—DETAILS

707 - 122
INFORMATION

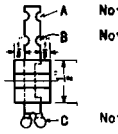
Engineer AWG
Draftsman C.B.Z
Checked by
✓
Log No P 11160-9-E8-25
ISSUE 1



MOULDED BAKELITE (BLACK)

TOP AND BOTTOM ROW DETAILS

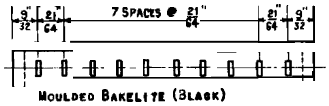
FIG. 1



NOTCH A FOR DISTRIBUTING FRAME WIRE

NOTCH B FOR TERMINAL CABLE FROM SELECTOR BANKS

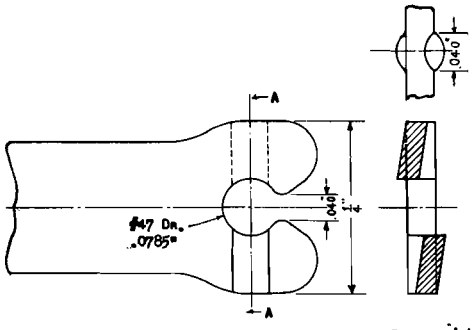
NOTCH C FOR VERTICAL STRAP WIRES



MOULDED BAKELITE (BLACK)

MIDDLE ROW DETAIL (OTHER DIMENSIONS SAME AS IN FIG. 1)

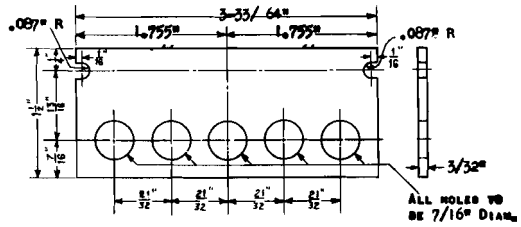
FIG. 2



ENLARGED VIEW OF END OF TERMINAL

FIG. 3

SECTION A-A



BANK TERMINAL FANNING STRIP

FIG. 4

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DISTRIBUTING TERMINAL ASSEMBLY

DESIGNATIONS

DISTRIBUTING TERMINAL STRIPS

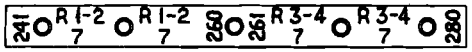
707-136
INFORMATION

ENGINEER grf
DRAFTSMAN
CHECKED BY MLG
L #P-13905, 12/2/24
ISSUE 1.
DESIGNATION "NT 100" CHANGED TO "HTDF"
L #P-15135, 4/25/25
ISSUE 2.

(See Note 7)
FIG. 1

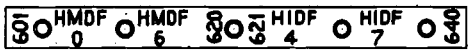
(See Note 8)
FIG. 2

(See Note 8)
FIG. 3



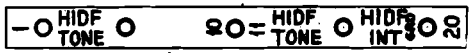
(See Note 12)
FIG. 4

(See Note 9)
FIG. 5



(See Note 9)
FIG. 6

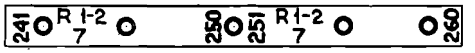
(See Notes 10 & 16)
FIG. 7



(See Note 11)
FIG. 8

(See Note 7)
FIG. 9

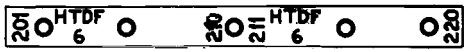
(See Note 8)
FIG. 10



(See Note 12)
FIG. 11

(See Note 9)
FIG. 12

(See Note 9)
FIG. 13



(See Note 9)
FIG. 14

(See Notes 10 & 16)
FIG. 15

- NOTES -

1. The typical designations shown on Figures 1 to 15 incl. shall be stamped on the face of the terminal strip clamping strips.
2. The designations shall be stamped in red with 3/16" characters.
3. Figs. 1 to 7 incl. show the method of designating 6 point terminal strips.
4. Figs. 8 to 15 incl. show the method of designating 3 point terminal strips.
5. Distributing terminal assemblies for selector frames are designed to mount W.E. Co's. code 100-A (3 point terminal strips) or code 100-D (6 point terminal strips).
6. On all figures, the numbers designated vertically are the trunk numbers.
7. Figs. 1 and 9 show typical designation of trunks to succeeding switches. The top horizontal row of characters comprising one letter and three numerals denote the shelf and bay number on which the succeeding switches are located. The single numeral under each shelf and bay designation indicates the level from which the jumpers are run. (See Note 10)
8. Figs. 2, 3 & 10 show typical designation of trunks to connectors. For 4 digit units, the "thousand" and "hundred" digits only are shown, as indicated by Figs. 3 & 10. For 5 digit units, the "ten thousand", "thousand" and "hundred" digits are shown, as indicated by Fig. 2. Where a particular connector group is split into two or three sub-groups for large P.B.X. groups, the numerical designation shall be followed by a suffix letter designating the regular and overflow shelves. This is illustrated in Fig. 2 since the "hundred" group of a particular group of connectors always corresponds to the level number of the preceding selector multiple, the level number from which the jumpers are run is indicated by the last digit of the connector group numbers. Therefore, no separate level designation will be required.
9. Figs. 5, 6, 12, 13 & 14 show typical designation of trunks to H.I.D.F., H.M.D.F. and H.T.D.F. the latter is for trunks to O.G. secondary line switches. The others are for misc. manual trunks etc.
10. Fig. 7 and 15 show typical designation of tie cables to multiple of like selectors on other frames, for associating partial groups.
11. Fig. 8 shows the designation for the first terminal strip of the top row of strips for all frames on which the vacant level tone circuits are terminated.
12. Fig. 4 and 11 show typical designation of trunks which go direct to repeaters.
13. Fig. A shows arbitrary numbering scheme when all term. strips are 3 point.
14. Fig. B shows arbitrary numbering scheme when all term. strips are 6 point.
15. Where both 3 point and 6 point strips are required on a particular frame, they shall be numbered to correspond to the numbering in Fig. A or B depending on their relative positions on the assembly.
16. The top horizontal row of numbers shown on Figs. 7 & 15, indicate the bay numbers of the frame on which the tie cable terminates.
17. The level designation will be omitted on terminal strips on which tie cables serving more than one level are terminated.

1	20,41	60,81	100,121	140,161	180
801	820,841	860,881	900,921	940,961	980
601	620,641	660,681	700,721	740,761	780
401	420,441	460,481	500,521	540,561	580
201	220,241	260,281	300,321	340,361	380

FIG. A
NUMBERING ARRANGEMENT FOR 3 POINT TERMINAL STRIPS

1	40,41	80,81	120,121	160,161	200
801	840,841	880,881	920,921	960,961	1000
601	640,641	680,681	720,721	760,761	800
401	440,441	480,481	520,521	560,561	600
201	240,241	280,281	320,321	360,361	400

FIG. B
NUMBERING ARRANGEMENT FOR 6 POINT TERMINAL STRIPS

STEP-BY-STEP MACHINE SWITCHING SYSTEM

EQUIPMENT ENGINEERING NOTES

DIVISION 1 ---GENERAL

DIVISION 11---TYPE OF EQUIPMENT

DIVISION II--(CONTINUED)

DIVISION III---CIRCUITS

DIVISION IV--AMOUNT AND ARRANGEMENT OF EQUIPMENT

DIVISION IV--(CONTINUED)

DIVISION IV (CONTINUED)

DIVISION IV (CONTINUED)

DIVISION V - CABLING AND WIRING

DIVISION V - (CONTINUED)

DIVISION VI - BUILDINGS AND FLOOR PLANS

DIVISION VIII - MACHINE SWITCHING "A" BOARD

DIVISION IX --- EQUIPMENT REQUIRED FOR MANUAL OFFICES IN STEP BY STEP AREAS - CALL INDICATOR EQUIPMENT

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Dec. 1, 1922.

DIVISION IX - EQUIPMENT REQUIRED FOR MANUAL OFFICES IN STEP-BY-STEP AREAS

PART II - DIALING EQUIPMENT

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August 1, 1.920,

DIVISION X - TOLL SWITCHBOARDS FOR MACHINE SWITCHING AREAS.

GENERAL.

General Features of the Step-By-Step Machine Switching System.

The Western Electric Company is prepared to furnish to the Associated Companies central office equipment of the step-by-step machine switching type. The term "step-by-step" is applied to this system owing to the action of the selecting mechanisms which are moved by means of electro-magnets one step at a time. The equipment enables a subscriber to complete simple calls without the aid of an operator, and is so arranged that the proper charge will be made in each case.

It is the purpose of these engineering notes to describe the step-by-step machine switching central office equipment, giving sufficient information in regard to the size, arrangement and functions of the various parts of the equipment to aid the telephone companies in engineering and ordering such central offices.

A subscriber's station in a step-by-step machine switching system is provided with a dialing mechanism which permits a subscriber to call the desired number. Mechanical selectors are provided at the central office for completing a connection from the calling line to the station corresponding to the number dialed. The selectors are described in detail in Division II, Section 3m, of these notes. Each pulse in a digit dialed directly causes the selecting mechanism on one of the selectors to advance one position, the selections thus being made in accordance with the decimal system. The multiple bank of each selector contains 100 sets of terminals with which the brushes of the selecting mechanism make contact. The terminals are arranged in ten groups or levels of ten sets each.

This arrangement limits the number of groups of trunks to which a particular selector has acceee to ten and the number of trunks in any one of the groups to ten.

The step-by-step system is intended primarily for use in single office districts, although it is also suitable for use in small multi-office districts. Used in single office or in small multi-office districts, the system compares favorably nith the panel type system in point of cost and in flexibility, and it is thought that the step-by-etep system should be considered for all single office dietricts and for multi-office districts where the number of offices in the ultimate will not exceed five or six.

If there are any two-party message rate lines in a district where the step-by-step system is employed, such lines are handled on a manual basis, since at present no circuit is available for operating lines of this sort on an automatic basie where this system is used. If a case is encountered where a considerable amount of two-party message rate service is to be rendered and where it would nppear desirable to adopt the step-by-step machine switching system, it is suggested that the question as to the proper course to follow be taken up with the American Telephone arid Telegraph Company.

In a single offioe district tha equipment must be arranged to care for completing calls from orie subscriber to another, for completing special service calls where an operator is required, such as toll calls, information calle. complaint calls, etc., and for completing calls from the operator to the subscriber. Since, where the step-by-step system is installed in multi-office districts, not all offices in the district will be changed from a manual to a

machine switching basis at the same time, it is also necessary in such districts to provide means for completing calls originating in a manual office for subecribers in a machine switching office, and for completing calls originating in a machine switching office for subscribers in a manual office,

In either single or multi-office districts the equipment is arranged so that the ringing of a machine switching subscriber's bell is automatic, an audible ringing signal being given the calling eubscriber while the ringing is in progress. When the receivers are replaced at the completion of the conversation the central office equipment is automatically restored to normal and the lines of both the called and calling parties are freed for further use.

A busy tone is sent to the calling subscriber in case the called line is busy. If the call is for a station that is out of order, the equipment is arranged so that the calling subscriber may be connected to a trouble operator, who makes a report to him. If the subscriber calls a non-working line or station, the connection is completed to an intercepting operator, who gives the subecriber such information as is necessary for him to obtain the party he desires.

If the callicg etation is an individual measured service station the central office equipment is arranged to operate a message register automatically. No method is available at preeent for measuring service by means of registers on party lines where this type of machine switching system is uaed. Accordingly, where party line measured service is provided it is necessary to ticket the calls, and manual positions are provided in the machine switching office

for handling calls from lines of this class. Calls incoming to such lines are handled mechanically in the usual manner.

Where a calling station is of the prepayment coin box type, the equipment may be arranged to collect or return the coins automatically. In some cases, however, it may be desirable for commercial reasone to handle calls from coin box linee on a manual basis, and in such cases the lines are terminated in answering jacks at manual positions, although calls incoming to the coin box linee are handled mechanically in the usual manner. It may also be found desirable to handle originating coin box traffic temporarily on a manual basis if such traffic is small in amount and can be handled at manual positions not otherwise fully loaded.

Rural lines are not at present to be handled mechanically, since euch linee must usually be operated on a magneto basis due to their electrical characteristics. Furthermore, the step-by-step machine switching equipment is not at present arranged for the code ringing required for lines of this type. Manual positions are therefore provided in the machine switching office for handling rural traffic, both originating and incoming. Mechanical subscribers reach the rural operator by dialing a suitable code.

Calls for information, complaint, etc., originating at machine switching stations are routed through the mechanical equipment to trunks terminating at manual positions by dialing the proper oode.

Calls from private branch exchanges are handled at the machine switching office in the same manner as calls from individual, lines. For calls to a P.B.X. the equipent is arranged to select

automatically an idle trunk in the P.B.X. group or to return a busy signal to the calling subscriber in caae all trunks are busy.

Calls originating at a party line station for other stations on the same line are completed by dialing a reverting code. The line is connected through the mechanical equipment to a reverting selector switch. After the calling party has dialed, he restores his receiver, and both his bell and that of the called party are rung. The bells continue to ring until the called party answers, or until the calling party trips the ringing by lifting his receiver.

Numbering Schemes:

Single Office Districts.

Step-by-step mackine switching offices are operated an a terminal per station basis, each subscriber's station, other than extension stations, and esch P.B.X. trunk line being assigned an individual call number and terminal. In single office districts this call number mag be a four digit number. The capacity of a single office unit with a four digit numbering scheme is eight thousand terminals, since it is considered undesirable to use numbers beginning with"0" or with "1".

The objectian to using numbers beginning with "0" is that the subscribers are liable to omit the"0"in dialing.

The uae of numbers beginning with "1" is undesirable due to the liability of an accidental interruption at the switchhook springs causing a "preliminary pulse" in the selecting circuit. The multiple arrangement of the selectors, described later under "Preliminary Pulses", guards against a wrong number being selected if a preliminary pulse is received, but the first level on first selectors is used to secure this guarding feature. This level, however, is available for routing

special service calls to operators as described later.

In single office districts where tha ultimate number of terminals is eight thousand or less, , the subscriber's stations and P.B.X. trunks rre assigned the four digit numbers from 2000 to 9999 and the calls are completed to the desired station or P.B.X. through a first selector, a aecond selector and a connector.

Where the number of terminals in a single office district exceeds 8000, all the stations or P.B.X. trunks in the district may be assigned five digit numbers. In this case, a call is completed to the terminal desired through a first selector, a second selector, a third selector, and a connector. An alternative method may be used in which 7000 of the terminals, as from 3000 to 9999, for example, assigned four digit numbers and calls are completed to them through first selectors, second seleotore, and connectors. Five numbers, from 20000to 29999, are then assigned to the terminals in excess of the first 7000, and calls are completed to them through first selectors, eecond selectors, third selectors, and connectors. With this arrangement, the capacity of the office is 17000 terminals. If this capacity is exceeded more than one level may be reserved for five digit numbers.

Trunks from the aero level at the first selectors are carried to answering jacks at manual switchboard positions known as zero operators' positions. In small offices it may be desirable to have the zero operators handle all classes of calls requiring manual operators, such as assistance calls. information calls, complaint calls, etc. In larger offices, however, it may be desirable to assign separate operator's positions for handling each class of service.

in such cases, three digit numbers are assigned to the operators other than the "0" operators, and they are reaohed through firet selectors, special second selectors and special third selectors.

Multi-Office Districts.

In multi-office districts each station is in general assigned a five digit number and calls are completed to the terminal desired through first selectors, eecond selectors, third selectors, and oonnectors. The zero and firet levels of the first selectors are reserved for the same reason as given above for single offioe districts, and are used for completing special service calls.

In some districte coneisting of one main office and one or two small outlying offices a saving may be effected by reserving several of the first selector levels in the main office for four digit numbers in that office and by assigning five digit numbers to the other terminals in the main office. One level is also reserved for trunks to each outlying offioe, the terminals in the latter being assigned four or five digit numbers depending on whether the number of terminals per office will ultimately be below or above one thousand. The first selector levels at eech outlying office correepond to the first selector levels in the main office. The economy effected by this scheme over that of assigning five digit numbers to all terminals in the diatrict lies in the faat that in some of the trains of selectors only two instead of three selectors are required. On ths other hand there may be a loss in efficiency in the inter-office trunks due to the fact that all of the trunks from a given outlying office to the main office cannot be run in a common

group. Where the traffic between the outlying offices and the main office is small and the losa in trunk efficiency is not great, however, this plan may result in the saving of enough selectors to warrant its adoption.

General Operating Plan.

Call from a Machine Switching Station to Another Machine Switching Station. Drawing No. 807-7 shows schematically the order of selection on a call from a machine switching station to another machine switching station. Figure 1 is the schematic for a call in a single office district where four-digit numbers are assigned to the subscribers' stations, and is down for the case where secondary line switches are not installed. Figure 2 is the schematic for an interoffice call from an office where five-digit numbers are assigned to the subscribers' stations in the district, and is shown for the case where secondary line switches are installed. It should be understood however, that the use of secondary line switches is not dependent on whether thr equipment is in a single or multi-office district.

Fig. 1. The subscriber's line terminates in the central office on a main distributing frame and is cabled to an intermediate distributing frame in the same manner as in manual offices. From the intermediate distributing frame the line is carried to the bank contacts of a plunger type line switch, one switch being provided for each line. The line switch provides means for connecting a calling line to the selectors required for completing the call. The switch corresponds to the answering jack in a manual equipment. A multiple of the subscriber's line is carried from the intermediate distributing

frame to terminal8 on the multiple banke of a group of connectors, these terminal corresponding to the multiple jacks in a manual equipment and providing means for completing incoming calls.

In offices where no seconäary line switches are provided, as shown in Figure 1, trunks are extended from the multiple banks of the line switches to the brushes of first selectors. Trunks from the multiple banke of the first selectors are extended to the brushes of second selectors, the trunks from any one level at the first selectors being terminated on selectors that have access to a particular 1,000 terminals. Trunks from the multiple banks of the second selectors extend to the bruehee of connectors, which are like seleotors except that after a particular level is selected, a particular set of terminals rather than any idle set of terminal8 in that level is selected. The multiple banks of the connectors provide terminale for 100 subscribers' stations (exclusive of extension stations) and P.B.X. lines.

Fig. 2. Figure 2 of the drawing shows the order of seleatfon for an interoffice call, The subscribers' lines terminate tn the same manner as described for Figure 1, but the trunks from the multiple banke of the primary line switches are extended to secondary link switches instead of to first selectors. The seconäary line switches are introduced for the purpose of reducing the number of first seleotors required, and they accomplish this by giving each line access to a large number of selectors (maximum of 100) instead of access to only a small number of selectore (maximum of 10).

From the nultiple banks of the secondary line switches trunks are extended to the brushes of first selectors. One of these c selectors chooses a group of trunks to one of the central office

units, or a group of trunks to operators for handling special service calls.

The trunks between line switches and selectors and between the various selectors in an office are three or four-wire trunks. In order to use a two-wire interoffice trunk, it is necessary to Introduce equipment known as a repeater for passing the dial pulses over the trunk and securing the necessary supervisory features. The outgoing interoffice trunke from the first selector multiple banks (or from outgoing trunk secondary switches where provided), are accordingly carried through repeaters as shown in Figure 2.

A reduction in the necessary number of trunks between two offices can be effected by employing what are known as outgoing trunk secondary switches at the originating office. The trunks from the first selector levels handling the interoffice traffic are terminated on switches similar to the secondary line switches used between primary line switches and first selectors. Without outgoing trunk secondary switches, an interoffice trunk group must be split into sub-groups of not more than 10 trunks each, whereas the secondary switches form the interoffice trunks into one or two large sub-groups, thus reducing the number of inter-office trunks and incoming aelectors required. The reduction in the number of trunks made possible by the use of the secondary switches may warrant their installation, particularly if the trunks are long.

The interoffice trunks terminate on the brushes of incoming second selectors in the called office. From the multiple banks of the second selectors, trunks are extended to the brushes of third selectors, the trunks from any particular level at the second selectors terminating on selectors which have access to a

particular 1,000 terminals. Brom the multiple banks of the third selectors, trunks are extended to the brushes of connectors, the trunks from a particular level at the third selectors terminating at connectors which have access to a particular 100 terminals.

Call from a Machine Switching to a Manual Station.

In general, the most desirable method of handling a call from a machine ewitching station to a manual station is by means of the "call indicator" system, which permits the machine switching subscriber to call the manual subscriber merely by dialing the manual subscriber's number. Drawing 807-10, Figure 1, ehows schematically the order of selection for calls handled in this manner. The order of aelection as far as the first selector is the same as on a cail for another machine switching subscriber. Trunks are extended from the multiple banks of first selectors, directly or through outgoing trunk secondary switchee, to repeaters. The outgoing trunks from the reyeaters terminate at the manual office in plug-ended trunks at a call indicator position. A call indicator, consisting of lampe for displaying the called number is provided at each call indicator position. Aeeociated with each call indicator is a number of "recorders", the

functions of which are to receive the dial pulses and to etore them until the operator is ready to handle the call, and to translate these pulses in such a manner as to set up the desired number on the call indicator. With each incoming trunk there is associated a recorder selector, the function of which is to connect its trunk to an idle recorder as soon as the trunk is seized at the outgoing end. When the subecriber has completed dialing, an "assignment" lamp associated with the trunk at the incoming end is lighted. When the operator is ready to handle the call, she presses a display key associated with the trunk and the called number is displayed. The connection is then completed in the same manner as at regular manual trunk positions. Call indicator equipment is arranged to display any call numbers below 10,000 with or without party lines letters, and to display call numbers above 9,999 without party line letters. Where lines above 9999 are operated, a separate group of trunks to the manual office is required to handle the traffic to these lines. A separate group of recorders for each position at which these lines are operated is also required. Details of the call indicator method of operation are given in G.E.C. No. 1076.

In a manual office where the amount of traffic incoming from machine switching offices is not sufficient to warrant the expense of call indicator equipment or where the office is to be converted to machine switching within a short time, answering jacks may be inatalled at

"A" operators' positions for terminating trunks from the machine ewitching offices. In this case, the machine switching subscribers dial either a code or the entire called number to reach the manual office, and the call is then handled on the same basis as a ringdown call from a manual office. Operation under this method is more costly and the service given is lese satisfactory than when call indicator equipment is wed,

In some cases where a manual office serving individual or jack per station lines ie to be converted to machine switching in the near future, it may prove economical to install machine ewitching selectors and connectors in the manual office instead of call indicator equipment, provided the switches may be installed in what will be their permanent location after the conversion. By this means, incoming traffic from machine switching offices can be handled on a machine ewitching basis.

Call from a Manual to a Machine Switching Station, Figure 2 of drawing 807-10 shows the order of selection on a call originated in a manual office for a subscriber in a machine ewitching office. The manual operator receives the call from the subscriber in the regular manner and selects an idle trunk in the outgoing group to the machine

switching office. The operator's poeition is equipped with a dial and each cord circuit at the position is provided with a locking "dial key." When the dial key of a particular cord circuit is thrown, the dial is connected to the front cord of that circuit and the operator may then dial over the machine switching trunk to which the cord is connected, Thie arrangement for aeeociating the dial with the cord circuits is known as the "dial key" plan and is considered etandard. Details of the method of operation with this arrangement are given in G.E.C. 1076.

An alternative arrangement for associating the dial with the cord circuits is known as the "listening key" plan. Under thie plan when the listening key of a particular cord circuit is operated and the dial is rotated from normal position, the latter is locked on that cord until the operator depresses a maeter releaee key or until the called party answers. Thie plan requires an extra pair of listening key contacts and an extra relay per cord circuit. Brom an operating standpoint, there is thought to be but little to choose between the dial key and listening key methods, but the cost of the relay equipment necessary under the listening key plan and the extra coet involved

in engineering and installing this equipment is considerable, and for these reasons the listening key plan is not regarded as standard.

In cases where the traffic trunked to machine switcting offices is light or where the manual board is soon to be replaced, it may be found economical to equip each position with an extra cord connected to the dial, known as a "dial cord*, and to provide each outgoing trunk to the machine switching offices with an extra jack, known as a "dial jack", mounted above the regular trunk jack. Before dialing, it is necessary that the front cord of the pair used in answering the subscriber be inserted into the jack of an idle trunk and that the dial cord be inserted into the associated dial jack. This method of dialing in general contemplatea that one group of trunks individual to each operator or each two operators will be provided, and that after a call hae been dialed the operator will preselect the next trunk to be used by trtnsferring her dial cord to the dial jeck of that trunk, doing this, as far as possible, as an overlap operation.

In order to assist an operator in selecting an idle trunk to a machine switching office, a master buey tone is provided if the group consists of more than ten trunks. Where a group consista of thirty or more trunks, the ten trunks that are connected to the first ten or to the last ten jacks in a strip are so wired that if all ten become busy a distinctive group busy tone is placed on the first or on the eleventh

jack of the strip. In similar manner, if there are less than thirty and more than ten trunks in a group, the tone is placed on the firet, sixth, eleventh and sixteenth jacks of each strip.

The trunks at the machine switching office end on incoming selectors, and the call is completed in the same manner as though a subscriber had dialed.

Toll Switching Trunk Connections to a Machine Switching Office. Drawing No. 807-9 shows the order of selection on a toll switching trunk connection from a long distance office to a machine switching office. Figure 1 shows schematically the connection in a district which is not expected to require more than one unit within the ultimate period. In thia case a separate group of switching trunks is provided for each 1000 terminals. These trunks terminate on "toll transmissiona selectors and are equipped to give repeating coil transmission. The different levels of the selectors route the calls to different groups of *toll connectors", each connector of a group having access to a particular 100 terminale. A sufficient number of toll connectorr is

provided for each 100 terminals to care for the maximum number of simultaneous toll connections to these terminale. Where desirable, "combination" connectors may be in-etalled which may be used for either toll or local connections. All or part of the connectors having access to a particular 100 terminals may be of the combination type.

Figure 2 shows the order of selection in a multi-office district or a single-office district which is expected ultimately to require more than one unit. In this case the toll switching trunks terminate on "toll incoming" eelectors. Each level on the toll incoming selectors routee calls to toll transmission selectors having access to a particular 1000 terminals. The trunks to these selectors are equipped to give repeating coil transmission. The multiple banks of these selectors lead to toll or combination connectors which are provided as described in connection with Figure 1.

Special Service Calls - Single Office Dietrlcts. Drawing No. 807-8 shows the order of selection for special service calls, including calls to toll recording operators. The order of selection up to the first

selector is the same as for a call to a subscriber. If all of the special service calls that require an operator are handled at one position or at positions of one class, trunks will be extended from the zero level at the first selectors to the manual positions, and the operators will be called by dialing zero. If it is desired to segregate the various classes of calls, auch as information calls, complaint calls, toll oalls etc., the special positions, other than the zero operators' positions, will be assigned 3-digit codes and reached through the first level of first selectors, the first level of special second selectors and through special third selectors. The zero operators' positions will still be reached over trunks from the zero level at the first selectoro.

Reverting calls are handled by dialing a 4-digit code and the reverting call switch used for reverting ringing is reached through the first level at the first selectors, the first level at special second selectors and the ninth level at special third selectors.

The preferred method of handling police, fire and ambulance calls is to assign regular subscriber's numbers to the telephones at the fire station, police station or hospital. Other methods are to assign 3-digit codes for such calls and to route them to special operators as in the case of other special service calls, or trunks may be extended from the special third selectors direct to telephones at the fire station, police station, or hospital.

Special Service Calls--Multi-office Districts. In districts where there is no AB toll service. or in districts where AB toll service is given but where the checking multiple, described later in these notes, is not employed for cehcking the number of a subscriber

originating an AB toll call, all special service positions may be centralized at one of the offices in the district. In a district where AB toll service is given and checking multiple is used, the AB toll and zero operators are located at their respective offices and the other classes of operators may be centralized.

The different classes of positions are reached by dialing their respective codes, as described above for single office districts, the calls being routed through the first levels of first and special second selectors, and through third selectors. On an interoffice call to a centralized position, the connection also includes the repeater in the interoffice trunk.

Preliminary Pulses. A special arrangement of selectors is used to guard against establishing a wrong connection in case of an unintentional momentary interruption of the subscriber's line at the switchhook springs in removing the receiver, causing a "preliminary pulse". A preliminary pulse has the effect of prefixing the digit "1" to the number dialed. Trunks are extended from the first level of the first selectors to the brushes of special second selectors as shown on Drawing No. 807-8. All levels of the special second selectors except the first level are multipled with the correaponding levels at the first selectors. Trunks from the first level of the special second selectors are extended to special third selectors, and trunks from the first level of the special third selectors are extended to auxiliary third selectors. All levels of the auxiliary third selectors except the first level are multipled

with the corresponding levels at the special tnird selectors. If a preliminary pulse occurs the calling line is connected through the first level of a first selector to a special second selector. If the call is for a subscriber or for a zero operator tne first digit dialed will be some number other than "1", and this digit will select at the sgeoial second selector a level which is multipled to the corresponding level at the first selectors and tne call will be completed in the usual manner. If the call is for an operator other than a zero operator the first two digits dialed will each be "1". On such a call the first digit dialed will cause the special second selector to extend the connection through its first level to a special third selector and the second digit dialed will cause the special third selector to extend the connection through its first level to an auxiliary third selector. The third digit dialed will be soae number other than "1", and this digit will select at the auxiliary third selector a level which is multipled to the corresponding level at the special third selectors and the call will be completed to the operator in the usual manner.

Naming of Central Office Units.

Experience in engineering step-by-step machine switching central office equipment has indicated that considerable confueion may be avoided by giving names to the machine switching units when first engineered and by selecting, if practioable, names which can be permanently retained. This practice has been followed on manual and panel equipment and it is desirable that auch a practice be followed in connection with step-by-step installationa. It is recommended that the practice outlined below be followed:

(1) Where only one unit (a unit being understood as ten thousand terminals or less) is to be inetalled in a building, one name should be given to all of the equipment.

(2) Where, in a five digit area, two or more units are to be installed in the same building, it is recommended that the following practicea be followed: If the distributing frames and racks for two or more of the units are common, and if a part of the switch equipment is also used in common, assign only one name to those units. Otherwise, assign a separate name to each unit. In the latter case, the main distributing frame, machine switching "A" board, desk equigmedt, power plant, etc., may be common to several units, and such common equipment should

be ordered under the name of the first unit installed.

(3) Where the machine switching equipment is installed on a combined four and five digit basis, and is all located in one building, one name should be given to the equipment.

The practice of assigning names is not intended to affeat the numbering scheme for a machine switching area, and where numerical office codes are used, which will be the usual case for step-by-step areas, the units should be named only for convenience in referring to them in specifications, drawings and correspondence.

A. T. & T. Co.
Eng. Dept.

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Information
Engineer
Draftsman
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STEP-BY-STEP MACHINE SWITCHING SYSTEM

Schematic Showing Order of Selection on a Connection from Machine Switching Station to Machine Switching Station

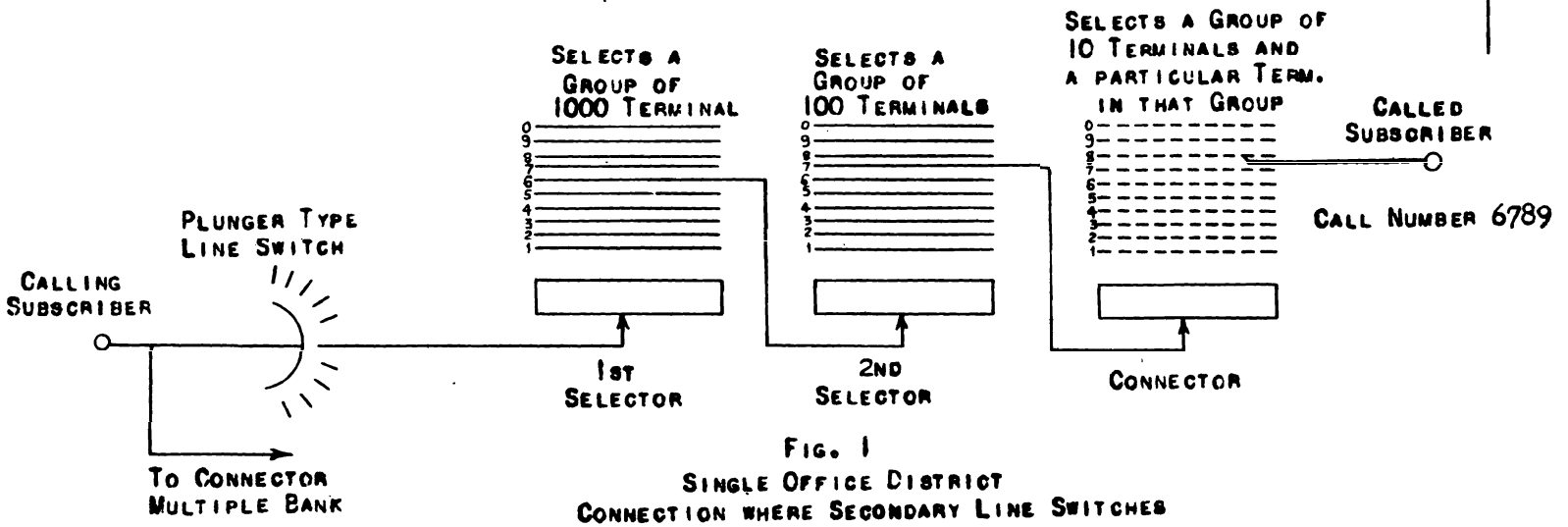

Fig. 1
Single Office District
Connection where Secondary Line Switches are not Provided

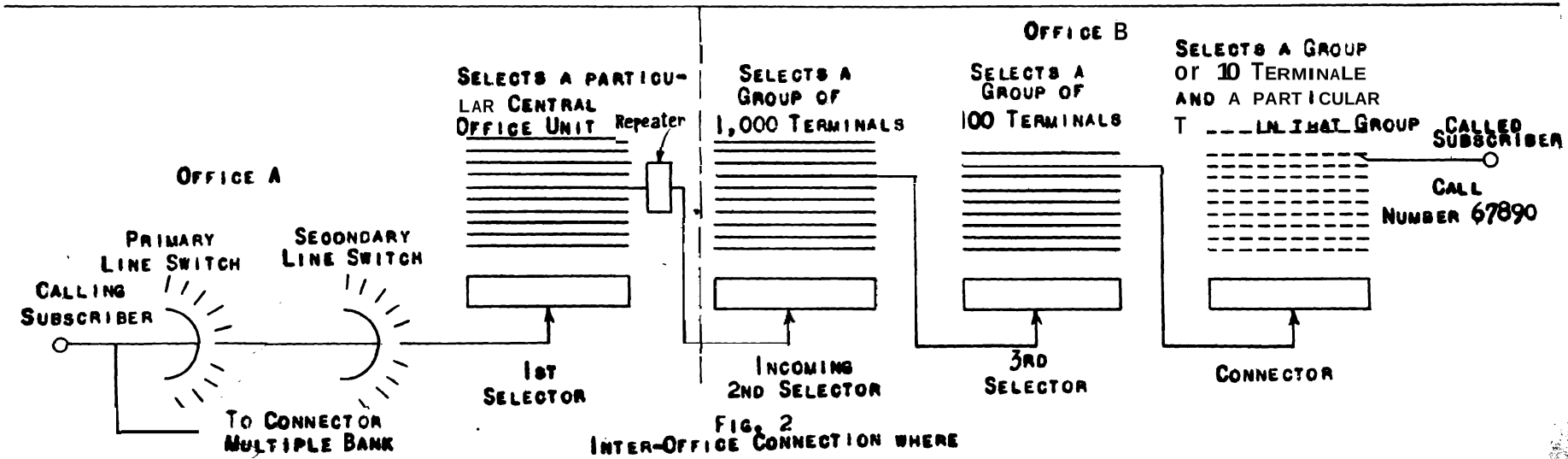

Fig. 2
Inter-Office Connection where Secondary Line Switches are Provided

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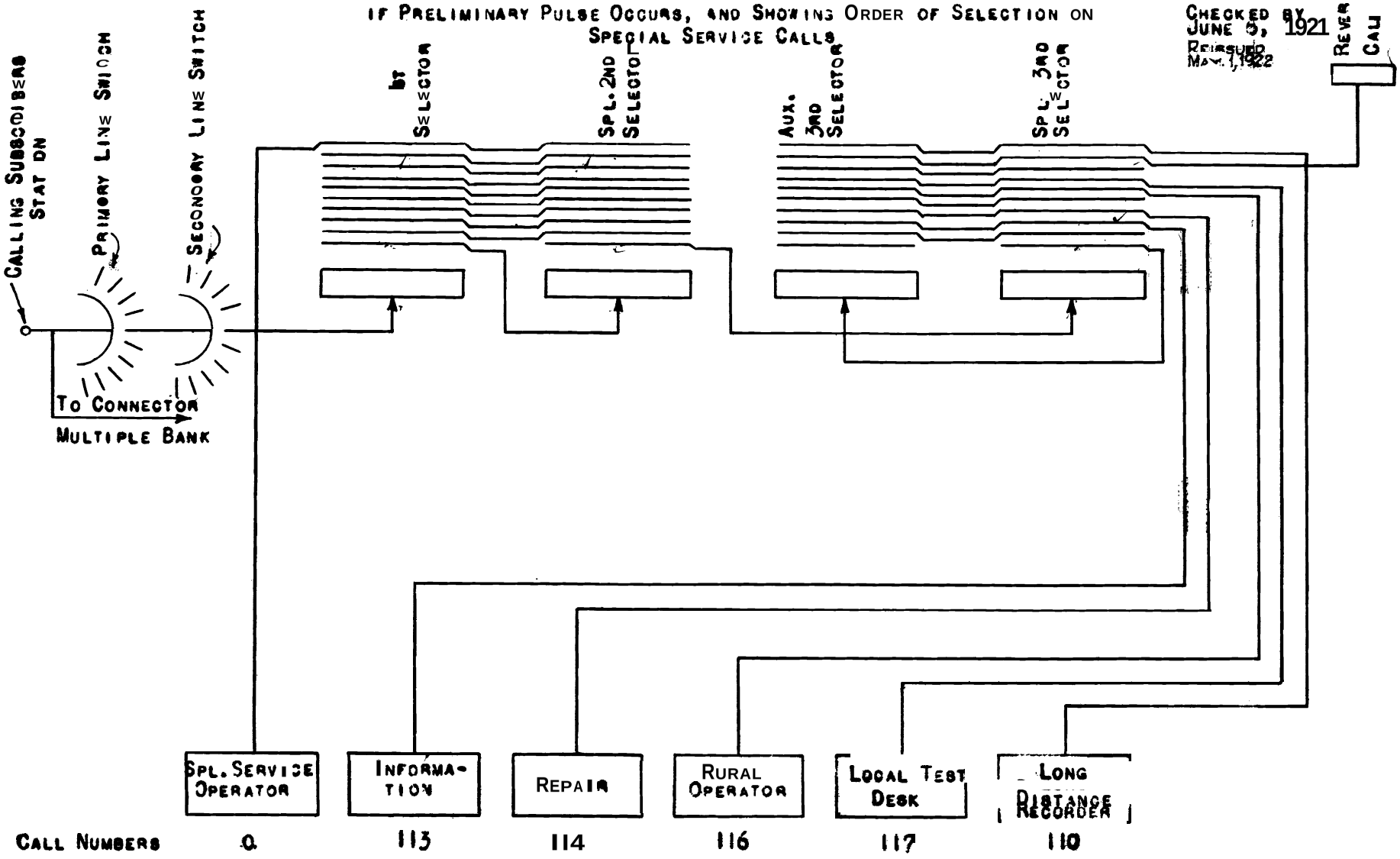
STEP-BY-STEP NACHINE SWITCHING SYSTEM

