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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements to Selection Systems for Electrical Lines or Circuits

We, INTERNATIONAL STANDARD ELECTRIC CORPORATION, a Corporation of the State of Delaware, United States of America, of 320 Park Avenue, New York 22, New York,

United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to electrical switching equipment, such as used in automatic telecommunication exchanges.

An object of the present invention is to provide improved "overflow" facilities, whereby the traffic handling capability of the equipment can be enhanced.

According to the present invention there is provided electrical switching equipment, such as used in automatic telecommunication exchanges, in which connections can be set up between a number of inlets to the equipment and a number of outlets therefrom via stages of switches, in which the first of said stages to which said inlets are connected includes switches each giving one of said inlets access to a number of links extending respectively to a number of switches of the second of said stages, in which switches of said first stage are assembled into sections each giving its inlets access to the same second stage switches, in which each said first stage switch also has access to a plurality of overflow links to other first stage switches, in which each said first stage switch section includes at least one overflow switch reachable from a different first stage section via one of said overflow links, each said overflow switch having access to the first stage—second stage links accessible to the other switches of its section, in which said second stage includes a plurality of switch sections each including a

number of switches giving access to the same set of said outlets, in which the switches of a second stage section are accessible from a plurality of different first stage sections, in which when an inlet-outlet connection is required an attempt is made to set up the connection from the inlet's first stage switch to a switch of the outlet's second stage switch section via a free first stage—second stage link, and in which if, although the wanted outlet is idle said connection attempt is unsuccessful due to internal blocking a connection is set up via one of said overflow links from the inlet's switch to an overflow switch of a different switch section with access to a free link extending towards the wanted outlet.

According to the present invention there is also provided electrical switching equipment, such as used in automatic telecommunication exchanges, in which inlets and outlets of the stage are inter-connected by two stages of electro-mechanical cross-bar switches, in which each cross-bar switch of the first of said two stages has access to a plurality of switches of the second stage and each switch of the second stage is accessible via a plurality of switches of the first stage, in which each first stage switch has at least one of its outlets connected to an inlet to a different one of said first stage switches, so that when a first stage switch is unable to reach a desired outlet from the equipment due to internal blocking a connection may be set up from that first stage switch to a different first stage switch from which a further attempt to set up the desired connection may be made, in which each multiple of a cross-bar switch of the first stage for an outlet to a different first stage switch is split into two portions, one of which forms an outlet to a second stage switch and one of which forms the outlet to said different first

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stage switch, separate switch-setting means being associated with said two portions, and in which each portion of one of said split multiples which forms the outlet to a second stage switch is connectable by its switch setting means to at least one multiple for an inlet from a different one of said first stage switches.

Although the invention is not so restricted it is described in its application to the well-known telephone exchange system marketed under the Registered Trade Mark Pentaconta: an early version of this is described in a paper by Fernand Gohorel, in "Electrical Communication," in Vol. 31, June 1954 at pp 75-106, and entitled, "Pentaconta Dial Telephone Switching Systems." A developed version of this system is described in a paper by Jacques P. Basset and Sierre Camus, entitled "1000B Pentaconta Cross-bar Switching System," published at pp 196-212 of "Electrical Communication" Vol. 38 March 2nd, 1963.

The present invention is an improvement of the so called entraide arrangement described in the second of the above mentioned papers.

An embodiment of the invention will now be described with reference to the accompanying drawings, wherein:

Fig. 1, is a trunking diagram of a switching arrangement according to the present invention;

Fig. 2, is the detailed circuitry of the arrangement of Fig. 1.

The switching arrangement shown in Fig. 1 comprises a primary stage EP and a secondary stage ES. The primary stage consists of a number of primary sections, two of which, sections SP1 and SP2, are shown. The secondary stage consists of a number of secondary sections, two of which, sections SS1 and SS2, are shown. In each section each selector is represented by a thick vertical stroke, and the multiplied selection levels by a thick horizontal stroke. A direct link connects every one of the primary sections to each one of the secondary sections. Thus, the direct link *mpd1* connects the primary section SP1 to the secondary section SS1. If that link is busy, a new connection can no longer be established directly from primary section SP1 to the secondary section SS1. In the arrangement described herein each section is an electro-mechanical cross-bar switch.

A primary section comprises primary selectors and overflow primary selectors. In the telephone exchange system designated by the above-mentioned Trade Mark "Pentaconta" these overflow selectors are known as entraide selectors, or mutual-aid selectors. For instance the primary section SP1 comprises primary selectors such as CV, and, entraide primary selectors such as ECV.

Each inlet of the selection unit is connected to a primary selector, such as inlet *en1* which is connected to selector CV. Some of the selection levels of selector CV, as can be seen from Fig. 1, give access to direct links each of which connects its primary section SP1 to one of the secondary sections. Other levels give access to entraide primary links such as *mpe1*, by which a primary section can be connected to another primary section.

