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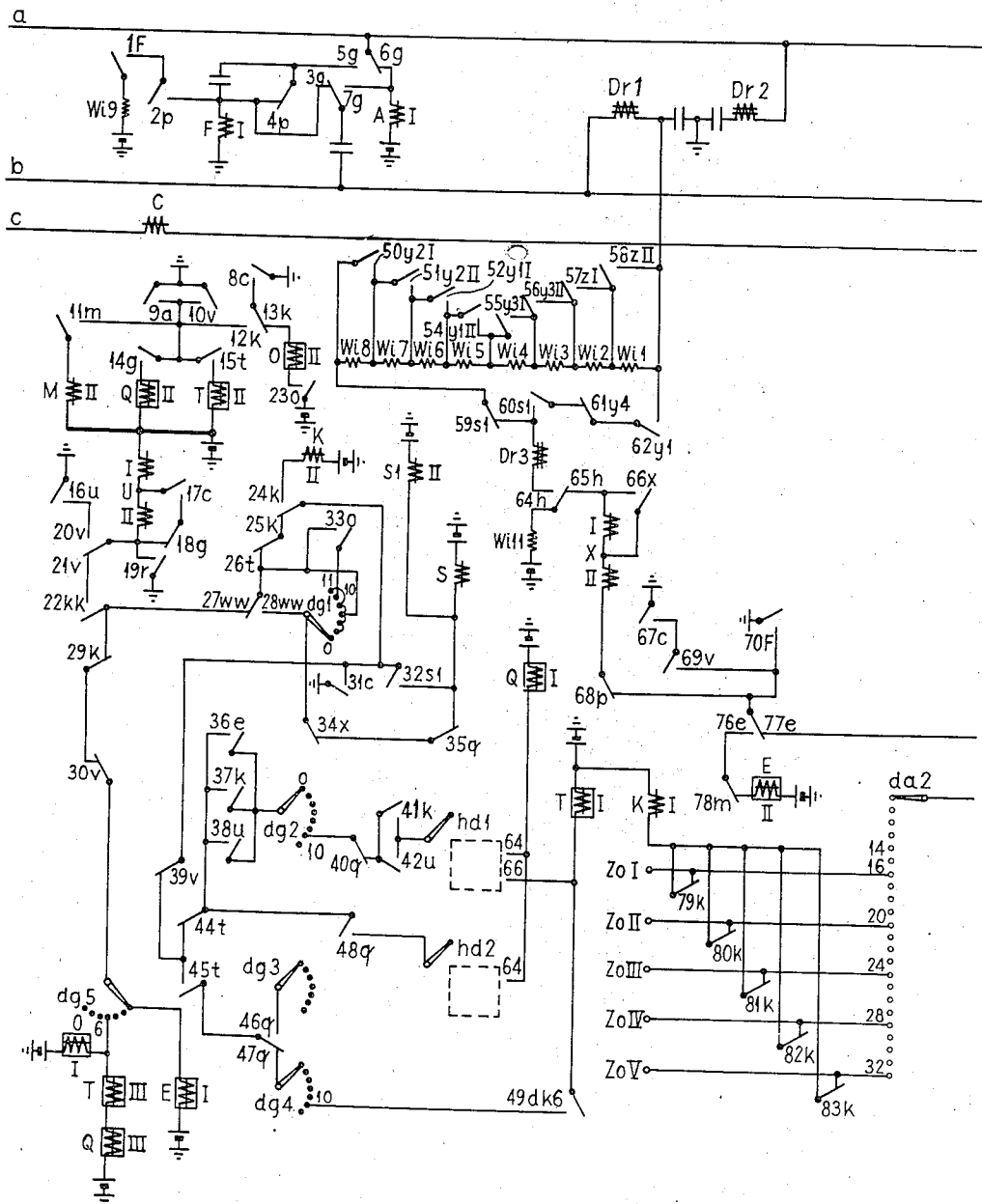
2,182,482

AUTOMATIC TELEPHONE SYSTEM

Filed July 22, 1937

2 Sheets-Sheet 1

FIG. 1



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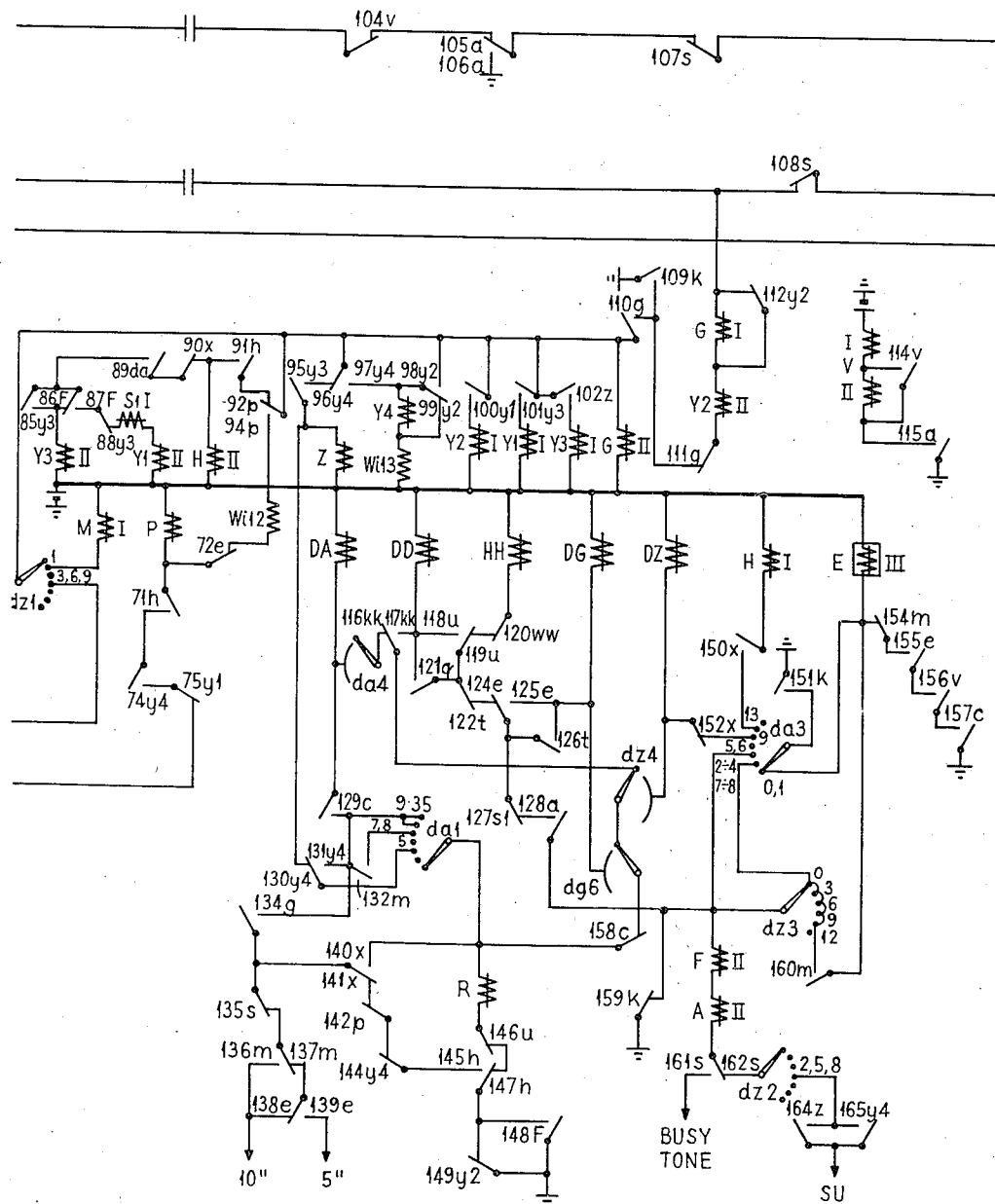
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2 Sheets-Sheet 2