Schematic Showing Method of Obtaining Desired Connection if Preliminary Pulse Occurs, and Showing Order of Selection on Special Service Calls

Information
Engineer Emu
Draftsman MAH
Checked by
June 6, 1921
Reissued
May 1, 1922



AMERICAN TEL.& TEL.CO.
Dept. of
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STEP-BY-STEP MACHINE SWITCHING SYSTEM

Schematic Showing Order of Selection on a Toll Switching Trunk Connection to a Machine Switching Office

807-9
Information
Engineer EMM
Draftsman
Checked by
May 1,1922

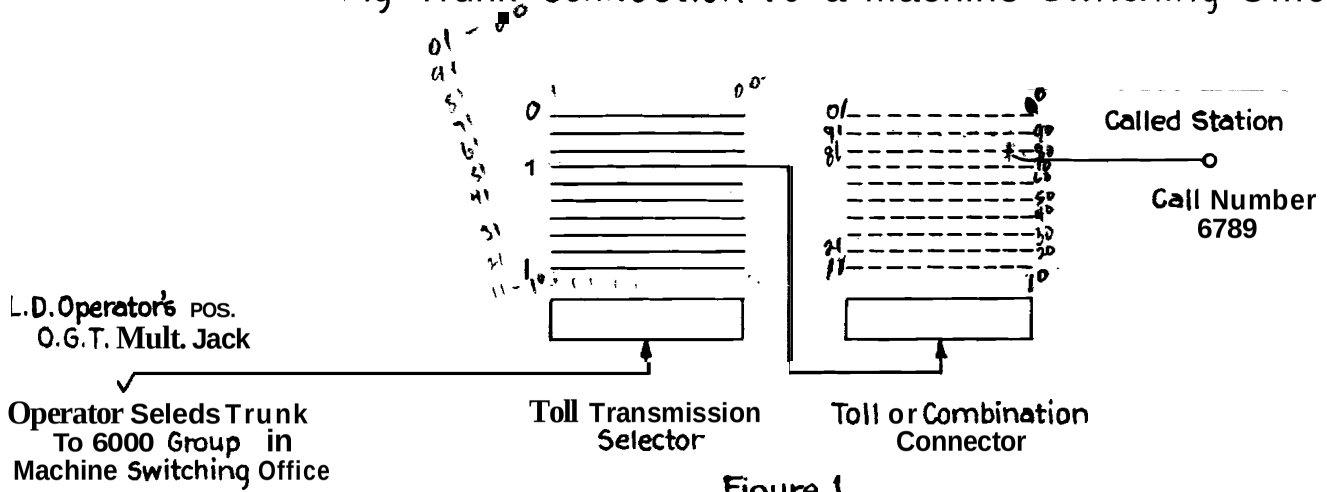

Figure 1
Single Office District

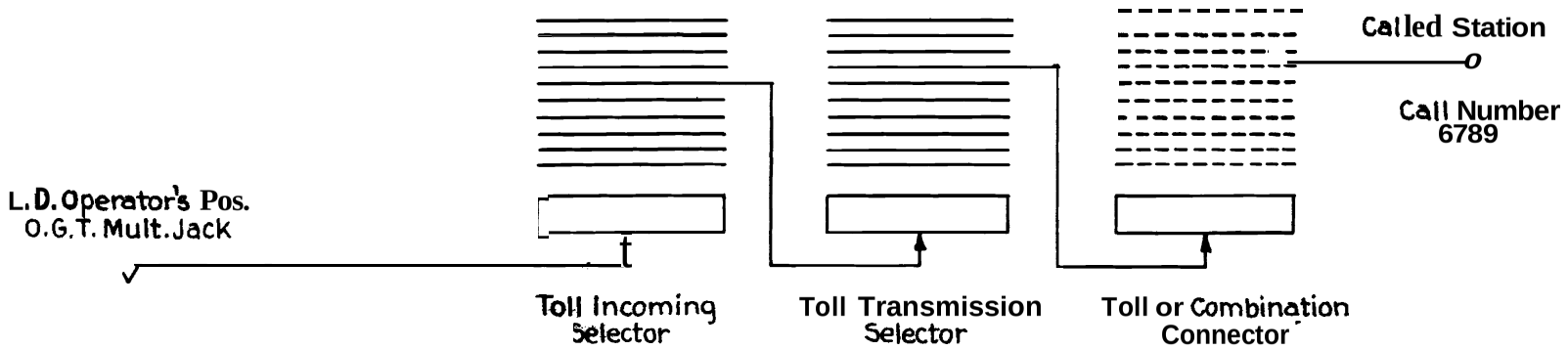

Figure 2
Multi-Office District

377-6789

7 digit

4

5

cond

., T. & T. Co.
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STEP-BY-STEP MACHINE SWITCHING SYSTEM

SCHEMATIC ORDER OF SELECTION FOR CALLS BETWEEN MACHINE SWITCHING AND MANUAL STATIONS

807 - 10
INFORMATION
ENGINEER Emu
DRAFTSMAN
CHECKED BY
MAY 1, 1920

REGISTER CHANGED TO RECORDER Emu MAY 1, 1922.

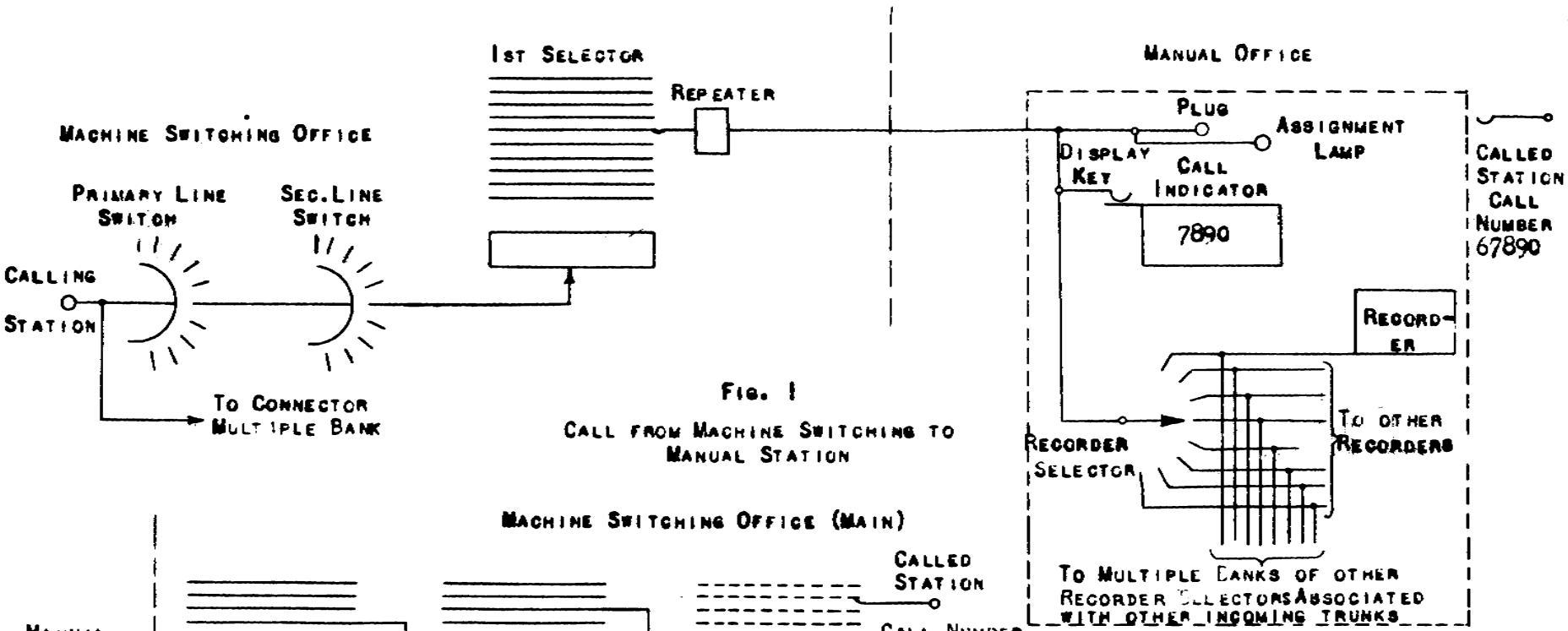

FIG. 1
CALL FROM MACHINE SWITCHING TO MANUAL STATION

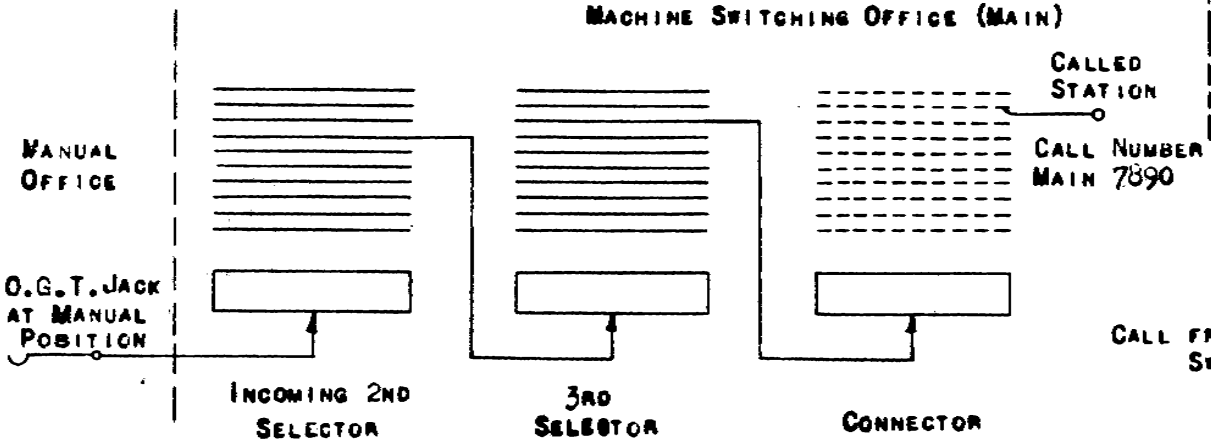

FIG. 2
CALL FROM MANUAL TO MACHINE SWITCHING STATION

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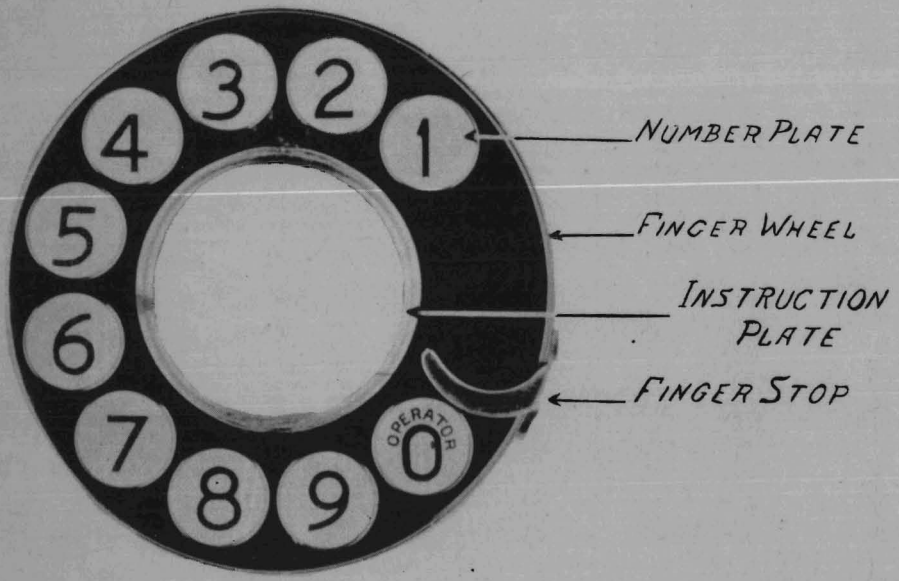
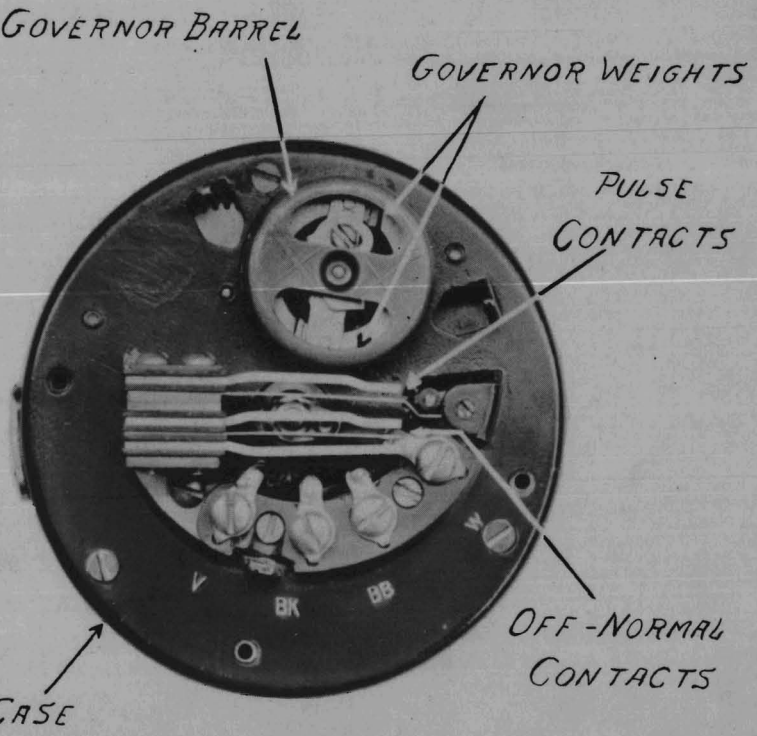
No. 1
May 1, 1920

STEP BY STEP MACHINE SWITCHING SYSTEM

Substation Dial





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No. 2
May 1, 1920

STEP BY STEP WCHIWE SWITCHING SYSTEM

Desk Stand with Dial

TYPE OF EQUIPMENT

Substations.

General. The principal difference between the substation equipment used in connection with step-by-step machine switching offices and that used in the common battery manual system consists of the addition of the dial. Most of the other points of difference are directly due to the use of this additional device. Front and rear views of the standard type of substation dial are shown in photograph No. 1 and a desk stand equipped with a dial is shown in photograph No. 2.

The machine switching desk stand differs from the manual type in that the base is changed in shape to afford a suitable mounting for the dial. No change in the size or form of wall sets or No. 50 coin collectors is required. On sets of these types the dial is mounted above the transmitter.

The wiring at machine switching substations differs from that used at manual stations, this difference arising from the need of providing a suitable circuit for dialing purposes. In addition it is necessary to pole and bias the ringers of machine switching substations in order to avoid bell-tapping during the dialing period.

A further point of difference between manual and machine switching substation equipment is found in the four-

party selective sets in the form of a 1/2 mf. condenser which is wired in series with the relay at the machine switching station. The use of thia condenser is necessary to insure that the relay will not be operated by the dial pulses, thus grounding one side of the line and interfering with pulse transmission and the proper operation of the central office equipment.

The Dial. The dial consiste primarily of two sets of switch contacts known as "pulse" and "off-normal" contacts, and of a mechanism by which the movements of these contacts are controlled. This mechanism is composed essentially of a finger wheel, a pulse wheel and pawl, a motor spring and a governor. The finger wheel contains ten holes and when the wheel is in normal position these holes register with digits on a number-plate, as shown in photograph Bo. 1.

In dialing, the subscriber inserts a finger in the finger wheel hole opposite the firet digit in the number to be dialed and rotates the wheel until the finger comes in contact with the finger stop. The finger is then removed and the wheel is driven back to normal position by the motor spring. During the return movement the pulse contacts are intermittently opened and closed by the pulse wheel and pawl,

the number of interruptions corresponding to the digit dialed. The remaining digits are dialed in a similar manner,

In order that the central office switches may function properly, it is important that the rate of interruption of the pulse contacts on the dial be fairly constant at all times. The speed of the finger wheel in returning to normal position, and consequently the rate of interruytion at the pulse contacts, is regulated by the governor which is located on the back of the dial and which is driven during the return movement through a train of gears. Provision is made on the governor for adjusting the speed of the dial when this becomes necessary. This adjustment should be made as described in detail in Handbook Specifications "Machine Switching Substations".

As soon as the dial is rotated to an off-normal position, and until it returns to normal, the off-normal contact springs are operated. The off-normal contacts, when operuted, eliminate dialing noises by opening the receiver circuit, and, by short-circuiting the transmitter, establish a path of uniform resistance through the subscriber's set during the period of interruptions.

The Ho. 2-A type dial is considered standard for machine switching substations. In a step-by-step machine switching area either the No. 2-AA or the No. 2-AE dial is

used. The No. 2-AA dial is provided with the number plate shown on photograph No. 1 and is for use in districte where there are no manual offices serving party lines on a jack per line basis. The No. 2-AE dial is like the 2-AA dial except that the number plate is provided with the party line letters J, M, R and W at the left of the numbers 5, 6, 7 and 9 fespectively. This dial is ueed in areas where one or more manual offices serving party line stations on a jack-per-line basis are to be reached by direct dialing.

The dial is provided with a removable instruction card placed under a celluloid cover. Details regarding instruction cards for machine switching stations are given in General Engineering Circulars Nos. 988 and 1011,

Changing Manual Stations to Machine Switching Stations. When changing deak stand equipment from a manual to a machine switching basis the best method to follow will be to remove the existing deak stands and replace them by new onee equipped with dials.

When changing wall sets of the earlier types from a manual to a machine switching baeis, the preferabls plan at present is to replace the existing sets by new metal ones

equipped witn dials. Although a wall set of the latest No. 533 type might be converted at the station by substituting for the old cover a new one provided with a dial, it is thought at present that there would not be sufficient advantage in this method of conversion to warrant its general adoption, and that ordinarily these sets should be replaced by new ones equipped with dials.

Consideration is being given to the adoption of an arrangement by means of which a wall set may be converted at the station for machine switching operation. The propoaed plan contemplates the use of a bracket, mounting a transmitter and dial, which is substituted for the existing transmitter bracket. It is thought that this arrangement will be of particular value for converting old type wall sets wkich, if removea and replaced by new ones, might be considered unsuitable for installation elsewhere. It is possible, furthermore, that this plan may in some cases be applied advantageously to the conversion of new wall sets as well as old ones.

In order to avoid the expense of removing No.50 coin collector sets a plan has been developed for converting these sets for machine switching operation without moving then from their present locations. This plan is covered in General Engineering Circular No. 988 and in Handbook Specifications "Machine Switching Substations".

Manual desk stands and wall sets removed from service should be reused in manual districts until such time ae an excess of manual equipment obtains. However, this condition will probably not obtain for a number of years. It is of course desirable as far as practicable to avoid expensive repairs on the removed apparatus.

Installing Substation Equipment in Preparation for Machine Switching Operation. Convertible machine switching substation equipment, provided with apparatus blanks instead of dials, may be installed in manual areas aoon to be converted to a machine switching basis, thus avoiding the manufacture and installation of manual apparatus which would probably have to be converted at some later time to the machine switching type. Careful consideration should be given to the use of wall set and desk stand equipment of this convertible type in manual areas in order to guard against prematurely creating a demand for machine switching service. It is thought, however, that convertible equipment of this type may be installed to advantage for replacements or aaditions in the subetation plant in areas that are scheduled for machine switching operation within about two years.

It is considered wnqcessary to adhere to this restriction in the case of coin collectore, and it is accordingly planned to make all new No. 50 coin collectore of the

maahine switching type, providing those to be used in manual areas with the necessary apparatus blanks,

In order to minimize conversion costs when changing from a manual to a machine switching basis at four-party selective stations having desk stand equipment, it appears advisable to anticipate machine switching operation to some extent by installing machine switching type subscribers' sets for stations of this type when changes in or additione to the substation plant are required. At preeent it is recommended that this practice be reetricted to areas where machine ewitehing ogeration is expected within about five years.

Further information regarding substation equipment and installation practicee will be found in General Engineering Circulars Nos. 988 and 1101, and in Handbook Specifications "Machine Switching Substations."

Wiring Plans, Where wiring plana, involving a holding feature for transferring calls are installed, it is advisable to use keys which when operated avoid any opening of the line at the substation, in order to remove the possibility of releasing the central office switches unintentionally. Detailed information regarding wiring plan practices and standard apparatus for use in connection with wiring plan8

is being prepared and will be issued as Handbook Specifications "Substation Wiring Plans".

Subetation Protection. It is considered standard practice to use at all machine switching substations the No. 26 and No. 27 protector blocks standarized in General Engineering Circular 917 - "Nos. 26 and 27 Protector Blocks", and in General Engineering Circular No. 935 "No. 26 and No. 27 Protector Blocks - Reduced Substation and Central Office Maintenance". Detailed information regarding substation protector installation at machine switching stations is given in Handbook Specifications "Machine Switching Substations".

TERMINAL EQUIPMENT

Main Distributing Frame: The standard type of main distributing frame ueed in manual offices and covered by the A.T. & T.Co.'s Specification No. 3836, will be employed in atep-by-step machine switching offices.

Intermediate Distributing Frame: The etandard type of I.D.F. used in manual offices and covered by the A.T. & T.Co.'s Specifications No. 3634, is used in step-by-step machine switching offices. This frame is shown on standard drawing No. 141-A-21. While the dimensions shown on this drawing were worked out to meet the requirements of manual equipments, it is thought that for the most part they can be applied satisfactorily in the case of step-by-step equfpmente. For some step-by-step offices, however, it will probably be desirable tc change certain of the dimensions, euch as tht length of the horizontal-side transverse bars, and accordingly it will be neceseary for the manufacturer to engineer auch parts of the I.D.F. individually for each job until suitable standard dimensions can be determined. In the meantime, it will be satisfactory to use drawing No. 141-A-21 aa a basis for floor plan layouts.

In addition to the cross connections provided in the subscribers' lines, cross connections are also required in the trunks between primary and eecondary line switches and

in those between line switches and first selectors. Theee may be nade on the same frame or on separate frames, depending on the floor plan layout. Where separate frames are provided, the frame used for subscriber's line cross-connections is knom as the line I.D.F., and the frame or frames used for the trunk cross-connections, as the trunk I.D.F.

Ln order to provide sufficient croas-connecting space on intermediate framea where four-party lines are terminated, the verticals will be spaced on 8" centers if so specified. Otherwise, the verticals will be mounted on 6-1/2" centers.

Provision for Relays: The various relays in the line switch, selector and connector circuits are grouped with the line switch, selector and connector mechanisms respectively.

Other relays, euch as those composing trunk repeaters, or miscellaneous relays that are involved in machine switching circuits, are grouped on unit type mounting plates or bases, as shown for a repeater in photograph No. 3, under Division II, Section 3r. The relays on a base are provided with a common dust-proof cover.

A relay rack similar in general design to the A. T. & T. Co's standard raok is provided for mounting relays associated with circuits for manual positions in the machine switching office. The relaye are located on mounting plates and are provided with individual dust-proof covers. The rack is shown on Drawing No.807-41.

Message Register Rack: Where message registers are employed, they will be mounted in the standard unit type message register rack used in manual offices and covered by the A. T. & T. Co.'s Specifications No. 3754. Peg count and overflow registers are also mounted in the standard rack.

Protectors: It is propoaed to employ porcelain type protector blocks mounted on 1/2 inch centers at the M.D.F. One No. 26 and one No. 27 blook is used for each side of the line. The No. 26 is a plain carbon block; the No. 27 consists of a small piece of carbon held in a porcelain mounting by a amall amount of low melting point glass and slightly recessed below the face of the

porcelain. These blocks have been used for substation protection, and have been found to require less maintenance than the plain carbon ones due to their greater freedom from carbon dust. It is thought that the extra coat of the porcelain type block will generally be justified in step-by-step machine switching offices because of the decreased work involved in maintaining the protectors where they are subject to fairly high potential discharges as a result of the lind interruptions at the dial.

Provision for Fuses: Fuses for line switches, selectors, connectori and repeatera are located on unit type fuse panels mounted on the framework accommodating the respective equipments. A.T.&T.Co.'s standard alarm type fuses will be uaed.

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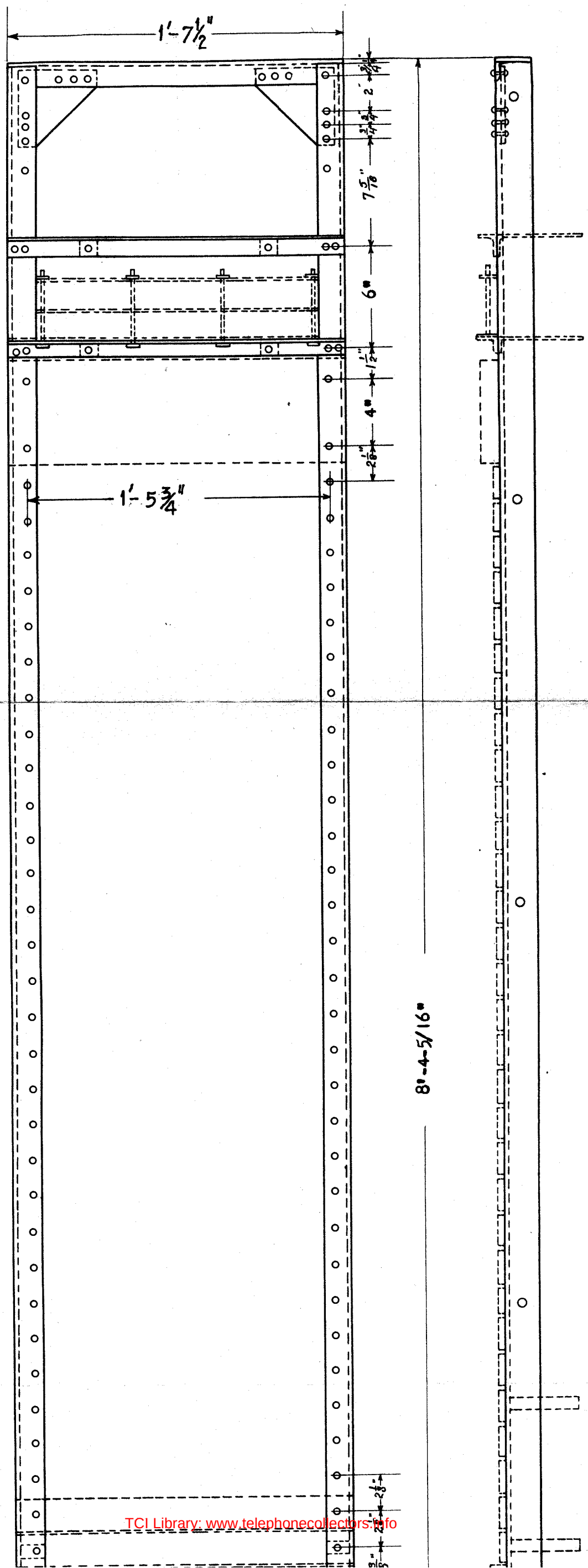
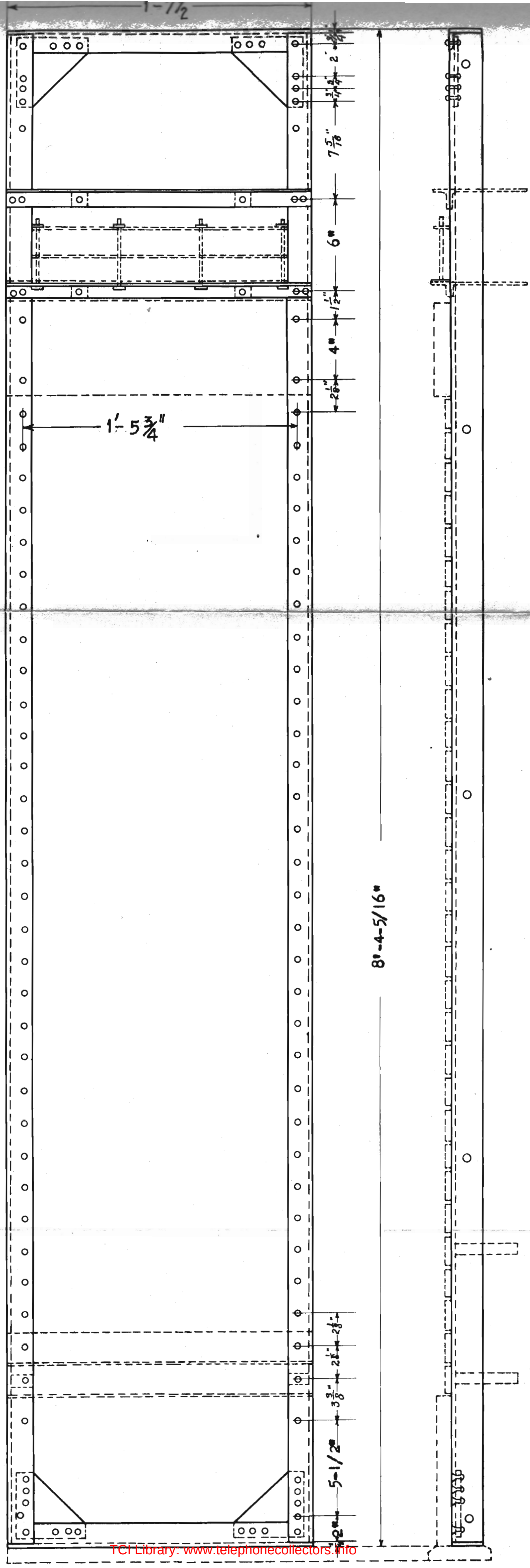
STEP-BY-STEP MACHINE SWITCHING SYSTEM

Unit Type Relay Rack
For Relays Associated with Circuits for Manual Positions Located in a Machine Switching Office





SWITCHING EQUIPMENT

Plunger Type Line Switch:

The assembly of a typical plunger type line switch is shown on Drawing No. 807-12 and in Photographs Nos. 4, 5 and 26. The switch consists essentially of a plunger. a relay and a combination magnet and relay all mounted on a pressed steel framework, end of a multiple bank.

The plunger is made from a thin sheet of clock-spring steel and is mounted on a pin 8 at the end of the plunger arm A in such a manner as to be capable of a rotary motion about S, through an angle of approximately 40 degrees. The plunger is also free to move in a longitudinal direction under the influence of the plunger arm pivoting about the point L. Near the tip of the plunger are mounted two hard rubber rollers, marked H, one on each side of the plunger. A slot is provided in the tail end of the plunger as shown at T, The plunger arm is normally held away from magnet Y and against the adjustable stop R by spring F pressing against a hard rubber roller mounted on the arm.

Broadly, the function of the magnet Y is twofold, namely, to operate the plunger arm and thus cause the plunger to move forward or to "plunge", and to operate the armature BCO, which, when attracted, actuates the springs B, The magnet is double wound, One winding, called the "pull-down" winding, is low in resistance and when energized operates both the plunger arm and the BCO armature. The other winding when energized alone operates the BCO armature

only. It is, however, sufficiently strong to hold up the plunger arm sfter it has been operated by the lon resistance winding.

All connections to the relay and magnet are made through a set of jacks mounted on the frame of the switch, as shown at J. These jacks are designed to engage a set of spring jacks located on the framework used for mounting the switch. The jacks, by avoiding the use of solder or screw conneotions, facilitate the work of installing or removing the switch.

The switch is mounted by means of machine screws passing through slots in its framework. The slots are cut so that it is merely necessary to looren the screws in ordrr to install or remove the switch. The slots also permits the switch to be adjustsd in relation to the multiple bank.

The multiple bank, shown in photograph No. 5, is composed of 10 sets of terminals arranged in an arc and mounted as a unit. Each set of terminals is arranged as shown schematically in Fig. 1, Drawing No. 807-13. Each set is divided into an upper and lower group of four terminals each with a slot between the groups. The bank is located in front of the line switch plunger so that the latter by turning about point S may be directed toward any one of the ten sets of terminals, or by plunging may enter between the upper and lower grougs of a particular set of terminals and cause them to operate as shown in Fig. 2 of Drawing No. 807-13. Referring to Fig. 1, the contact pieces are flat individual pieces of stiff brass, each one being provided with a soldering lug. The contact

springs are of bronse and the corresponding springs in the ten different sets of terminals composing a bank are multipled together throughout the bank; in fact, corresponding springs are merely projections from the edge of a sheet of bronze which is assembled as a whole in the multiple bank. Bach side of the line to which a particular line awitch corresponds is multipled through the bank of that switch by being connected to a lug provided on one end of the multiple terminal strip, aa shown schematioally in Fig. 3, Drawing No. 807-13.

When the plunger entere a set of terminals, the line with which the switch is associated is connected through two of the pairs of contacts to the particular trunk that is terminated on the rot of terminals which the plunger enters. The other two pairs of contacts in the aet are aleo made, these contacts serving to establish cortain local connections necessary to the functioning of the central office mechanism. In operating, the plunger rollers impinge against the spring contacts, firrt causing them to bend until they touch their respective contact pieces and then straightening them slightly, thus produoing a rubbing contact that insures positive connection. When the line switch operates, the tip of the plunger enters the rlot between tho upper and lower groups of terminals and is guided into place by a series of teeth in the rlot.

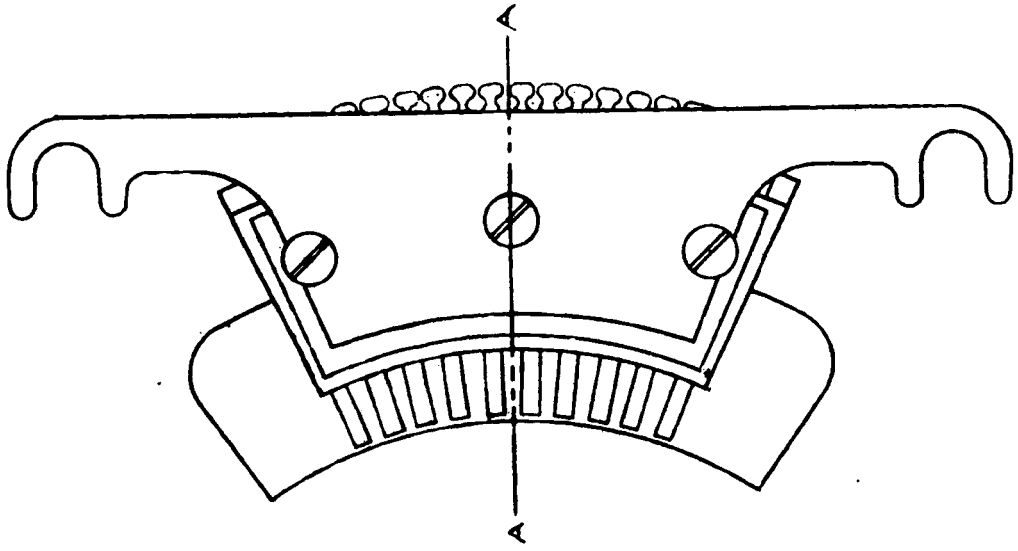
Solenoid Type Master Switch:

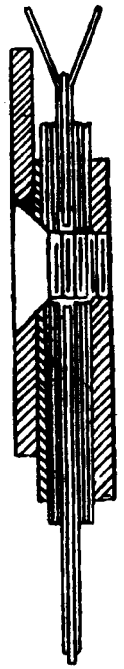
The device which controle the movement of a line switch plunger about the point S and consequently determines which of the ten sets of terminals the plunger will enter when the switch plunges is known as the master switch. A typical master switch is shom in photograph No. 6 and on Drawing No. 807-14.