It was seen above that if the link *mpd1* is busy when a connection has to be set up for an inlet to SP1, the establishing of a direct connection between sections SP1 and SS1 is no longer possible. However, another link giving access to SS1, such as the link *mpd2* may be available. By setting the selector CV to an entraide level the inlet *en1* can be connected via the entraide primary link *mpe1* to the entraide primary selector EDV of the primary section SP2. This can extend the connection to the available link *mpd2*, giving access to secondary section SS1, which would render the outlet *st* accessible. Symmetrically speaking, it would also be possible to establish a connection between inlet *en2*, and outlet *st*, through primary selector DV, entraide primary link *mpe2*, entraide primary selector ECV and direct link *mpd1*.

Some of the selection levels of selector ECV give access to the direct links which link its primary section SP1 with the secondary sections, as for the selector CV. However, the levels of selector ECV which correspond to the level of CV which give access to entraide primary links do not give access to entraide primary links, but access to entraide secondary links such as *msel*. The number of these levels is variable, depending upon the traffic. It is generally less than the number of secondary sections, so that a primary section does not have available for use an entraide secondary link towards every one of the secondary sections. This causes no inconvenience, since, as will be seen, the designation of a primary section for handling a call needing entraide is conditional on the existence of available links towards the secondary section, this including, even in first choice, the existence of available entraide secondary links.

A secondary section comprises secondary selectors and entraide secondary selectors. For instance, the secondary section SS1 comprises secondary selectors such as TV, and entraide secondary selectors such as ETV. An outlet of the switching arrangement is connected to one or several selection horizontal levels in one or several secondary sections. That is, some at least of the outlets accessible via the switching arrangement are each accessible via two or more secondary sections. Each secondary selector is reached by a single direct link from a par-

particular primary section, whereas an entraide secondary selector can be reached by one or several entraide secondary links. For instance, the selector ETV is accessible from the primary sections SP1 and SP2, through links *mse1* and *mse2* respectively. In this way, the total number of entraide secondary selectors is limited in accordance with the maximum traffic to be handled by the entraide without any consideration of the number of entraide levels of the primary sections.

The general operating process of the switching arrangement described above will now be explained, assuming that a connection must be established between inlet *en1* and outlet *st* for various conditions of the connection network.

In the first case, the direct link *mpd1* is assumed to be available. The call originating upon inlet *en1* puts into operation the primary section SP1. The identity of the requested outlet results, in well known and currently used manner, in a marking which puts into operation the secondary section SS1. The secondary section SS1 marks the available links via which it is accessible. The primary section SP1 receives an availability marking through a direct link: the link *mpd1*, which means that the entraide is not necessary. The selections are accomplished, in the primary section SP1, in the direction of the link *mpd1*; and, in the secondary section SS1 in the direction of the outlet *st*. Finally, the connection is realized, linking the inlet *en1* to the outlet *st* by: the primary selector CV, the direct link *mpd1* and the secondary selector TV. In a similar way, inlet *en2* could have been connected to outlet *st*, through primary selector DV and direct link *mpd2*.

In the second case, the direct link *mpd1* is assumed to be busy, whereas the links *mpd2* and *mse1* are available. When secondary section SS1 marks the available links, the primary section SP1 would not therefore receive any availability marking through a direct path, so that entraide is requested. This request causes, inside the primary section SP2, the hunting for the marking of availability of links leading to secondary section SS1. Simultaneously, the primary section SP1 marks the available entraide primary links by which it can reach the other primary sections. The primary section SP2 hunts for this marking also, and, more particularly, for the coincidence between the marking originating from the secondary section SS1 and the marking originating from the primary section SP1. If the link *mpd1* is available, the section SP2 will fulfil thus the conditions for answering the request for entraide.

Moreover, due to the existence of direct links and available entraide secondary links,

there are two possibilities of connection. A choice is then made, giving preference to the selection of an entraide secondary link.

All the necessary conditions exist for proceeding with the selections and connections. The secondary section SS1 selects the outlet *st*. The primary section SP2 selects the entraide secondary link *mse2* marked by section SS1. The primary section SP1 selects the entraide primary link *mpd1* leading to the primary section SP2. The connection is accomplished between the inlet *en1* and the outlet *st* by: the primary selector CV, the entraide primary link *mpd1*, the entraide primary selector EDV, the secondary link *mse2* and the entraide secondary selector ETV.

In the same manner, the inlet *en2* could have been connected to outlet *st*, through the medium of: the primary selector DV, the entraide primary link *mpd2*, the entraide primary selector ECV, the entraide secondary link *mse1* and the entraide secondary selector ETV.

There now remains to describe the case where the direct link *mpd1* is busy, at the same time as the entraide secondary link *mse2*.

The operating process is the same as in the foregoing case, with the exception that, in this instance, the primary section SP2 which takes care of the entraide is able to select a direct link. The connection is then established between inlet *en1* and outlet *st*, through the medium of: the primary selector CV, the entraide primary link *mpd1*, the entraide primary selector EDV, the direct link *mpd2* and the secondary selector TV. In a similar manner, a connection between inlet *en2* and outlet *st* would be established through: the selector DV, the entraide primary link *mpd2*, the entraide primary selector ECV, the direct link *mpd1* and the secondary selector TV.