FIG. 2



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AUTOMATIC TELEPHONE SYSTEM

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The present invention concerns a circuit arrangement for zone metering in remote communication systems and more particularly in automatic telephone systems in which the zone is determined by numbers comprising different numbers of digits.

In such arrangements it is necessary to provide switching means which render impossible any further influencing of the zone characterizing devices after the reception of the impulse train which completes the characterization of the zone. It may happen, however, that the zone characterizing devices are brought by impulse trains into positions over which no zone determination can take place as can occur if the zone characterizing devices are set by numerical impulses which do not correspond to the prescribed characterizing digits. The determination of the zone can also be made impossible in the event of faults in the path serving for zone characterizing (a break in the zone cable).

In order now to prevent an unnecessary setting of the zone characterizing devices in such cases and to prevent as rapidly as possible any further setting up of the call, switching means are associated with the zone characterizing devices, according to the invention, which directly after the impulse train by which the zone characterizing devices are either brought to a position enabling the zone to be determined or are brought to a position which does not allow of such a zone determination, either enable the establishment of the call to proceed in the one case or prevent it in the other case, while in both cases preventing any further influencing of the zone characterizing devices.

An embodiment of the invention is represented in the drawings, comprising Figs. 1 and 2.

The main parts of the repeater shown are as follows:

(1) *Rotary switch DG.*—This rotary switch is set in a definite manner by the first numerical impulse train transmitted by the calling subscriber and operating on the repeater. According to the number of digits necessary for determining the zone of the call a wiper of this rotary switch is either directly connected to a zone contact or a wiper of a two-motion switch is connected up by a wiper of this rotary switch.

(2) *The two-motion switch.*—The two-motion switch with its vertical magnet HH and its rotary magnet DD is set by the second and third impulse train operating on the repeater. In particular cases it takes up a fourth digit.

(3) *The time switch DZ.*—The time switch

is influenced by a time switching device which operates so that it receives a stepping impulse every minute. The time switch determines in the present embodiment the moment for transmitting a definite number of metering impulses.

(4) *The assessor DA.*—The assessor is advanced by steps when the moment arrives for transmitting metering impulses, the stepping being continued until one of its wipers finds a zone contact characterized by a particular potential. On each step metering potential is applied over one of the speaking leads and in this way the calling subscriber's meter is advanced a definite amount. The assessor serves moreover to register the small units of time. It is under the influence of a five or ten seconds contact and registers these time impulses until a larger interval of time, namely a minute, has elapsed. The minute units are then taken up by the time switch DZ as previously mentioned.

The mode of operation of the devices shown will now be described in detail.

Setting the zone characterizing devices.—The seizure of the repeater takes place over the c-lead in which is disposed relay C. Relay C is energized. Relay C closes contact 31c and thereby completes the following circuit: earth, contact 31c, 25k, 26t, 27wv (rotary off-normal contact operated when the two-motion switch is in its operated position) 29k and 30v, wiper dg5 in the rest position, winding I of relay E, battery and earth. In this circuit relay E energizes and by closing its contact 125e connects the impulsing contact 128a to the magnet of the rotary switch DG. When now a numerical impulse train is transmitted by the calling station relay A is energized impulsively in the following circuit by the impulsive application of earth to the upper speaking lead in the preceding connecting device: earth in the preceding connecting device, upper speaking lead, contact 5g, winding I of relay A, battery and earth. Through the impulsive closing and opening of contacts 105a and 106a earth is connected to the upper speaking lead on each impulse so that impulses are transmitted to the subsequent connecting devices over contact 107s corresponding to the impulses received and these serve to set these connecting devices. Through the impulsive closing of contact 115a the following circuit is completed for relay V: earth, battery, windings I and II of relay V, contact 115a and earth. When it energizes for the first time relay V closes contact 114v and thus short-circuits its winding II. It is thereby made slow-to-release and this suf-

fices to hold up the contacts of relay V during the individual impulse trains. The rotary switch DG is now set by the impulsive closing of contact 128a, the magnet being operated over the following circuit: earth, contacts 159k, 128a, 127sl and 125e, the magnet of the rotary switch DG, battery and earth. The wipers of the switch DG are thus brought to a particular contact. Although wiper dg5 has left its rest position relay E remains operated throughout the impulse train in the following circuit: earth, contacts 157c, 156v, 155e and 154m, winding III of relay E, battery and earth.