The trunk capacity of a line switch multiple bank is 10, and each 10 trunks, known as a trunk sub-group, is multipled through enough line switches to give it a proper load. The line switches having access to a aubgroup of trunks are known as a subgrcup of line switches. One master switch is provided for each subgroup of line switches, its function being to control each of the line switches in the subgroup so that the plungers of idle switches are at all times directed toward the terminals of an idle trunk. The way in which the line and master switches are arranged is shown in photographs No. 7 and 8. Photograph No. 7 shows psit of one side of a line switchboard. It will be noted that the line switches are arranged in vertical columns and also in four divisions of 25 ewitches each. At the top of each division space is provided for a master switch; that is, capacity is provided for 4 subgroups of switches. Extending vertically in front of each division is a master switch bar. The frameworks of 12 of the line switches in each division are located on one side of the master switch bar and the frameworks for the other 13 switches are located on the other side of the bar. On photograph Ho. 8 the left-hand switches are shown in place, and the right hand switches are omitted. All of the plungers in

STEP BY STEP MACHINE SWITCHING SYSTEM

Master Switch Bank



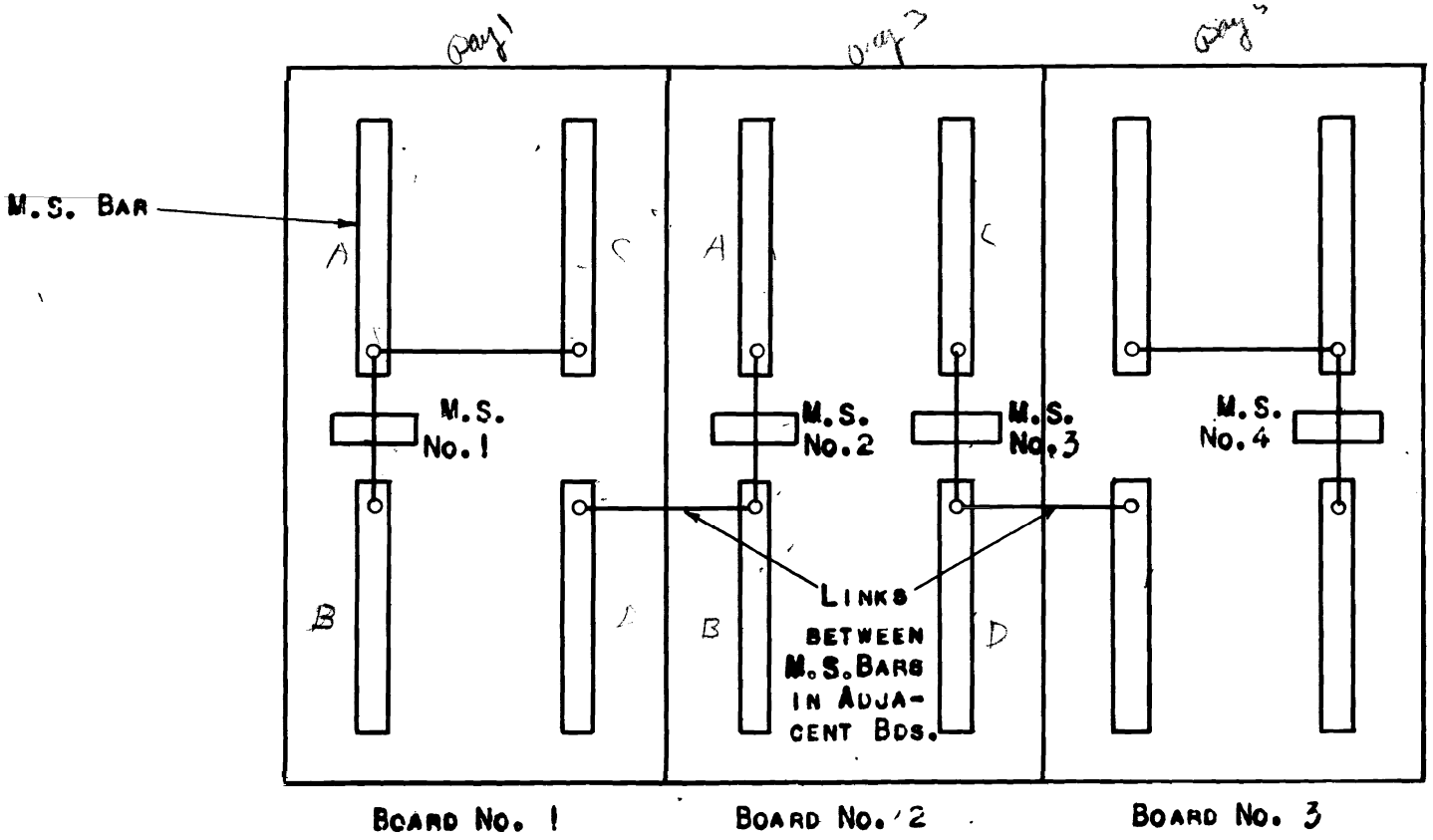


I. T. & T. Co.
Eng. Dept.

807 - 6
Information
Engineer
Draftsman
May 1, 1920.

STEP-BY-STEP MACHINE SWITCHING SYSTEM

Schematic Showing Mechanical Connection between Master Switch Bars where from 50 to 75 Line Switches are Controlled by each Master Switch



A. T. & T. Co.
Eng. Dept.

Information
May 1, 1920
Engineering
Draftsman

STEP BY STEP MACHINE SWITCHING SYSTEM
ARRANGEMENT, AND OPERATION OF A SET OF TERMINALS IN A LINE SWITCH BANK

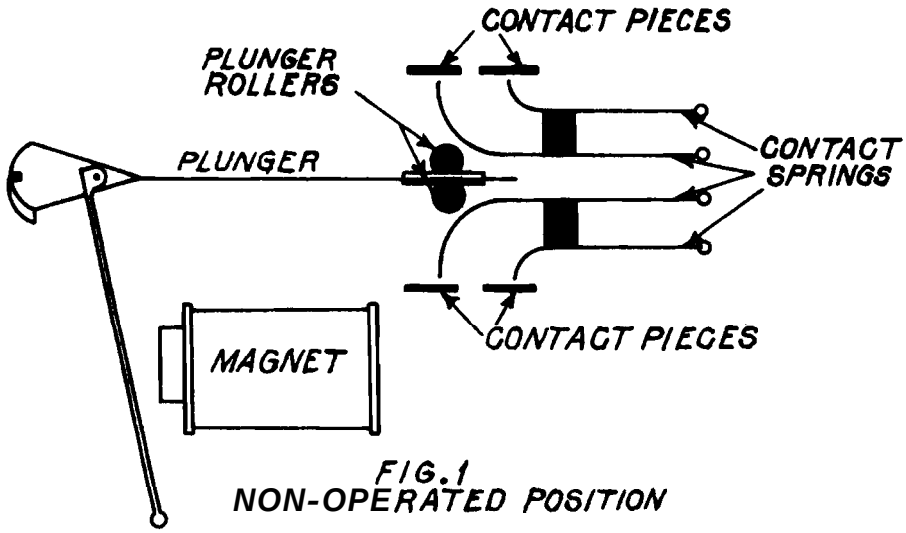


FIG. 1
NON-OPERATED POSITION

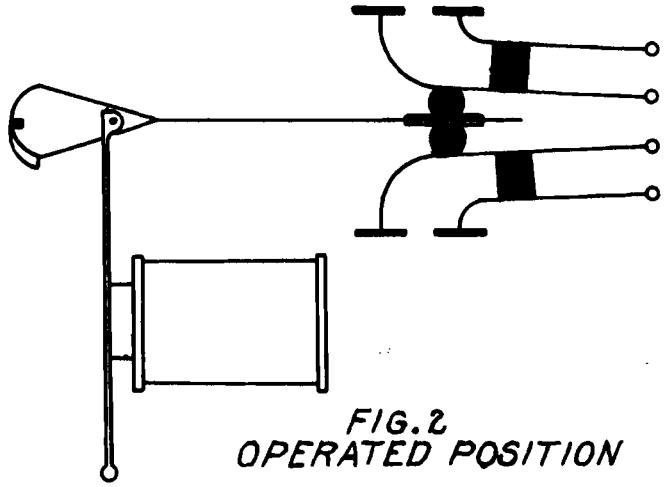


FIG. 2
OPERATED POSITION

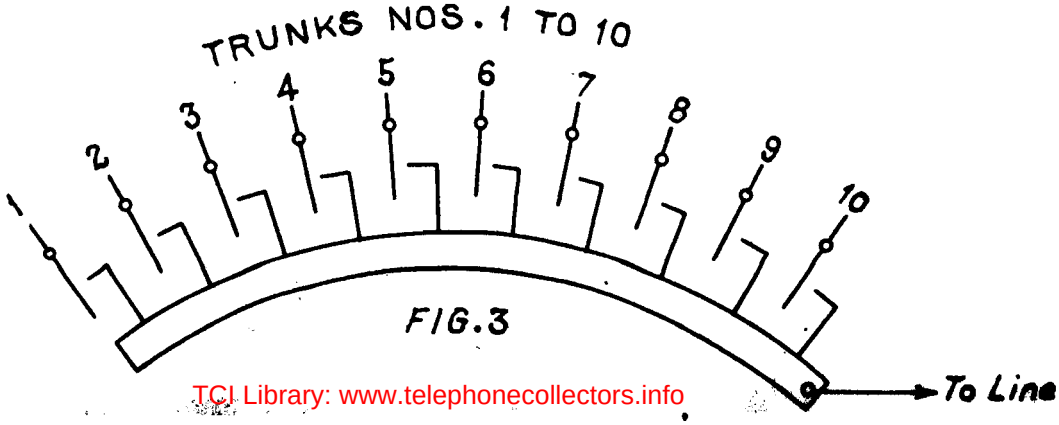


FIG. 3

a division are in a single vertical column behind the bar and all of the multiple banks in a division are in a single pile behind the plungers.

A master switch mounted above either of the upper divisions of line switches is called a tog master switch, while one mounted immediately above either of the lower divisions of switches is called a bottom master switch. Top and bottom master switches differ slightly in their mechanical construction due to the methode of mounting them.

As shown on Drawing No. 807-13 Fig. 3, the trunk contacts in the various sets of terminale in a line switch bank are numbered consecutively from 1 to 10 towards the right facing the plunger side of the bank. When assembled on a line switchboard, the various contacts corresponding to trunk No. 1 in the different banks are multipled vertically by means of loop strap wires run behind the banks. In a similar manner the contacts corresponding to each of the other nine trunks are multipled vertically.

Two of the contact pieces in each set of terminals in each line switch bank are for use in conjunction with the maeter switch and these oontacts are also multipled vertically as in the case of the trunk contacts. The wires from these master switch contact pieces are led to ten pairs of terminals composing a master switch bank, of which there is one for each master switch. The master switch bank is shown on drawing No. 807-15.

If it is desired to place more than 25 but not more than 50 line switches in a subyroup, the two left-hand or the two right-hand divisions of banks are multipled together. In auch a case the

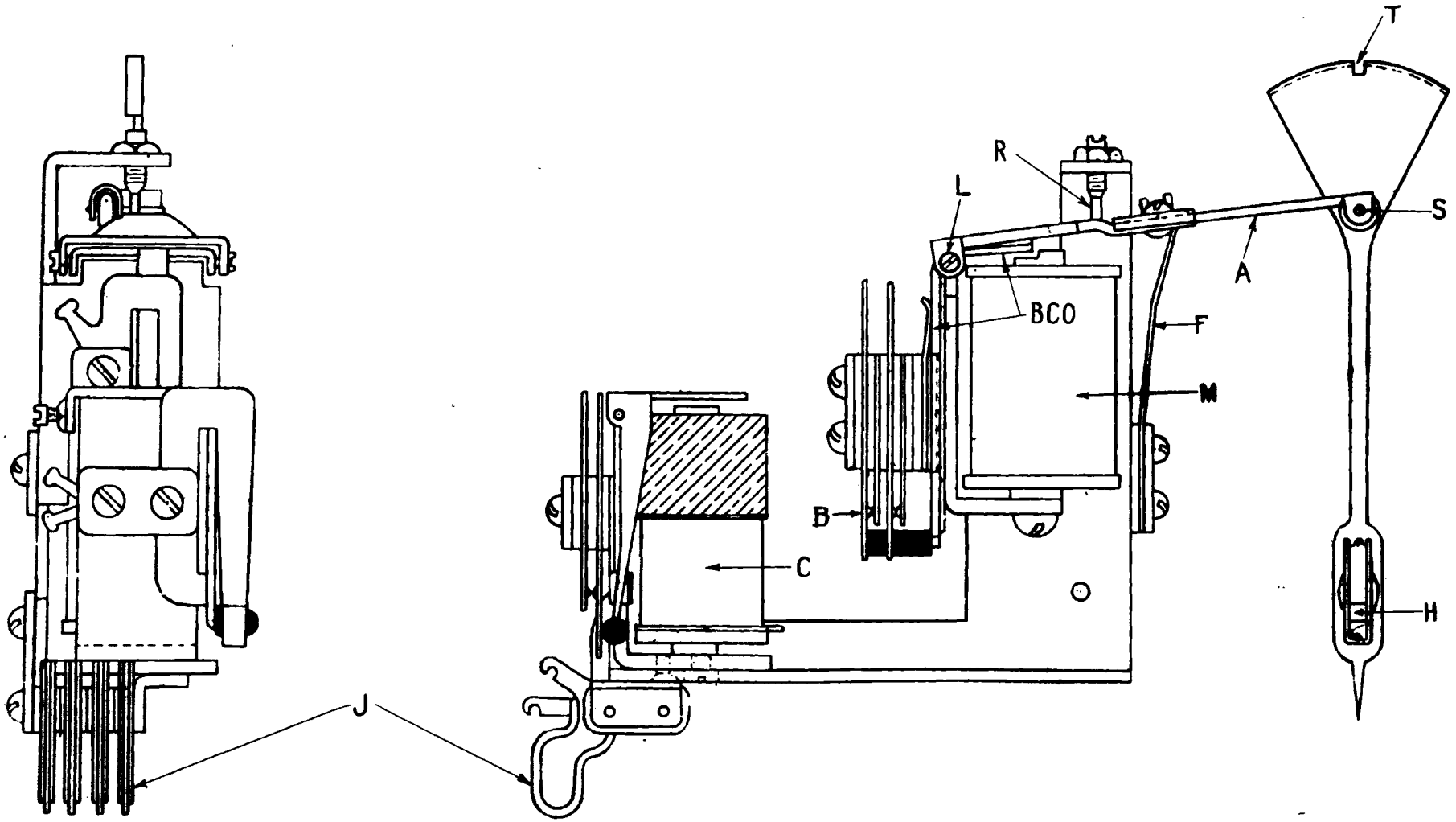
top master switch is omitted and the two corresponding master switch bars are linked togethor mechanically to act as a unit, both bare being controlled by a single master switch.

If it is desired to place more than 50 but not more than 75 line switches in a subgroup, three of the divisions of line switch banks on one eide of the line switchboard are multipled together and the three corresponding master switeh bars are linked together mechanically, so that they may be controlled by one master switch; in this case it is the practice to employ one of the bottom master switches for contolling the three master switch bars. Where three divisions of line switches are placed under the control of one master switch, it becomes desirable, in order to avoid wasting the space for the fourth division of switches, to provide means for placing a division of line switches located in one board under the control of a master switch located in another board. Since several line switchboards are placed in a line-up, this can be accomplished by using a link between master switch bars in adjacent boards, as shown on drawing No. 807-6. This drawing shows three line switchboards in one line-up, mounting four subgroups of 75 line switches each.

If it is desired to place from 76 to 100 switches in a subgroup, the four divisions of banks on one side of a line switch board ere multipled together, provision being made for mechanically linking together the four corresponding rnaster switch bars ao that they may be controlled by one bottom master switch.

STEP BY STEP MACHINE SWITCHING SYSTEM

Primary Line Switch.
Assembly.



A.T.& T. Co.
Eng. Dept.

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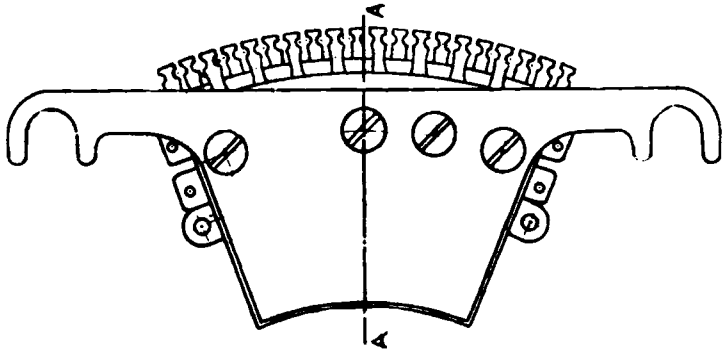
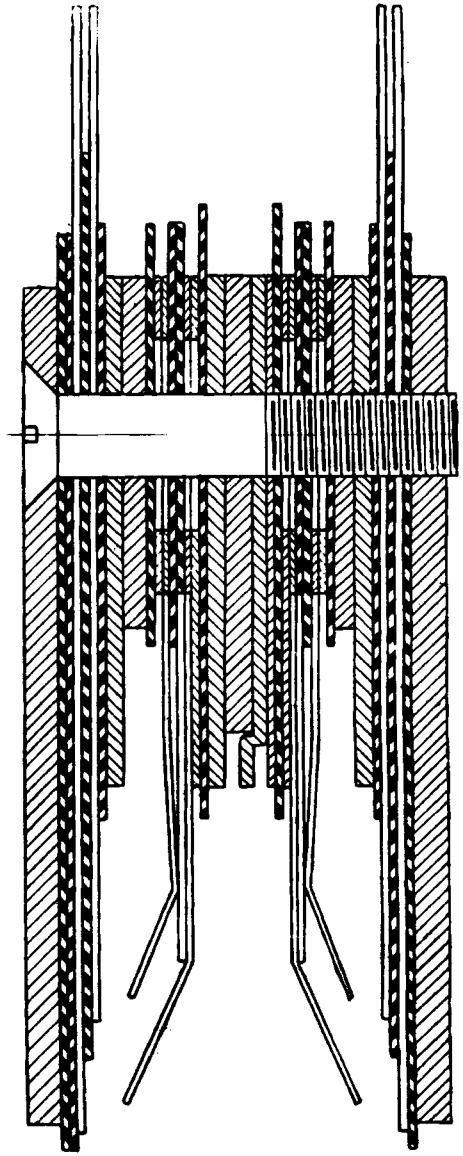
Information
May 1, 1920

STEP BY STEP MACHINE SWITCHING SYSTEM

Line Switch Bank Assembly





SEC. A-A

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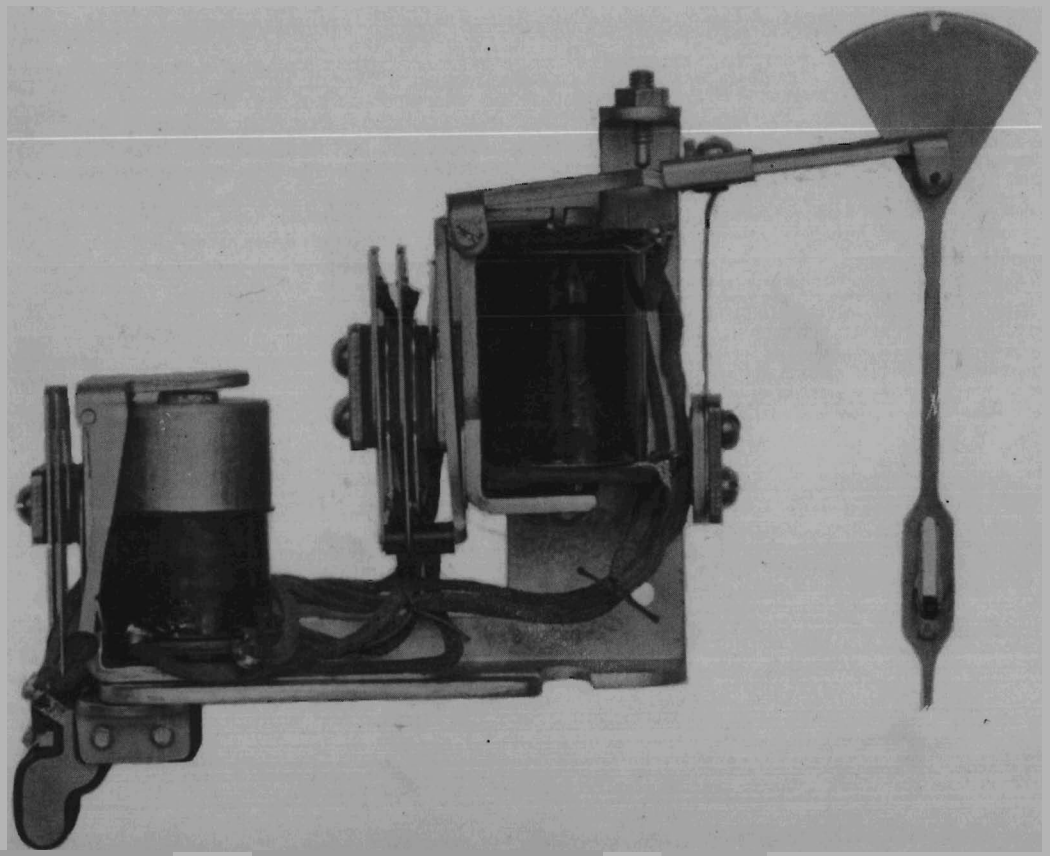
STEP BY STEP MACHINE SWITCHING SYSTEM

No. 4
May 1, 192(

Typical Line Switch
without Multiple Bank



A.T.& T. Co.
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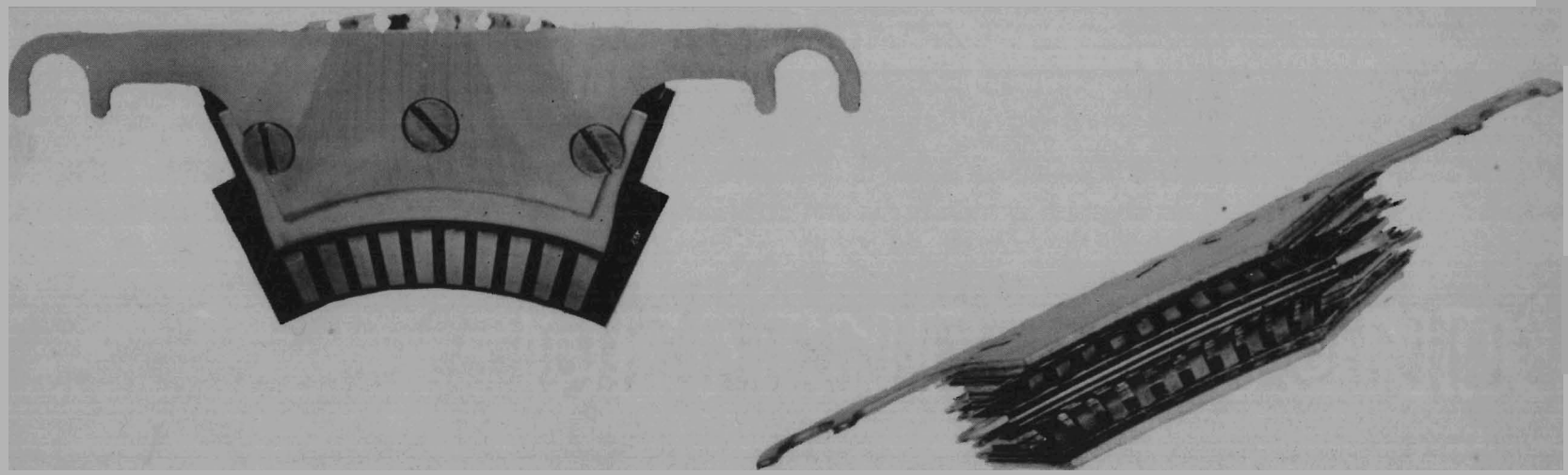
STEP BY STEP MACHINE SWITCHING SYSTEM

Line Switch Bank

No. 5
May 1, 1920



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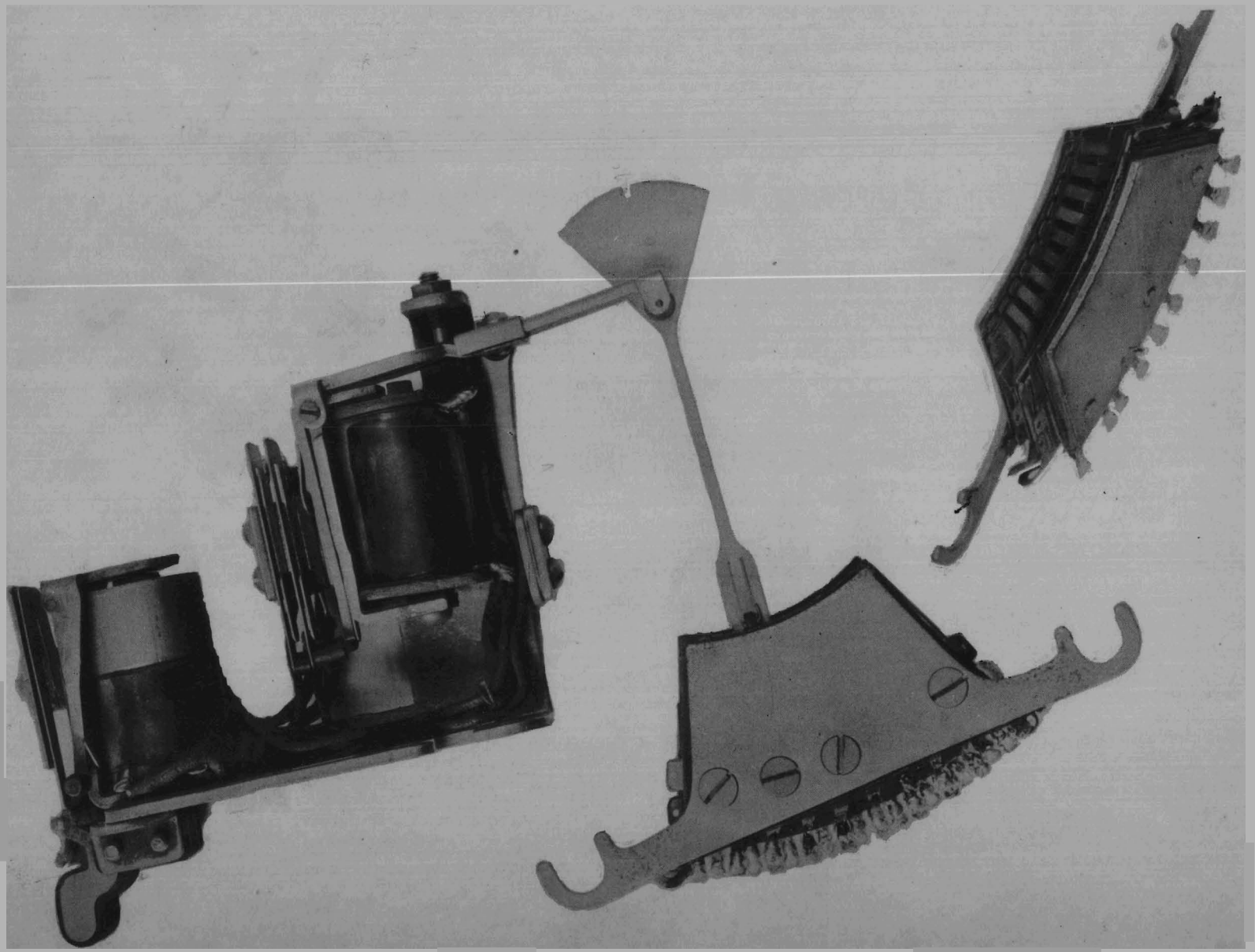
STEP BY STEP MACHINE SWITCHING SYSTEM

Primary Line Switch with Bank

No. 26
May 1, 1920



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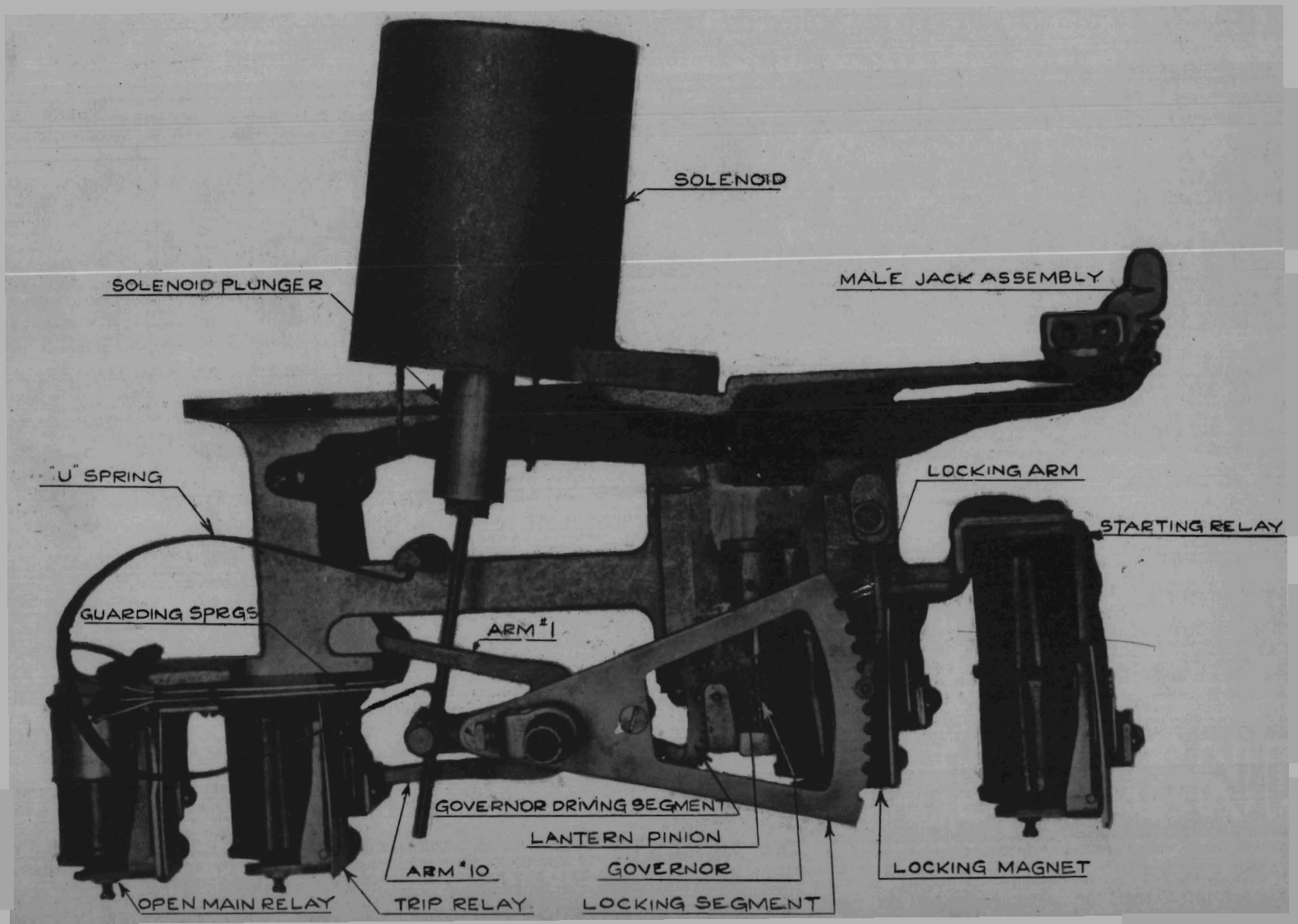
STEP BY STEP MACHINE SWITCHING SYSTEM

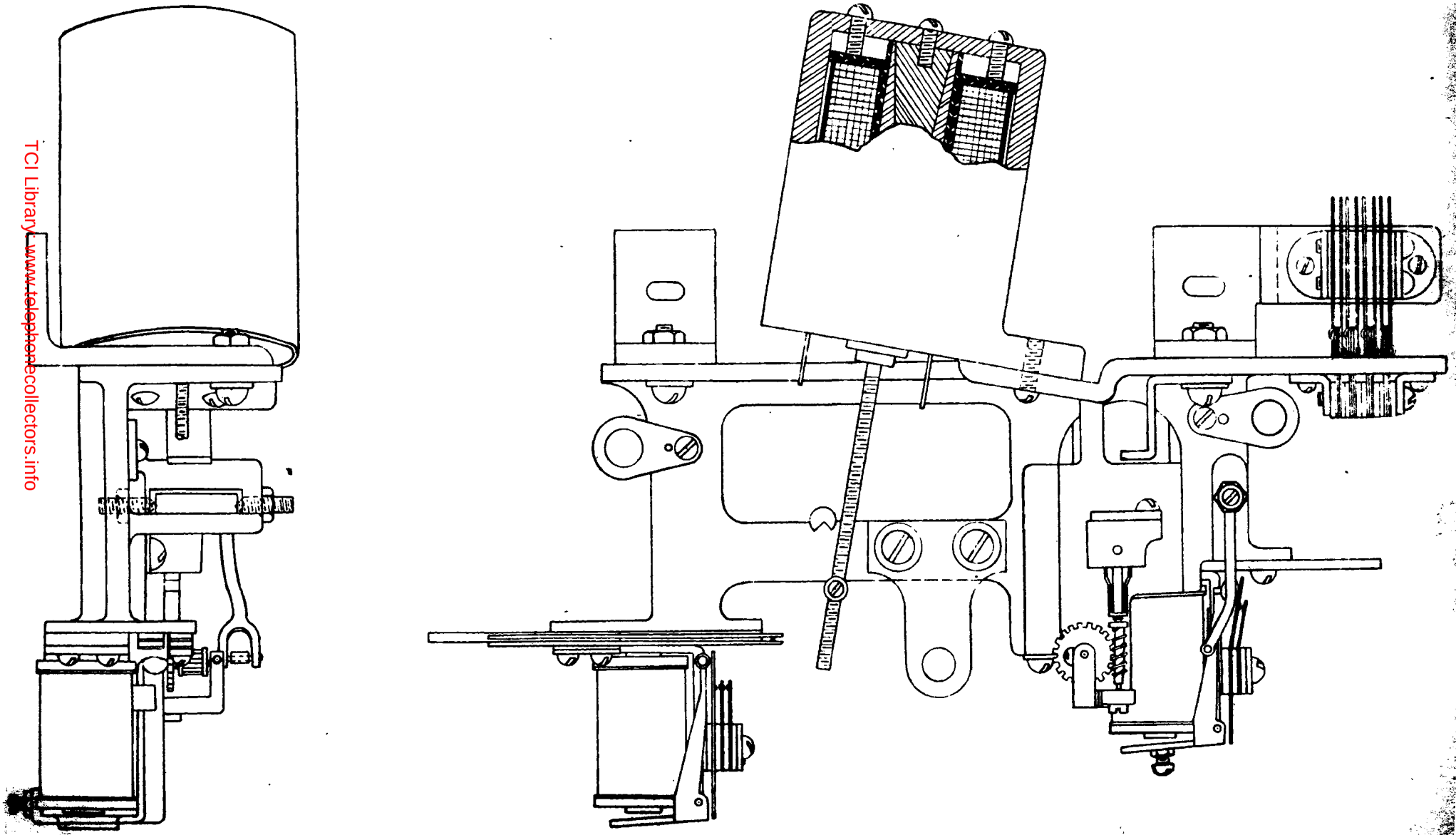
Typical Master Switch

No. 6
May 1, 1920



STEP BY STEP MACHINE SWITCHING SYSTEM

Primary Master Switch
Top Switch



STEP BY STEP MACHINE SWITCHING SYSTEM

[redacted]

No. 7

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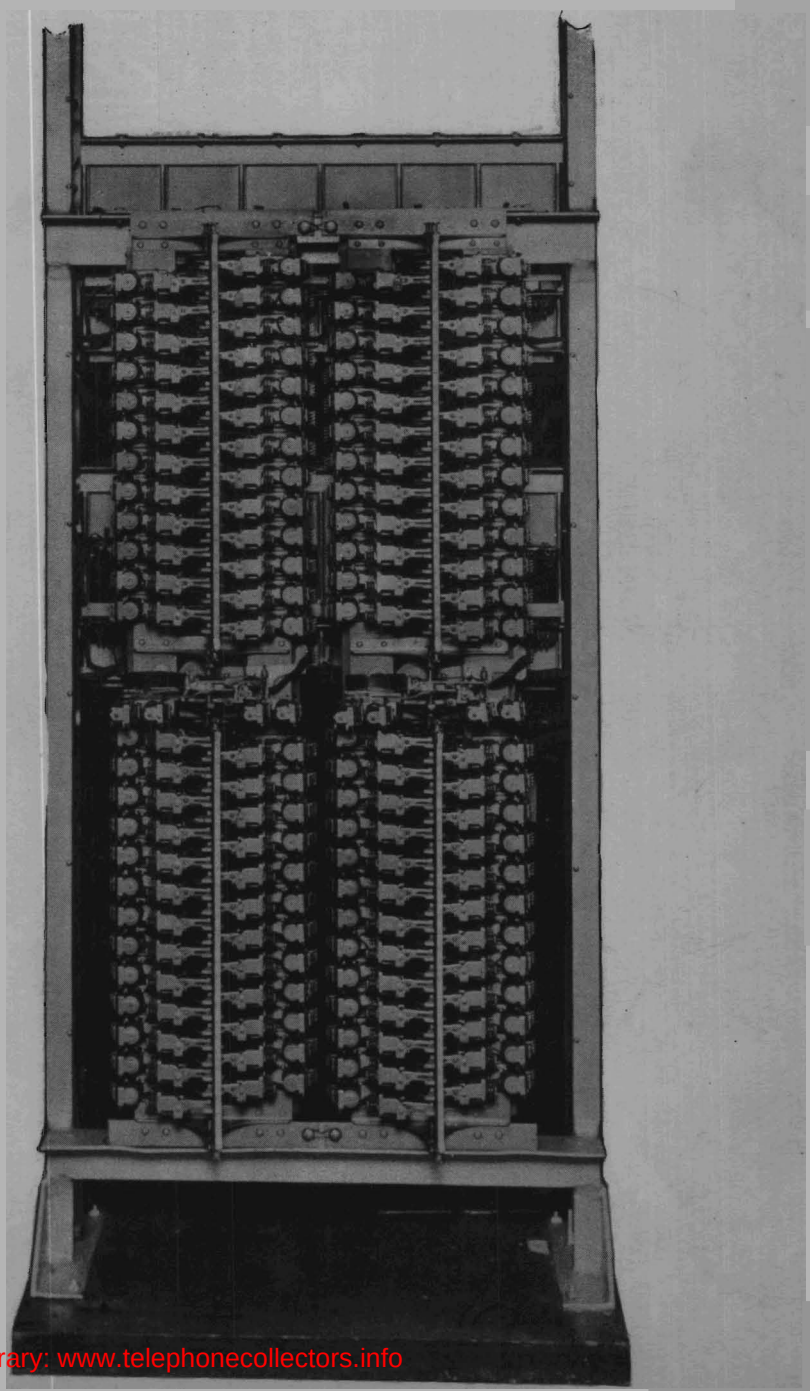
Partial View of Line Switchboard, showing 100 Line Switches and Two Master Switches

May 1, 1920



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STEP BY STEP MACHINE SWITCHING SYSTEM

Line Switches and a Master Switch in Place

Wo. 8

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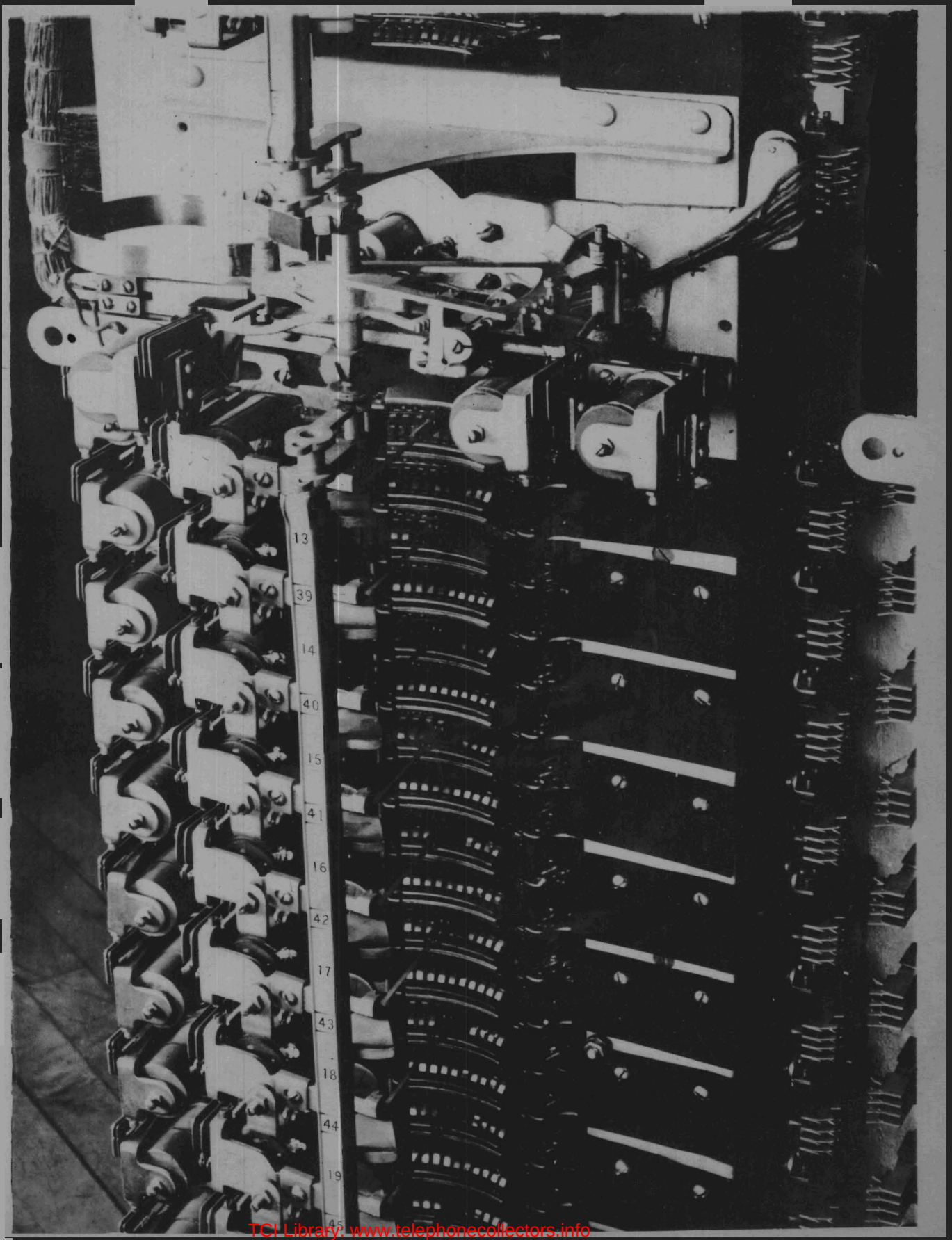

The master switch bar is the medium through which the movement of the master switch is transmitted to the plungers. The line switch side of the master switch bar is provided with a longitudinal ridge which engages the plunger slot T, drawing No. 807-12, when the plunger is in the released position. When the line switch operates, however, the plunger, in moving forward into its bank, disengages itself from the bar.