Figure 2 represents the detailed circuits of: a primary section SP1, a secondary section SS1, a common control device, the marker MQ, and, some circuits of a second primary section SP2. It illustrates the essential parts of those circuits, enabling to describe the operating process of a selection unit such as the one shown in fig. 1 wherein are found certain of the elements bearing the same references.

A primary section, as has already been seen above, comprises primary selectors and entraide primary selectors. These selectors make up a crossbar multi-switch. In a well-known and currently used manner, a connection is realized in such a multi-switch by setting into position one of the selection bars common to all the selectors to designate the level upon which the connection must be made, and then, by energizing a connection electro-magnet proper to the selector to be

connected. The selection bar is then released but the established connection remains held as long as the connection electro-magnet of the selector stays energized.

- 5 Same applies concerning the selectors of a secondary section.

The selection bars are controlled by selection electro-magnets, the windings of which are in a well-known and currently used circuit which can only set one selection bar at a time, even where several selection levels are simultaneously requested. Moreover, this circuit supplies an indication which indicates which is the level finally selected. To simplify the description, the circuits for setting into position the selection bars are represented, for each section, in the form of a simple rectangle, for instance the rectangle CB for section SP1.

- 20 The connection electro-magnets of the selectors are represented by a square and designated by a reference made up of two or three capital letters (electro-magnet CV, for instance). The connection contacts of a selector are shown above the electro-magnet (connection contacts CVc). Moreover, the connection electro-magnet has auxiliary contacts that operate whatever may be the level at which the connection is made. It bears the same reference as the selector, but it is followed by a number (auxiliary contacts CV1 and CV2).

- The general operating process of the entire selection unit and the operating process proper to each section are controlled by circuits with relays, diodes and resistors. A relay is represented by a small rectangle with, on either side, the connections of one winding or of two windings. It bears as reference two small letters. The first letter is an *m* for the relays of marker MQ, *c* for the section SP1, *d* for the section SP2 and *t* for the section SS1. In the detached contact form of representation, the contacts of a relay are positioned anywhere on the diagram. They bear the reference of the relay which controls them, followed by a number. For instance, the relay *cg* (section SP1) controls the contact *cg1* situated in the circuit of the relays *ck* and *cl*.

- Finally, it is worth noting that all the circuits are supplied by the same direct current source, the positive terminal of which is earthed. All the circuits which lead to the negative terminal of this current source have an arrow at their end.

- Connection by a direct link* — It is here assumed that a call originates at the inlet *ent1* of the primary section SP1, which has to be connected to an outlet *st* of the secondary section SS1 in order to reach the junctor circuit JC, a direct link being available; which thus avoids making use of the entraidé.

- 65 Inlet *ent1* is connected to primary selector

CV. It has five conductors: two talking wires *a*, *b*; wire *t* for holding the connection and two signalling wires *d* and *e*. The wires *a*, *b*, *t* must be connected to the junctor JC, whereas the wires *d* and *e* end up in the selection unit.

The call setting is controlled by a unit such as a register which has received numerical or other indications as to the routing to be given to the connection. It causes the earthing of wire *d*. Through contact CV1, this potential energizes relay *cg*. A multiplying arrow shows that relay *cg* is connected to all the inlets of section SP1. When *cg* operates it closes its contact *cg1* to request the services of a marker which serves the switching arrangement. If a selection is already in process inside the switching arrangement, the marker MQ is busy so its relay *ma* is operated. The contact *mal* is thus open, so the closing of contact *cg1* is without any effect.

If the marker MQ is available, the relay *ma* is at rest with its contact *mal* closed. Closure of contact *cg1* therefore causes relay *ck* to energize via its left winding. Therefore, the contact *ck1* changes over to complete a circuit through the relay *ma* of the marker, the right-hand winding of relay *ck*, and the relay *cl*, all in series. The contacts, such as *ck1*, in the various primary sections (the contact *dk1* of section SP2, for instance) are connected in series in such a way that the circuit from relay *ma*, inside the marker, can only be closed from one primary section; this prevents any double connection. If it is assumed that only section SP1 is calling, the relays *ma*, *ck* and *cl* are energized in series. The contact *mal* opens and makes the marker MQ unavailable i.e. it busies MQ. Contacts of relay *cl* establish the circuits necessary for selection to be effected. In particular, at the closure of contact *cl2* the circuit of relay *cq* is completed, so it energizes.

After the closure of contact *cl1*, the wire *e* of the calling inlet is connected to wire *fc* of the common unit for information transmission. This is an information by-path indicated by FC, which serves all control units of the exchange including the switching arrangement shown. The information by-path FC is used by the register for transmitting very rapidly to the marker a numerical indication defining which outlet is to be connected to the inlet *ent1*. This information is received by a group of registering and marking relays represented by a rectangle ENR-MQG, which causes the marking of the outlet *st*, by earthing a corresponding wire such as wire *ms*. There are as many wires *ms* as there are connected circuits at the outlet side of the selection unit.