If the zone is determined merely by the first numerical impulse train operating on the repeater the wiper dg2 stands on one of the contacts 1 to 5, 7 to 9 which is connected directly to one of the zone contacts ZoI to ZoV. If in particular cases the zone is determined by two impulse trains operating on the repeater a further setting of the rotary switch takes place in accordance with the second impulse train received. The necessary requirement for this is that the first impulse train shall have brought the wipers of the rotary switch into position 6. After relay V has released on account of the prolonged opening of contact 115a after the impulse train comprising six impulses the following circuit is established over wiper dg5: earth, contacts 31c, 25k, 26t, 27ww, 29k and 30v, wiper dg5 in position 6, windings III of relays T and Q, battery and earth, and winding I of relay O, battery and earth. After the first impulse train the locking circuit for winding III of relay E is broken by the opening of contact 156v so that relay E releases. Since, however, relay T has been energized in the circuit just described the impulse train which now follows is transmitted to the magnet of the rotary switch DG over contact 126t, while an undesired setting of the vertical magnet HH of the two-motion switch which was connected up when contact 124e closed is prevented by the opening of contact 122t. The second impulse train is thus transmitted to the magnet of the rotary switch DG over the following path: earth, contacts 159k, 128a, 127sl and 125t, the magnet of the rotary switch DG, battery and earth. At the end of this impulse train relay T releases again, this being a slow-release on account of the construction of the relay. Relay Q also remains up until after the end of the impulse train and also until the end of its natural release period, over the circuit: earth, contact 9a or 10v, 14q, winding II of relay Q, battery and earth. Wiper dg2 is disconnected by contact 44t and wiper dg3 is connected up through the closing of contacts 45t and 46q. The zone contact is thus reached in the present case over wiper dg3 whose contacts are connected to the zone contacts ZoI to ZoV in a particular manner.

If the zone is not to be determined until the third impulse train operating on the repeater has been transmitted the rotary switch DG is brought to position O by the first impulse train operating upon it, i. e., the impulse train comprises ten impulses. In this case relays T and Q cannot energize. As already mentioned relay E releases a short time after the termination of the first impulse train (through the opening of contact 156v). Contact 125e is thereby opened and the magnet of the rotary switch DG is disconnected and the vertical magnet HH of the two-motion switch is connected up by the closing of contact 124e. The second impulse train

operating on the repeater is thus repeated to the vertical magnet HH over the following circuit: earth, contacts 159k, 128a, 127sl, 124e, 122t, 119u, 120ww (off-normal contact which is opened after the first rotary step of the two-motion switch) vertical magnet HH, battery and earth. The wipers of the two-motion switch, of which only the two wipers hd1 and hd2 are shown, are thus raised to a particular level. The contact field of the two-motion switch is indicated by dotted squares adjacent the wipers hd1 and hd2 for the sake of simplicity. Since the off-normal contact 22kk is closed after the first vertical step of the two-motion switch the following circuit is set up when relay V releases: earth, battery, winding I of relay U, contacts 17c, 18g, 21v, 22kk, 27ww (rotary off-normal contact of the two-motion switch opened after the latter has taken the first rotary step), 26t, 25k, 31c and earth. In this circuit relay U energizes. When now the third impulse train is received relay V is energized throughout this impulse train. Consequently contact 20v is closed thereby completing a locking circuit for relay U: earth, contact 16u, 20v, 18g, and 17c, winding I of relay U, battery and earth. During this impulse train, contact 119u is opened so that the vertical magnet HH is disconnected and contact 118u is closed thereby switching in the rotary magnet DD of the two-motion switch. The third impulse train operating on the repeater accordingly operates the rotary magnet of the two-motion switch, this taking place over the following circuit: earth, contacts 159k, 128a, 127sl, 124e, 122t and 118u, rotary magnet DD, battery and earth. In the level to which the switch has been set the wipers are accordingly brought to a particular contact. On the termination of the impulse train relay V releases and releases relay U by opening contact 20v. The contacts of the two-motion switch are wired to the zone contacts ZoI to ZoV in a particular way.

According to the embodiment it is also possible to determine the zone only after four impulse trains have operated on the repeater. If, for example, the first impulse train operating on the repeater comprises ten impulses, wiper dg2 is brought to position 10. If then the two-motion switch is stepped to the sixth level and then set on the fourth contact in the sixth level the wipers hd1, hd2, stand on a line characterized by the number "64." After relay V releases after the third impulse train operating on the repeater the following circuit is completed: earth, battery, winding I of relay Q, line 64, wiper hd1, contact 42u (relay U remains up after relay V has released because it is made slow-to-release to a certain extent through the short-circuiting of its winding II), contact 40q, contact 10, wiper dg2, contacts 38u, 44t, 39v, 31c and earth. Relay Q opens its contact 40q, breaks the circuit just mentioned and closes contact 48q, whereby the following locking circuit is established for relay Q independently of the contacts of relay U, over wiper hd2: earth, battery, winding I of relay Q, line 64, wiper hd2, contacts 48q, 44t, 39v and 31c and earth. Relay Q closes its contact 121q whereby the next impulse train is also transmitted to the rotary magnet DD of the two-motion switch in spite of contact 118u being open: earth, contacts 159k, 128a, 127sl, 124e, 122t and 121q, magnet DD of the two-motion switch, battery and earth. During this impulse train relay Q holds up over its

winding II in a circuit which has already been set out. The characterization of the zone (setting on a particular zone contact) now takes place over wiper *hd2* of the two-motion switch whose contacts are connected to the zone contacts ZoI to ZoV in a particular way.

The characterization of the zone by four impulses trains operating on the repeater can be effected in an alternative manner. If, for example, impulse trains corresponding to the number "066" are sent in to the repeater wiper *hd1* of the two-motion switch will stand on line 66 so that after the release of relay U and during the release period of relay U the following circuit is closed: earth, battery, winding I of relay T, line 66, wiper *hd1*, contacts 42u and 40q, wiper *dg2*, contacts 38u, 44t, 39v and 21c and earth. In this circuit relay T energizes and by opening its contact 44t disconnects wipers *hd1* and *hd2* of the two-motion switch and by closing contact 45t connects wiper *dg4* of the rotary switch DG. The following locking circuit is established for relay T: earth, battery, winding I of relay T, level contact 49dk6 (closed when the two-motion switch is set on level 6), contact 10, wiper *dg4*, contacts 47q, 45t, 39v and 31c and earth. During the impulse train which now follows relay T holds up over its winding II in a circuit which has previously been described. The fourth impulse train received by the repeater is now also taken up by the rotary switch DG whose magnet is operated by contact 126t: earth, contacts 159k, 128a, 127sl and 126t, the magnet of the rotary switch DG, battery and earth. The characterizing of the zone now takes place over wiper *dg4* of the rotary switch DG over a contact of the latter which is directly connected to one of the zone contacts ZoI to ZoV.

ZONE CONTROL

For each of the numerical impulse trains operating on the repeater the zone control sets in automatically: i. e., switching operations are promoted whereby testing takes place after each impulse train has been transmitted as to whether the zone has already been characterized, and any influencing of the zone characterizing devices by further numerical impulse trains is prevented. The particular device executing this zone control is the zone control relay K.