The mechanism controlling the movement of the master switch bar, that is, the master switch proper,(photograph No.6) consists esaentially of a locking segment and two tripping arms Nos.1 and 10 working in conjunction with a locking arm controlled by a combination magnet and relay, of a solenoid which operates the segment and bar so as to move the terminal ends of the line switch plungers from left to right, of a "U" spring which is capable of moving the segment and bar in the opposite direction, of a governor which regulstes the angular speed of the bar, of a master switch terminal bank and wiper, and of a group of relays which set up the required circuit combinations for the proper operation of these parts. Thie apparatus, with the exception of the master switch bank, is assembled as a group on a cast brass base and all wiring is carried to a set of jacks mounted on the baee in the same manner as in the case of the line switch.

In order to trace the operation of the master awitch, assume that all of the plungers under the control of the switch are in the non-oparated position, (which implies that all of the trunks in the subgroup are idle), that all of the plunger slots

are engaged by the bar, and that all plungers are directed toward the extreme right-hand sst of contacts in the terminal banks. Each plunger is thus preparsd to enter the particular set of contacts corresponding to trunk No. 10, and if a call is initiated on any one of the lines in the subgroup of line switches being considered, the corresponding line switch will operate and connect the line through to trunk No. 10, ds. When tha plunger enters the terminal bank, it disengages itself from the master switch bar, snd through the resulting operation of the spring contacts, ground potential is placed on the master switch contacts for trunk No. 10, This condition establishes a circuit through the locking magnet which, in energizing, disengages the locking arm from the locking segment; the latter then commences to rotate under the influence of the "U" spring. At the same time the master switch wipers are carried to the next pair of contacts on the master switch bank, these contacts corresponding to trunk No. 9, On the assumption that trunk No.9 is idle, the master switch wipers no longer rest on grounded terminals, the magnet is released and the locking arm engages the locking segment and arrests its motion. During the movement of the locking segment through this small angle the master switch bar has been rotated through the same angle and has carried with it all of its line switch plungers except the one of the line which originated the call. These have been rotated until each one is directed toward the terminals of trunk No.9. It will be noted that during this movement of the master switch both the master switch bar and the line switch plungers

have been rotated in a counter-clockwise direction, viewing the mechanism from the top.

The next switch to operate in this subgroup connects its line to trunk No. 9, and the master switch immediately redirects all of the non-operated plungers toward the terminals of trunk No. 8. This operation is repeated until nine plungers have ogerated and all of the other plungers are directed towards the terminals of trunk No. 1. When in this position tripping arm No. 1 on the locking segment holds the guarding spring aontacte closed, and when the tenth line switch plunges, a circuit, including these contacts and the winding of the solenoid, is completed and the solenoid attracts its plunger. At the same time the master switch magnet is locked up and the locking segment is rotated by the solenoid plunger in the direction opposite to that in which it moved under the influence of the "U" spring. This movement is continuous until tripping arm No. 10 comes into contact with the guarding springe. The trig relay, which was locked up mechanically when the guarding spring contacts were closed and which remained in the locked condition throughout the return movement of the master switch, is released when tripping arm No. 10 strikes the guarding springs. The release of thetrip relay restores the circuit to the condition which obtained originally and the master switch is again prepared to direct its line switch plungers towards the highest numbered idle trunk. What trunk this is will, of course, depend on what line switches have been released in the Interim. If the highest numbered trunk to have been released happens to be No. 4, the masterswitch will move continuously past

trunks Nos. 10 to 6, inclusive, and will stop when the plungers are opposite trunk No. 4. If none of the trunks have been releasad, the master switeh will maintain an oscillatory movement tetween the limits of its motion at the rate of about 100 complete cycles per minute.

Drawing No. 807-16 is a schematic diagram showing four of a subgroup of line switches under the control of a master switch. Lines Nos. 1 and 3 have not originated calls and the plungers on these lines are shom prepared to connect their respective lines to trunk No. 7. The plunger for line Po. 2 has previously connected its line to trunk No. 5, but has been released and has not yet been engaged by the master switch bar. Line No. 4 is shown oonnected through to trunk No. 8.

In order to avoid the possibility of a line switch plunging while the master switch is passing over busy trunks and causing a double connection, the battery feed for the line switch magnets is taken through the contacts of the open main relay on the master switch which keeps the feed wire open whenever the master switch is in motion. This feed wire is known as the open main.

It will be noted that at the instant when a plunger is released its slot will usually not be in alignment with the ridge on the master switch bar and the plunger will therefore not be engaged by the bar. The plunger will later come under the control of the master switch however, when tha ridge again comes opposite the plunger slot during the return movement of the master switch under the influence of the solenoid, or during its hunting movement under the

influence of the main spring. If in the meantime the line which has been released again initiates a call, its switch will plunge into the same trunk which it had originally seized and which became idle when the plunger receded from its bank.

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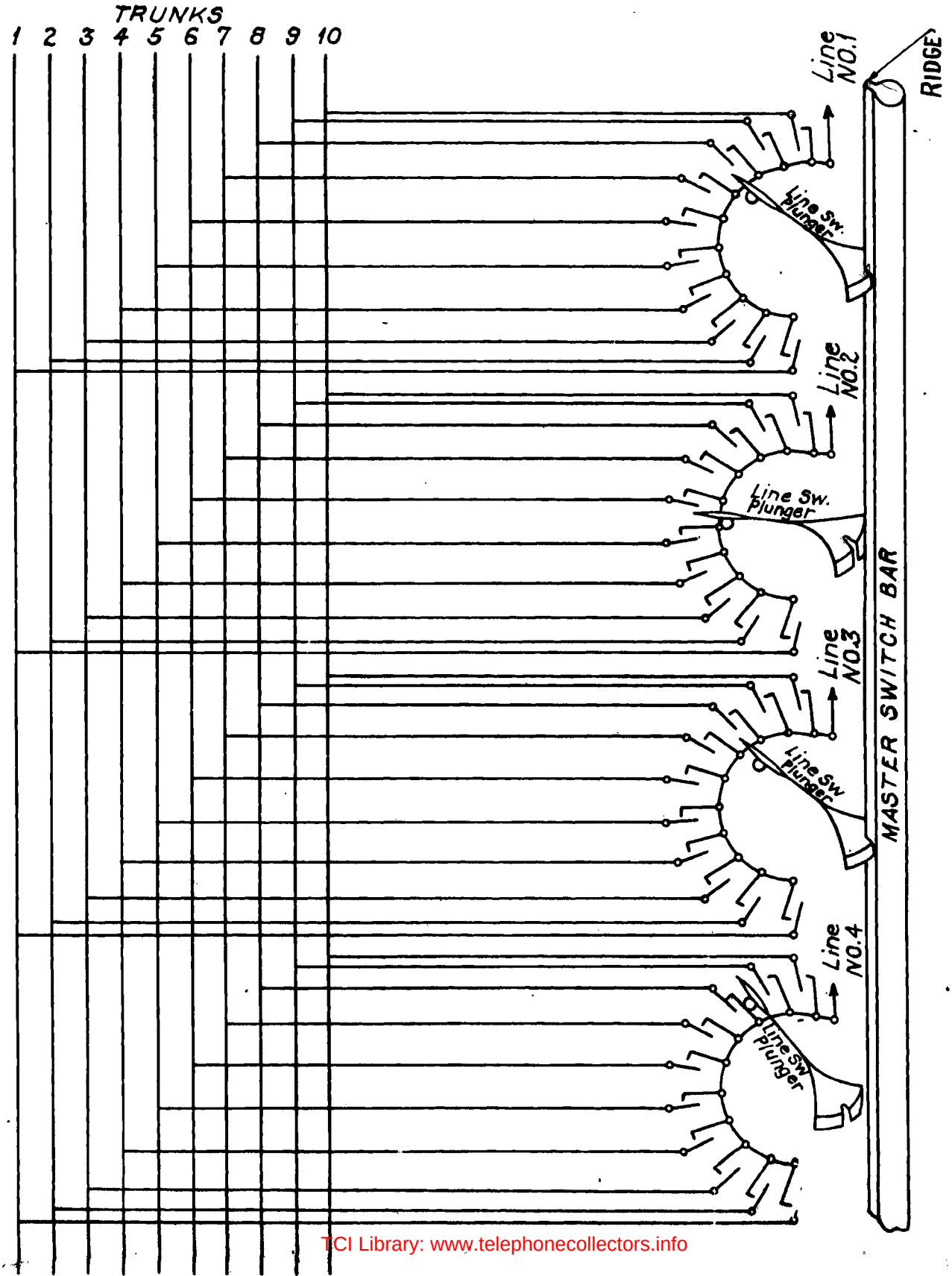
Engineer
Draftsman

STEP BY STEP MACHINE SWITCHING SYSTEM
Schematic showing Relation of Line Switches and Trunks.



Primary Line Switch:

A line switch of the plunger type, described in Division II, Section 3-a, is associated with each working subscriber's line and, in general, with each private branch exchange trunk, and the switch is known as the primary line switch. The assembly of the switch and its bank is shown on drawings Nos. 807-12 and 807-44.

In offices where secondary line switches are not installed the primary switch serves to connect the subscriber's line or P.B.X. trunk with which it is associated directlg to a trunk to a first selector. In offices having secondary line switchea, a primary switch connects the subscriber's line or P.B.X. trunk to a trunk to a secondary line switch.

The line relay on a primary line switch corresponds in a general way to the line relay used in manual equipments, since it operates when the subscriber removes his receiver from the hook and initiates the sequence of operations necessary for the completion of the call. The armature on the primary lire switch magnet, marked BCO on drawing 807-12, is known as the "bridge cutoff" armature, and when operated cuts off the line relay C at springs B.

The reason for using primary line switches is to reduce the number of first aelectore required to handle the traffic originated by a given number of subscribers' lines. Instead of terminating the subscribers' lines directly on expensive first selectors, the line switch is provided for quickly connecting its calling line to an idle first selector. With this arrangement only as many first selectors are required as are necessary to care for the maximum number of lines busy on originating calls at thc same time, taking

into ac'count the efficiency of the trunk groups between the line switches and the selectors.

A first selector must be associated with a calling line by the time the first pulse is dialed. Ordinarily the plunger of a line switch is standing opposite the terminale of an idle trunk (that is, the trunk is "preselected"), and since the operation of the line switch is practically instantaneous, the time consumed in associating a selector with a calling line is very small. Thie time is increased, however, if the maeter switch is hunting for an idle trunk when the call originates, and may be a considerable interval if all 10 trunks to which the line has access are busy, since in this case the connection cannot be completed to the selector until one of the trunks is released, To care for this condition a dial tone may be used, this tone being placed on the line as eoon as the first selector is chosen, tbus informing the calling subscriber that he may proceed with the dialing.

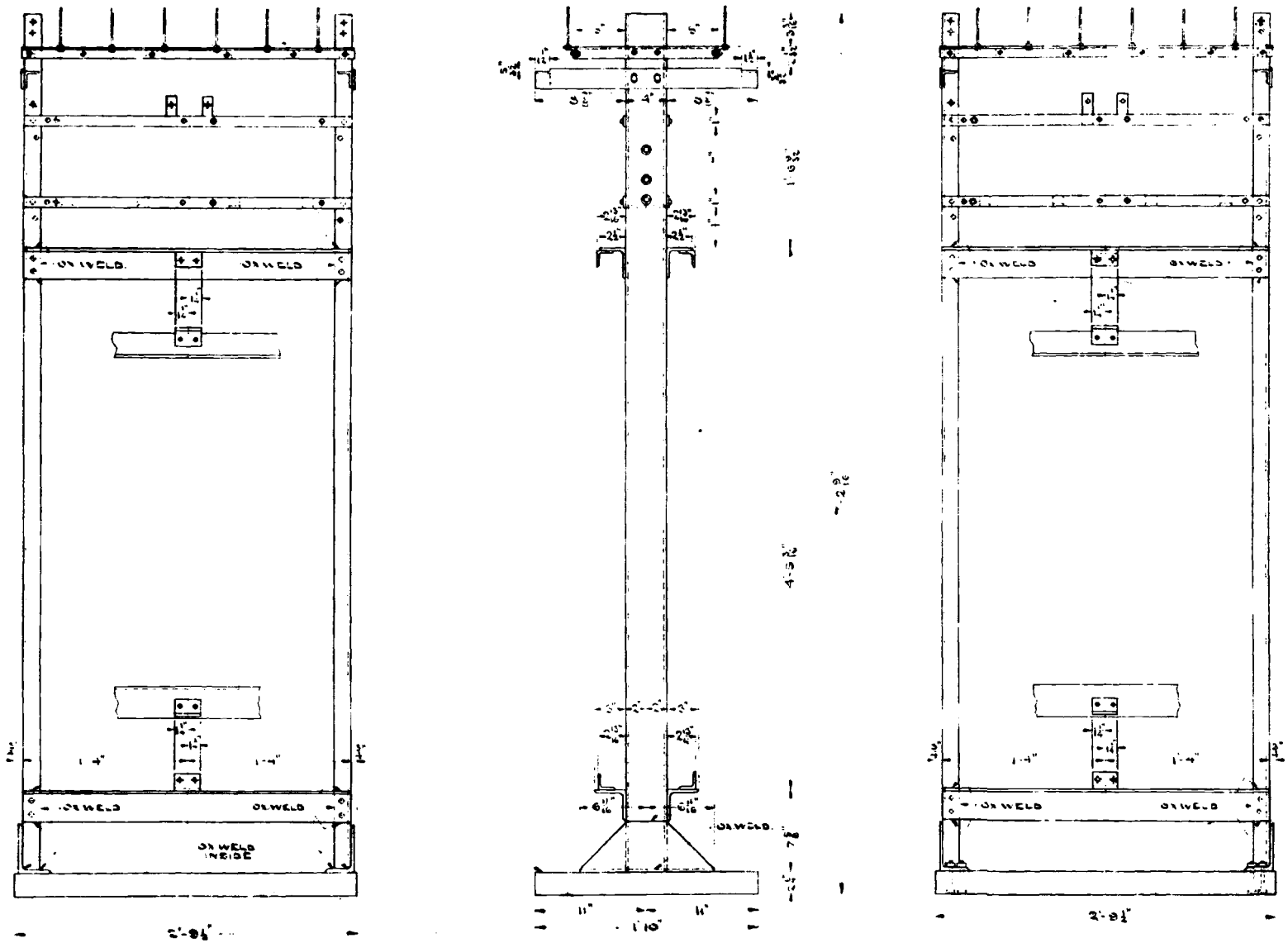
~~Primary Master Switch:~~

A solenoid type maeter switch, described in Division II, Section 3-b, is provided for controlling the plungers in each aub-group of primary line switches, and is known as the primary master switch. A partial assembly of a primary master switch is shown on Drawing No. 807-14.

Where the trunks from the primary line switches lead directly to first selectors, the functions and operation of the primary maeter switch are aa described in Section 3-b. Where the trunks lead to secondary line switches the primary master switch requirea an extra relay which gives the master switch the "pick-up" feature described in Division III. This relay is also provided, however, where the trunks from the primary line switches lead directly to first selectors, in order that all primary master switches may be uniform, whether or not secondary line switches are installed.

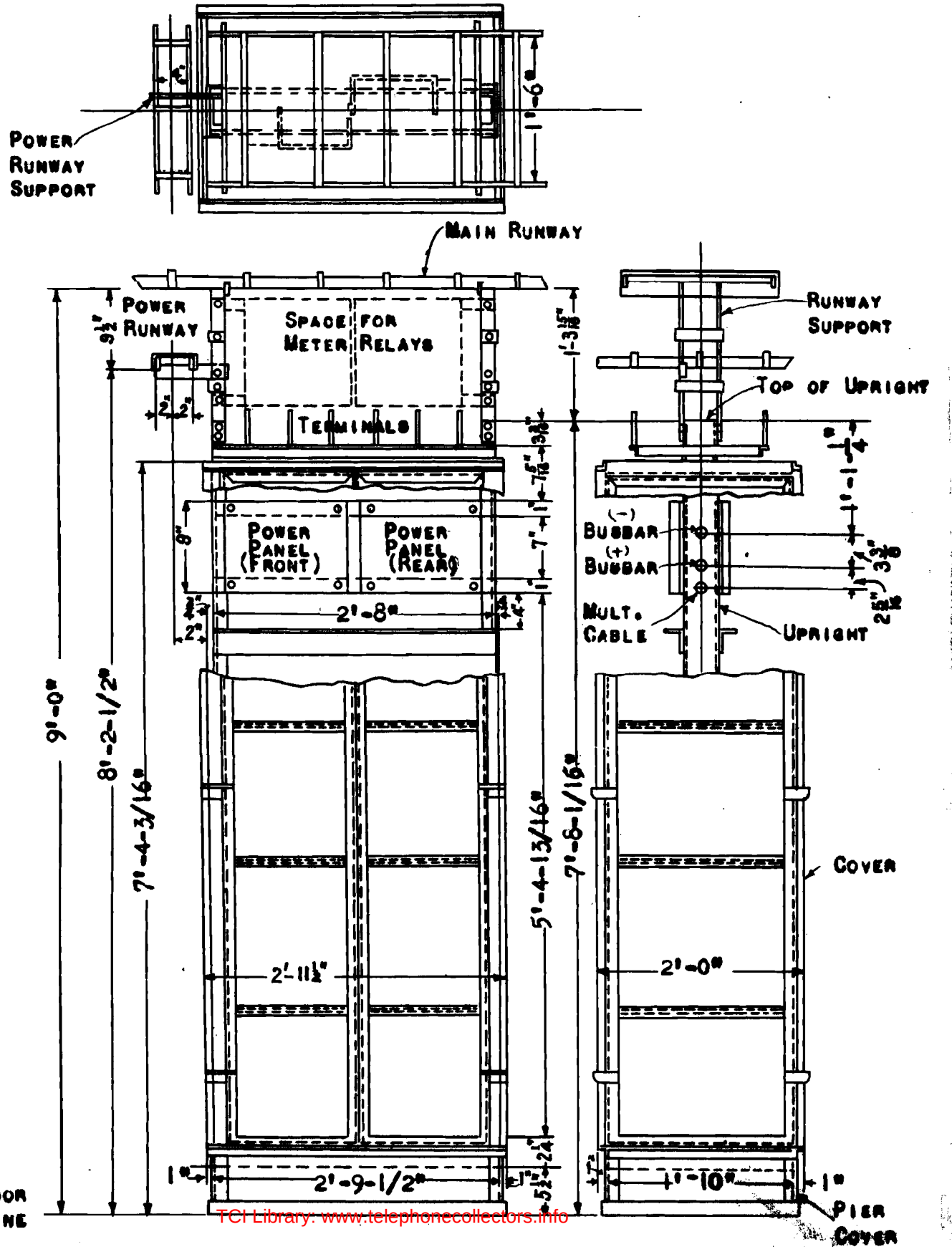
STEP BY STEP MACHINE SWITCHING SYSTEM

Line Switchboard Framework
Assembly
Capacity - 200 Line Switches



STEP-BY-STEP MACHINE SWITCHING SYSTEM

PRIMARY LINE SWITCHBOARD ASSEMBLY
CAPACITY - 200 LINE SWITCHES



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Erg. Dept.

STEP DY STEP MACHINE SWITCHING SYSTEM

No. 9
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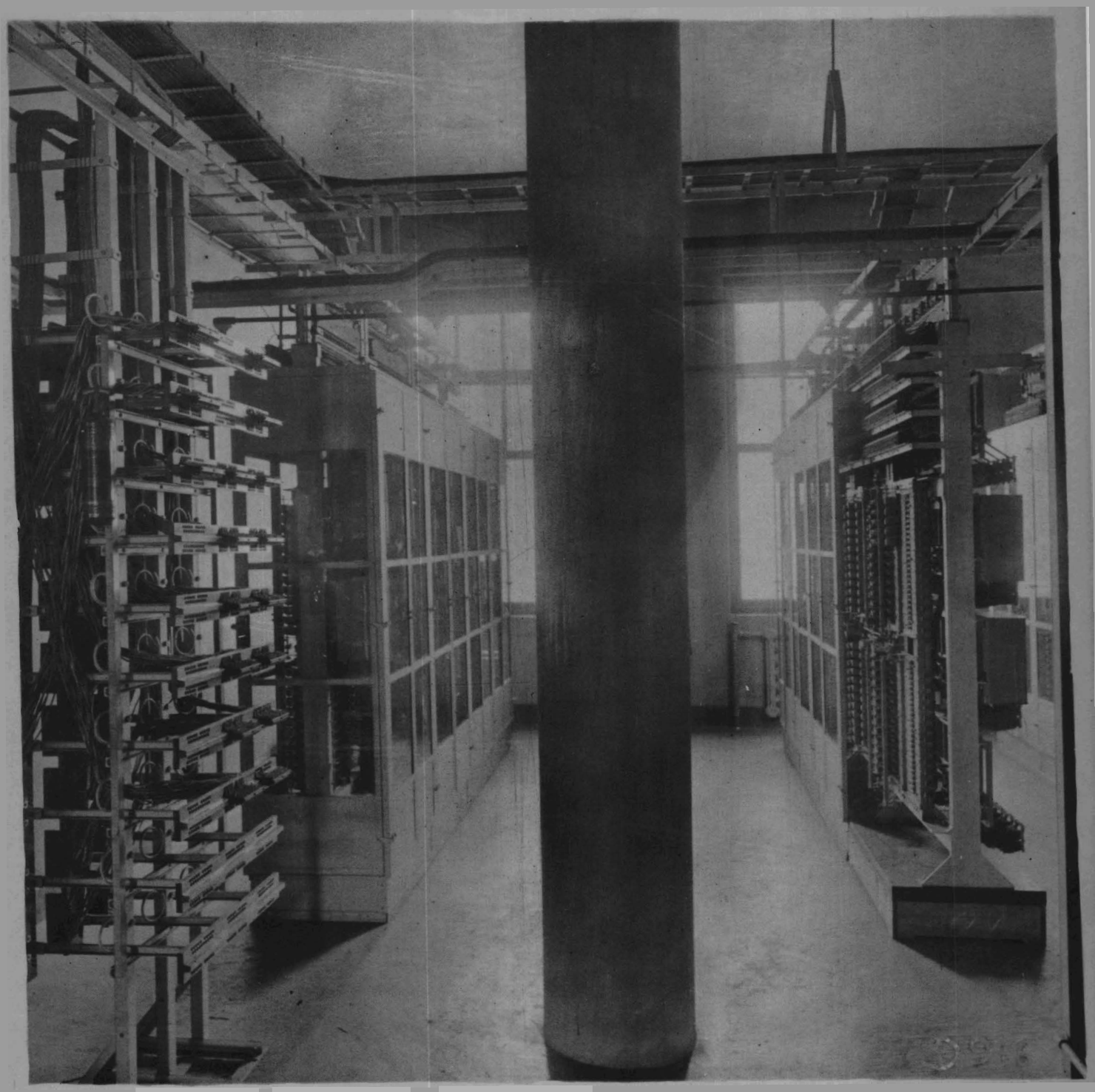
Line Switchboards, showing Framework, Casing and Base



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Eng. Dept.

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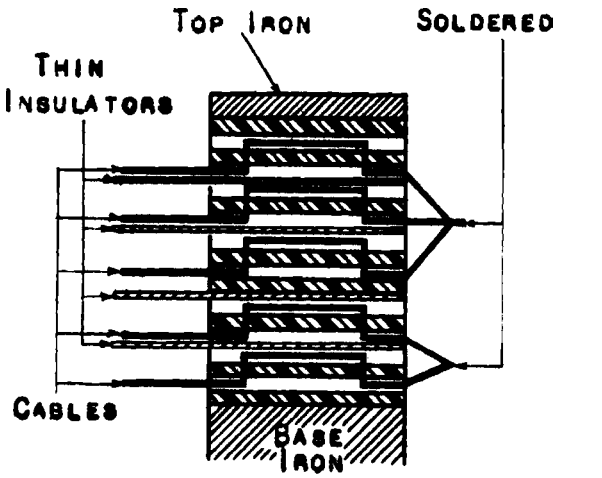
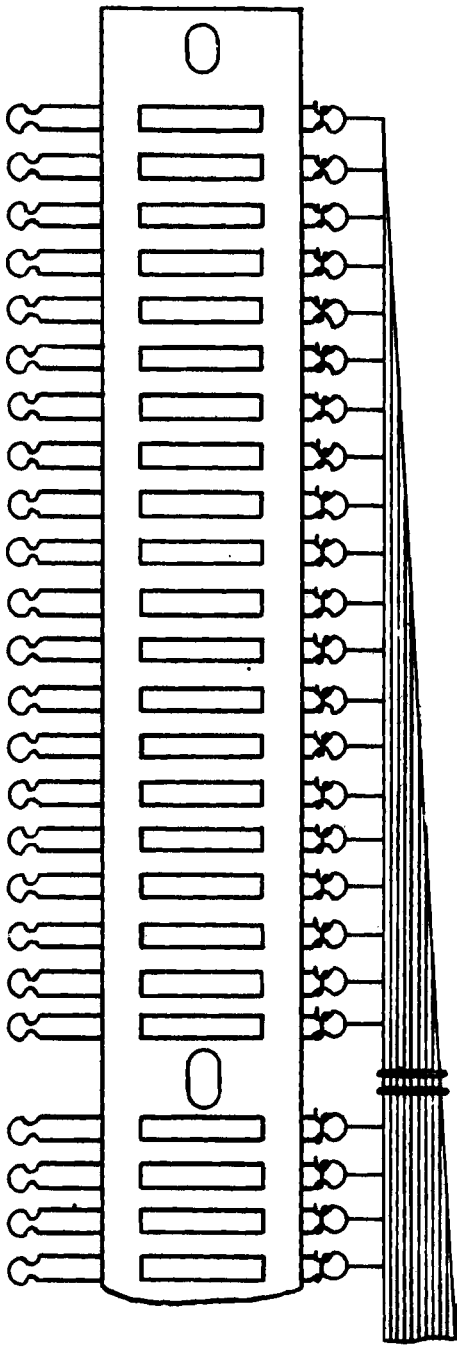
May 1, 1920

STEP BY STEP MACHINE SWITCHING SYSTEM

Flat Type Terminal Strip
Used at Line Switch and Selector Boards



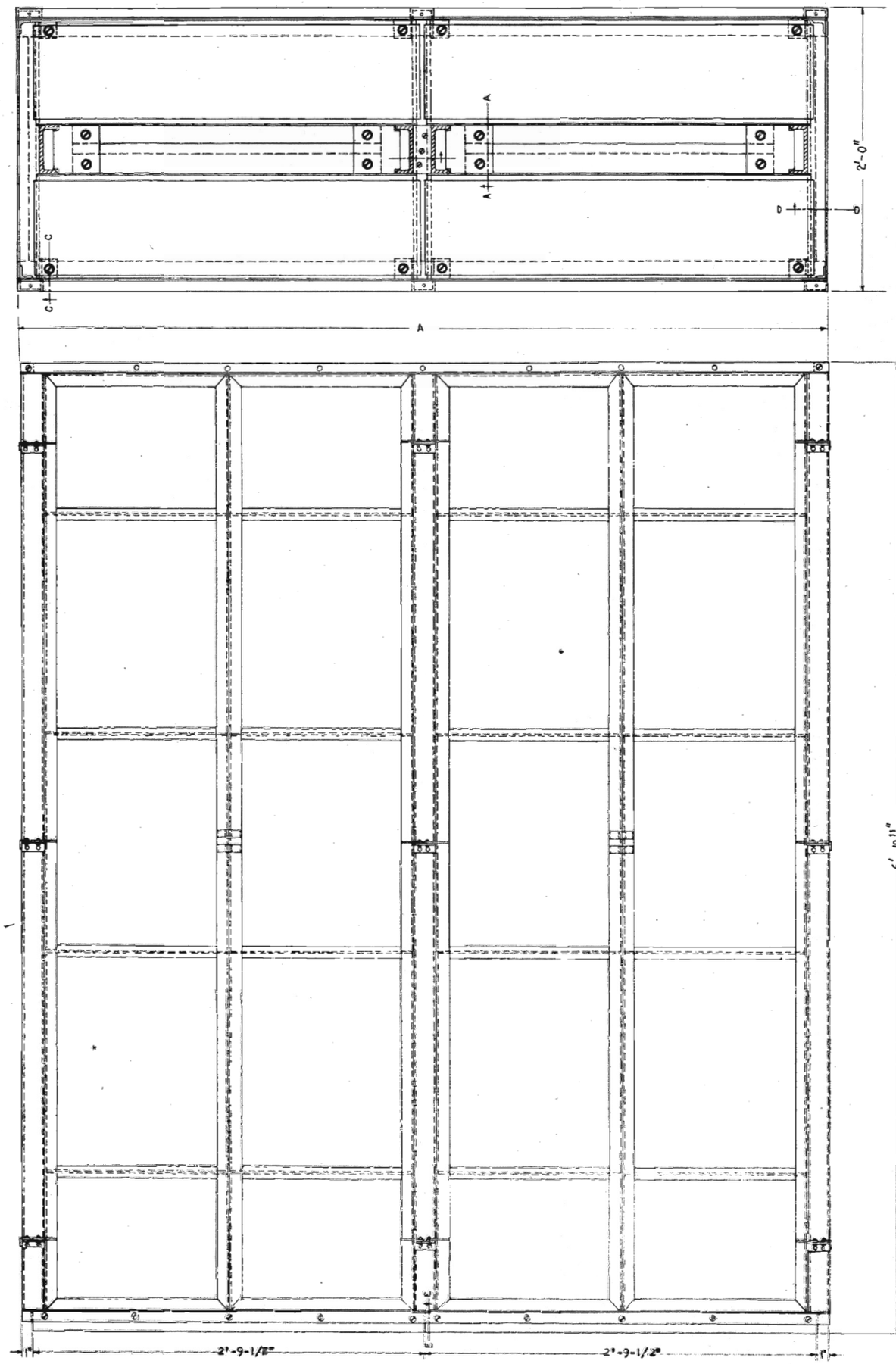
Cross Section of Terminal Assem.