It can be seen that wire *ms*, used for marking the outlet *st*, passes inside the

junctor JC over a contact *dis*. This contact, belonging to an availability relay (not shown) is closed if the junctor is available. It is open if the junctor is busy. In the latter case, the marking is without any effect; and the marker, through means (not shown) gives a 'busy' signal.

It will be assumed that junctor JC is free and that its contact *dis* is closed. The marking potential then reaches the secondary section SS1 and causes, through a resistor, the energizing of the piloting relay *ta*.

The secondary section SS1 then marks the links over which the primary sections can reach it. For that purpose an earth, supplied via the contact TV1 when the secondary selector of direct link TV is free, is applied over contact *tal* and wire *dmd*, to the primary section SP1. The same applies for the other secondary selectors, in relation to the other primary sections. Similarly, the availability of the entraide secondary selector ETV is marked by the wire *dme*, over contact *ta2*, now closed. The multiplying arrow indicates that the wire *dme* leads to several primary sections. In fact, since the entraide secondary selector can be reached from several primary sections, the indication of availability must be given to all these primary sections. In the section SP1, however, no account is taken of this marking because contact *cq3* is then open.

In the primary section SP1, the reception of the availability indication causes, through diode *d1*, the energizing of relay *cp*. The multiplying arrow shows that the relay *cp* can be energized by a similar circuit from each one of the secondary sections. The diodes, such as *d1*, decouple the circuits from each other. In the section SP2, the corresponding relay *dp* energizes under the same conditions, i.e. when a call is for an outlet from that section.

Now can be examined how operates the request for entraide circuit, which is the circuit of relay *mj*. In the primary section SP1, immediately the connection to the marker MQ is made, the negative potential is applied to a terminal of the energizing winding of relay *mj*, through contacts *cp1* and *c13*. However, the earth is not applied to the other end of the winding and the relay remains at rest. The contact *mj1* then allows relay *cq* to energize over its contact *c12*. Then the relay *cp* energizes in the section SP1. Its contact *cp2* applies the earth to winding of relay *mj*, but at the same instant the opening of contact *cp1* cancels the negative voltage upon the other end of the winding. The relay *mj* remains, therefore, at rest and the relay *cq* operates. The entraide is not requested.

The contact *cq1* being closed, the earth received on wire *dmd* is routed back in the direction of the secondary section from

which it originates in order to energize the relay *tm*. The multiplying arrow shows that identical circuits passing through the different primary sections are all connected to relay *tm*.

The energizing of relay *tm* shows that the choice of the process of connection is accomplished (no entraide; connection by means of a direct link). The closure of contact *tm1* brings the secondary section SS1 into calling condition upon the marker. In practice, any connection will interest not only one outlet but several, through any one of which it is possible to establish that call. Several secondary sections, same as section SS1, receive a marking (*ta*) and have a free direct link with the section SP1 (*tm*). The call onto the marker is effected through an exclusion circuit comprising the relays *tn*, *to*, *mt* analogous to the seizure-of-the-marker circuit (*cl*, *ck*, *ma*).

If the relay *mt* is at rest condition, the contact *mt1* supplies the negative potential which enables the energizing of relay *to*. The operating process of contact *tol* establishes a circuit comprising in series; the relay *mt*, the right winding of relay *to* and the relay *tn*. It is assumed, as shown in the figure, that contact *tol* is the first of the chain of similar contacts inside the other secondary sections. The relay *to* therefore holds, whereas relays *mt* and *tn* energize. Opening of contact *mt1* cancels the negative potential in order to prevent any other secondary section from connecting onto the marker.

The closing of contacts such as *tn1* will connect the marking wires, originating from the junctors, onto the setting of selection bar circuit TB. It has already been seen above that one of these wires is marked by an earth applied inside the registering and marking device ENR-MQG. A selection bar is set in dependence on this marking, preparing the connection to outlet *st*. In order to indicate that the selection is done, the circuit TB supplies a negative potential transmitted by the contact *tn3* to a terminal of the winding of relay *mf*.

In addition, the closing of contacts, such as contact *tn2*, establishes the marking circuit of the primary sections. The marking earth is supplied in the primary section SP1, by the contact *cq2*, towards all the secondary (multiplying). It is routed to the primary section SP1, by contact *tn2* and contact TV2 of the free secondary selector, along a marking wire *mmd* proper to the link *mpd*, connected to the setting of selection bars circuit CB. A selection bar is set under control of this marking. To indicate to the marker that the primary selection is done, a negative potential, supplied by the circuit CB, is transmitted by the contact *c14* upon winding of relay *mm* which energizes.