(a) Zone control after the first impulse train operating on the repeater

The rotary switch DG is set so that its wipers do not rest on contacts 6 or 10. By the setting of the rotary switch DG in accordance with another digit the zone is characterized solely by this first impulse train operating on the repeater. After the release of relay V the following circuit for relay K is set up: earth, battery, winding I of relay K, one of the contacts 79k, 80k, 81k, 82k or 83k, one of the zone contacts ZoI to ZoV, wiper *dg2*, in a position other than 6 or 10, contacts 38e, 44t, 39v, and 31c and earth. Relay K energizes and by opening its contact 159k brings the influencing of the zone determining devices by numerical impulse trains to an end.

Relay K locks up over the following circuit throughout the duration of the call: earth, battery, winding II of relay K, contacts 24k and 31c and earth. Contact 31k maintains the earth connected over contact 31c connected to wiper *dg2* and the corresponding zone contact.

It may be mentioned that relay X is energized over the following circuit during each im-

pulse train: earth, contacts 67c, 69v and 68p, windings II and I of relay X, contact 65h, resistance Will, battery and earth. Relay X closes its contact 66x and thereby short-circuits its winding I so that after relay V has released and contact 69v has opened it retains its contacts in the operated position for a short time. After the release of relay V and the closing of contact 39v it is possible for relay K to energize. If, however, this is not possible on account of the presence of a fault in the zone lead relay S energizes after relay X has released, in the following circuit: earth, battery, the winding of relay S, contacts 35q and 34x, wiper *dg1* in a position other than 0, 6 or 10, contacts 26t, 25k and 31c and earth. If, therefore, the zone circuit cannot be exerted in a positive sense relay S energizes and by opening its contacts 107s and 108s disconnects the stepping leads and renders the further setting of connecting devices impossible. Relay S1 also energizes and at contact 127sl disconnects contact 128a. Through the closing of contact 161s a busy signal is applied to windings II of relays A and F and is induced in the windings I of these relays which are connected to the speaking leads and is thus transmitted to the calling subscriber. Winding I of relay F is connected over contact 3g and a condenser to the lower speaking lead and winding I of relay A to the upper speaking lead over contact 6g. The relays S and S1 hold up in the circuit set out above until the calling subscriber replaces his receiver on account of the prolonged busy signal and transmits the signal for the release of the devices which have been set.

(b) Zone control after two impulse trains have operated on the repeater

In this case the calling subscriber transmits an impulse train corresponding to the number "6" as the first impulse train. Wiper *dg5* is thus set on contact 6, over which relays T and Q are energized over their windings III and relay O over its winding I after relay V has released. After this impulse train relay K cannot yet energize because contact 6 of the rotary switch is not connected to any of the zone contacts ZoI to ZoV. Similarly the blocking relay S cannot energize because this is disconnected by contact 35q. Thus although the zone control relay K cannot energize after the first impulse train the blocking of the connection by relay S is also prevented. Only when the rotary switch DG has received a further impulse train is the following circuit set up for relay K: earth, battery, winding I of relay K, one of the contacts 79k to 83k, one of the zone contacts ZoI to ZoV, a contact in the contact bank associated with wiper *dg3*, wiper *dg3*, contacts 46q, 45t, 39v and 31c and earth. When relay K energizes in this circuit, contact 12k and the two relays Q and T remain energized in the following circuit until the end of the call: earth, contacts 8c, 12k and 14q, winding II of relay Q—and contact 15t, winding II of relay T, battery and earth. After relay K has energized and locked up at contact 24k a particular zone contact is connected to earth over contact 31c by way of wiper *dg3* and contacts 45t and 46q.

If, however, relay K is not able to energize in the above circuit on account of a break in the zone lead or because a false second number has been dialled whereby wiper *dg3* is set on a contact which is not connected to a zone con-

tact, no locking circuit is set up for relays Q and T so that after relay X has released the following circuit is established for the blocking relay S: earth, battery, the winding of relay S, contacts 35g and 34x, wiper dg1, contacts 26t, 25k and 31c and earth. Relay S1 also energizes over winding II and at contact 127sl disconnects the impulse contact 128a.

If the calling subscriber dials an impulse train corresponding to the number "4" the above-circuit for the blocking relay S cannot be established when relay K does not energize since contact 10, to which wiper dg1 is then set, is not connected to the other contacts of this contact bank. As already described relay O was energized over its winding I when wiper dg5 was set on contact 6. Relay O locks up in the following circuit: earth, contacts 3c and 13k, winding II of relay O, contact 23o, battery and earth. This locking circuit remains in existence until the clearing signal is given if the zone controlling relay K cannot energize. In this case the following circuit is closed for the blocking relay S: earth, battery, winding of relay S, contacts 35g and 34x, wiper dg1 in position 10, contacts 33o, 26t and 25k, 31c and earth.

(c) *Zone control after the third impulse train operating on the repeater*

After the rotary switch DG has been set on the 10th contact the wipers of the two-motion switch stand on some line which is not especially indicated (but not on lines 64 and 66) after the next two impulse trains. After relay V has released at the end of the third impulse train operating on the repeater, the circuit for the zone control relay K is set up over wiper hd1 and wiper dg2 in position 10, the circuit being set up over contact 38u of relay U which maintains its contacts operated after the release of relay V. Relay K locks up as before at contact 24k throughout the duration of the call and at contacts 37k and 41k maintains the connection of earth to the corresponding zone contact.

If for the reasons mentioned above the circuit for relay K is not completed the blocking relay S and relay S1 become energized in the following circuit after relay K has released; earth, battery, the windings of relays S and S1, contacts 35g, 34x and 28ww (rotary off-normal contact of the two-motion switch which is closed when the switch takes its rotary step) contacts 26t, 25k and 31c and earth. Relay S initiates the operations already described for preventing the further establishment of the call and for communicating a busy signal to the calling subscriber, while relay S1 prevents the zone characterizing devices from being influenced by further numerical impulse trains at contact 127sl.

(d) *Zone control after the fourth impulse train operating on the repeater*

If the two-motion switch is set on line 64 relay Q is energized as already stated and this disconnects wiper hd1 of the two-motion switch at contact 40g and connects up wiper hd2 by closing contact 48g. During the fourth impulse train operating on the repeater, which is also received by the rotary magnet DD, of the two-motion switch, relay Q remains operated over its winding II for some time after relay V has released at the end of the fourth impulse train. Thus the wipers of the two-motion switch stand on a particular line (not shown) which is connected to one of the zone contacts ZoI to ZoV.