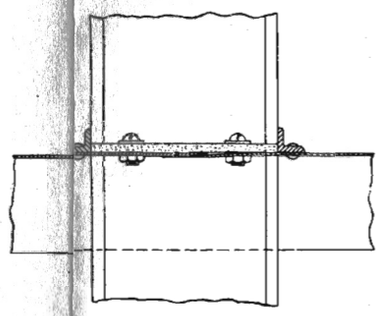


Section of Terminal Strip with Cable Fanned Out

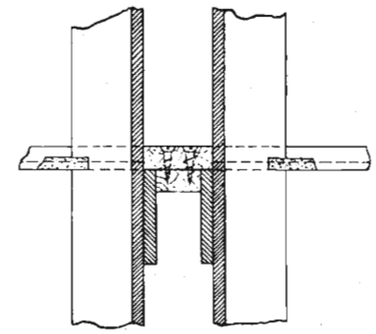
STEP BY STEP MACHINE SWITCHING SYSTEM

LINE SWITCH BOARD CABINET ASSEMBLY

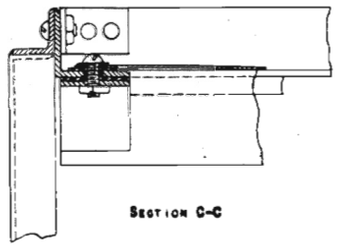




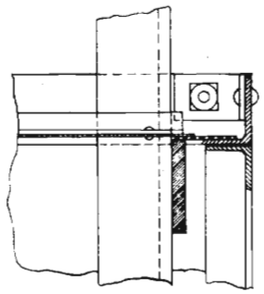
SECTION A-A



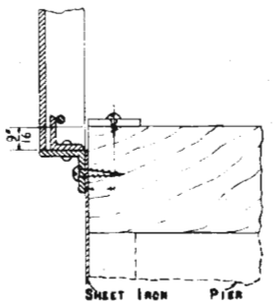
SECTION B-B



SECTION C-C



SECTION D-D

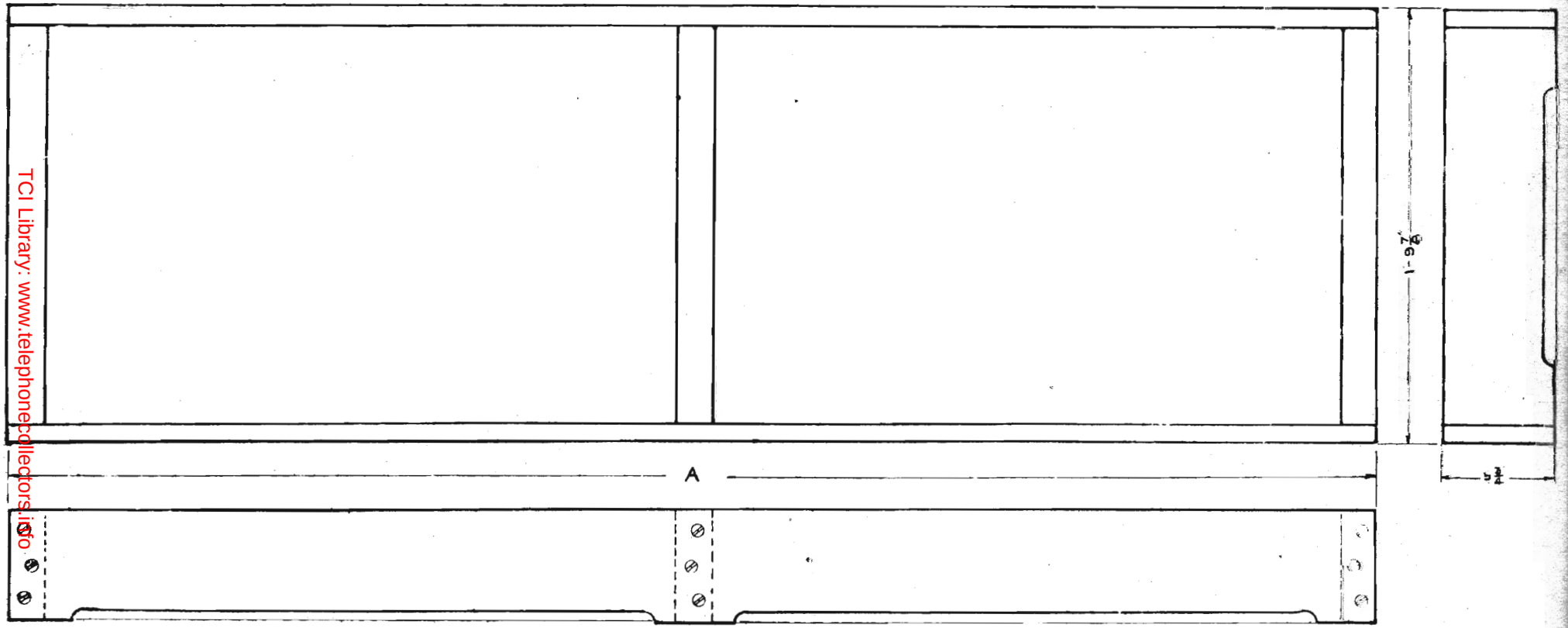


SECTION E-E

No. of Boards per Unit Cabinet	Value of "A"
1	2' 11-1/2"
2	5' 9"
3	8' 6-1/2"
4	11' 4"
5	14' 1-1/2"

STEP BY STEP MACHINE SWITCHING SYSTEM

Line Switchboard Base Assembly



No. of Boards on Unit Base	Value of "A"
1	2'-9-1/2"
2	5'-7"
3	8'-4-1/2"

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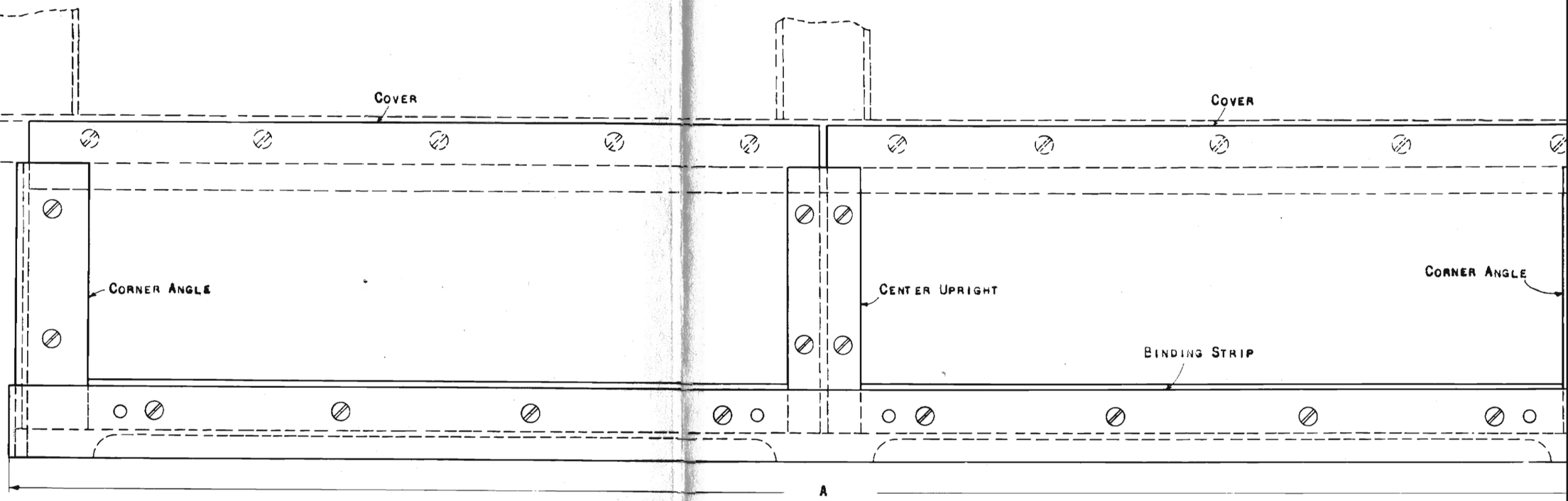
ENGINEERING DEPARTMENT

STEP BY STEP MACHINE SWITCHING SYSTEM

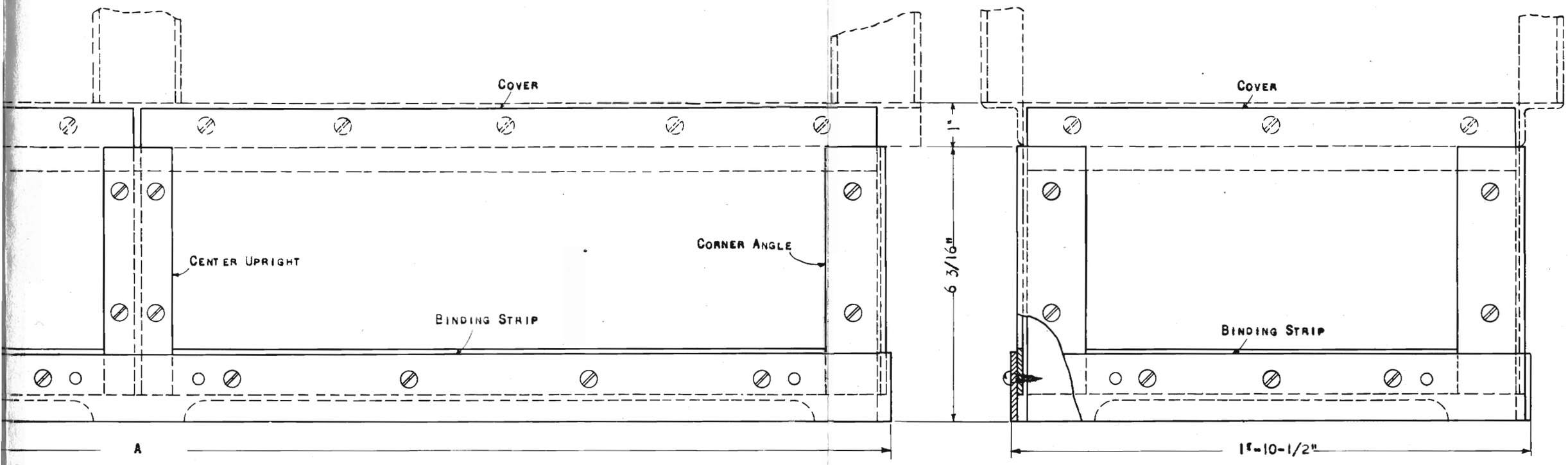
LINE SWITCH BOARD BASE COVER ASSEMBLY



No. of Boards per Unit Base Cover	Value of "A"
1	2' 10"
2	5' 7-1/2"
3	8' 5"
4	11' 2-1/2"
5	14' 0"

STEP BY STEP MACHINE SWITCHING SYSTEM

LINE SWITCH BOARD BASE COVER ASSEMBLY



No. of Boards per Unit Base Cover	Value of "A"
1	2' 10"
2	5' 7-1/2"
3	8' 5"
4	11' 2-1/2"
5	14' 0"

Primary Line Switchboard:

The primary line switches and their aesociated maeter switches are mounted on unit type frameworks. A framework and its switch equipment is known ae a line ewitchboard. Drawing No. 807-17 shows the framework and drawing No. 807-74 shows the aseembly of a primary line ewitchboard. Photograph No. 7 ehowe the line switch and maeter switch equipment on one side of a line ewitchboard, and photograph No. 9 shows a number of theee boards mounted in a line.

The line switches for one bosrd are mounted on four hinged gates, two on each side of the framework. Each gate haa a capacity for 50 line switches which may be arranged in either one or two sub-groups. The hinged gate mountings permit the ewitchee to swing out to give acceee to their wiring.

Spate is provided at the top of the frame for mounting platea for the relaya required in connection with message register lines, and provieion is made above the line ewitchee for fuse panels for mounting alarm type fuses, as shown on drawing No. 807-74.

Terminal strips for making the conneotion between the local wiring to the line switches and the cabling leading to the line switch board are located at the top of the frame. The type of terminal strip used is shown on Drawing No. 807-18. The aeaembbed terminal consists of a number of flat terminal etripe superimposed upon eaoh other as shown on the drawing. Terminal lugs, arranged at one end for eolder-ing to a wire, are mounted in flat strips of insulating composition. The connection at the terminal strip is made by bringing the wires

from the local form to the lugs in one of the flat strips, and the wires in the cable to the lugs on another strip. The two strips are then mounted adjacent to each other in the assembly, and the free ends of corresponding lugs are bent and soldered together as shown on the drawing. With this arrangement the wires can be formed out and soldered to the individual flat atrips in the shop, and it is only necessary for the installer to assemble the strips on the line switchboard framework and solder the corresponding lugs together.

A unit type metal framework casing with glass doors and end panels is provided for enclosing the line switches, as shown on drawing No. 807-19. Standard casing units are available for 1, 2, 3, 4 or 5 line switchboards mounted in a line,

Primary line switchboards are mounted on unit type wooden bases or piers, as shown on drawing No. 807-20. Standard units are available for mounting 1, 2 or 3 boards. Where more than 3 boards are mounted in a line, bases are made up by combining standard units. Sheet iron covers are provided for the piers as shown on drawing No. 807-21. Cover units are available for 1, 2, 3, 4 or 5 boarde in a line.

Secondary Line Switch:

As stated in Division 11, Section 3-c, ae many first selectors are provided ae are necessary to care for the maximum number of eimultaneoue calle, taking into account the efficiency of the trunk sub-groups between the primary line switches and the first selectors. The efficiency of the ten-trunk subgroups from primary line switches is low, and in order to obtain the advantage of larger trunk subgroups and thus reduce the number of first selectors required, secondary line switches may be used,

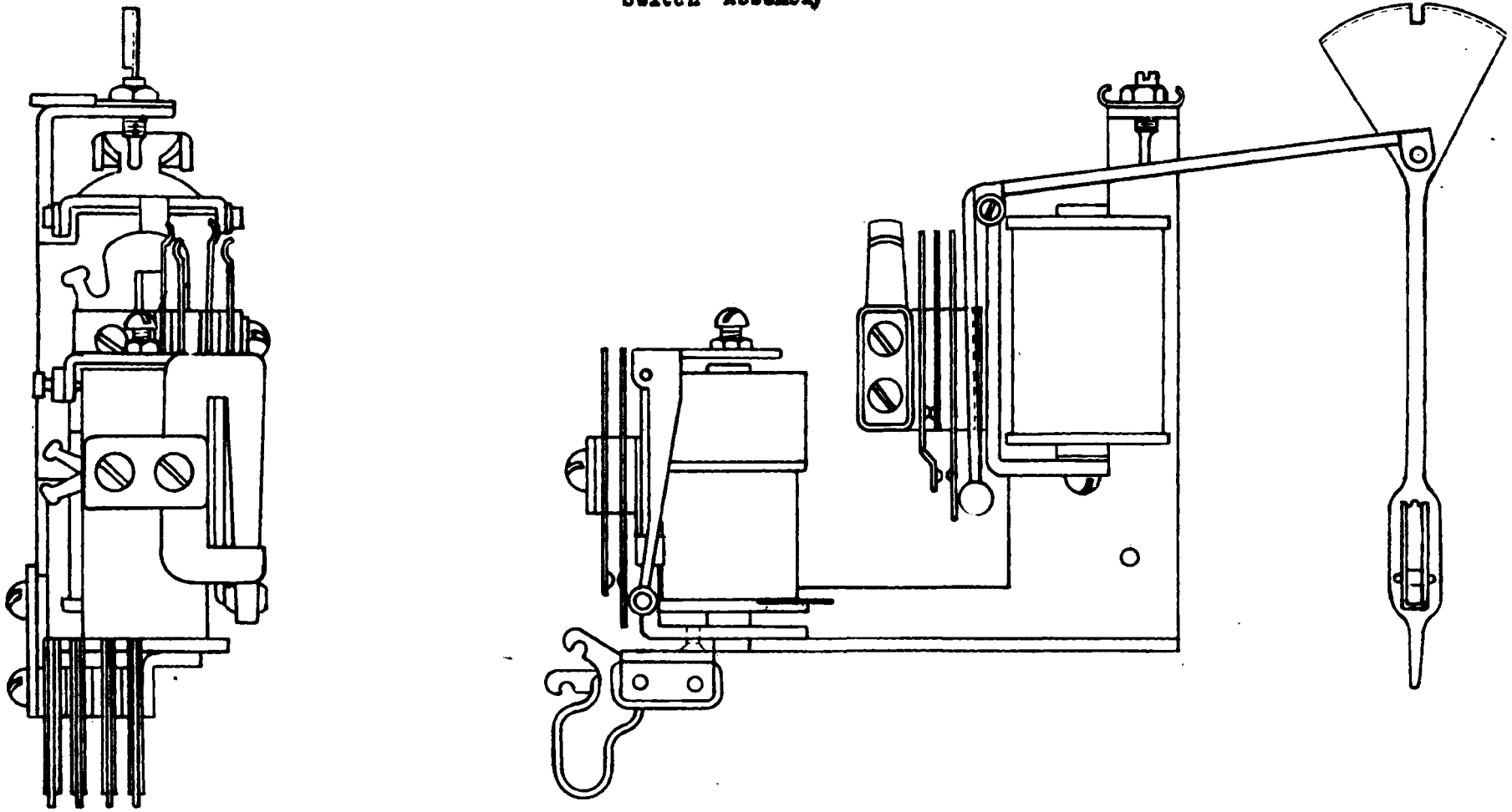
Where secondary line switches are used, the trunka from the primary line switch banke terminate at the line switch springs in the multiple banks of the secondary switches and the trunka from the multiple banks of the secondary switches are extended to the brushes of the first selectors.

Line switches of the same general type as the primary switches previouely described are used for secondary line switches, so that the number of trunks per subgroup between the secondary switches and the first selectors is limited to ten. However, the various trunks in a subgroup from the primary line switches are terminated at switches in different subgroups of seoondary lihe switches, so that each subgroup of primary ewitches may have access to ten eubgroups of secondary switches or to one hundred trunks to first selectors. The effect of this arrangement ie to increase the efficiency of the trunke to first selectors to a value somewhat less than the efficiency which would be obtained if subgroups of one hundred trunke each were used from primary switches to first selectore. This arrangement is described in more detail in Division IV of these notes.

The assembly of the secondary line switch is shown on drawing No. 807-22. The secondary switch is similar mechanically to the primary switch, but the windings of the relay and magnet and the bank wiring are changed ae required for the proper functioning of the switch in its intermediary capacity. The secondary line switch magnet, moreover, is not provided with a BCO armature for the operation of its epring contacts. On the secondary line switch, these contacts do not need to be operated independently of the plunger, as is the case at a primary line ewitch on an incoming call, so that on the secondary switch the contacts are actuated directly by the plunger arm, as shown on the drawing.

STEP BY STEP MACHINE SWITCHING SYSTEM

Secondary Line
Switch Assembly



Secondary Master Switch:

A solenoid type master switch, described in Division II, Section 3-b, is ured for controlling the plungers in each sub-group of secondary line switches. A partial assembly of the seoondary master switch is shown on drawing Ho. 807-23. Its functions and operation are similar to those of the primary master switch. In addition, the seoondary master switch circuit is arranged to make all trunks incoming to its rub-group test buey at tbe primary switches when all the outgoing trunks in its sub-group to first selectors are busy. When this condition exists, a group of relays associated with the secondary master switch also sets up the circuit arrangement for the operation of the "pick-up" described in Division III. The additional relays for these circuit features are mounted on the secondary line switch board separate from the master switch base.

Secondary Line Switchboard:

Secondary line switches and their associated master switches are mounted on unit type frameworks of the same kind and capacity as the primary line switch framework, shom on drawing No. 807-17. Space is provided for relays, fuses and terminal strips as in the primary line switchboard, and a casing and base is provided as described for the primary boards.

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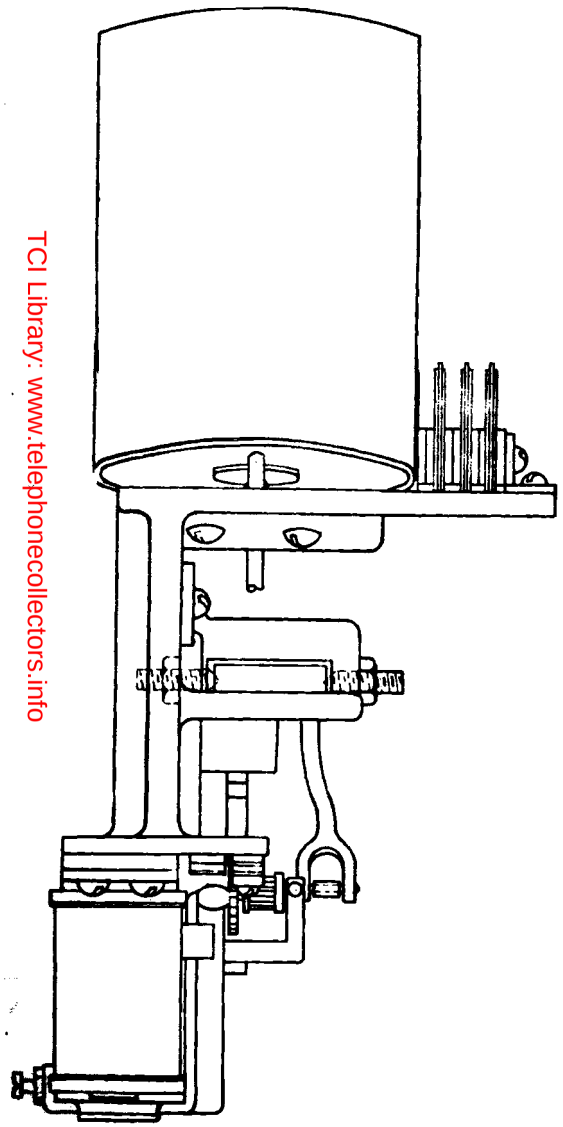
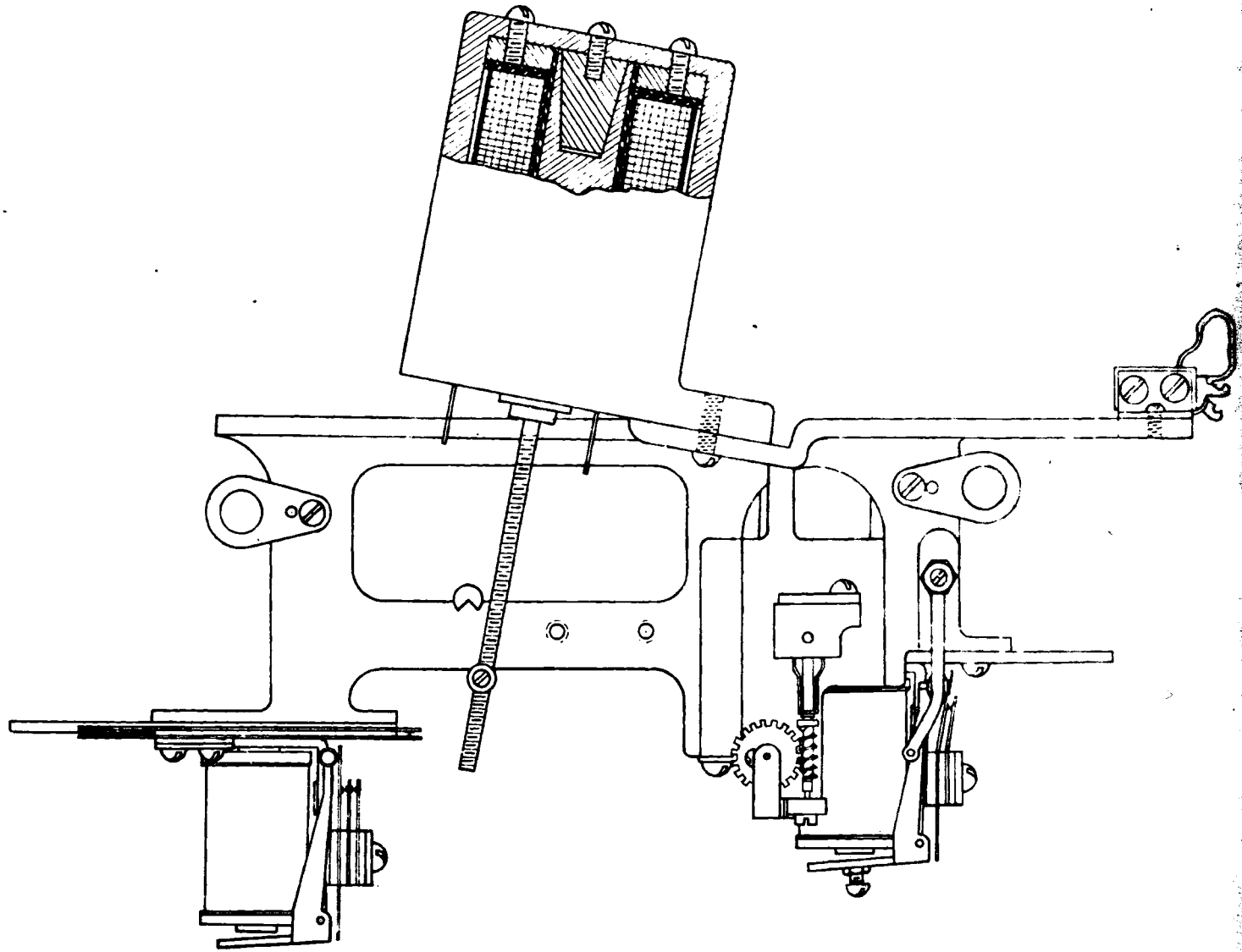
STEP BY STEP MACHINE SWITCHING SYSTEM

Secondary Master Switch
Bottom Switch





Outgoing Trunk Secondary Switch:

Since a selector has access to a maximum of but ten trunks on a given level, interoffice trunks, like local trunks, must be run in sub-groupe of ten or less if they are carried directly from the selector banke through the repeatera to the incoming office. In order to uee larger interoffice trunk groups, thus reducing the number of interoffice trunks and incoming second selectors necessary to handle the traffic, outgoing trunk secondary switches may be installed. These switches are interposed between the first selectors and the repeaters. The trunks from the multiple banks of the selectors terminate at the line switch springs in the multiple banks of the outgoing trunk secondary switches and the trunks from the multiple banks of these switches are extended through the repeaters and the interoffice trunks to the brushes of the incoming second selectors.

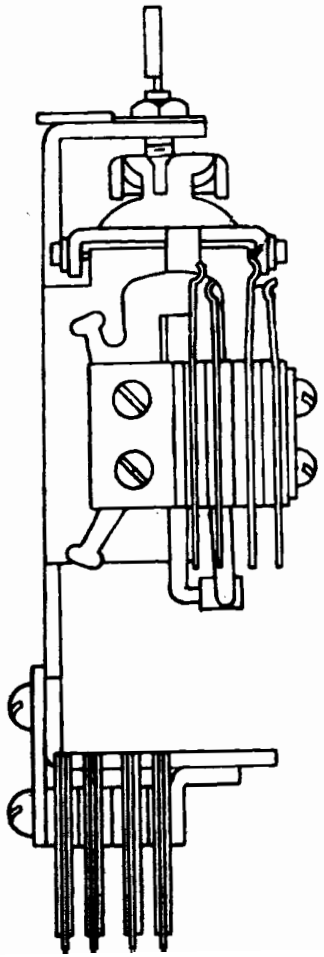
Outgoing trunk secondary switches are of the plunger type and of the same general construction as the secondary line switches previously described, so that the number of interoffice trunks to which a particular sub-group of outgoing trunk secondary switches has access is limited to ten. The various trunks in each sub-group from the first selactors, however, are distributed over the different sub-groups of outgoing trunk secondary switches so that each sub-group from the first selectora may have access to as many as ten sub-groups of secondary switches and therefore to as many as 100 inter-office trunks. This has effect of forming the inter-office trunks into one or two large groups, working at somewhat less than full efficiency. This matter is discussed further

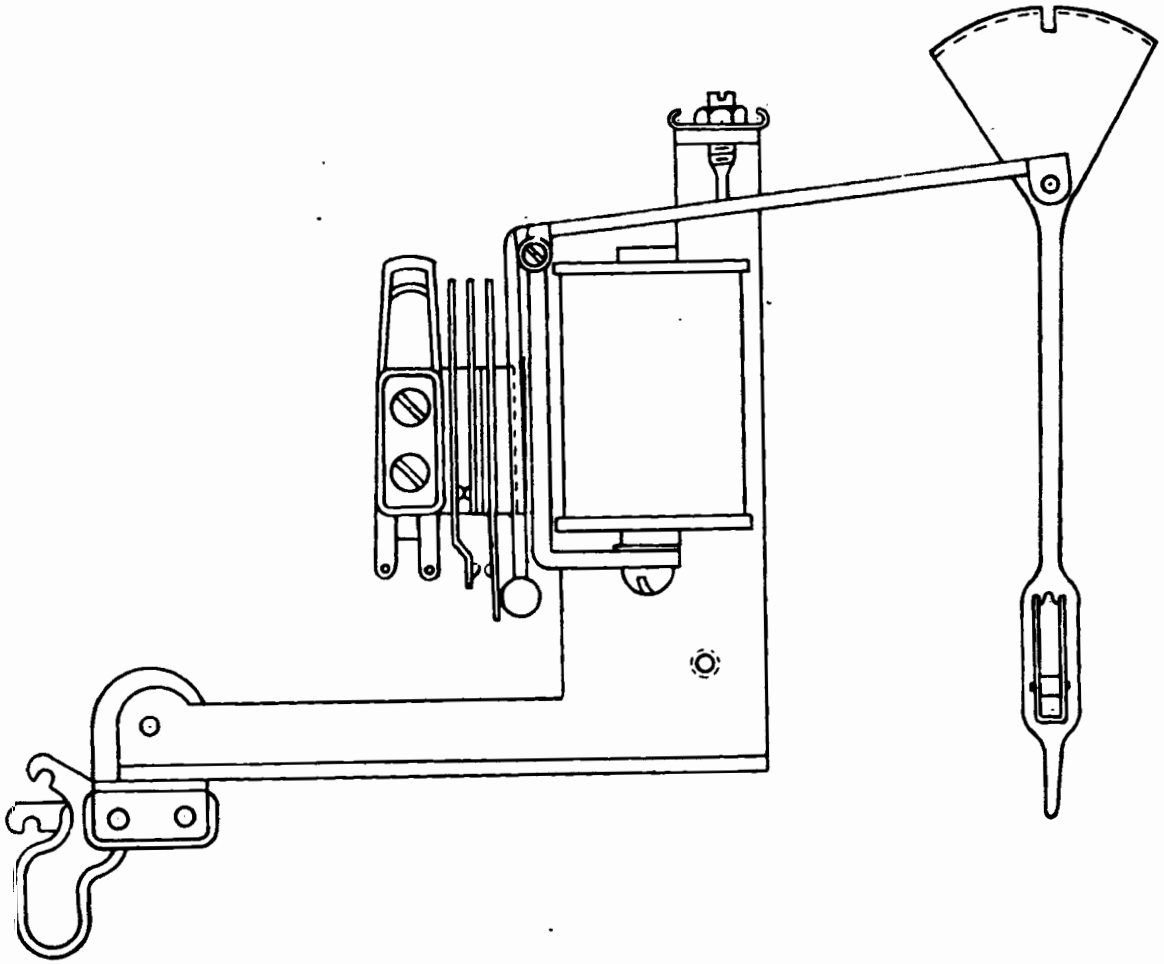
under Division IV, "Amount and Arrangement of Equipment."

The assembly of the outgoing trunk secondary switch is shown an drawing No. 807-50. This switch is similar to the secondary line switch, but dua to tha somewhat different circuit conditions under which the outgoing trunk secondary switch operates the separate relay used on secondary line switches is not required and is therefore omitted.

STEP BY STEP MACHINE SWITCHING SYSTEM

Outgoing Trunk Secondary Switch Assembly





Outgoing Trunk Secondary Master Switch:

A solenoid type master switch, described in Division II Section 3-b, is used for controlling the plungers in each sub-group of outgoing trunk secondary switches. This master switch is similar to the secondary master switch described under Division II, Section 3-g. Provision ia nade for making all trunks incoming to a sub-group of outgoing trunk secondary switches test busy at the first selectors when all trunks outgoing from that sub-group become busy, as in the case of secondary line switches. The outgoing trunk secondary master switch, however, is not arranged for the "pick-up" feature, since the trunks to its sub-group of switches lead from selectors, on which the "pick-up" feature is not required.

Outgoing Trunk Secondary Switchboard:

Outgoing trunk secondary switches and thelr master switches are mounted on unit frameworks of the same type and capacity as the primary line switch framework, shown on drawing No. 807-17. The framework is mouqted on a base, is enclosed by a casing and provides for relays, fuses and terminal strips as described in connection with primary line switchboards.

Step-by-Step Selector:

The assembly of the selector employed in the step-by-step machine switching system is shown on assembly drawings Nos. 807-24, 807-25, 807-26 and 807-27, and on photographs Nos. 11, 12, 13, '14, 15 and 16.

As shown on the assembly drawings and photographs the selector consists essentially of:

1: A main shaft S carrying two or more sets of brushes or wipers W, a hub H and a cup spring C.

2: A pair of magnets V and its associated armature U carrying a pawl P, called the vertical pawl. Magnets V are called the vertical magnets.

3: A pair of magnets R and its associated armature A carrying a pawl called the "rotary" pawl. (This pawl is not shown). Magnets R are called the rotary magnets.

4: A dog D, (serving a double function and accordingly called a double dog), and a fixed dog Y.

5: A release magnet M and its associated armature T.

6: A group of relays G.

7: Two or more selector banks. (Also called multiple banks.)

The parts included under items 1 to 5 inclusive are carried on a cast iron frame P. Frame F and the relay group G are mounted oq a pressed steel base L. The base is designed to accommodate a maximum of six horizontally mounted relays. The selector banks are made up as separate units and are secured to the selector frame by the bank rods K passing through the bank rod holes in the assembled

banke and in the selector frame. The banka may readily be detached from the selector by removing the nuts at the top of the bank rods. The selector is provided with a removable steel dust-proof cover which is set over a felt strip at the baae of the selector frame as shown in photograph No. 14.

All electrical connections to the selector except those to the multiple banks are made through a eet of jacks mounted on the back of the base ae shown in photograph No. 13 and at J on drawing No. 807-27. These engage spring jacks on the framework used for mounting the selectors. The wiring on the back of the selector base is protected by a sheet steel cover held in place by a catch X.

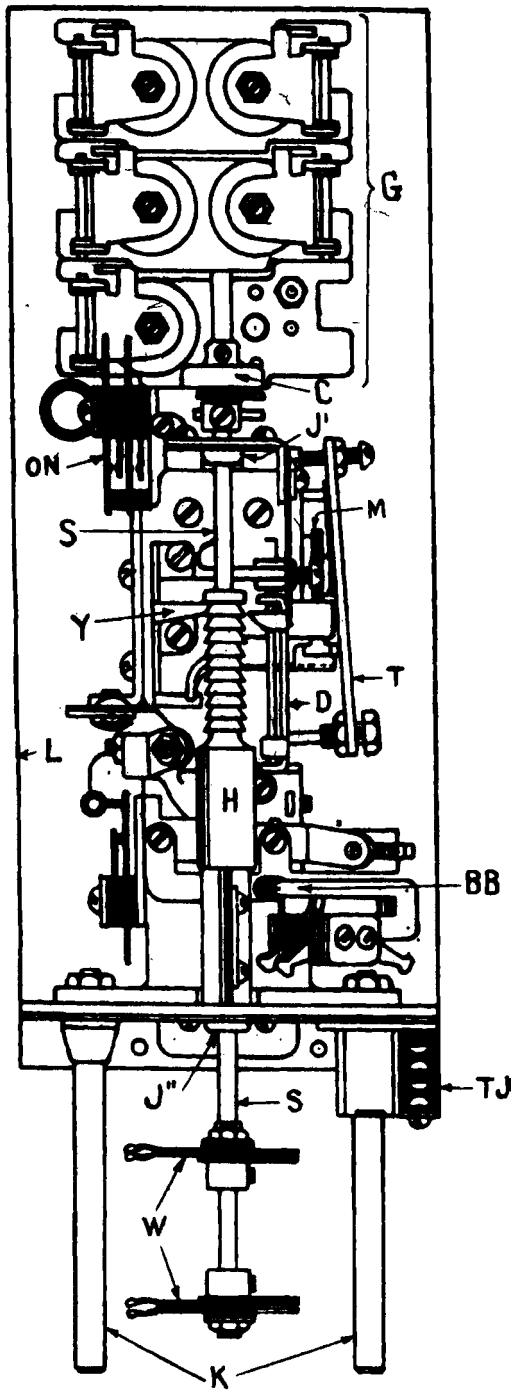
One set of brushes is provided for each selector bank. In photograph No. 15 there are two sets of brushes and two selector banks although aome selectors require more than two of each. The different sets of brushes are rigidly secured to the shaft S. They are mounted at right angles to it and parallel with one another.

The selector bank, shown in photograph No. 16 and on drawings Nos. 807-42 and 807-43, consists of 100 sets of terminals disposed in ten horizontal rows or levels, each level containing ten sets. The sets of terminals in a level are arranged in the arc of a circle and when the bank is mounted on its selector, the center of the circle is coincident with the center line of the shaft.

The trunk incoming to a selector is wired to the brushes and the outgoing trunks are wired to the multiple banks. It is the purpose of the selector to connect its incoming trunk with any idle trunk in a particular outgoing trunk group. The outgoing trunks are so wired to the selector banke that all trunks connected to a

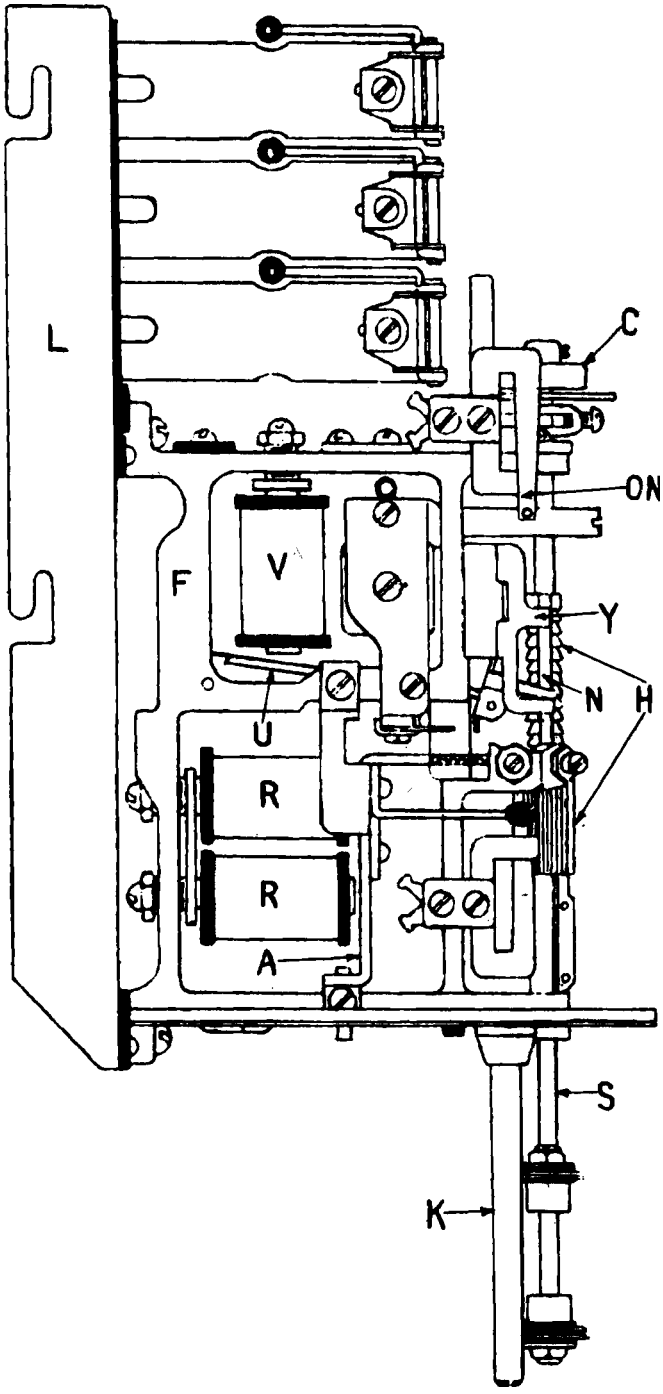
STEP BY STEP MACHINE SWITCHING SYSTEM

Selector Assembly
Front View



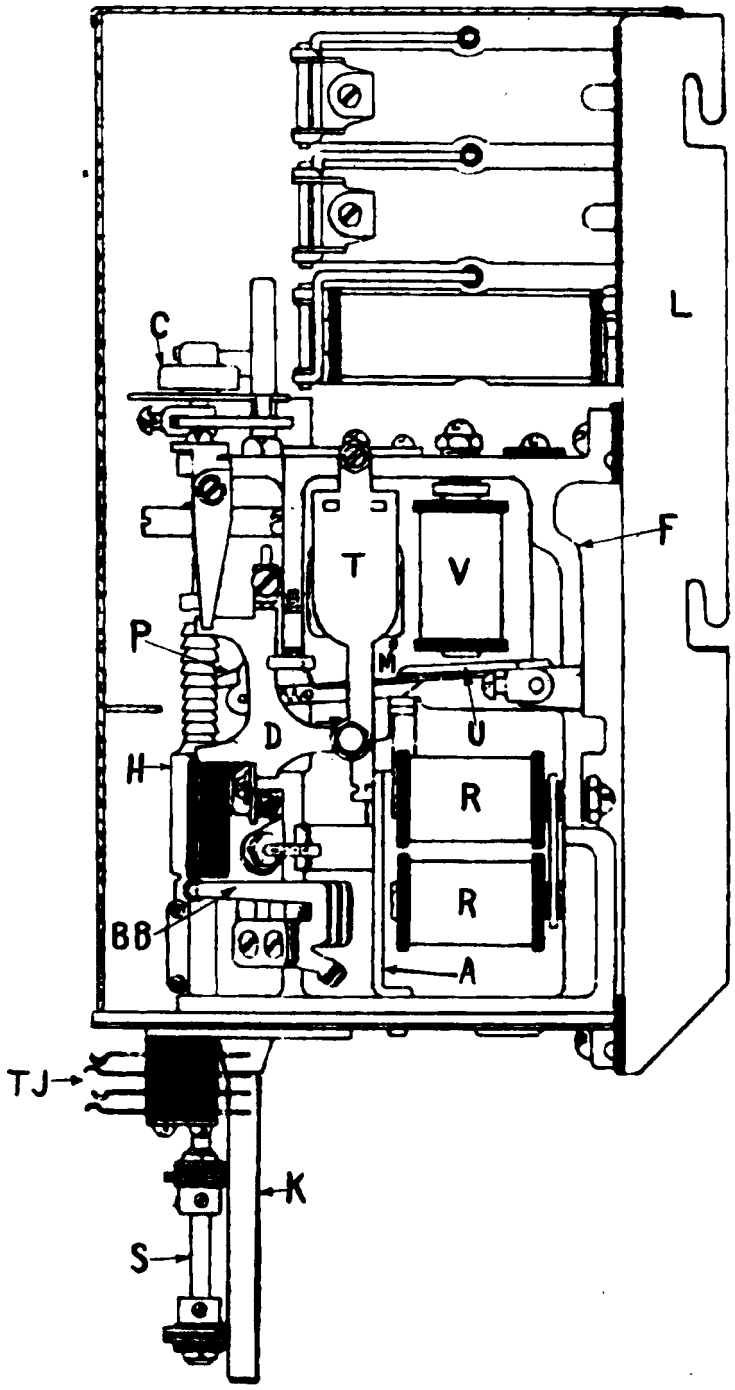
STEP BY STEP MACHINE SWITCHING SYSTEM

Selector Assembly
Left View



STEP BY STEP MACHINE SWITCHING SYSTEM

Selector Assembly
Right View



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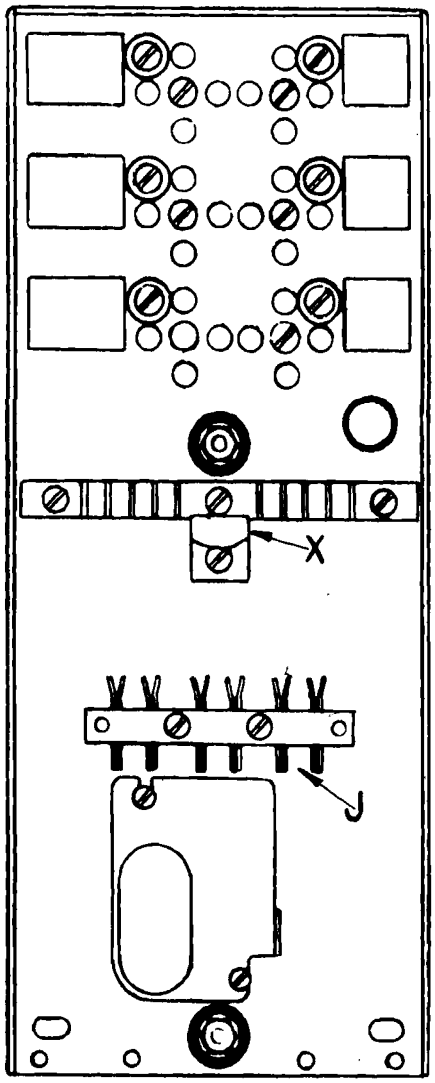
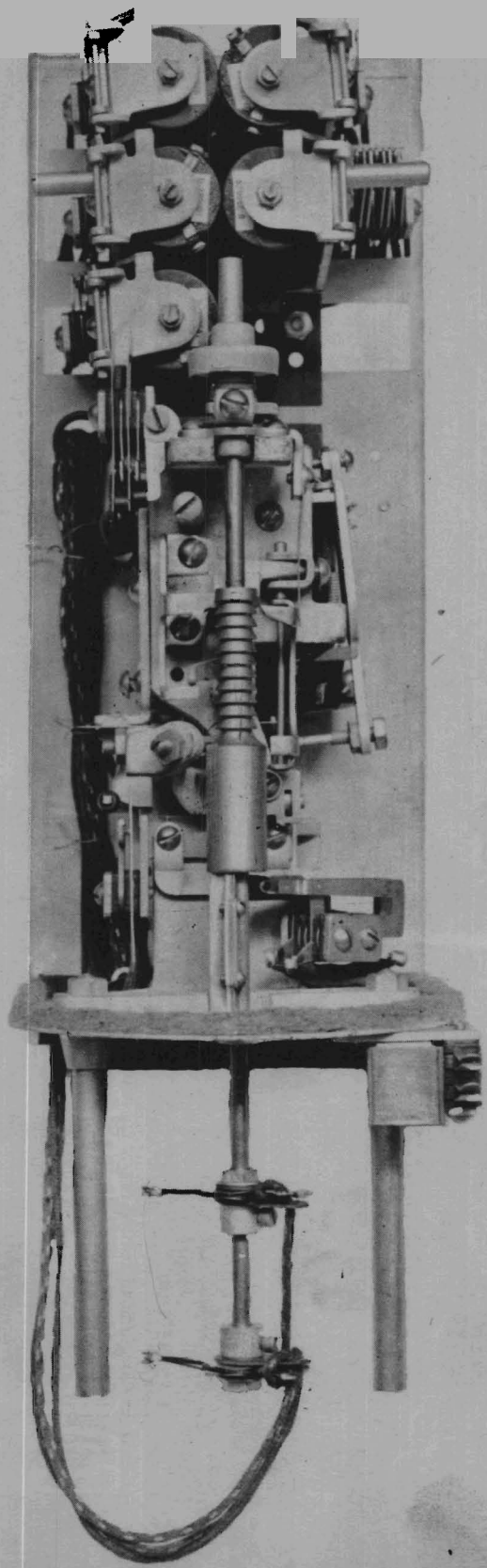
STEP BY STEP MACHINE SWITCHING SYSTEM