Closure of contact *mm1* completes the circuit of relay *mf*, so this relay *mf* energizes and its contact *mf1* applies an earth wire *fs* towards the information by-path and the register, to signal that the selections are prepared and that the connection can take place.

It is the register that causes the connection by applying earth to wire *t*. Immediately then, the electro-magnet of the primary selector CV energizes. A set of connection contacts CVc closes in concordance with the selection made. The wires *a*, *b*, *t*, are connected by the link *mpd* to the secondary selector TV. The earth on wire *t* then causes the energizing of the electro-magnet of the secondary selector TV. A set of connection contacts TVc closes in concordance with the selection made. The wires *a*, *b*, *t* are connected to outlet *st* and to junctor JC.

The requested connection is established by the direct link *mpd*.

The release of the circuits is caused by the opening of contact CV1 of the primary selector, bringing along the release of relay *cg*. It is possible to check that all the circuits are released successively.

Entraide by an entraide secondary link—Now will be described the operating process of the selection unit when a call originates on the inlet *enr2* of the primary section SP2 and must be connected to outlet *st* of the secondary section SS1, a direct link not being available; whereas the section SP1 has one direct link and one entraide secondary link for reaching the secondary section SS1.

The circuits of the secondary section SP2 are identical to those of the primary section SP1. When the call originates, the operating process is therefore the same as the one just described for the primary section SP1 up to the marking of the outlet *st* and to the marking of the links by the secondary section SS1 (energizing of relay *ta*). In particular, the section SP2 is connected to marker MQ by the energizing of relay *dl*.

Anyhow, at this instant, the relay *dp* of primary section SP2 does not energize, because the direct link connecting section SP2 to section SS1 is busy. However, since link *mpd* is available, earth is applied from contact *tal* over wire *dmd* and, in the primary section SP1, the relay *cp* energizes. Simultaneously, the secondary entraide link *mse* being also free, earth is applied to wire *dme*, over contact *ta2*. In the primary section SP1, the relay *cv* energizes at the same time as relay *cp*.

Closure of contacts *cp2* and *cv2* supplies the earth to energize the relay *mj*. Now, in the section SP2, since the relay *dp* is not energized, negative is still applied through contacts *dpl* and *dl3*. The relay *mj*, after some delay due to its shorted winding, can

energize through the following circuit; negative potential in the section SP2, resistor, *dpl*, *dl3*, relay *mj* in the marker, contacts *cp2* and *cv2* in the section SP1. This constitutes the request for entraide. The opening of break contact *mj1* releases relay *dq* in the section SP2. Closure of contact *mj2* supplies an earth meant at the same time for the section which requests the entraide and for one, or several, sections which can answer to this request.

In the section SP2, the earth connection of contact *mj2*, routed by the contact *dl5*, energizes the relay *di*. The relay *di* has a contact such as *dil* for the entraide level of the section SP2. If the entraide primary link *mpe2* which connects the section SP2 to the section SP1—is available, the corresponding entraide primary selector ECV is at rest condition in the primary section SP1. It supplies therefore an availability earth by its contact ECV1. The contact *dil* passes this earth relay *cm* of the primary section SP1, to signal the existence of a free primary link usable for the entraide connection required (it will be seen that the relay *cf* is energized, in the section SP1). Moreover, opening of contacts *di2* and *di3* breaks the circuits of the relays *dp* and *dv*, so that the sudden release of a link does not come to disturb the process in course.

In the primary section SP1, the earth at contact *mj2*, through the break contact *cl5* and the contacts *cp5* and *cv5*, energizes relay *cf*. The relay *cf* has a contact such as *cf1* for each entraide primary selector of the primary section SP1. If the availability earth of an entraide primary link (ECV1) is sent back by the primary section (SP2) which requests the entraide (*dil*), the relay *cm* energizes.

The primary section SP1, in which the relays *cm*, *cp* and *cv* are energized, can answer to the request for entraide, and, establish the connection in two ways onto the secondary section SS1: by a direct link or by an entraide secondary link. Both possibilities are signalled to the marker which chooses between them. An earth is transmitted by the contacts *cm1* and *cp3* for energizing the relay *md*. Another earth is transmitted by the contacts *cm2* and *cv3* for energizing the relay *me*. This latter characterizes the possibility of using an entraide secondary link and it energizes effectively. Opening of contact *me1* prevents the energizing of relay *md*, rejecting the eventual use of a direct link.

In order to express this choice, the contact *me2* sends an earth which, through contact *cv4*, causes the energizing of relay *cs* in the primary section SP1. The primary section SP1 can answer to the request for entraide by applying the process of connection chosen by the marker. The closure of



contact *cs1* sets the primary section SP1 into calling condition upon the marker. Since, in practice, the number of primary sections is more than two, it is possible that other primary sections may answer to the request for entraide as section SP1. The cal to the marker is accomplished through a lock-out circuit comprising the relays *cn*, *co*, *mh* analogous to the circuits for seizure of the marker (*cl*, *ck*, *ma*). The relay *mh* being at rest the contact *mh1* supplies the potential which enables the energizing of relay *co*. To simplify the explanations, it will be assumed that only the relay *co* of section SP1 has started to operate. The operation of contact *co1* establishes a circuit comprising in series; the relay *mh* of the marker, the right winding of relay *co* and the relay *cn*. The relays *mh* and *cn* energize and the relay *co* holds. Opening of contact *mh1* cancels the negative potential, to prevent any other primary section from answering the request for entraide now that section SP1 is designated for taking care of the connection. The section SP1 will now be called entraide section.