During the release period of relay Q the zone control relay K is tested as to its ability to energize, in the following circuit: earth, battery, winding I of relay K, one of the contacts 79k, to 83k, one of the zone contacts ZoI to ZoV, wiper hd2 of the two-motion switch, contacts 48g, 44t, 39v and 31c and earth. The blocking relay S is not able to energize because contact 25k is open. If, however, relay K does not energize within the release period of relays Q and X a circuit which may be seen from the drawing is once more set up for the blocking relay S.

If the two-motion switch is brought by the third impulse train operating on the repeater to line 66, relay T is operated as already explained and this holds up over its winding II during the following fourth impulse train until the end of this train, when relay V releases. At contact 44t the wipers of the two-motion switch are disconnected and wiper dg4 of the rotary switch DG is connected up at contact 5t. The wipers of the rotary switch DG are stepped further by the fourth impulse train, so that wiper dg4 is set on a contact which is connected to one of the zone contacts ZoI to ZoV. When relay V releases at the end of the fourth impulse train the zone control relay K is tested as to its ability to energize in the following circuit: earth, battery, winding I of relay K, one of the contacts 79k to 83k, one of the zone contacts ZoI to ZoV, wiper dg4 set on a particular contact, contacts 47g, 45t, 39v and 31c and earth. If relay K cannot energize during the release period of relay X, the circuit for the blocking relay S and for relay S1 is again closed.

The wanted subscriber replies

When the wanted party replies after all the impulse trains have been transmitted, in which connection it should be noted that the upper speaking lead is broken by the opening of contact 104v during each impulse train in order to prevent the calling subscriber being disturbed, battery potential is applied to the lower speaking lead in one of the succeeding connecting devices. Thus the following circuit is established: earth, battery in the succeeding connecting devices, the lower speaking lead, contacts 108s and 112y2, winding II of relay Y2, contacts 111g and 109k and earth. Relay Y2 which energizes in this circuit at contact 112y2, breaks the previously existing short-circuit for winding I of relay G so that this relay can energize in the above-mentioned circuit. Relay G closes its contact 110g and thereby locks up over earth, contacts 109k and 110g, winding II of relay G, battery and earth. Through the opening of contact 111g it breaks the above-mentioned circuit. Through the closing of contact 134g the following circuit is closed for the switch DA which responds to the small units of time of five or ten seconds: earth, battery, the magnet of switch DA, contacts 129c, 135s, 137m, and 139e, the five-seconds contact and earth. Relay E was operated over its winding III in the following circuit: earth, contact 151k, wiper da3 of the assessor in positions 0—1, winding III of relay E, battery and earth. The assessor consequently receives five seconds impulses and steps its wipers at intervals of five seconds. When wiper da3 has left contacts 0 and 1 relay E releases and by closing its contact 138e switches on a 10 seconds contact in place of the five seconds contact so that now the assessor is advanced at intervals of 10 seconds. When after the expiry of

about a minute the wipers of the assessor reach contact 9 the assessor commences to pass automatically to the zero position. This occurs in the following manner: When wiper *da1* reaches the

5 ninth contact the following circuit is completed: earth, battery, magnet DA of the assessor, contact 129c, contact 9, wiper *da1*, the winding of relay R, contacts 146u, 147h, 149y2 and earth. Relay R which energizes in this circuit closes

10 its contact 19r and thus completes the following circuit for relay U: earth, contact 19r, winding II and I of relay U, battery and earth. By the opening of contact 146u the above circuit in which magnet DA and relay R were energized

15 is broken. The assessor magnet DA and also relay R release, so that the circuit for relay U at contact 19r is broken again. Magnet DA and relay R are again operated by the closing of contact 146u. The interaction between relays U

20 and R continues until wiper *da1* has left its last contact 35 and has passed into the rest position. The following circuit for the magnet DZ was closed over wiper *da3* in position 9: earth, contact 151k, wiper *da3*, position 9, contact 152x,

25 magnet DZ of the time switch, battery and earth. The time switch accordingly advances its wipers from the rest position to the first contact. The following circuit then obtains for relay M: earth, battery, winding I of relay M, contact 1, wiper

30 *dz1* of the time switch, contacts 110g and 109k and earth. Relay M holds up throughout the duration of the call in the following locking circuit: earth, battery, winding II of relay M, contacts 11m, 12k and 3c and earth. When the

35 circuit already mentioned for winding III of relay E is closed again when wiper *da3* moves into the rest position the 10 seconds contact remains connected to the assessor magnet because of the closed contact 135m. When now after expiry of

40 the second minute the wipers of the assessor pass to position 7 the play between relay R and U sets in once more, relay R being energized together with the assessor magnet in the following circuit: earth, contacts 149y2, 147h and 146u,

45 the winding of relay R, wiper *da1* in position 7, contacts 132m and 129c, magnet DA of the assessor, battery and earth. The assessor is thus switched back to its normal position. On passing through position 9 the circuit previously

50 mentioned for the time switch DZ was again closed so that the wipers of the time switch are set at contact 2. The third minute of the conversation now commences. When the switch

55 passes to position 5 under the influence of the 10 seconds contact relay Z energizes in the following circuit: earth, battery, the winding of relay Z, contact 130y4, contact 5, wiper *da1*, the winding of relay R, contact 146u, 147h and 149y2

60 and earth. Relay Z closes its contact 102z and thereby completes the following circuit for relay Y3: earth, contacts 109k, 110g and 102z, winding II of relay Y3, battery and earth. Relay Y3 closes its contact 101y3 and thereby completes the following circuit for relay Y1: earth,

65 contacts 109k, 110g, 101y3, winding I of relay Y1, battery and earth. Relay Y1 causes relay Y2 to energize over its winding I by closing contact 100y1. This battery relay by closing its contact 98y2 switches on relay Y4 over earth,

70 contacts 109k, 110g and 98y2, the winding of relay Y4, resistance W113, battery and earth. The opening of contacts 130y4 and 96y4 disconnects the circuit of relay Z. Relay Z at contact 102z opens Y3. Contact 101y3 breaks the circuit

75 for relay Y1. Relay Y1 disconnects the

circuit of relay Y2 at contact 100y1 so that the latter relay deenergizes. Relay Y2 closes its contact 99y2 and thereby short-circuits the winding of relay Y4 so that in spite of its locking contact 91y4, relay Y4 is caused to deenergize. For

5 the period between the operation of relay Z and the release of relay Y4 a warning signal is transmitted to the calling subscriber shortly before the expiry of the third minute of the conversation, in that the following circuit is established:

10 buzzer *Su*, contact 164z or 165y4, wiper *dz2* set on contact 2, contact 162s, winding II of relays A and F, wiper *da3* in one of the positions 5 and 6, contact 151k and earth. The buzzer tone is transmitted inductively to windings I

15 of relays F and A in the speaking leads and hence to the calling subscriber. Winding I of relay A is now connected over contacts 17g and a condenser to the lower speaking lead and winding I of relay F to the upper speaking lead over

20 a condenser and contact 5g. During the release period of relay Y4 which was short-circuited after the release of relay Y2 the assessor is advanced from position 5 to position 6: earth, battery, magnet DA of the assessor, contacts 129c

25 and 131y4, wiper *da1* in position 5, the winding of relay R (which does not energize in this circuit) contacts 146u, 147h and 149y2 and earth. After a further 10 seconds the wipers of the

30 assessor are brought to contact 7 from which they are advanced to the zero position by the aid of the relay interrupter RU in the manner already described. When wiper *da3* passes through

35 position 9 the circuit for the time switching relay DZ is again closed so that the wipers of the time switch pass to position 3. The following circuit for relay X is now completed over wiper

40 *dz1* of the time switch: earth, contacts 109k and 110g, wiper *dz* in position 3, contacts 17e and 68p, windings II and I of relay X, contact 65h, resistance W111, battery and earth. When the

45 assessor moved into position 13 the following circuit is set up for relay H: earth, battery, winding I of relay H, contact 150x, wiper *da3* of the assessor in position 13, contact 151k and

50 earth. Relay H locks up over earth, battery, winding II of relay H, contacts 91h, 92p, 110g and 109k and earth. Relay H opens contacts 65h and thus breaks the circuit just described for relay X which accordingly releases.

Metering for the first unit of time

Through the closing of contact 64h a metering potential is applied to the lower speaking lead over a series of resistance and choke-coils:

55 earth, battery, resistance W111, contact 64h, choke-coil Dr3, contact 59s1, resistances W18, W17, W16, W15, W14, W13, W12 and W11, choke-coil Dr1, lower speaking lead. On account of the various resistances and the choke-coils the

60 application of the metering potential by contact 64h to the lower speaking lead is damped so that the subscriber engaged in conversation is disturbed as little as possible. Through the closing of contact 145h the assessor magnet DA

65 receives a stepping impulse over the following path: earth, battery, assessor magnet DA, contacts 129c, 134g, 141x, 142p, 144y4, 145h, 149y2 and earth. The assessor magnet possesses a contact 89da which is now closed and by means

70 of which the following circuit is established: earth, battery, winding II of relay Y3, contacts 86f, 89da, 90x, 92p, 110g, 109k and earth. Relay Y3 at contact 95y3 switches on relay Z and at contact 101y3 switches on relay Y1. The cir-

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5 cuits are as follows: earth, contacts 109x, 110g,
 and 151y3, winding I of relay Y1, battery and earth
 and: earth, contacts 109k, 110g, 96y4, 95y3, the
 winding of relay Z, battery and earth. By closing
 10 its contact 100y1 relay Y1 energizes relay
 Y2. By the closing of contact 98y2 relay Y4 is
 energized and thus locks up by closing contact
 97y4. Through the opening of contact 96y4 the
 15 above-mentioned circuit for relay Z is broken
 and this consequently releases. After relay Z
 relay Y3 releases, the winding II of this relay
 having been disconnected meanwhile at contact
 89da. After relay Y3 relay Y1 releases, after relay
 Y1 relay Y2 and after relay Y2 relay Y4, all
 being short-circuited.

20 The above-mentioned operations are now repeated
 because the circuit for the assessor magnet
 DA which was opened at contact 144y4 when relay
 Y4 energized is completed again at this contact
 after relay Y4 has released. The assessor magnet
 is advanced a further step and by closing its contact
 89da causes the switching on of relays Y3, X, Y1, Y2
 and Y4 in the manner described above.

25 Each time these relays perform this set of operations
 a metering impulse passes over the lower speaking
 lead to the metering relay in the preceding connecting
 device in that the individual resistances W11 to W18
 30 are short-circuited in succession by the contacts of
 the above mentioned relays and on the subsequent release
 of the relays are switched in again in the succession W11
 to W18. Each of said relays possess contacts which
 draw up and release at moments displaced from one
 35 another in time so that for example contact 50y2
 is closed before contacts 51y2, 52y1 before 54y1,
 55y3 before 56y3, and 57z before 58z. Thus the above-
 mentioned contacts are closed in succession and in this
 way the metering potential connected to the lower speaking
 40 lead is gradually increased to an extent which suffices
 to energize the metering relay connected to the lower
 speaking lead in the preceding connecting device. On the
 subsequent release of these relays at the end of each
 45 metering impulse, the resistances W11 to W18 are
 gradually switched in and the current over the lower
 speaking lead is gradually reduced again so that the
 metering relay in the preceding connecting device can
 50 release. On account of the gradual switching in and
 switching out of the resistances and by the gradual
 application and disconnection of metering battery subscribers
 engaged in conversation are disturbed as little as
 55 possible. For each step of the assessor one metering
 impulse is transmitted over the lower speaking lead.
 The number of metering impulses to be transmitted at
 the end of every three minutes interval is determined
 60 by the setting of the zone characterizing devices, i. e.,
 by the setting of the rotary switch DG and of the two-
 motion switch HH/DD. Over the wipers of these
 switches a particular zone contact ZoI to ZoV is
 connected to earth as previously described. As has
 65 been mentioned, relay H, which determines the moment
 for commencing metering, is energized when wiper da3
 passes through position 13. The transmission of metering
 impulses accordingly only commence when the wipers of
 70 the assessor have reached contact 14. If, for example,
 the zone characterizing devices connect the zone
 contact ZoI to earth, as many metering impulses are
 transmitted as there are steps necessary in order to
 bring wiper da2 from position 14 to that position to
 75 which the zone contact ZoI is connected. In the example
 shown this would be two

impulses. After the transmission of two metering
 impulses the following circuit obtains during the
 release period of relay Y4 which is the last of the
 relay chain to deenergize: earth on zone contact
 5 ZoI applied by the zone characterizing devices,
 wiper da2 on contact 16 contacts 75y1, 74y4
 and 71h, the winding of relay P, battery and earth.
 Relay P at contact 142p breaks the stepping circuit
 for the assessor magnet DA which was closed during
 10 the transmission of metering impulses. At contact
 94p it locks up over earth, battery, the winding of
 relay P, contact 72e, resistance W12, contacts 94p,
 109g and 109k and earth. By the opening of contact
 92p the above-mentioned locking circuit for relay H
 15 which determines the commencement of metering is
 broken so that this relay releases. The result of this
 is that contact 147h is closed and consequently a circuit
 is completed which circuit contains the relay R and the
 20 assessor magnet DA. The interaction of relays R
 and U by means of which the assessor is restored to
 normal now sets in once more. When the assessor has
 reached its normal position relay E is operated again
 over winding 3 and by opening contact 72e breaks the
 25 locking circuit for relay P and thus causes this to
 release. This terminates the metering for the first 3
 minutes interval. Under the influence of the 10 second
 switch the assessor magnet DA is now stepped around
 30 again and the second 3 minutes interval commences,
 and after the expiry of 6 minutes the second transmission
 of two metering impulses takes place in the manner
 described.