Salsator Assembly
Rear Vier



STEP BY STEP MACHINE SWITCHING SYSTEM

Selector - Front View



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STEP BY STEP MACHINE SWITCHING SYSTEM

Selector - Right View

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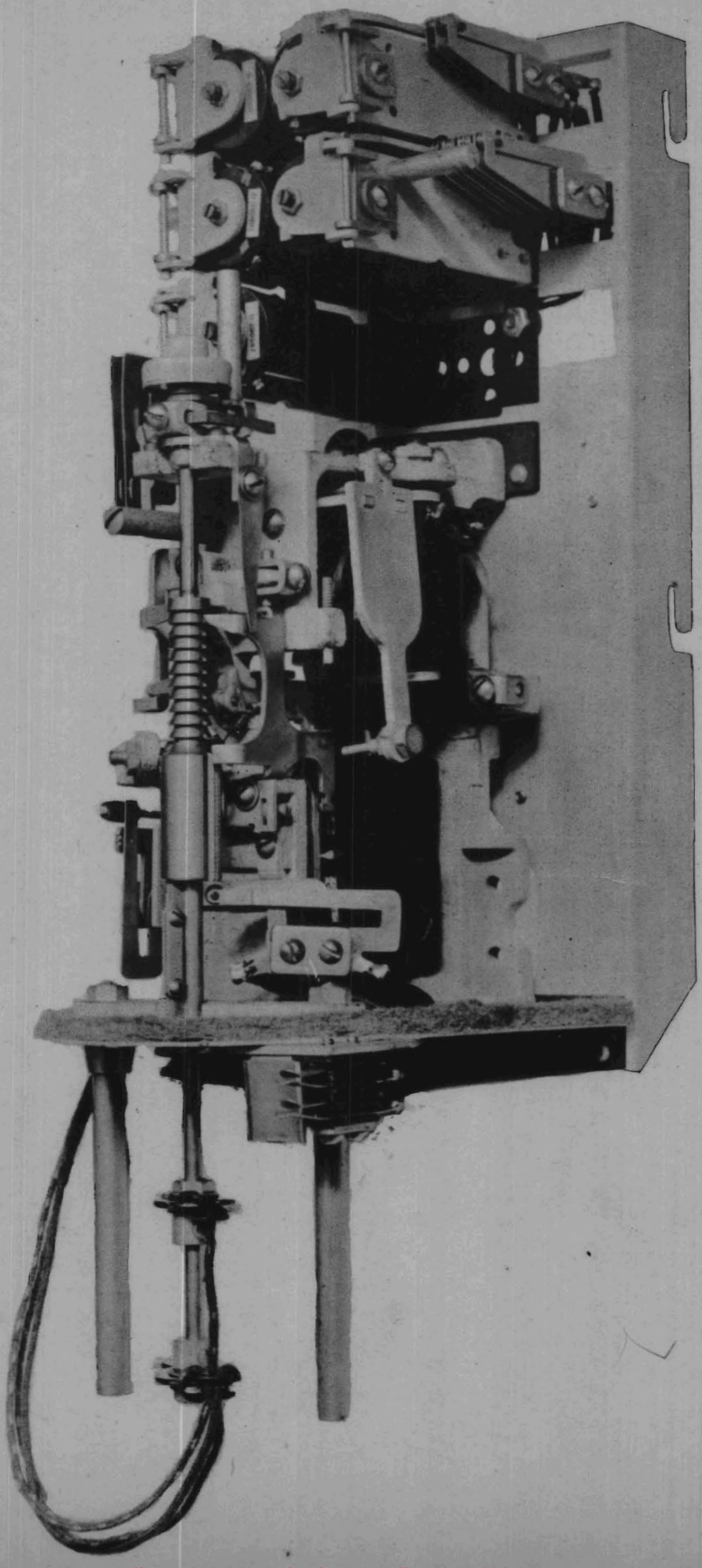

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STEP BY STEP MACHINE SWITCHING SYST

No. 13
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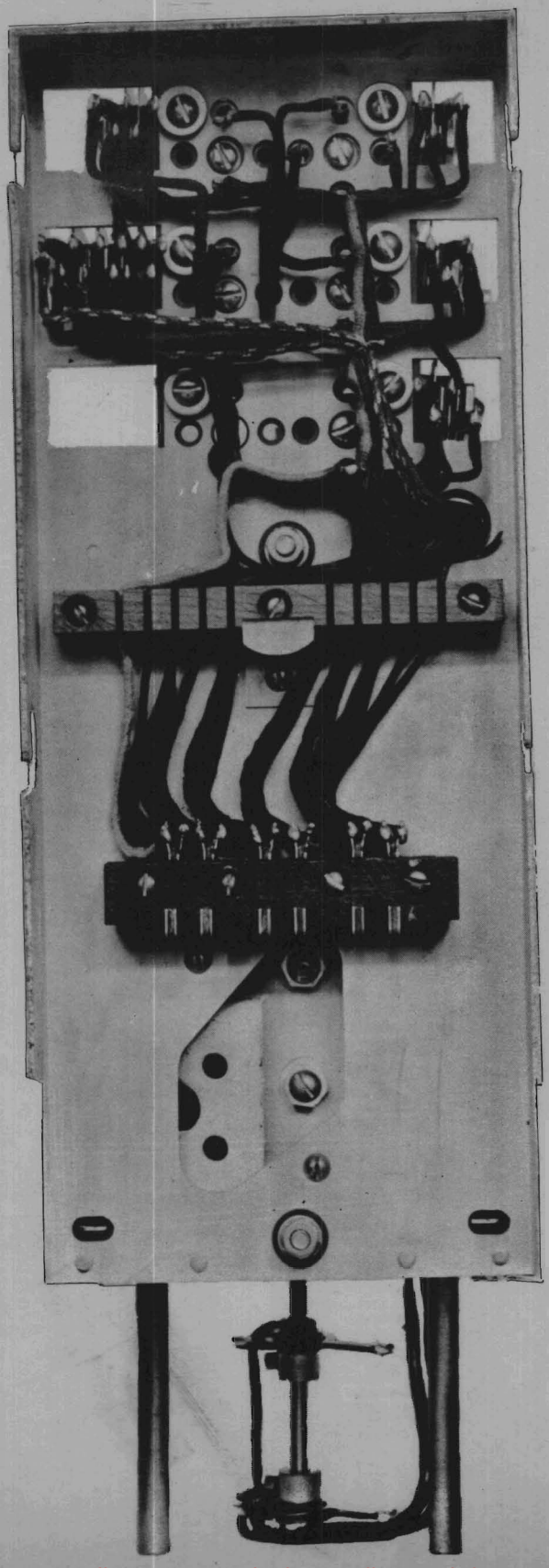
Selector - Rear View



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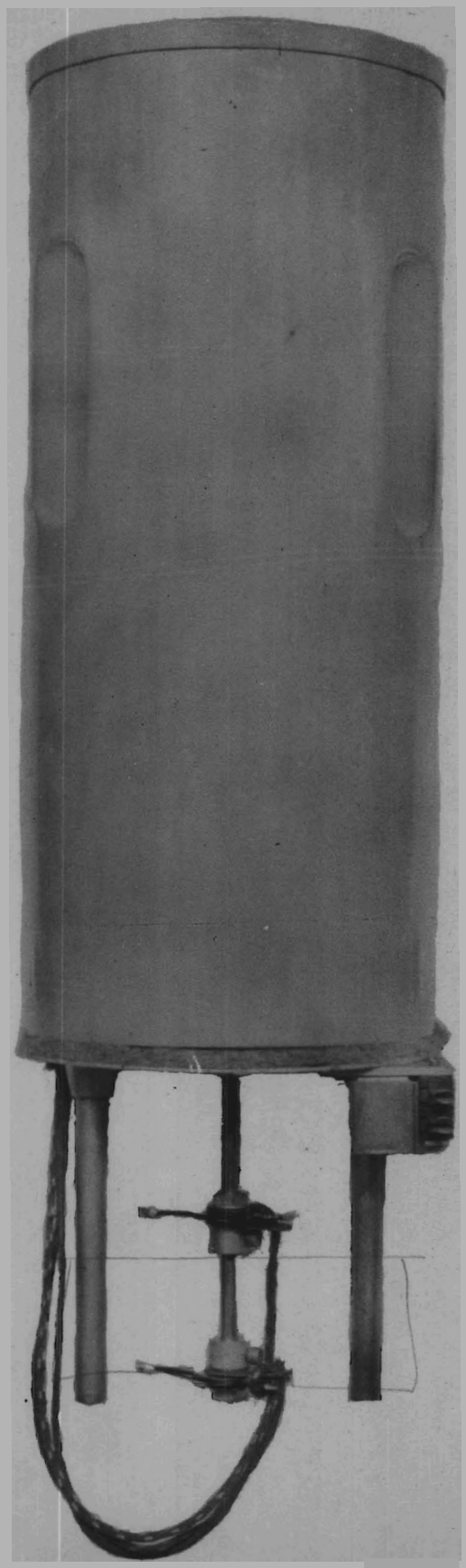
STEP BY STEP MACHINE SWITCHING SYSTEM

No. 14
May 1, 1920.

Selector - Front View
Covar in Place



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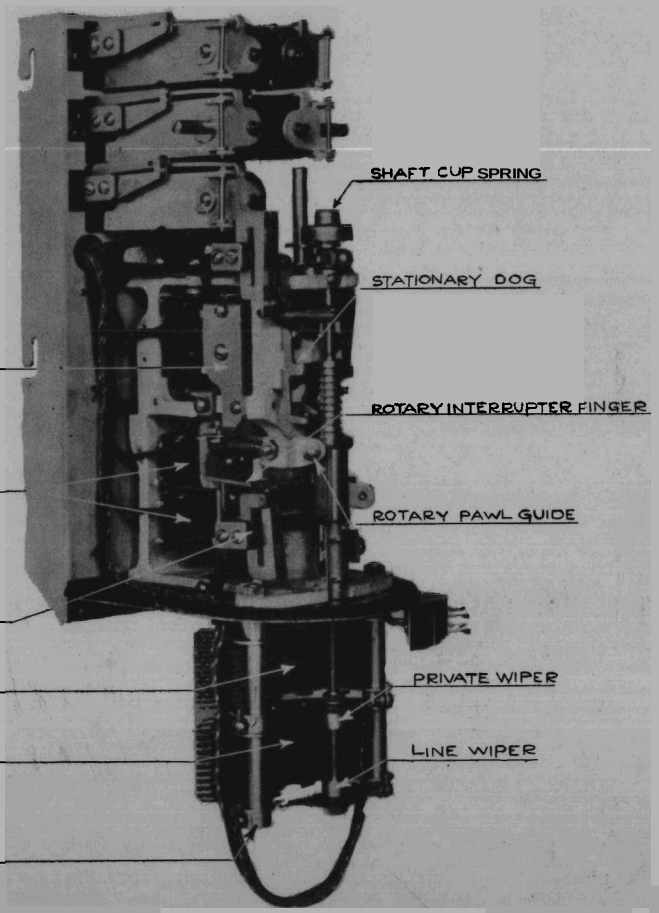
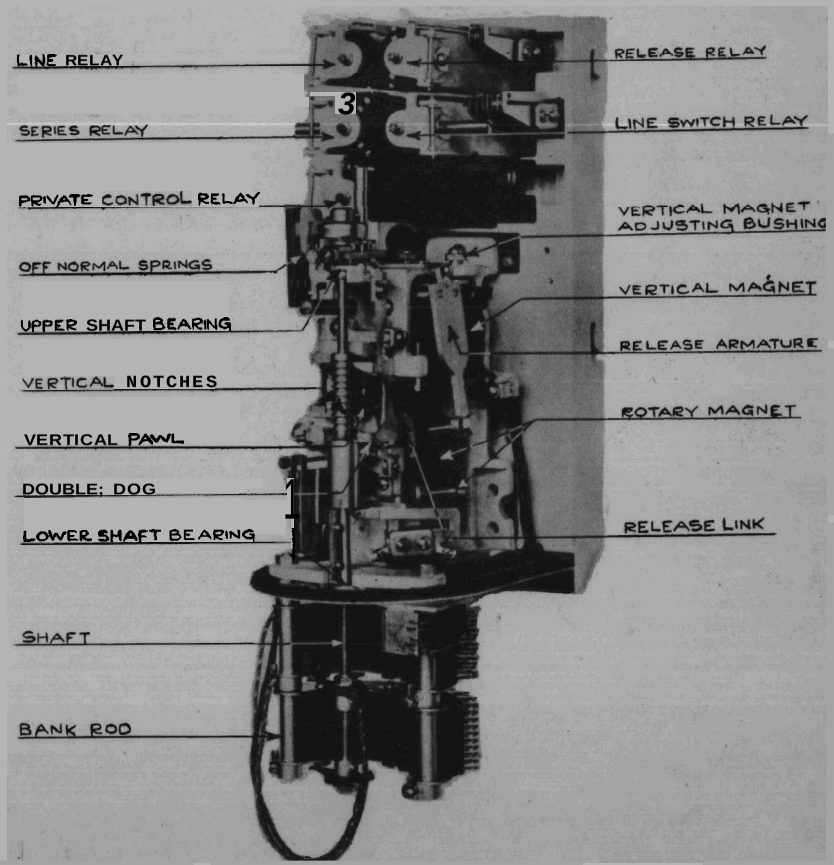
STEP BY STEP MACHINE SWITCHING SYSTEM

Selector with Multiple Banks in Place

No. 15
May 1, 1920.





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STEP BY STEP MACHINE SWITCHING SYSTEM

Selector Multiple Bank

No. 16
May 1, 1920.

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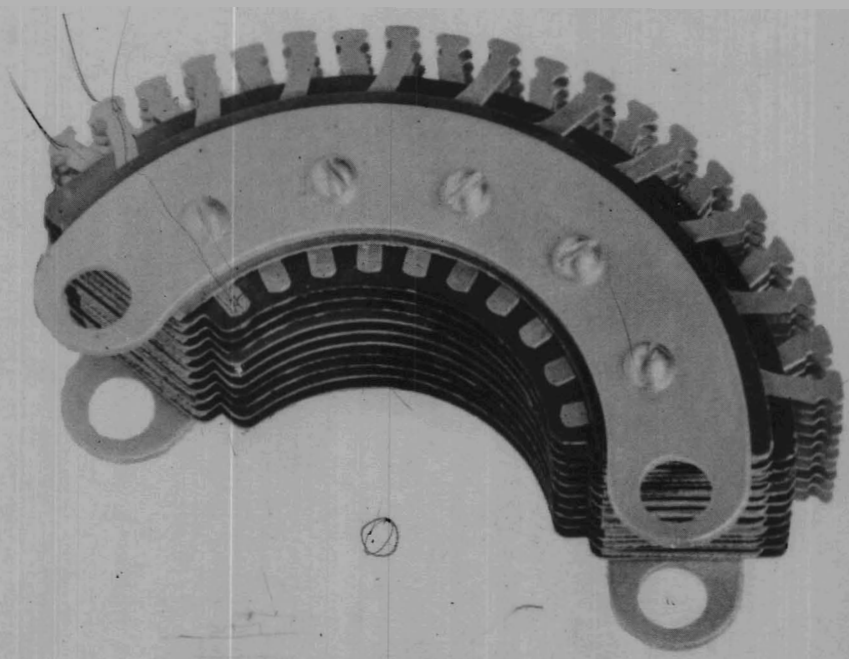

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STEP BY STEP MACHINE SWITCHING SYSTEM

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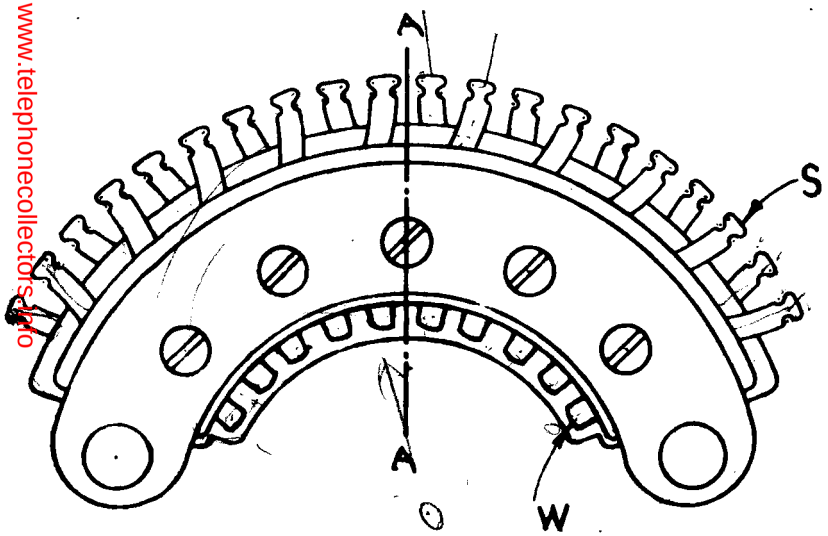
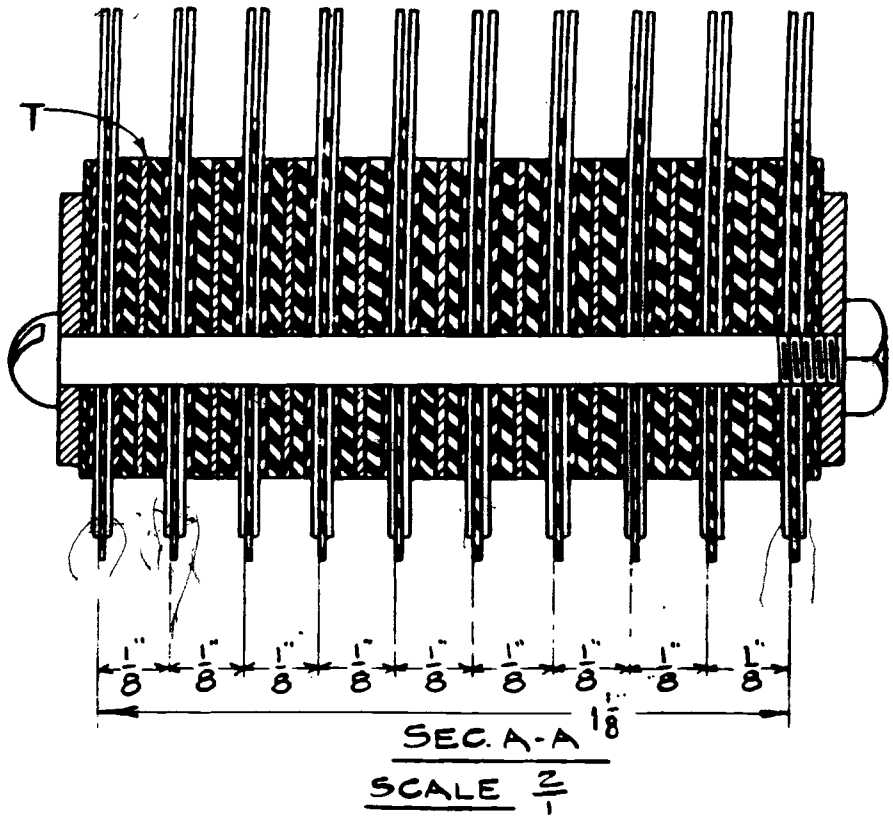
Selector or Connector
Line Multiple Bank





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SCALE 2/1

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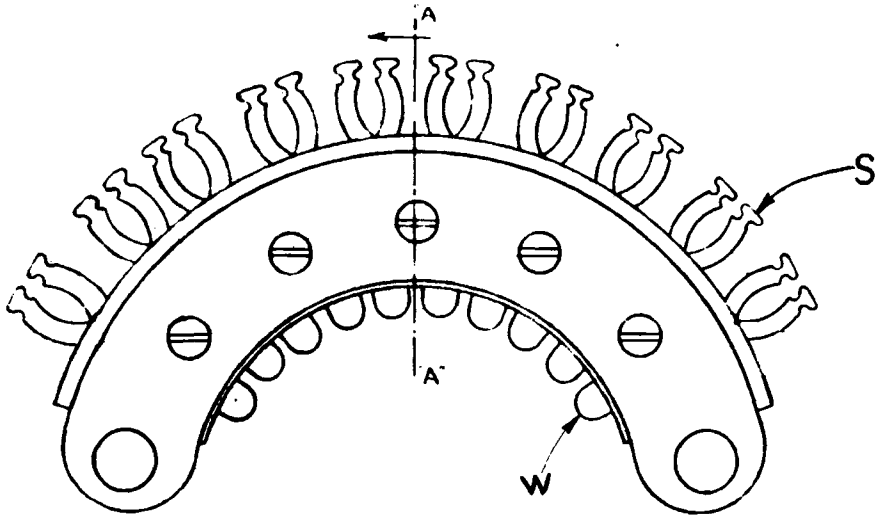
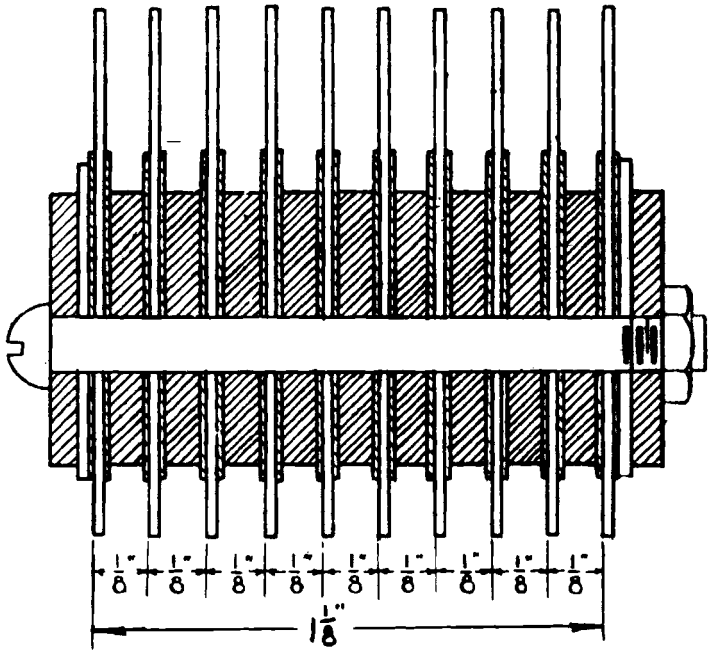
STEP BY STEP MACHINE SWITCHING SYSTEM

Selector or Connector
Private Multiple Bank



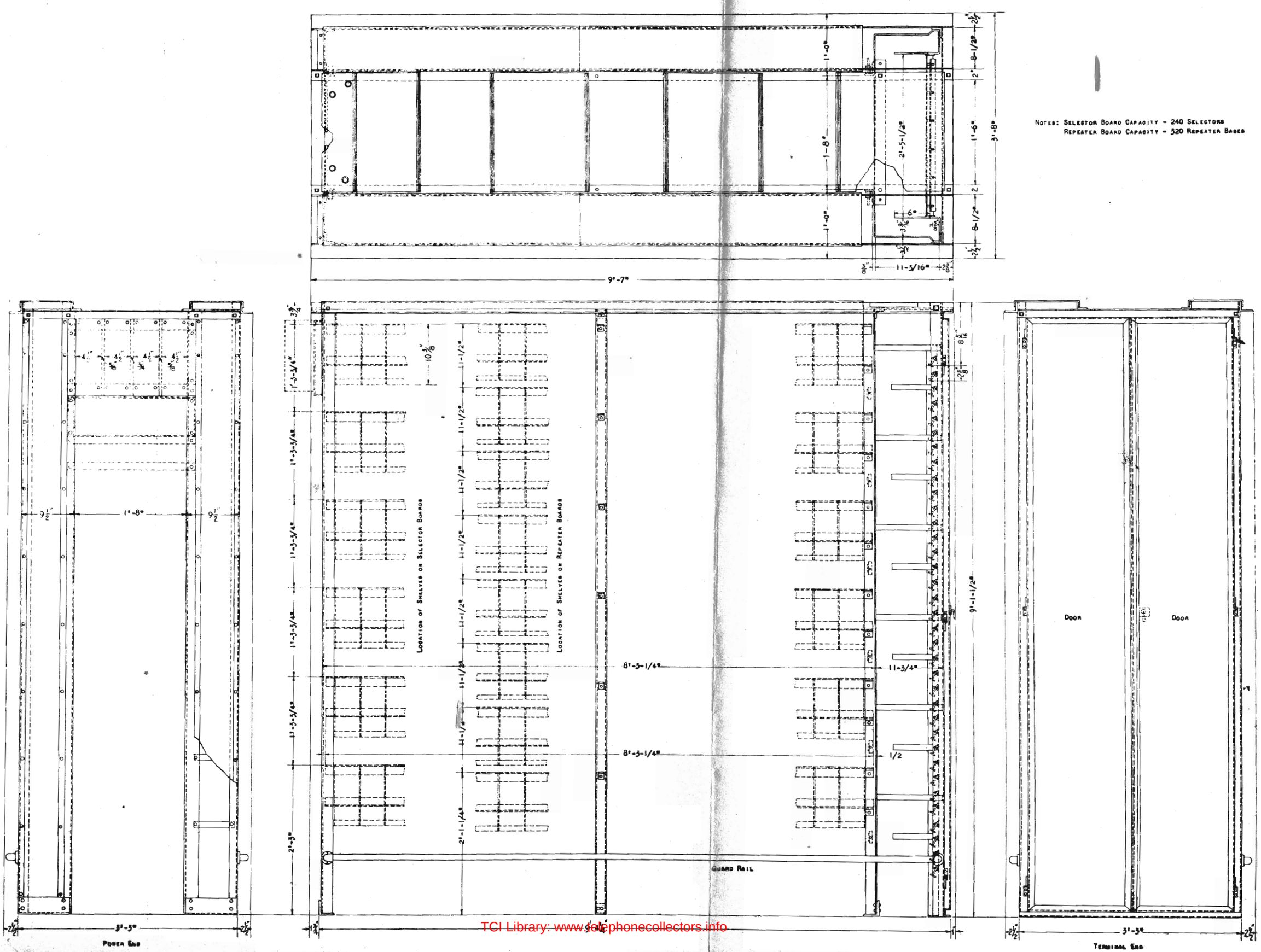


SECTION "A-A"
DOUBLE SIZE.

STEP-BY-STEP MACHINE SWITCHING SYSTEM

SELECTOR AND REPEATER BOARD ASSEMBLY

NOTES: SELECTOR BOARD CAPACITY - 240 SELECTORS
REPEATER BOARD CAPACITY - 320 REPEATER BASES



given level of terminals are in the same trunk group. In making its trunk selection, therefore, the brushes are required to choose the proper level of terminals, and may then select any terminal in that level provided the terminal is not connected to a trunk already made busy by some other selector. To accomplish this shaft S is made free to move vertically and also to rotate through a limited arc about its own axis, the vertical movement carrying the bruahes to the required level of terminals and the rotary movement sweeping the brushes over the terminals of that level. It is to be noted that the vertical motion of the shaft is under the control of the calling party so that the brushes will be connected to the proper terminal level, but that the rotary motion of the shaft is accomplished without the aid of external control since the calling party is not concerned as to what particular idle trunk in a group is used in the establishment of his connection.

When the shaft is in auch a position that each set of brushes which it carries is directed toward a point a little to the left and slightly below the lowest left-hand set of terminale in its corresponding selector bank, the shaft is said to be in normal position.

Selector Action: During the time that a selector is idle its shaft is in normal position, and the only direction in which it can move from this position is vertically upward.. As the selector receives ita set of pulses from the dial, the shaft is moved upward by pawl P, which is actuated by the armature U of the vertical magnets. The first time that armature Ü is attracted the ahaft is moved upward just far enough to bring each of its sets of brushes opposite

the lowest or first level of terminals in the respective multiple banks. If the brushes are to be raised to the fifth level of terminals, armature U is attracted by its magnet five times, each movement of the shaft raising the brushes through a distance equal to the spacing between adjacent terminal levels. The total travel of the brushes is thus accomplished by moving them a step at a time or "step-by-step", and it is from this action that the system using this type of selector derives its name. Owing to the relative position of the zero with respect to the digits on the subscribers dial, the number of the terminal level selected, counting from the bottom up, will correspond to the digit dialed, the zero on the dial being considered as ten.

When the brushes have reached the proper level, the shaft is rotated in a clockwise direction (viewing it from the top) by means of the rotary pawl which is controlled by armature A of the rotary magnets. The first time that armature A is attracted, the shaft is rotated just far enough to bring each of its sets of brushes into contact with the left-hand or first set of terminal of the level in question. If the trunk associated with the first set is not in use, the rotary motion will stop and leave the brushes connected to that trunk. If, however, the trunk is buey at the time, the electrical condition of these terminals will be such as to cause the rotary magnets to continue to operate, and the brushes will be rotated to the second set of terminals. This action will be continued until an idle trunk in the group of ten is found.

If all of the trunks in the group are busy, the shaft will be rotated paat the last set of terminals in the level and cam springs BB will be closed. This places a busy-back tone on the trunk incoming to the selector.

Selector Mechanism: The ahaft S, made of drill rod steel, passes through an upper bearing J' and lower bearing J^a, each of which is provided with a felt wick oil cup. Within cup C at the top of the shaft is mounted the coil spring which tends at all times to keep the shaft in normal position relative to its rotary movement. Hub H is made of bronze and is riveted to the shaft. Two sets of teeth are milled on the hub. The teeth of one set are termed "vertical teeth"; these are the ones that are engaged by pawl P for moving the shaft upwards. The vertical teeth pass part way around the hub in a horizontal plane. They are not carried entirely around the hub in order to leave a vertical alot N opposite the tip of the stationary dog Y when the ahaft is in the non-rotated position. The tip of dog Y extends to the bottom of the vertical teeth, so that the slot is necessary to allow the shaft to move vertically when in the non-rotated position.

The primary function of dog Y is to engage the vertical teeth when the shaft is returning from a rotated position to the non-rotated position, end thus take the weight of the shaft and its attached garte which would otherwise be borne by the brushes bearing on the terminal levels, since during the return rotary motion, dog D is out of engagement with the teeth on the hub. Another purpose of dog Y is to prevent any vertical motion of the ahaft when in a

rotated position, if a selector should receive a set of pulses through its vertical magnets after having rotated. In such a case, the shaft would be moved up and the brushes bent down so that they would thereafter fail to register with the terminal levels were it not for the engagement of the vertical teeth by dog Y, since dog D cannot prevent the shaft from moving upward.

During the time that the vertical magnets are not' energized, pawl P is tipped backward and thus held away from the vertical teeth. This allows the shaft to fall to its normal position under the influence of gravity, whenever it is in its non-rotated position and is not being held up by dog D. When the vertical magnets energize, pawl P is moved upward and also forward, and wedges itself between the particular vertical tooth that it engages and a projection on tke switch framework, so that during the time that the vertical magnets remain energized, pawl P prevents the shaft from moving vertically. This insures against the ahaft being moved upward more than one step at a time in case the vertical magnet attracts its armature very suddenly due to an abnormally heavy pulse of current through its windings.

The other set of teeth on the hub are termed "rotary teeth." These are milled vertically on the larger part of the hub and are engaged by the rotary pawl for rotating the shaft.

The rotary pawl is normally held away from the rotary teeth so that the shaft may be restored to the non-rotated position provided it in not being held by dog D. The rotary pawl, when operated, is

wedged between the teeth and the switch frame to insure against rotating the shaft more than one step at a time,

The function of double dog D is to engage the vertical and rotary teeth on the shaft so as to hold the shaft in any position to which it may be moved by the action of the pawls. When the release magnet M operates, armature T releases the double dog and permits the shaft to return to normal under the influence of the cup spring and gravity.

Each selector is provided with a set of "off-normal" springe marked "ON" on the drawings. When the shaft is in normal position these springs are held open by a cam ogerated by the shaft. The circuit of the releaae magnet is opened by these springs.

The selector is also equipped with a set of test jacks shown at TJ. These jacks usually consist of two pair8 of springs, the upper pair being connected to the two sides of the incoming trunk, the lower pair being connected to the release wire of the trunk and to ground.

Multiple Banks and Brushes; Two types of multiple banks are employed, known as line banks and as private banks.

The line bank, the assembly of which is shown on drawing No. 807-42, is made up of 200 brass contact pieces or terminals arranged in pairs and mounted in ten horizontal rows or levels of 10 pairs of terminals each. The ten pairs of terminals composing each level are arranged in the arc of a circle, the upper terminals of the various pairs being separated from their corresponding lower terminals by a thin sheet of insulating material, Adjacent levels

are separated by two thicker sheets of insulating material. A eheet of tin T is placed between the sheets used for insulating adjacent levels and the various tin sheets are aonnected to ground through the assembling screwirs. These sheets form electrostatic shields for preventing cross-talk between adjacent terminals.

The outer ende of the terminals, marked S, form the soldering lugs for the multiple wiring and the inner ends, marked W, form the contacts over which the brushes of the selectora'wipe, the arrangement being such that the upper brush of a set makes contact with the upper terminale while the lower brush makes contact with the lower terminals.

The private bank, the assembly of which is shown on drawing No. 807-43, is like the line bank except that it contains only 100 terminals which are arranged in ten horizontal rows of ten single terminals each. The term "private" as uaed in the step-by-step machine switching system is analogous to the term "sleeve" ae ueed in manual equipment, and the private bank terminale, forming merely a part of the control circuits, do not need to be shielded by tin sheets as in the case of line bank terminals.

The brushes for both lfne banke and private banks consist of two flat spring brass strips; one end of eaoh strip is shaped to wipe over the bank contacts, the other end forming a soldering lug for the wiring. An insulating strip separates the two brass strips and the whole is mounted on a collar and secured by means of a nut. The collar is slipped over thc shaft and is fastened in the desired position by a set-screw.

The construction of all eelectors and their mechanical action are, in general, the same, irrespective of their position in the trsin; that is, regardless of whether they are first, second, third, or fourth selectors, or whether they are "special" selectors in the sense that they handle traffic of a special nature. The circuit featuree of the various kinds of selectors vary to some extent, however, and such variations are gointed out in the circuit descriptions of Div. III.