The relay *ct* is energized by a circuit comprising contacts *mj1*, *cn2* and *cs2*. The closure of contact *ct1* sends the availability earth of the entraide secondary selector ETV to the relay *tm* of section SS1. The secondary section gets them into calling condition towards the marker, as has already been seen above. The connection to the marker, is accomplished by the energizing of relay *tn*. The setting into position of a selection bar takes place in section SS1 and when this operation is done, a negative potential is applied onto the circuit of relay *mf*.

On the other hand, the closure of contacts such as *cn1* takes care of the marking of the entraide primary links ending into the entraide section SP2. For instance, the entraide primary link *mpe2* being available, the earth supplied by the contact ECV2 is sent to primary section SP2 in order to cause the selection of the corresponding entraide level. In the primary section SP2, the relay *dt* is at rest condition and the circuit DB for the setting into position of the selection bars receives the marking of the entraide primary links. A selection bar is therefore set according to this marking. To signal that the selection is done, the circuit DB supplies a negative potential to its left outlet transmitted by the contact *dl6* so as to energize the relay *mk* in the marker.

In the section SS1, the closure of contacts such as *tn4* takes care of the marking of the entraide secondary links. The entraide secondary link being available, the earth is transmitted by the contact ETV2 onto the entraide section SP1 in order to cause the selection of the corresponding entraide level.

In this connection, it is good to note that

the relay *dq* has released in the primary section SP2 and contact *dp2* is open, same as contact *cq2*. The earth connection, enabling the marking of the direct links, is therefore not supplied; and this will forcibly limit the selection—between primary stage and secondary stage—to the entraide secondary links. Moreover, the marking of the entraide secondary links is efficient in one primary section only, the one whose relay *ct* (or *dt*) is operating.

A selection bar is therefore set into position in the entraide section SP1. In order to signal that the selection is done, the setting of the selection bars circuit will supply then the negative potential upon its left outlet, transmitted through the contact *cn3*, the contact *me3* and the contact *mk1* (selection made in the section SP2) onto the relay *mm* which energizes.

The closure of contact *mm1* completes the circuit of relay *mf*, thus gathering together the three indications of end of selection. The relay *mf* energizes. Its contact *mf1* applies the earth onto wire *fs* in order to signal to the register that the selections are prepared and that the connection can take place.

The register causes the connection by applying the earth onto wire *t*. The electromagnet of the primary selector DV energizes. A set of connection contacts DVc closes in concordance with the selection done. The wires *a*, *b*, *t* are connected by the entraide primary link *mpe2* onto the entraide primary selector ECV. The earth of wire *t* causes the energizing of the electromagnet of selector ECV. A set of connection contacts ECVc closes and the wires *a*, *b*, *t* are connected by the entraide secondary link *mse* onto entraide secondary selector ETV. A set of connection contacts ETVc closes, and, finally, the wires *a*, *b*, *t* are connected onto outlet *st* and onto junctor JC. The requested connection is established by an entraide primary link and an entraide secondary link. The release of the circuits of the line selection unit begins as soon as contact DV1 is open.

Entraide by a direct link—Now will again be taken up the foregoing example of the operating process in assuming that there does not exist any entraide secondary link available for establishing the requested connection, whilst the entraide is indeed necessary.

The first difference in the development of operations appears when the secondary section SS1 marks the links which connect it onto the primary sections. In fact, since it is assumed that the entraide secondary link is busy—contact ETV1 being open—the relay *cv* of the primary section SP1 remains in rest condition. Consequently, after section SP1 will have received the marking

of section SP2, which energizes the relay *cm*, the earth will be applied by means of contacts *cm1* and *cp3* in order to energize the relay *md* of the marker; whereas relay *me* remains at rest condition (it is assumed, of course, that there does not exist any primary section other than SP1 which could be in a measure to answer to the request for entraide by having at its disposal an entraide secondary link).

Due to this fact, the marker supplies an earth through contact *md2* in order to energize the relay *cr* of primary section SP1 (in replacement of relay *cs*). The primary section SP1 is then authorized to answer to the request for entraide and, through contact *cr1*, gets into calling condition upon the marker. The relays *co* and then *cn* would energize when the section is designated to answer to the request for entraide.

At this instant, closure of contact *cn2* causes the energizing of relay *cq*, instead of *cr* in the foregoing case. The closure of contact *cq1* sends back the availability earth received upon wire *dmd*, in direction of relay *tm* of the secondary section SS1. The closure of contact *cq2* affords the marking earth of the direct paths, and, in particular, the earth enabling the secondary section to mark the wire *mmd*. It is seen, thus, that instead of selecting the entraide secondary link *mse*, the direct path *mpd* will be selected.