It may be mentioned that after the lapse of each
 interval of 3 minutes, i. e., when the wipers of the
 35 time switch DZ are set in positions 3, 6, 9, etc.,
 relay E is held energized over its winding 3 during the
 following time unit of 1 minute. So long as wiper da3
 stands on contacts 0 and 1 relay E is energized in a
 circuit which has been mentioned earlier. In positions
 2 to 4 of the assessor DA, E is energized as follows:
 40 earth, contacts 151k, wiper da3 on contact 2, 3 or 4
 over contacts 0, 3, 6, 9, 12 of the bank associated with
 wiper dz3, contact 160m, winding III of relay E,
 battery and earth. In positions 5 and 6 of wiper da3
 45 relay E is held energized over the following circuit:
 earth, contact 151k, wiper da3, on contact 5 or 6,
 wiper dz3 on one of the contacts 3, 6, 9, etc.,
 contact 160m, winding III of relay E, battery and earth.
 By this means so long as wiper dz1 stands on one of
 50 the contacts 3, 6, 9, etc., any undesired operation
 of relay X at contact 77e and any consequent premature
 energizing of the relay H which promotes metering at
 contact 150x is prevented.

It can be seen directly from the drawings that if
 another zone contact is connected to earth over the
 zone characterizing devices, a different number of
 metering impulses is transmitted. If, for example,
 60 the zone contact ZoII were connected to earth then
 6 metering impulses would be transmitted after each
 3 minute interval in the case of such a call. If the
 zone contact ZoIII were connected up 10 metering
 impulses would be transmitted, in the case of zone
 contact ZoIV 14, and in the case of zone contact ZoV
 18 impulses for every 3 minute interval.

When the calling subscriber hangs up on finishing
 his conversation, battery potential is applied to the
 70 upper speaking lead in the preceding connecting device
 so that the following circuit is set up for relay F in
 the repeater: earth, battery in the preceding connection
 device, upper speaking lead, contacts 5g, 4p, winding I of
 75 relay

F and earth. Relay F closes its contact 70f and thereby completes the following circuit for relay X: earth, contacts 70f, 68p, windings ii and i of relay X, contacts 65h, resistance W11, battery and earth. Relay X closes its contact 149x and thereby brings the assessor magnet DA under the influence of the relay interrupter. With the aid of relays R and U the assessor is advanced until, in position 13 a circuit which has already been given for relay H is set up over wiper da3. Relay H locks up at contact 91h and by opening contact 147h interrupts the interaction between relays U and R. The assessor magnet DA receives a stepping impulse over the following path through the closing of contact 145h: earth, contacts 149y2, 145h, 144y4, 142p, 141x (relay X was deenergized by relay H at contact 65h), 134g, 129c, assessor magnet DA, battery and earth. The assessor magnet operates its contact 89da so that the following circuit is set up: earth, battery, winding II of relay Y1, winding I of relay S1, contacts 88y3, 87f, 89da, 90x, 91h, 92p, 110g, 109k and earth. In this circuit relays Y1 and S1 energize. Relay S1 locks up over: earth, battery, winding II of relay S1, contacts 32s1, 31c, and earth. Through the opening of contact 59s1 the resistance chain W11—W18 is disconnected and by the closing of contact 60s1 the full strength of the metering battery is applied directly, while eliminating the resistance chain, to the lower speaking lead: earth, battery, resistance W11, contact 64h, choke-coil Dr3, contacts 60s1, 61y4 and 62y1, choke-coil Dr1, and the lower speaking lead so that the metering relay in the preceding connecting device will immediately energize and cause the meter to be advanced. Relay Y1 closes contact 109y1 thereby switching on winding I of relay Y2. At contact 98y2 relay Y2 switches on relay Y4 which locks up by closing contact 97y4. Relay Y4 opens contact 144y4 and thereby breaks the circuit for the assessor magnet DA. By the opening of contact 89da the circuit over which relays Y1 and S1 were energized is broken so that relay Y releases. Relay S1 holds up over its winding II. At contact 109y1 relay Y1 breaks the circuit for relay Y2 so that contact 98y2 is closed and relay Y4 is short-circuited. The stepping circuit for the assessor magnet is thus closed again at contact 144y4 so that the cycle of operations is started afresh. During each cycle the metering impulse is started up by the closing of contact 62y1 and terminated by the opening of contact 61y4. In this way a corresponding number of impulses is transmitted at a relatively more rapid rate. Thus on metering at the end of the call only the relays Y1, Y2 and Y4 of the group Z, Y1—Y4 are used. The transmission of metering impulses is terminated when wiper da2 passes into a position which is connected to earth over one of the zone contacts ZoI to ZoV and over the zone characterizing devices, as has already been explained in detail. The metering terminating relay P disconnects earth from the upper speaking lead by opening its contact 4p, this being the signal that the preceding connecting device is released. Relay F in the repeater continues to hold up for the moment in a local circuit: earth, battery, resistance W18, contacts 1f, and 2p, winding I of relay F and earth. Relay F holds up until relay P releases after the end of the metering and when the repeater is released. Through the disconnection of earth from the upper speaking lead the c-lead in the preceding connecting de-

vice is broken so that relay C in the repeater releases.

Restoration of the switches in the repeater

After the release of relay C and the closing of contact 158c the following circuit is completed: earth, contacts 149y2, 147h, 146u, winding of relay R, contact 158c, wiper dg6 in the working position, magnet DG of the rotary switch, battery and earth. In this circuit in addition to magnet DG relay R also energizes so that through the interaction between relays R and U the wipers of the rotary switch are stepped until the rest position is reached.