Selector Boards:

Selectors are mounted on unit frameworks of the type shown on Drawing No. 807-28 and in photograph No. 19. Such a framework, together with its equipment, is known as a seleotor board,

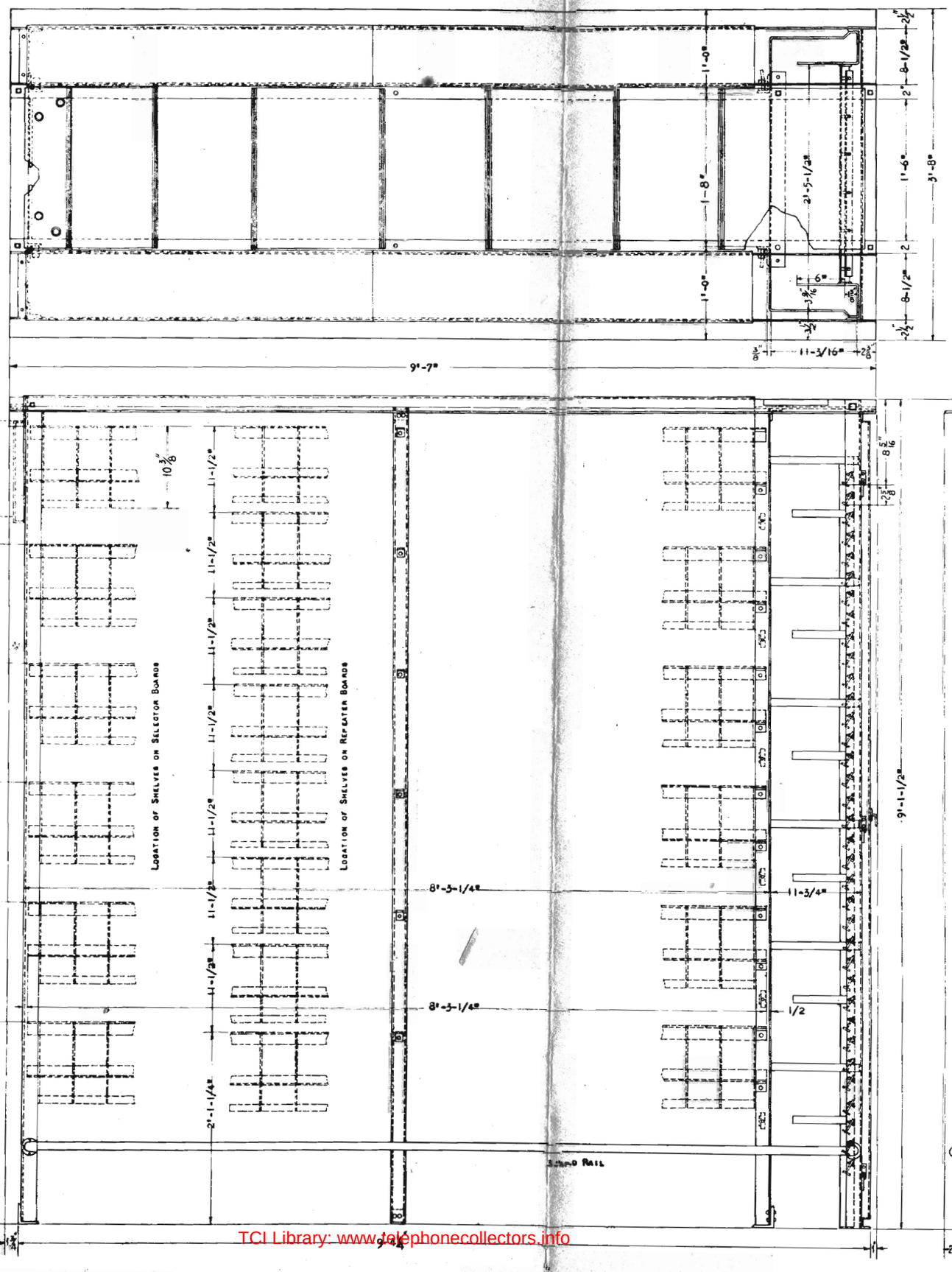
The board is double-sided, the two sides being parallel and spaced about 3 feet apart, The two sides of the board are aonneated by cross-members, forming the whole into a mechanical unit. Each side is provided with 6 horizontal supports called shelves, and each shelf has a oapacity for 20 eelectors, The capacity of the board is therefore 240 eelectors. The assembly of a shelf is shown on Drawing No. 807-29, and a shelf of eelectors is shown in photograph No. 21, Each ahelf is equipped with 20 sets of jacks arranged to receive the selector jacks previously described. The ahelf is insulated C—— the uprights supporting it. The selector is supported by means of pins in the shelf which engage slots in the seleotor base, the slots hooking over the pins so that if the multiple bank is detached from the seleotor the latter may be put in place or removed without the use of tools.

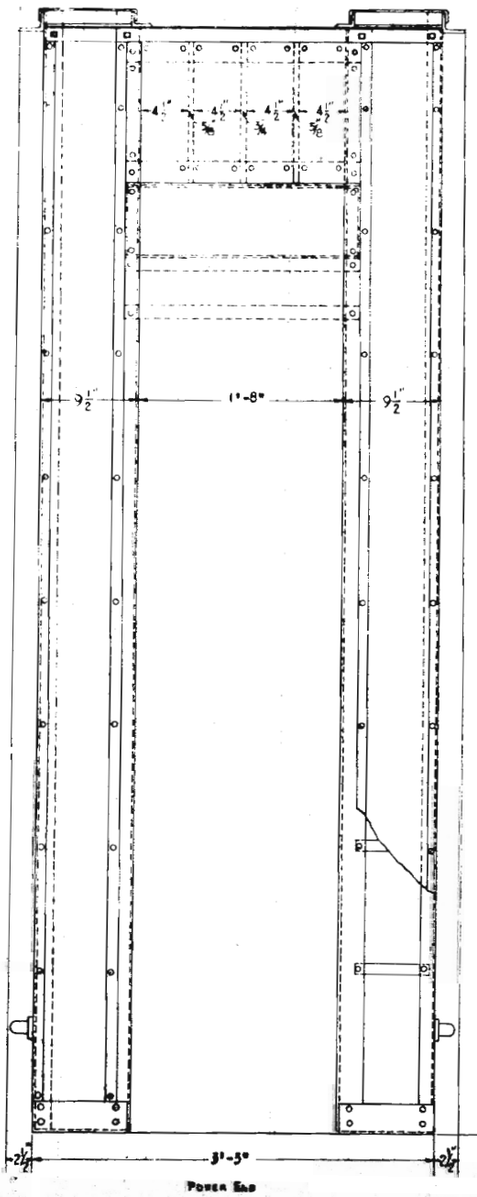
At one end of the board, known as the terminal end, teminal strips of the type shown on Drawing Wo 807-18 are mounted horizontally between the two aides of the board, as shown in photograph No 20. The terminal strips are used for making the connections between the wiring from the selector banke and the trunk multiple cables leading from the selector board. The terminal end of the board is enclosed by two steel doors.

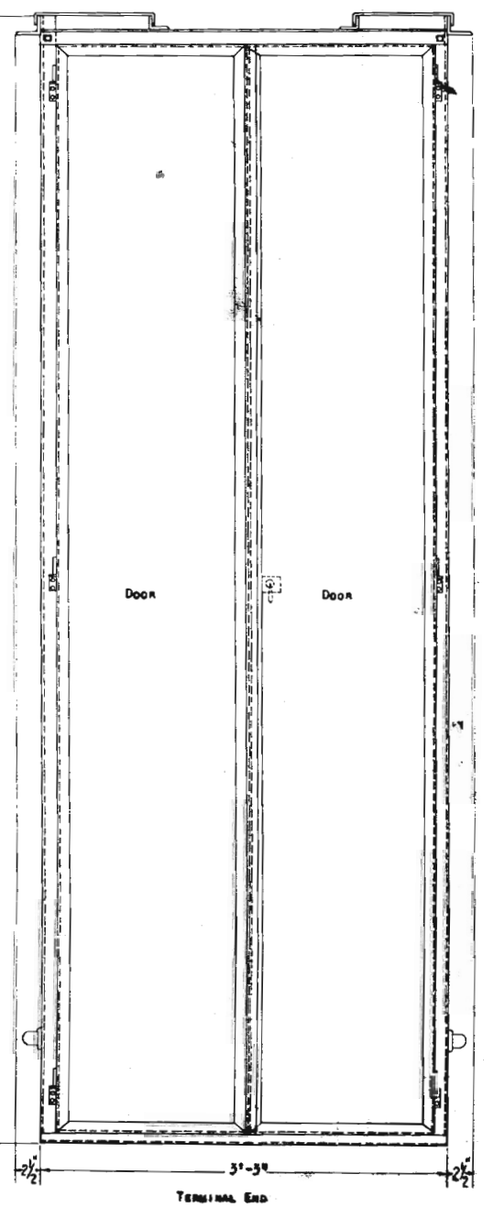
The other end of the board is known as the power end, and

STEP-BY-STEP MACHINE SWITCHING SYSTEM
SELECTOR AND REPEATER BOARD ASSEMBLY

NOTES: SELECTOR BOARD CAPACITY - 240 SELECTORS
REPEATER BOARD CAPACITY - 320 REPEATER BASES







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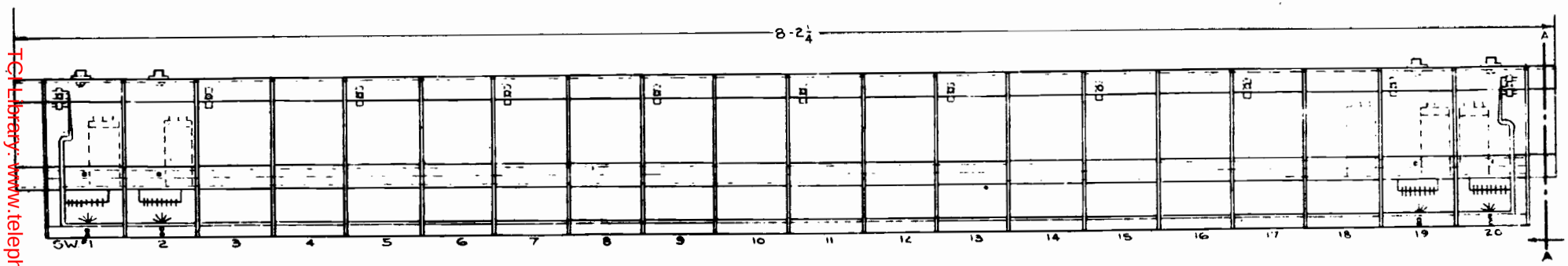
STEP BY STEP MACHINE SWITCHING SYSTEM

Selector Boards showing Doors at Terminal Ends

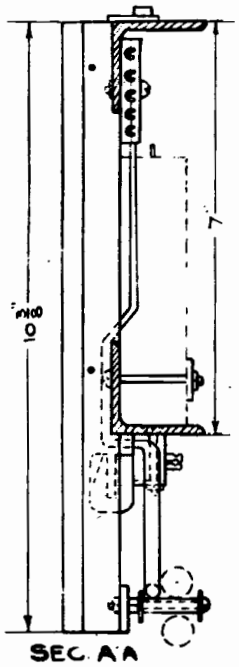
No. 10
May 1, 1920.

STEP BY STEP MACHINE SWITCHING SYSTEM

Selector and Repeater Board Shelf Assembly



FRONT VIEW



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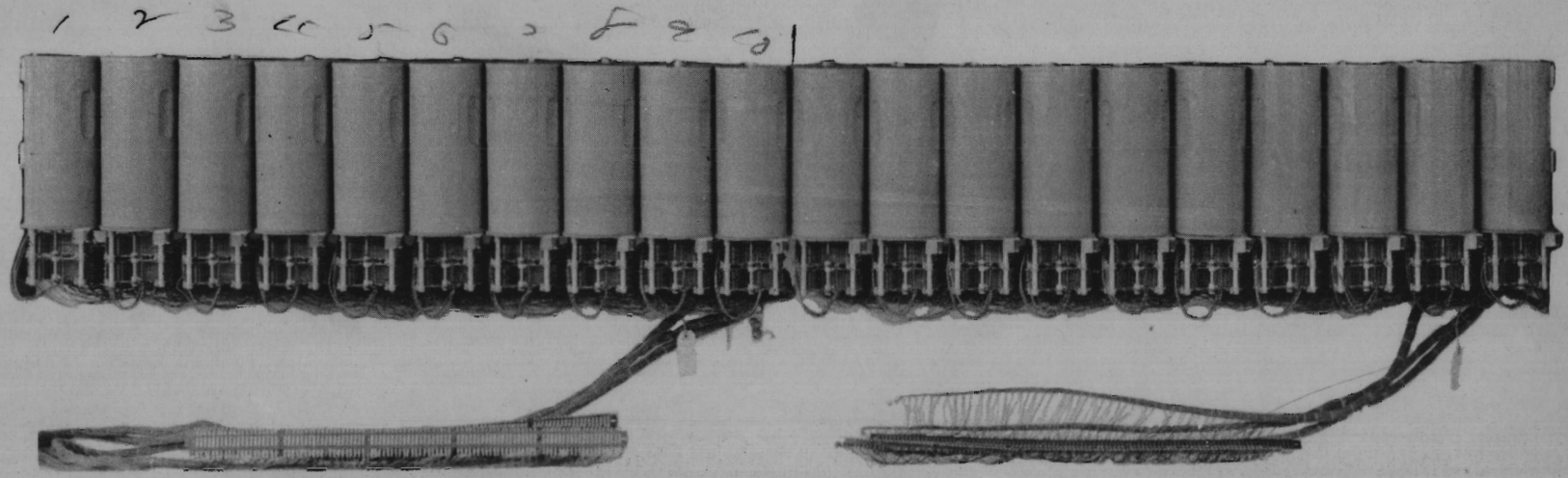
STEP BY STEP MACHINE SWITCHING SYSTEM

Shelf of Selectors
Showing Multiple Wiring and Terminal Strips

No. 21
May 1, 1920.



outside and inside views of this end of the board are shown in photographs Nos. 17 and 18 respectively. The power end of the board is open to permit of entrance to the interior for maintenance work on the multiple banks and other equipment.

Above the entrance are mounted two unit type relay mounting bases, with can covers for accommodating the supervisory and release relay equipment associated with the selectors. This provides capacity for one supervisory and two release relays for each shelf of selectors.

A slate power panel for mounting standard A. T. & T. Co. alarm type fuses and fuse alarm pilot lamps is located below the relay equipment, this providing the power fuse equipment for the entire board. The assembly of the fuse panel is shown on Drawing No. 807-30.

A lamp panel is located below the power panel and mounts two strips of lamps, arranged 20 per strip, which are used as supervisory and release signals for the selectors. The assembly of the lamp panel is shown on Drawing No. 807-31.

The top of the selector board is fitted with a glass cover to protect the multiple terminals and other equipment from dust. An iron pipe guard rail is provided at the bottom of each side of the frame. All steel parts of the selector framework are given a protecting coat of aluminum paint.

In offices where it is necessary to exercise special precautions because of high humidity conditions, both sides of each selector board is enclosed by glass doors, and the power end of the

board is provided with a sheet steel door. This permits the use of a heater in each board for reducing the humidity.

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STEP BY STEP MACHINE SWITCHING SYSTEM

No. 17

Power End of Selector Board
Outside View

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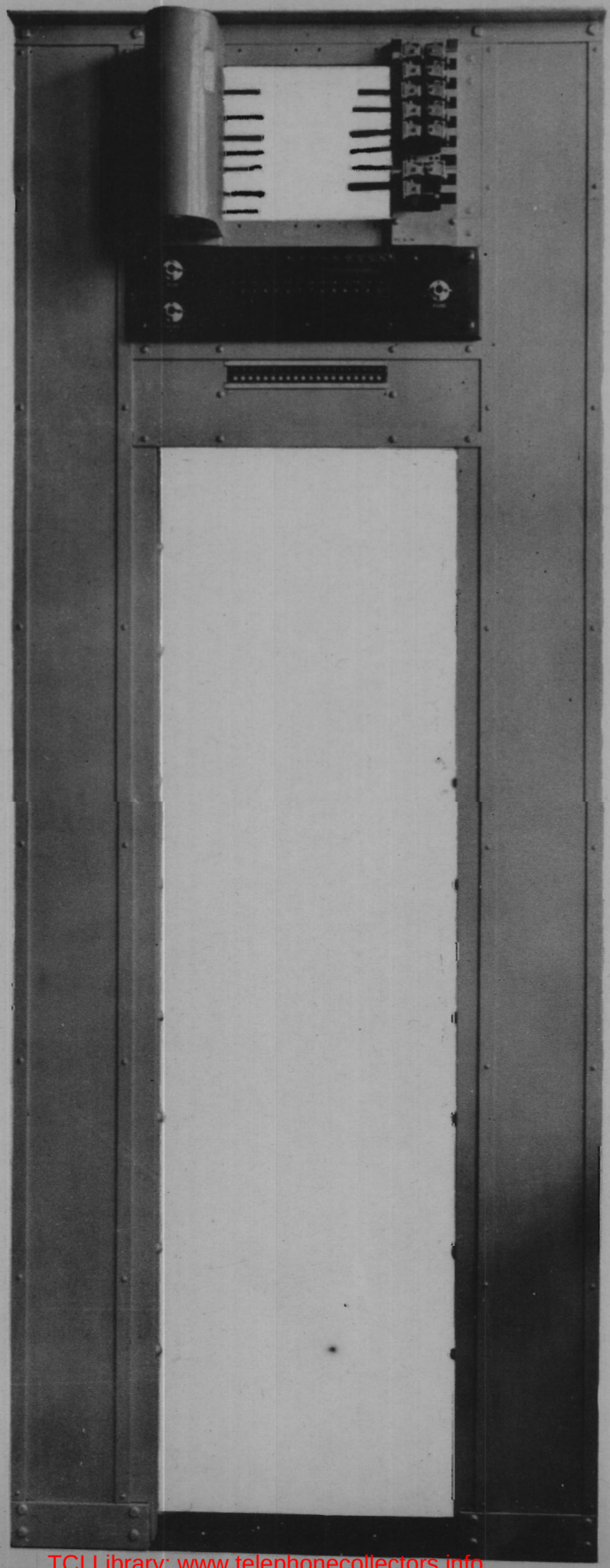

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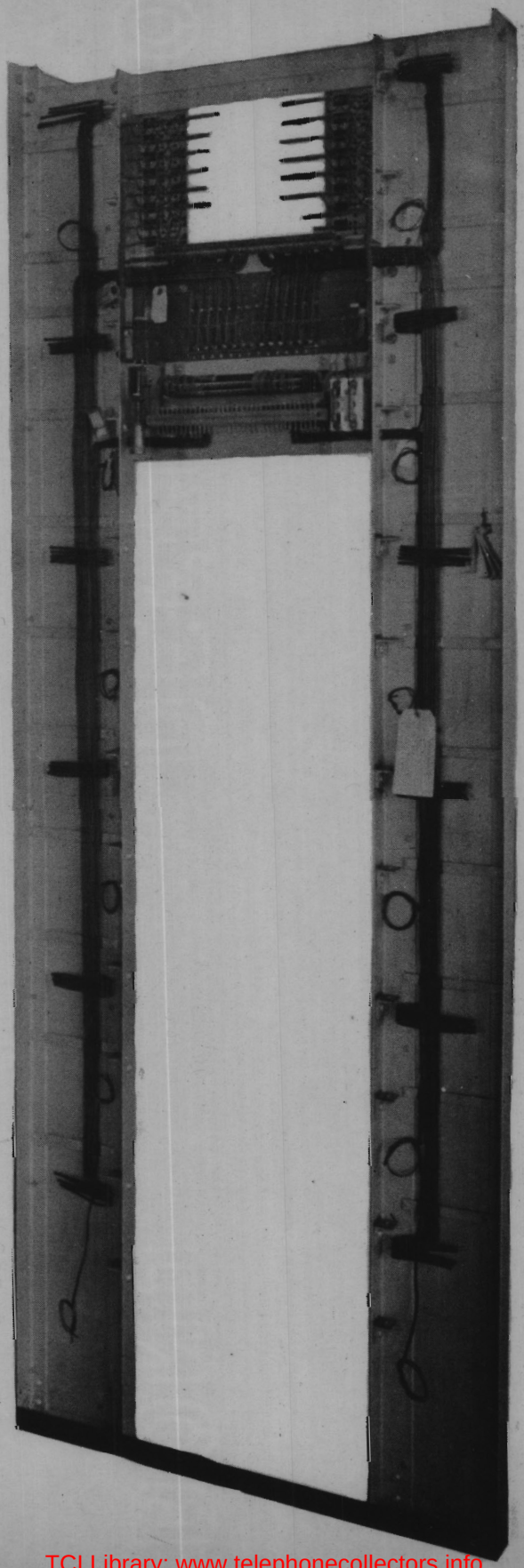
STEP BY STEP MACHINE SWITCHING SYSTEM

No. 18
May 1, 1920.

Power End of Selector Board
Inside View



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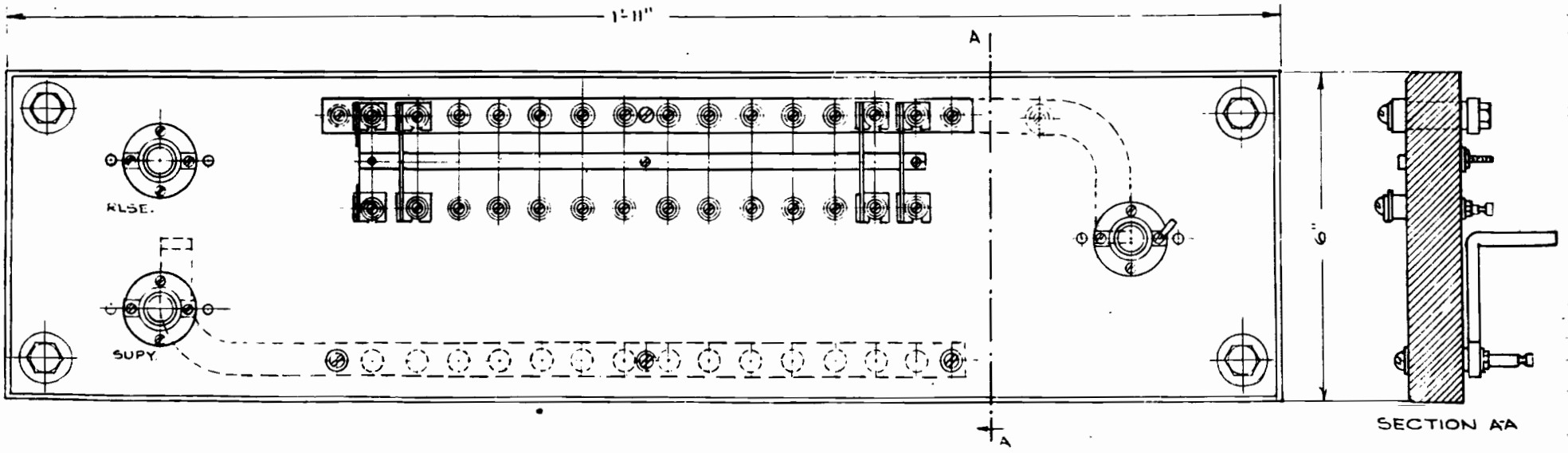
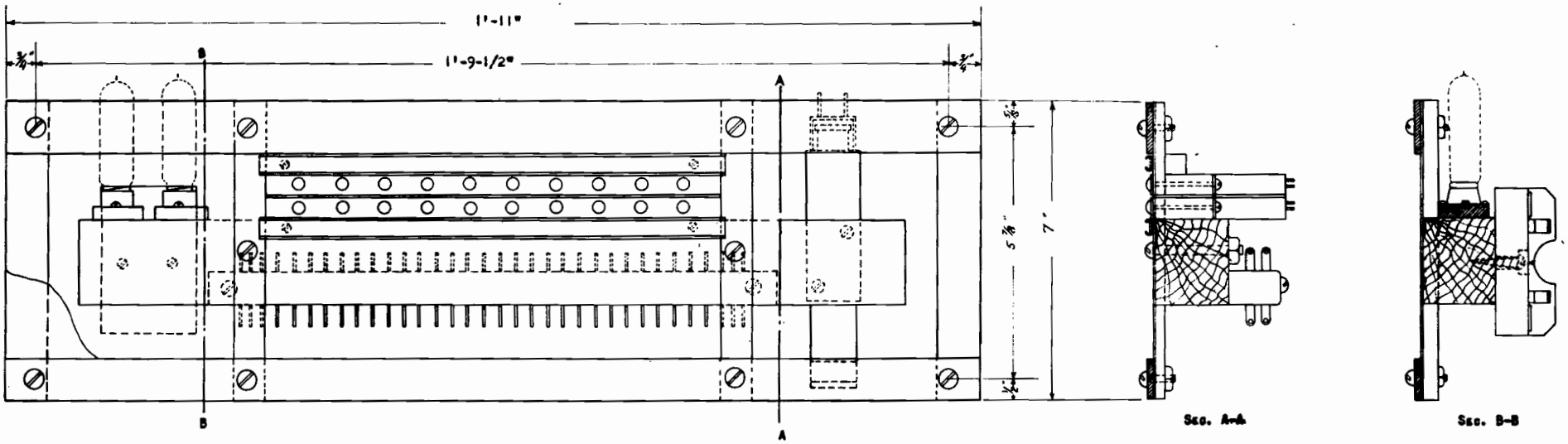
STEP BY STEP MACHINE SWITCHING SYSTEM

Selector Board
Fuse Panel Assembly



STEP BY STEP MACHINE SWITCHING SYSTEM

Lamp Panel Assembly



The Connector:

The assembly of the connector employed in the step-by-step machine switching system is shown on Drawings No. 807-32, 807-33, 807-34 and 807-35 and in photographs Nos. 22, 23, 24 and 25.

The construction of the connector is identical with that of the selector previously described, except that the base of the connector is made higher in order to accommodate a maximum of 10 instead of 6 horizontally mounted relays.

In general, the principal functions of the connector are:

1. To make the final selection in the establishment of the connection.
2. To supply ringing current to the called line in case the latter is found idle.
3. On a connection local to the originating office, to supply talking battery to both parties, or on a connection not local to the originating office, to supply talking battery to the called subscriber.
4. In case the called line is found busy, to place the busy back tone on the calling line.

Connectors are of two general classes, namely, those used to serve subscribers' lines only, and those used to serve P.B.X. trunk lines or both P.B.X. trunk lines and subscriber's lines. The latter are known as trunk-hunting connectors, and also as "rotary" connectors.

Connectors for Subscribers' Lines Only: The trunk incoming to the connector from the last selector in the train is wired to the connector brushes. The subscribers' lines which the connector is to serve

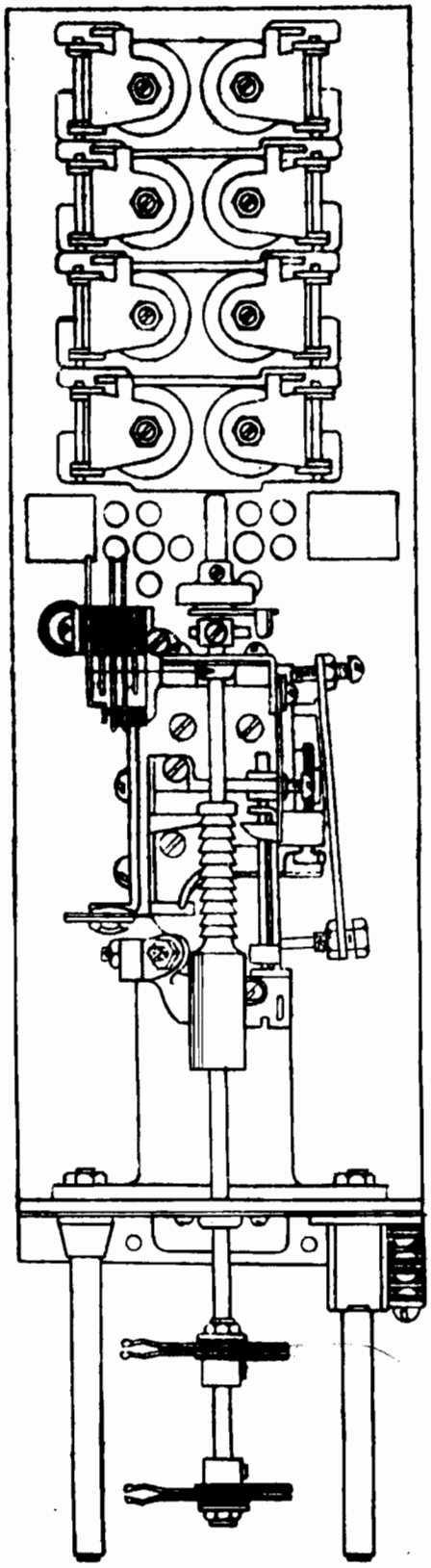
are wired to its multiple banks, which, like selector banks, consist of 100 sets of terminals arranged in ten horizontal rows or levels of 10 sets of terminals each. Since one set of terminals is required for each subscriber's station, a connector can serve a maximum of but 100 stations (exclusive of extension stations.)

In its mechanical action the connector is similar to the selector, since its brushes are capable of choosing any set of terminals in its multiple banks by stepping vertically to the required level and by then rotating to the required terminals. With the connector, as with the selector, the upward movement of the shaft is controlled by the pulses coming from the dial at the calling station. The rotary movement of the shaft of a connector, however, instead of being controlled independently of the subscriber's dial, is governed directly by another series of pulses from the dial, since it is necessary for the connector to select a particular terminal set in the chosen level in order to complete the connection to the desired station. For example; if the last two digits in the telephone number of the subscriber being called are 54, the connector will be stepped to the 5th level by the series of pulses next to the last, and will then be stepped around to the 4th set of terminals in the 5th level by the last set of pulses.

Trunk-hunting Connector: The trunk-hunting connector differs from the type just described in that it is capable of hunting over a predetermined group of terminals in a level and of seizing the first idle set of terminals in the group. It is thus enabled to test a

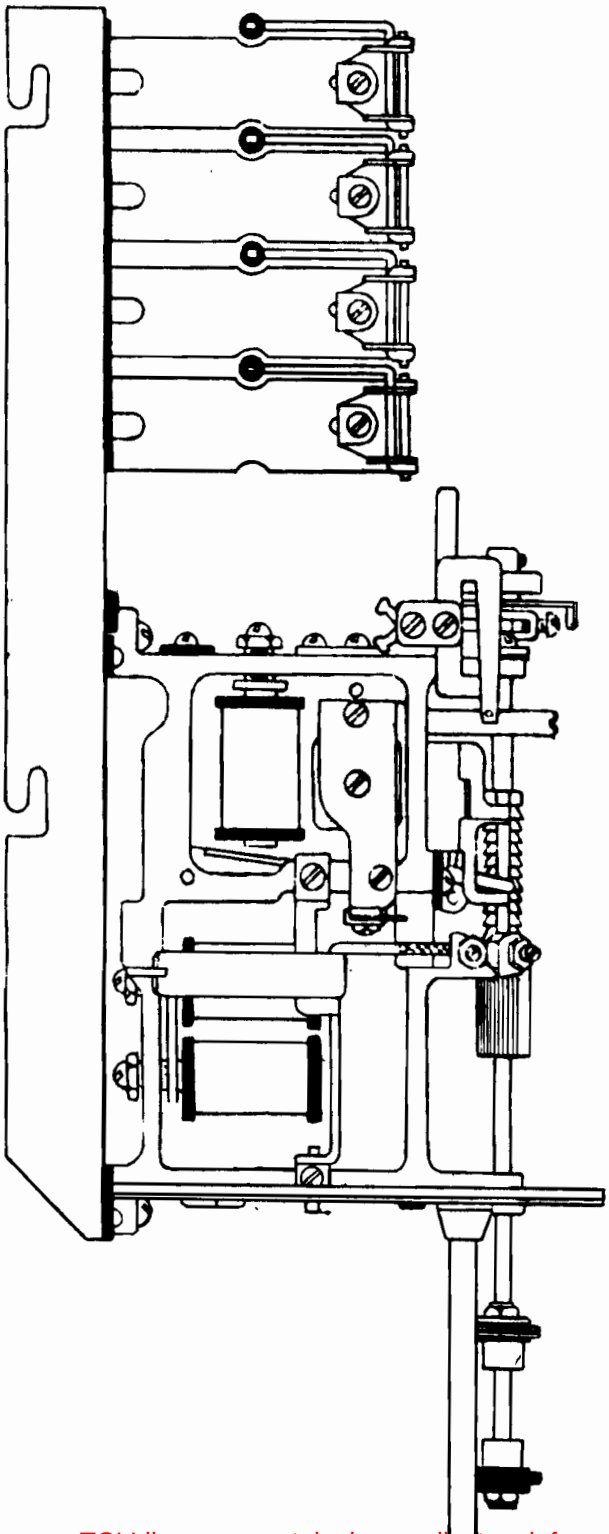
STEP BY STEP MACHINE SWITCHING SYSTEM

Connector Assembly
Front View



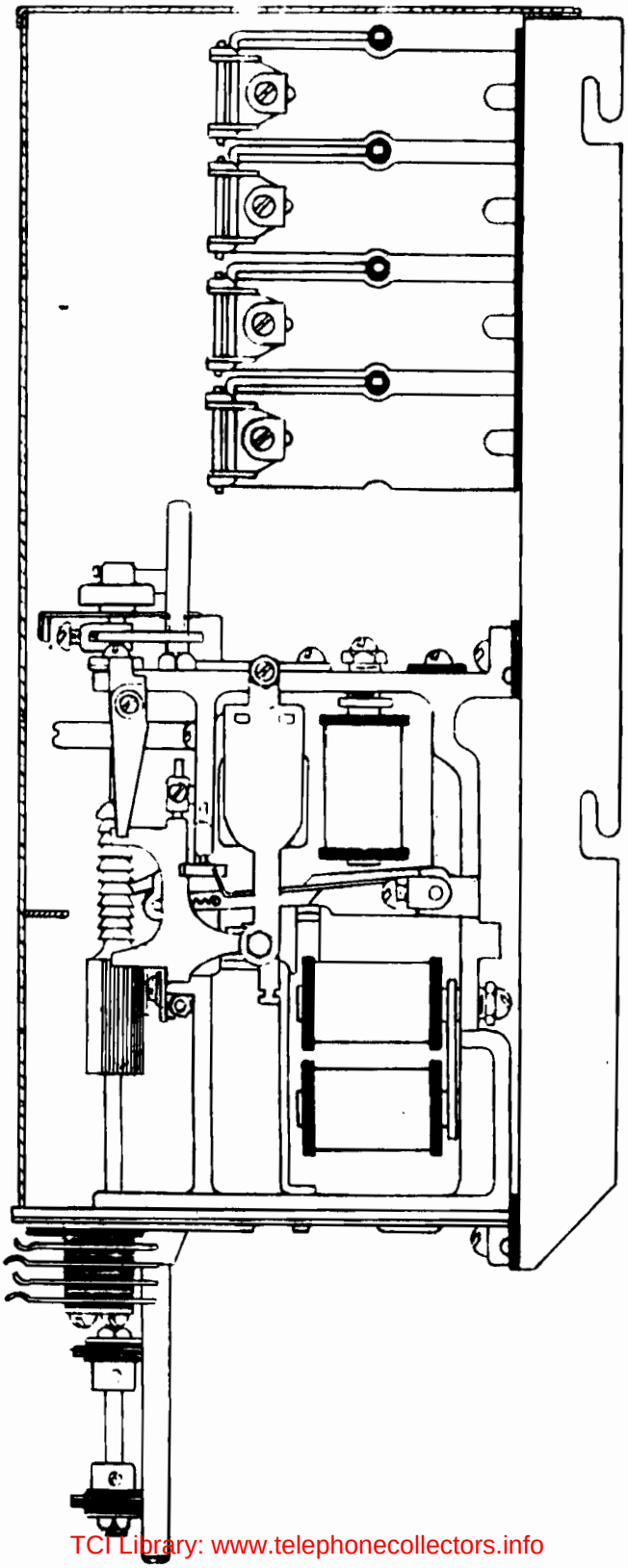
STEP BY STEP MACHINE SWITCHING SYSTEM

Connector Assembly
Left View



STEP BY STEP MACHINE SWITCHING SYSTEM

Connector Assembly
Right View



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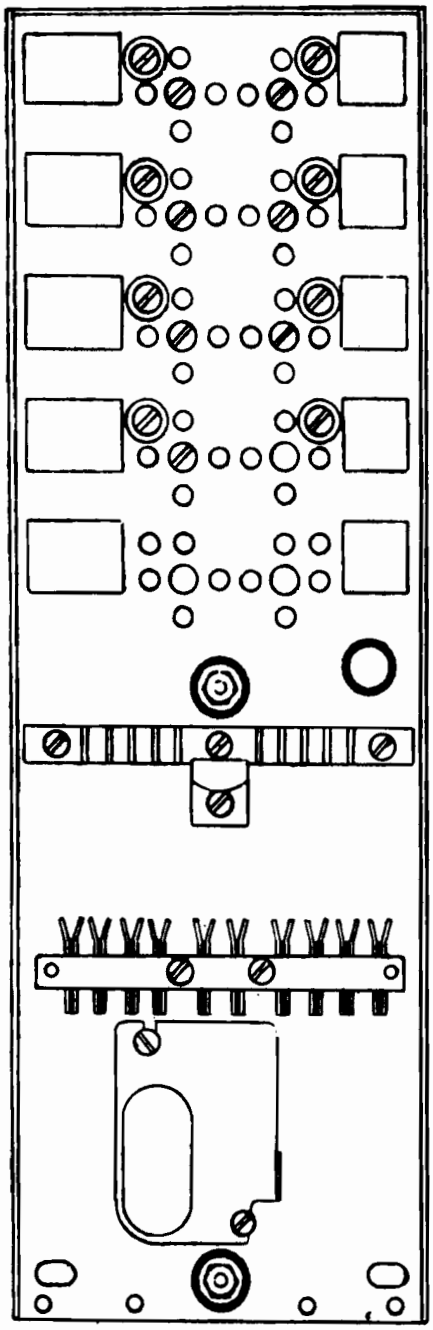
STEP BY STEP MACHINE SWITCHING SYSTEM

Connector Assembly
Rear View



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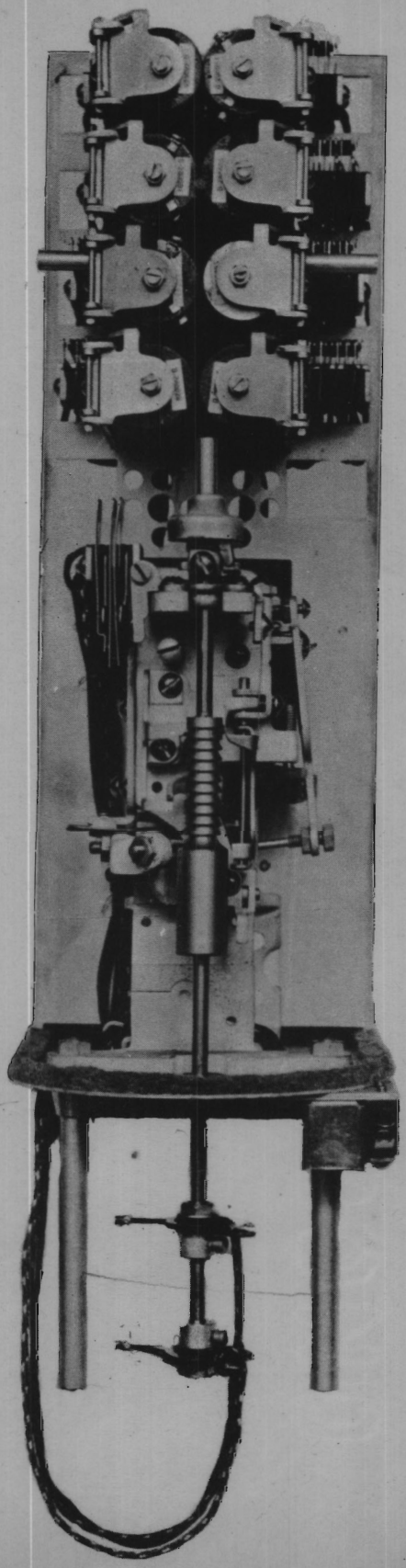
STEP BY STEP MACHINE SWITCHING SYSTEM

Connecter - Front View

No. 22
May 1, 1920.