In the secondary section SS1, after the energizing of relay *tn* for the connection onto the marker, the selection bar is set into position; and, the winding of relay *mf* receives a negative potential.

In the primary section SP2, the marking of the link *mpe2* causes the selection—as has already been seen above. When it is done, the negative potential transmitted by the circuit DB causes the energizing of relay *mk* of the marker.

In the entraide section SP1, the selection of the direct link *mpd* results, inside the circuit CB, into the sending of a negative potential along the outgoing wire on the right, causing through contacts *cn4*, *md3* and *mk1* the energizing of relay *mm*.

Finally, the relay *mf* is energized by the closure of contact *mml*.

The indication of end of selection is sent, and the register commands the connection by applying an earth onto wire *t*. The electro-magnets of the primary selector DV, and of the entraide primary selector ECV, energize as in the case of the foregoing operating process. Then, because of the selection of a direct link, the inlet *ent2* is connected, by the link *mpd*, onto the secondary selector TV whose electro-magnet energizes in its turn. Inlet *ent2* is, finally linked to the outlet *sr* and to the junctor JC.

The release of the circuits of the selection

unit takes place starting from the opening of contact DV1; as has been seen above.

WHAT WE CLAIM IS:—

1. Electrical switching equipment, such as used in automatic telecommunication exchanges in which connections can be set up between a number of inlets to the equipment and a number of outlets therefrom via stages of switches, in which the first of said stages to which said inlets are connected includes switches each giving one of said inlets access to a number of links extending respectively to a number of switches of the second of said stages, in which switches of said first stage are assembled into sections each giving its inlets access to the same second stage switches, in which each said first stage switch also has access to a plurality of overflow links to other first stage switches, in which each said first stage switch section includes at least one overflow switch reachable from a different first stage section via one of said overflow links, each said overflow switch having access to the first stage—second stage links accessible to the other switches of its section, in which said second stage includes a plurality of switch sections each including a number of switches giving access to the same set of said outlets, in which the switches of a second stage section are accessible from a plurality of different first stage sections, in which when an inlet-outlet connection is required an attempt is made to set up the connection from the inlet's first stage switch to a switch of the outlet's second stage switch section via a free first stage—second stage link, and in which if, although the wanted outlet is idle said connection attempt is unsuccessful due to internal blocking a connection is set up via one of said overflow links from the inlet's switch to an overflow switch of a different switch section with access to a free link extending towards the wanted outlet.

2. Equipment as claimed in claim 1, and in which some of the links accessible to said overflow switches are links solely used for overflow connections, preference in setting up a call via an overflow switch being given to the use of said overflow links.

3. Equipment as claimed in claim 2, and in which the second stage switches which are reached via the first stage—second stage links used solely for overflow are themselves accessible via two or more links arriving from different first stage sections.

4. Equipment as claimed in claim 1, 2 or 3, and in which each said switch section is a co-ordinate multi-switch.

5. Equipment as claimed in claim 4 with claim 2 or 3, and in which the multiples of said multi-switch giving access to said overflow links are split into two portions, one portion of each such multiple giving



of section SP2, which energizes the relay *cm*, the earth will be applied by means of contacts *cm1* and *cp3* in order to energize the relay *md* of the marker; whereas relay *me* remains at rest condition (it is assumed, of course, that there does not exist any primary section other than SP1 which could be in a measure to answer to the request for entraide by having at its disposal an entraide secondary link).

Due to this fact, the marker supplies an earth through contact *md2* in order to energize the relay *cr* of primary section SP1 (in replacement of relay *cs*). The primary section SP1 is then authorized to answer to the request for entraide and, through contact *cr1*, gets into calling condition upon the marker. The relays *co* and then *cn* would energize when the section is designated to answer to the request for entraide.

At this instant, closure of contact *cn2* causes the energizing of relay *cq*, instead of *ct* in the foregoing case. The closure of contact *cq1* sends back the availability earth received upon wire *dmd*, in direction of relay *tm* of the secondary section SS1. The closure of contact *cq2* affords the marking earth of the direct paths, and, in particular, the earth enabling the secondary section to mark the wire *mmd*. It is seen, thus, that instead of selecting the entraide secondary link *mse*, the direct path *mpd* will be selected.

In the secondary section SS1, after the energizing of relay *tm* for the connection onto the marker, the selection bar is set into position; and, the winding of relay *mf* receives a negative potential.

In the primary section SP2, the marking of the link *mpe2* causes the selection—as has already been seen above. When it is done, the negative potential transmitted by the circuit DB causes the energizing of relay *mk* of the marker.

In the entraide section SP1, the selection of the direct link *mpd* results, inside the circuit CB, into the sending of a negative potential along the outgoing wire on the right, causing through contacts *cn4*, *md3* and *mk1* the energizing of relay *nm*.