The time switch is then brought to normal. The following circuit obtains: earth, contacts 149y2, 147h, 146u, winding of relay R, contact 158c, wiper dg6, in the rest position, wiper dz4 in the working position, magnet DZ of the time switch, battery and earth. The time switch is stepped by the relay interrupter RU until it has reached the normal position. Thereupon the two-motion switch is restored to normal. The following circuit obtains: earth, contacts 149y2, 147h and 146u, winding of relay R, contact 158c, wiper dg6, in the rest position, wiper dz4 in the rest position, off-normal contact 117kk (closed after the first vertical step of the two-motion switch), rotary magnet DD of the two-motion switch, battery and earth.

The rotary magnet is stepped until the rest position is reached under the influence of the relay set U/R.

Finally the assessor is restored. The following circuit obtains: earth, contacts 149y2, 147h, 146u, winding of relay R, contact 158c, wiper dg6 in the rest position, wiper dz4 in the rest position, off-normal contact 116kk, (closed when the two-motion switch is in the normal position) wiper da4 in the working position, magnet DA of the assessor, battery, earth. When the assessor has reached the normal position under the influence of the relay set U/R this circuit is broken at wiper da4.

Through the release of relay C the other switching devices are also restored to normal. The locking circuit for relay M is broken at contact 8c and the locking circuit for relays S1 and K at contact 31c. Similarly at contact 8c the locking circuit for relays Q and T is broken, provided these have been energized. The locking circuit for relay P is broken at contact 109k. At the same time, at this contact, the locking circuit for relay G is broken. After relay P has released the locking circuit of relay F is broken at contact 2p.

The calling subscriber hangs up during metering

In the event of the calling subscriber replacing his receiver when a metering impulse has just been produced by the relay chain Z, Y1—Y4, the transfer to rapid metering cannot take place before the termination of this metering impulse since the first impulse of the more rapid succession can only be transmitted when the first and last relays of the chain have released again. If, for example, during a call a train of six metering impulses is transmitted after expiry of three minutes and the calling subscriber hangs up during the second of these, relay F energizes as already described by the application of battery potential to the upper speaking lead in the preceding connecting device. Relay F closes its contact 87f and thereby prepares a circuit for relay S1, (winding I) and for relay Y1 (winding II). 75

These relays cannot energize, however, because contact 88y3 of relay Y3 which only energizes, however, in the case of metering during a call is opened. This releases when after relay Y4 has energised the circuit for relay Z is broken by the opening of contact 130y4 and the locking circuit for relay Y4 is broken by contact 89da. When the second metering impulse is terminated, that is when relay Y4 has released on account of the short-circuit established at contact 99y2 the assessor magnet energizes over contact 144y4 so that now relays S1 and Y1 become energized when contact 89da closes and thus commences the first impulse of the more rapid succession. The further operations then take place in the manner described above.

What is claimed is:

1. In an automatic switching system, means for extending connections to a plurality of zones, zone determining means in said system operated in accordance with the zone to which a connection is extended for determining the particular metering impulses to be transmitted for a connection, and blocking means operated after the zone determining means has been operated for preventing the further extension of the connection unless said zone determining means is operated to a proper position to determine said impulses.

2. An automatic switching system as claimed in claim 1, in which said blocking means is also effective for preventing any further influencing of the zone determining means.

3. An automatic switching system as claimed in claim 1, in which the blocking means includes two relays, one of said relays operated to prevent the further extension of a connection, and the other of said relays is affected by said zone determining means to either prevent or allow the operating of said one relay.

4. In an automatic switching system, means for extending connections to a plurality of zones, zone determining means in said system having a plurality of contacts each associated with the transmission of particular metering impulses in accordance with the zone to which a connection is extended, blocking means for preventing the further extension of a connection, and other means operated through any one of said contacts to render said blocking means ineffective.

5. An automatic switching system as claimed in claim 4, normally closed contacts associated with said other means, and means including said closed contacts for rendering said blocking means effective.

6. An automatic switching system as claimed in claim 4, in which the operation of either of said blocking or other means is effective to prevent further influencing of the zone determining means.

7. An automatic switching system as claimed in claim 1, a test relay in said zone determining means, said relay tested as to its ability to operate after the determination of said impulses and said blocking means thereafter rendered effective or ineffective in dependence upon said relay.

8. In an automatic switching system, means responsive to impulse trains for extending connections to a plurality of zones, zone determining means in said system for determining, in accordance with the zone to which a connection

is extended, the particular metering impulses to be transmitted for that connection, devices in said determining means responsive to said impulse trains and testing means associated therewith rendered effective responsive to a particular setting of one of the devices for determining whether the connection may be completed.

9. An automatic switching system as claimed in claim 8, means affected by said testing means for preventing the further extension of a connection, and other means associated therewith for rendering the same ineffective at times when one of said devices does not have a particular setting.

10. An automatic switching system as claimed in claim 8, wherein a fault in said device having a particular setting renders said testing means ineffective and prevents further extension of a connection.

11. In an automatic switching system, means for extending connections to a plurality of zones, a zone determining device in said system operated in accordance with the zone to which a connection is extended for determining the particular metering impulses to be transmitted thereto, said device including a circuit for maintaining potential on said means through a series of inductances and a series of relays each associated with certain of said inductances, and means for operating said relays in sequence responsive to one of said metering impulses to transmit impulses by varying the effective inductance of said circuit.

12. In a metering arrangement associated with means responsive to impulses transmitted for extending connections, a plurality of control leads for determining a number of metering impulses to be transmitted periodically over a connection, a stepping switch, having access through certain of the bank contacts thereof to said control leads, responsive to a particular impulse train for rendering a particular control lead effective, other contacts of said switch engaged simultaneously with said certain contacts, a relay operative in a circuit including one of said other contacts for preventing further extension of a connection on termination of a particular impulse train, and another relay associated with said control leads operated in a circuit including said particular control lead to render said first relay ineffective.

13. In a metering arrangement associated with means responsive to a series of impulse trains for extending connections, a plurality of control leads for determining a number of metering impulses to be transmitted periodically over a connection, stepping switches, having access through certain of their bank contacts to said control leads, one of said switches responsive to a particular impulse train of the series for rendering a particular one of the control leads effective, other contacts of one of said switches rendered effective by certain impulse trains of the series, a relay operative in a circuit including one of said other contacts for preventing further extension of a connection on termination of a particular impulse train, and another relay, associated with said control leads, operated in a circuit including said particular control lead to render said first relay ineffective.

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