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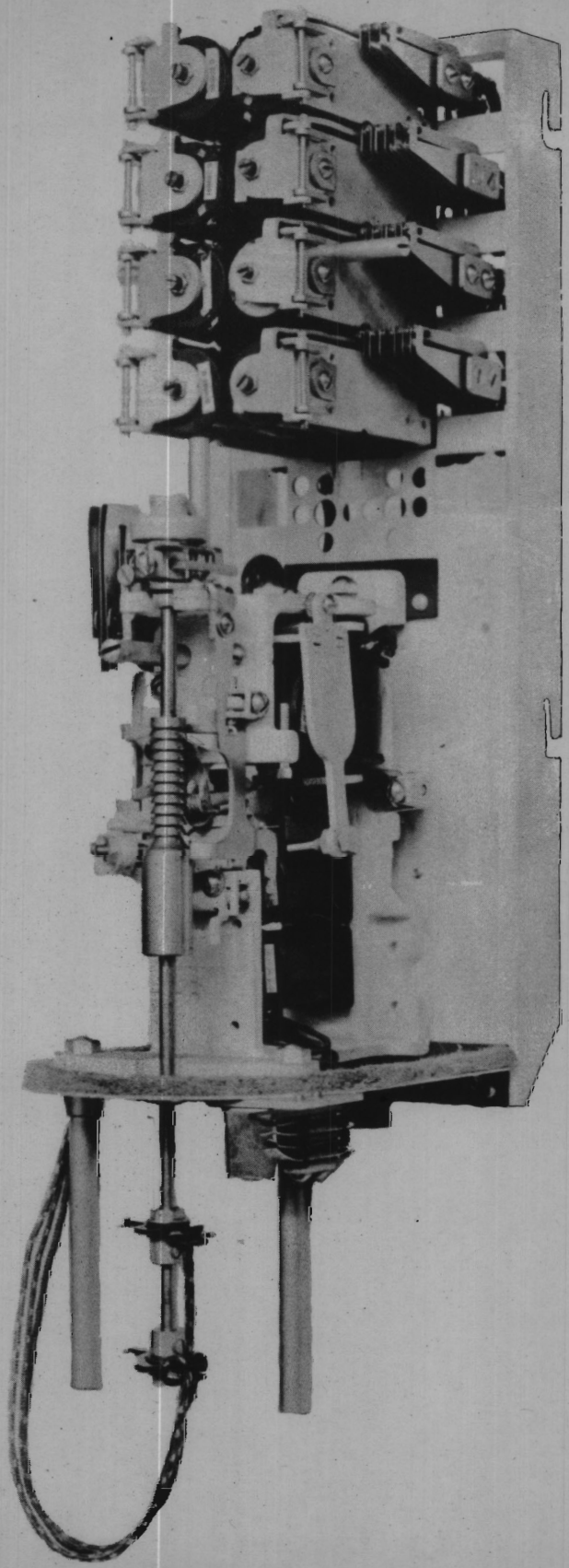
STEP BY STEP MACHINE SWITCHING SYSTEM

No. 23
May 1, 192C.

Connector - Right View



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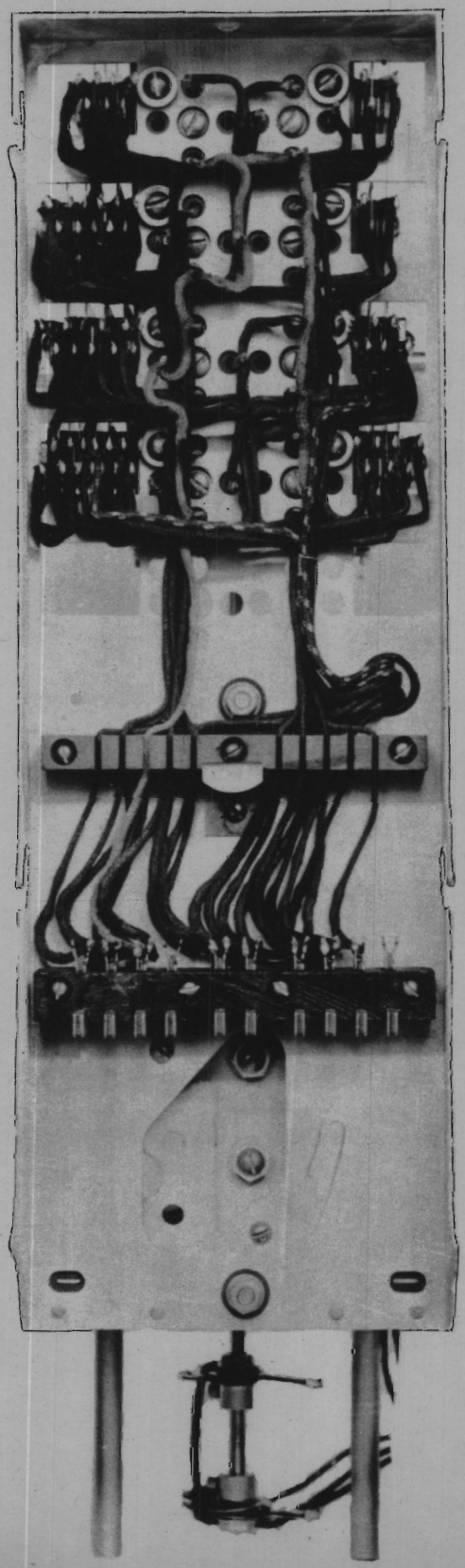
STEP BY STEP MACHINE SWITCHING SYSTEM

Connector - Rear View

No. 24
May 1, 1920.



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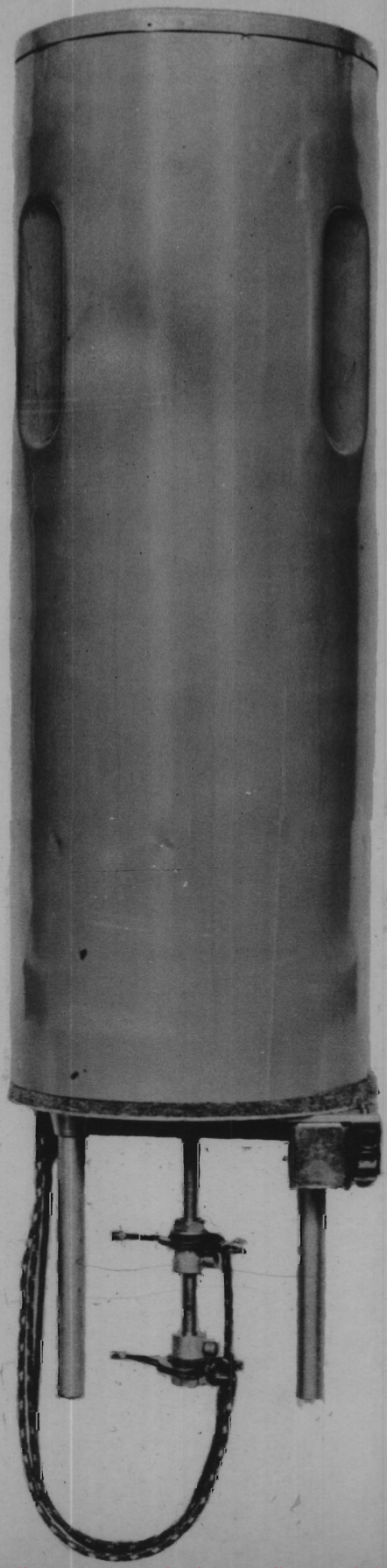
STEP BY STEP MACHINE SWITCHING SYSTEM

No. 25
May 1, 1920.

Connector
Front View with Cover in Place



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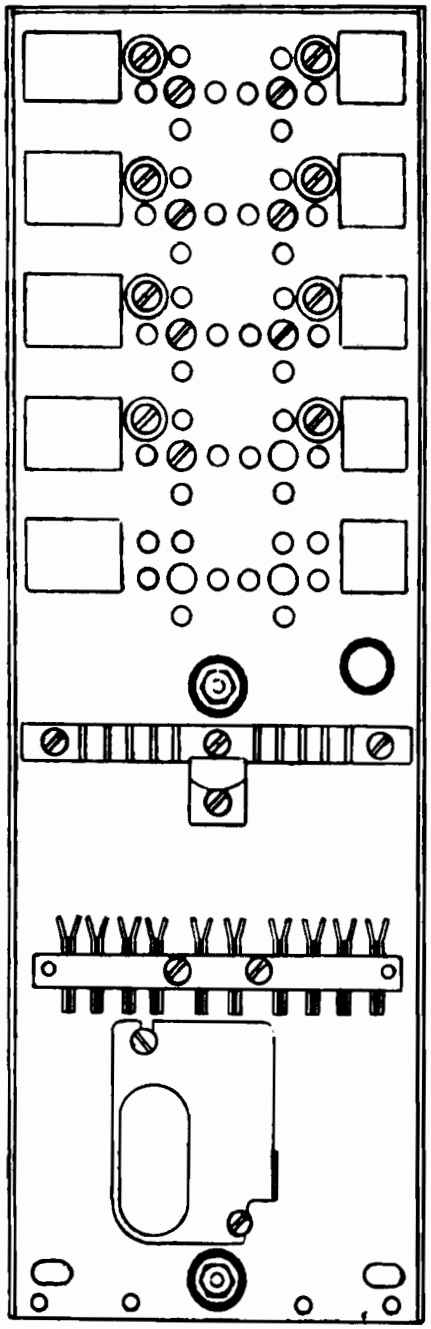
STEP BY STEP MACHINE SWITCHING SYSTEM

Connector Assembly
Rear View



group of P.B.X. trunks, and to establish connection over an idle trunk, or to place the busy back tone on the calling subscriber's line in case all of the trunks in the group are found busy.

Assume that the last two digits of the listed number of a P.B.X. are 54 and that there are five trunks in the P.B.X. group. The vertical and rotary movements of the trunk-hunting connector brushes to the 5th level and to the 4th set of terminals in that level are effected in the same manner as with the connector previously described. If terminal No. 54 is found busy, the rotary movement will be continued automatically until an idle terminal in the group of five is found, or if there be none, until terminal No. 58 is reached, when the hunting will stop and the busy back tone will be placed on the calling line.

To accomplish this, a private bank, consisting of paired terminals as in a line bank, is used. The upper and lower terminals of the private pair corresponding to each P.B.X. trunk are strapped together at the terminal strips except on the highest numbered trunk in the P.B.X. group, the private pair of which is not strapped. It is the electrical condition established by the absence of the strap on the last trunk that causes the mechanism to stop hunting when that trunk is reached. In this way a direct line station can also be served by a trunk-hunting connector by omitting the strap between the private terminals, which prevents any automatic rotation of the brushes after the station has been selected.

Connectors are classified as "Local," "Toll," Combination," "Test," etc., depending upon their circuit arrangements, which vary to some extent in accordance with the particular functions to be

performed. They all have, however, the general construction and mechanical action just described. The circuit variations of the different classes are outlined under the circuit descriptions in Division III.

Connector Boards:

Connectors are mounted on unit type frameworks as shown on drawing No. 807-51, and in photograph No. 27. The framework and its equipment is called a connector board.

The connector board framework is similar to the selector board framework in that it is provided with shelves on both sides for mounting its switch equipment. The overall heights of the selector and connector boards are the same, but due to the greater height of the connector switch the connector shelves are mounted on wider centers than the selector shelves and the connector board framework provides space for only five shelves on a side.

It is expected that the number of connectors required to serve a group of 100 individual or party line stations will ordinarily be about 10 or 12, but in some offices the number may be only 7 or 8, while in others it may be 15 or greater. For the purpose of preserving a regular numbering scheme at the connector boards, it is desirable to place, as far as practicable, all connectors serving a given 100 terminals on the same shelf. In order to permit of this arrangement and to avoid the excessive waste of framework and floor space that would result if but one standard length were adopted for connector boards, the boards are made in the following types:

1 - A board of a length sufficient to mount 10 local, toll or combination connectors and one test connector per shelf. (One test connector is required for each group of 100 subscribers' terminals.) The total capacity of the board is therefore 110 connectors. This board provides fuse capacity for 16 connectors per shelf.

2 - A board of a length sufficient to mount a total of 16 connectors per shelf. The total capacity of the board is therefore 160 connectors. Structurally, this board is composed of two units, one of the units being identical with the board described above under "1", the other unit having a capacity of 5 connectors per shelf and being designed to be placed in line with and adjacent to the first unit at the fuse panel end. This board is shown on drawing No. 807-51.

3 - A board of a length sufficient to mount five connectors per shelf. The total capacity of the board is therefore 50 connectors. This board provides fuse capacity for 5 connectors per shelf.

The assembly of the connector board shelf providing capacity for 11 connectors is shown on drawing No. 807-52, and the assembly of the partial shelf providing capacity for 5 connectors at a board of the type described under "2" is shown on drawing No. 807-53. Each shelf is insulated from the uprights supporting it, and is equipped with spring jacks arranged to receive the jacks of the connectors. Pins are provided in the shelves for mounting the connectors in the same manner as described for selectors in Section 3-n.

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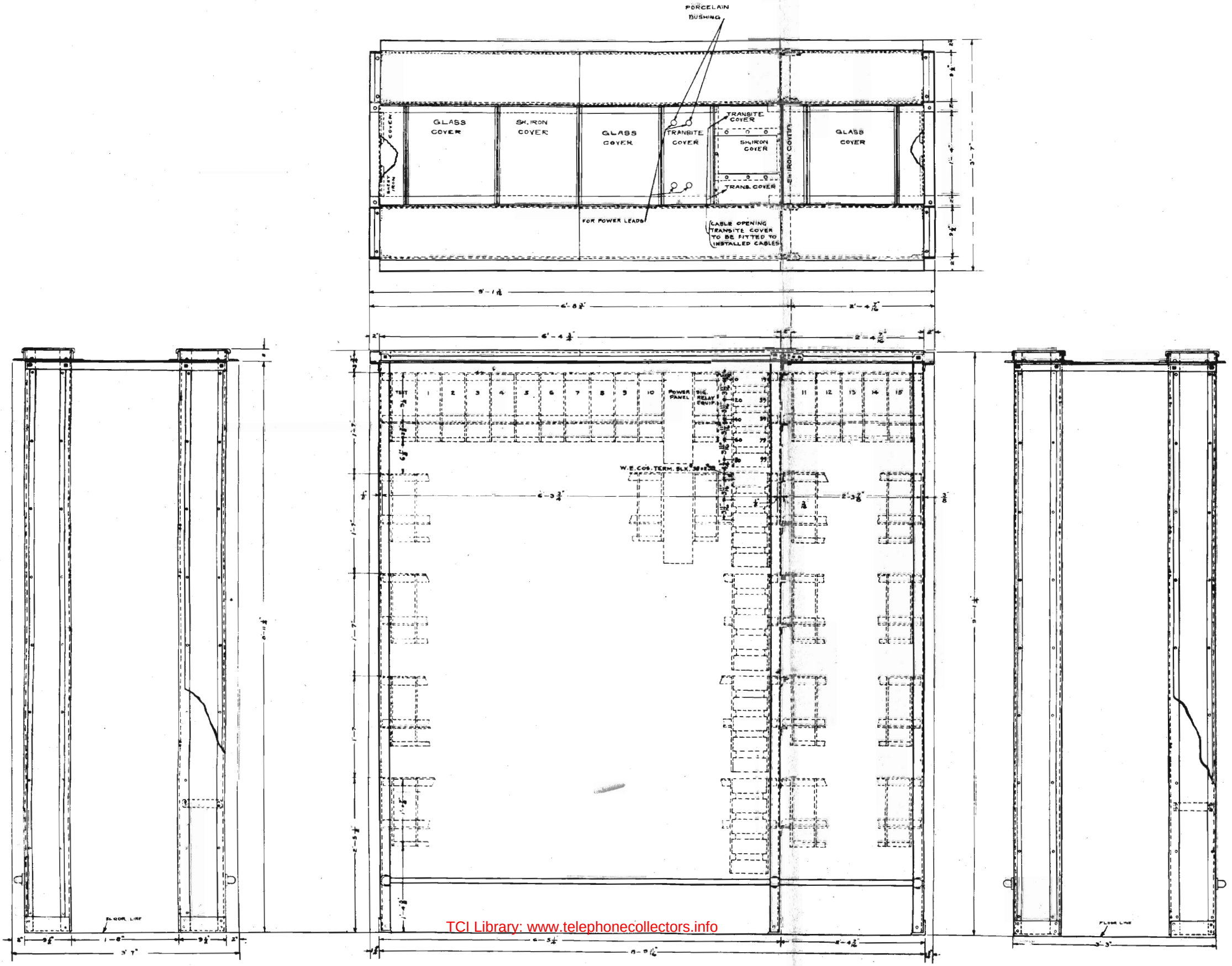
STEP-BY-STEP MACHINE SWITCHING SYSTEM

Connector Board Assembly
Capacity - 160 Connectors



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STEP-BY-STEP MACHINE SWITCHING SYSTEM

Connector Shelf Assembly
Capacity-Eleven Connectors

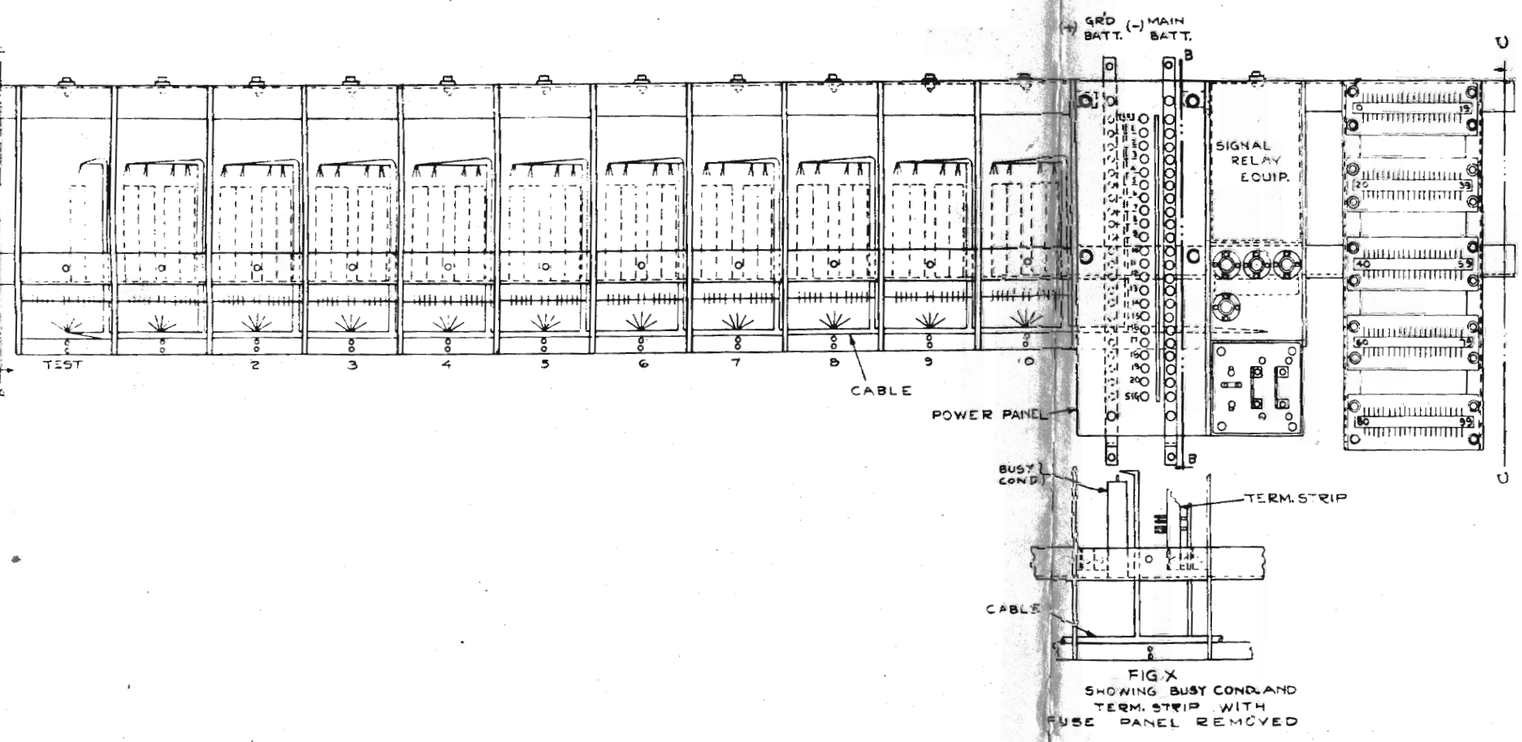
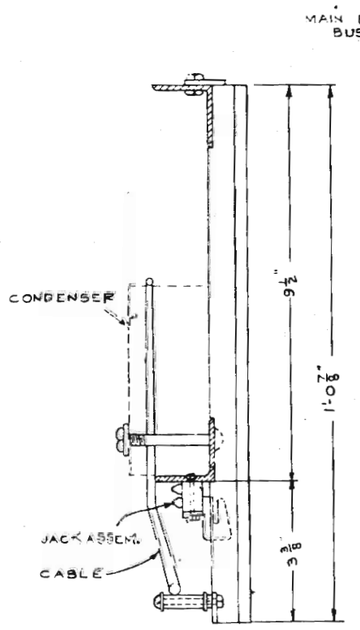
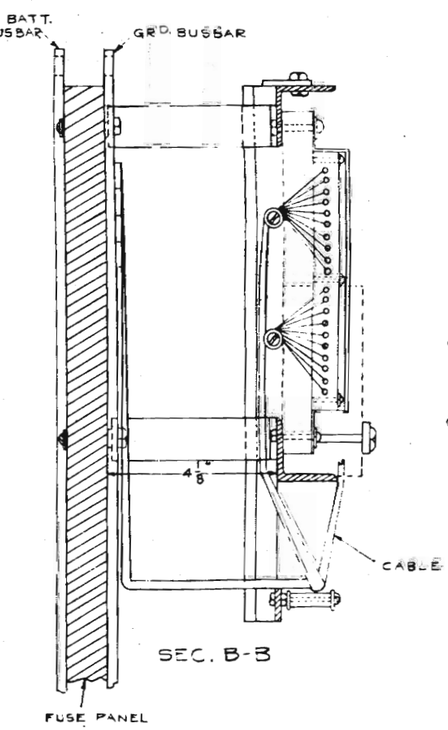


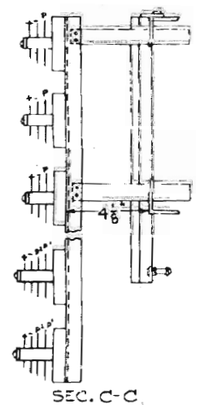
FIG. X
SHOWING BUSY COND. AND TERM. STRIP WITH FUSE PANEL REMOVED



SEC A-A
SCALE 6" = 1'-0"



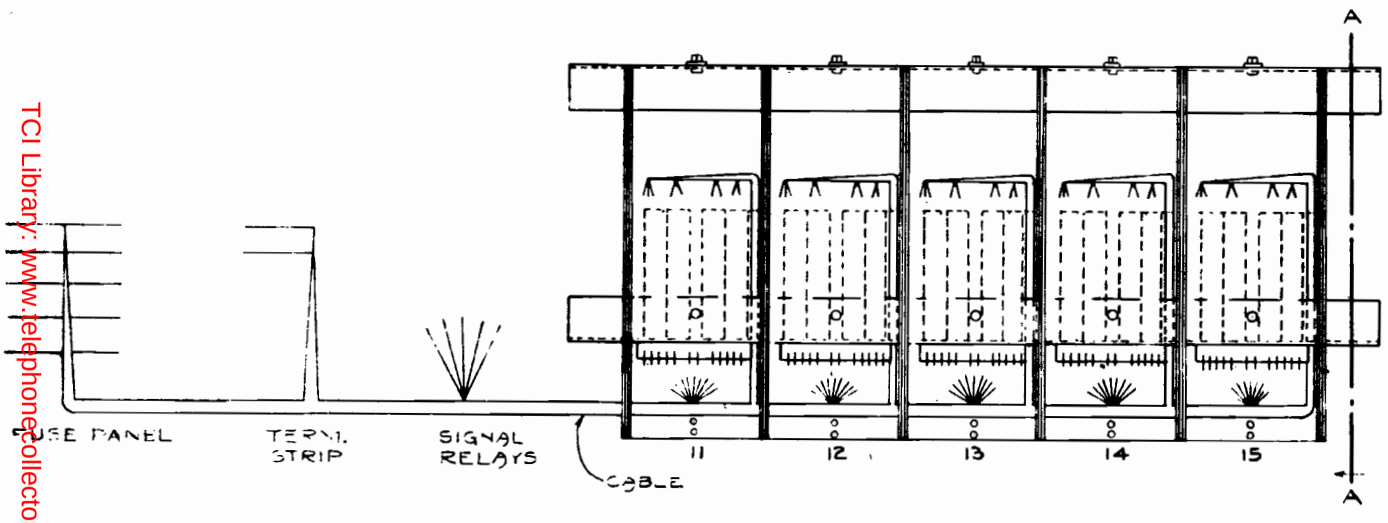
SEC. B-B

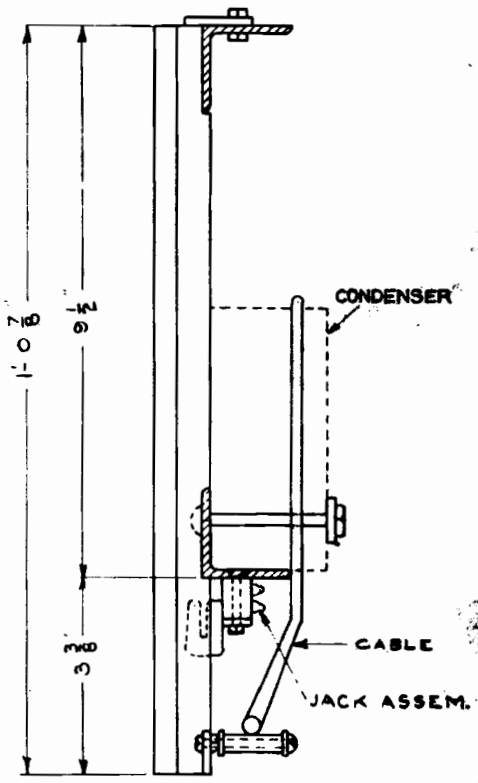


SEC. C-C

STEP-BY-STEP MACHINE SWITCHING SYSTEM

Connector Partial Shelf Assembly
Capacity - Five Connectors





SEC: A-A

The terminal strips at connector boards are employed for making the connections between the multiple bank wiring and the cabling leading to the intermediate distributing frame. The terminal strips are of the American Telephone and Telegraph Company's standard type and are mounted, together with the fuse panel, supervisory and release relays, and lamp signals on the sides of the board near one end. Since there is no equipment across either end of the board, several boards may be placed in a line if floor plan considerations make this desirable.

The connector board, like the selector board, is provided with a glass roof and with an iron pipe guard rail at the bottom of each side. When conditions of high humidity are encountered the connector boards may be enclosed in casings similar to those provided for the selector boards.

The Repeater:

The trunks from first selectors or from outgoing trunk secondary switches are 3-wire trunks. In order to permit the use of two-wire inter-office trunks, a group of relays known collectively as a repeater is employed at the originating office for each inter-office trunk. The repeater receives the dial pulses from the calling station and repeats them over the trunk to the incoming selector, and also provides the necessary features for supervision over the two-wire trunk. A further function of the repeater is to supply talking battery to the calling subscriber.

The relays constituting the repeater are mounted on a unit type base having a capacity for eight or for ten horizontally mounted relays, as shown on Drawings Nos. 807-36, 807-37 and 807-38. A typical repeater is shown in photograph No. 3. Dust proof covers for the relays and wiring are provided as for selectors. The relays are wired to a set of jacks mounted on the rear of the base, and a set of test jacks is provided for each repeater.

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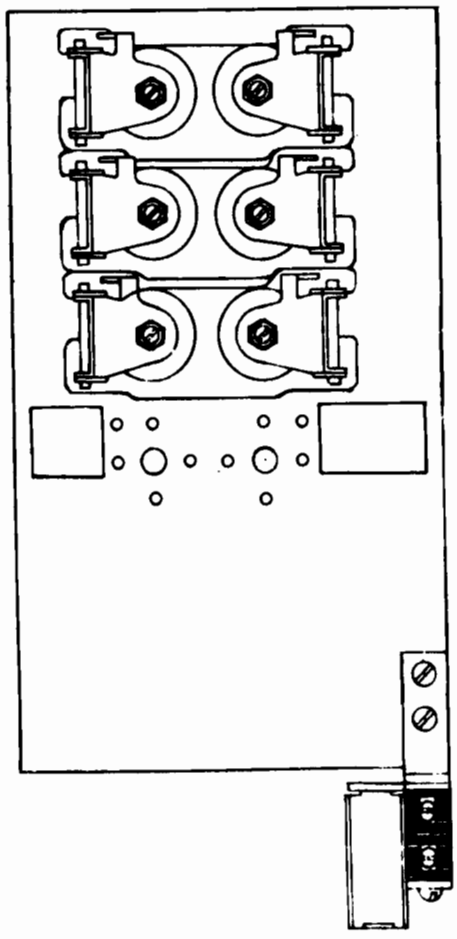
STEP BY STEP MACHINE SWITCHING SYSTEM

Repeater Assembly
8 Relay Capacity
Front View



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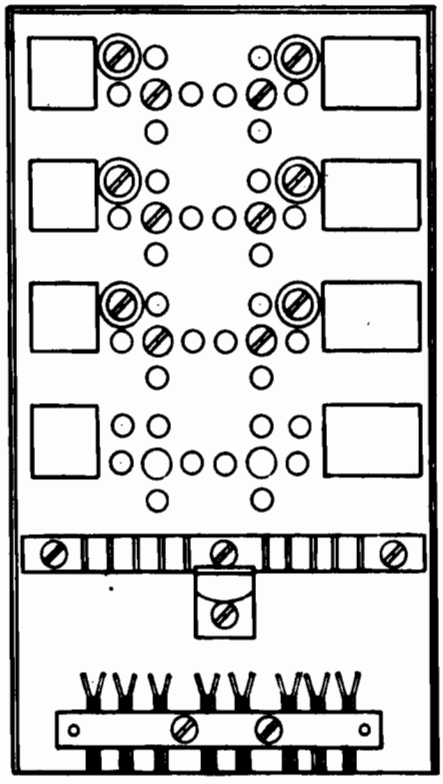
STEP BY STEP MACHINE SWITCHING SYSTEM

Repeater Assembly
8 Relay Capacity
Rear View



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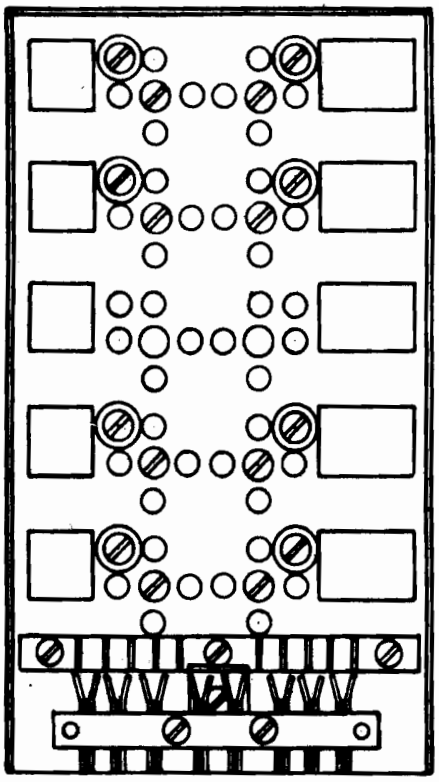
STEP BY STEP MACHINE SWITCHING SYSTEM

Repeater Assembly
10 Relay Capacity
Rear View



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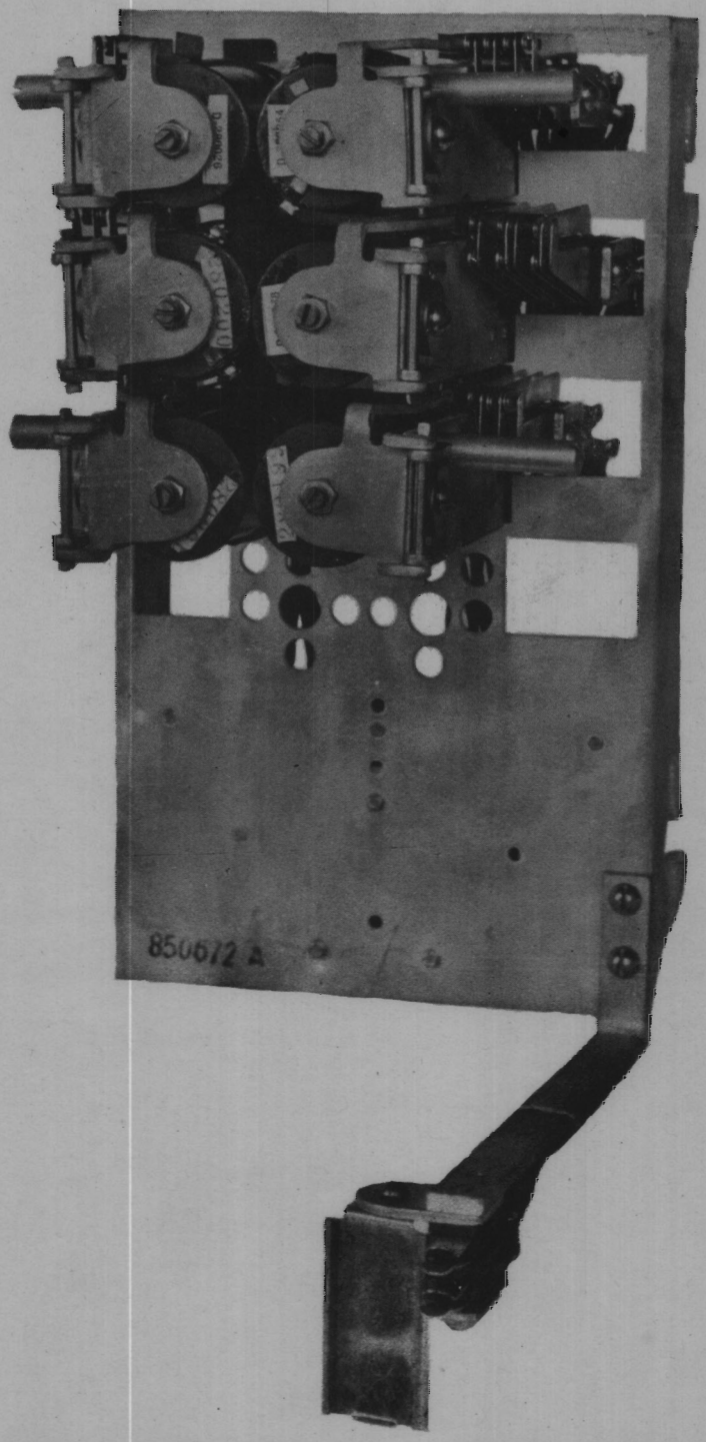
STEP BY STEP MACHINE SWITCHING SYSTEM

Typical Repeater

No. 3
May 1, 1920



Repeater Boards:

Repeaters are mounted on unit type frameworks, as shown on Drawing No. 807-28. The framework and its equipment is called a repeater board.

The repeater board is of the same general construction and has the same over-all dimensions as the selector board described in Division II, Section 3-n. Due to the fact that the repeater contains no switching mechanism or multiple banks, the height of the repeater base is less than that of the selector. The repeater shelves can therefore be mounted on closer centers than selector shelves, and the standard repeater frame provides space for eight shelves on a side. The total capacity of the framework is therefore 320 repeater bases. The arrangement of the shelves, glass cover and fuse panel are the same as described in connection with selector boards.

The association between the trunks from first selectors or from outgoing trunk secondary switches and the repeaters is subject to change, and in order to facilitate changes of this nature, a cross-connecting frame, with terminals similar to the standard terminal strips used on the I.D.F., is placed at the terminal end of the repeater board. Drawing 807-40 shows the assembly of this frame.

Steel doors similar to those provided at the terminal end of selector boards are provided for enclosing the cross-connecting frame. Repeater boards may be enclosed in a casing similar to that provided for selector boards to care for conditions of high humidity.

STEP BY STEP MACHINE SWITCHING SYSTEM

Repeater Cross-Connecting Frame Assembly