Finally, the relay *mf* is energized by the closure of contact *mm1*.

The indication of end of selection is sent, and the register commands the connection by applying an earth onto wire *t*. The electro-magnets of the primary selector DV, and of the entraide primary selector ECV, energize as in the case of the foregoing operating process. Then, because of the selection of a direct link, the inlet *ent2* is connected, by the link *mpd*, onto the secondary selector TV whose electro-magnet energizes in its turn. Inlet *ent2* is, finally linked to the outlet *st* and to the junctor JC.

The release of the circuits of the selection

unit takes place starting from the opening of contact DV1; as has been seen above.

WHAT WE CLAIM IS:—

1. Electrical switching equipment, such as used in automatic telecommunication exchanges in which connections can be set up between a number of inlets to the equipment and a number of outlets therefrom via stages of switches, in which the first of said stages to which said inlets are connected includes switches each giving one of said inlets access to a number of links extending respectively to a number of switches of the second of said stages, in which switches of said first stage are assembled into sections each giving its inlets access to the same second stage switches, in which each said first stage switch also has access to a plurality of overflow links to other first stage switches, in which each said first stage switch section includes at least one overflow switch reachable from a different first stage section via one of said overflow links, each said overflow switch having access to the first stage—second stage links accessible to the other switches of its section, in which said second stage includes a plurality of switch sections each including a number of switches giving access to the same set of said outlets, in which the switches of a second stage section are accessible from a plurality of different first stage sections, in which when an inlet-outlet connection is required an attempt is made to set up the connection from the inlet's first stage switch to a switch of the outlet's second stage switch section via a free first stage—second stage link, and in which if, although the wanted outlet is idle said connection attempt is unsuccessful due to internal blocking a connection is set up via one of said overflow links from the inlet's switch to an overflow switch of a different switch section with access to a free link extending towards the wanted outlet.

2. Equipment as claimed in claim 1, and in which some of the links accessible to said overflow switches are links solely used for overflow connections, preference in setting up a call via an overflow switch being given to the use of said overflow links.

3. Equipment as claimed in claim 2, and in which the second stage switches which are reached via the first stage—second stage links used solely for overflow are themselves accessible via two or more links arriving from different first stage sections.

4. Equipment as claimed in claim 1, 2 or 3, and in which each said switch section is a co-ordinate multi-switch.

5. Equipment as claimed in claim 4 with claim 2 or 3, and in which the multiples of said multi-switch giving access to said overflow links are split into two portions, one portion of each such multiple giving

access to an overflow link to a different primary switch section and the other giving access to a link to a second stage switch section.

5 6. Equipment as claimed in claim 2 or 3, and in which all overflow switches in the same primary switch section have access to the same set of secondary switches.

10 7. Equipment as claimed in any preceding claim, and in which when a connection is to be set up to an outlet an electrical marking is applied to that outlet, which causes availability signals to be sent in respect of every second stage switch via which
15 that outlet can be released to the respective first stage switch section.

8. Equipment as claimed in claim 7 as dependant on claim 2 or 3, in which said availability signals received from second
20 stage switches via normal first stage-second stage switches act on a first signal means while such signals received via overflow links act on a second signal means, and in which this used separate signal means controls choice between said links.

25 9. Electrical switching equipment, such as used in automatic telecommunication exchanges, in which inlets and outlets of the stage are inter-connected by two stages of
30 electro-mechanical cross-bar switches, in which each cross-bar switch of the first of said two stages has access to a plurality of switches of the second stage and each switch of the second stage is accessible via a
35 plurality of switches of the first stage, in which each first stage has at least one of its outlets connected to an inlet to a different one of said first stage switches, so that when a first stage switch is unable to reach a desired outlet from the equipment due to internal blocking a connection may be set up
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from that first stage switch to a different first stage switch from which a further attempt to set up the desired connection may be made, in which each multiple of a cross-
45 bar switch of the first stage for an outlet to a different first stage switch is split into two portions, one of which includes the outlet to said different first stage switch, separate switch-setting means being associated with
50 said two portions, and in which each portion of one of said split multiples which forms the outlet to a second stage switch is connectable by its switch-setting means to at least one multiple for an inlet from a different one of said first stage switches.
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10. Equipment as claimed in claim 9, and in which some at least of the inlets to second-stage switches are accessible from outlets of a plurality of said first stage
60 switches.

11. Equipment as claimed in claim 10, and in which the outlets of said first stage switches which share inlets to said second stage switches are each themselves accessible
65 via one or more first stage switch inlets reached from different first stage switches.

12. Equipment as claimed in claim 9, 10 or 11, and in which each switch inlet is connected to one of the vertical multiples of its
70 cross-bar switch, each switch outlet being connected to a horizontal multiple of its cross-bar switch.

13. Electrical switching equipment, such as used in automatic telecommunication ex-
75 changes substantially as described with reference to the accompanying drawings.

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BK

