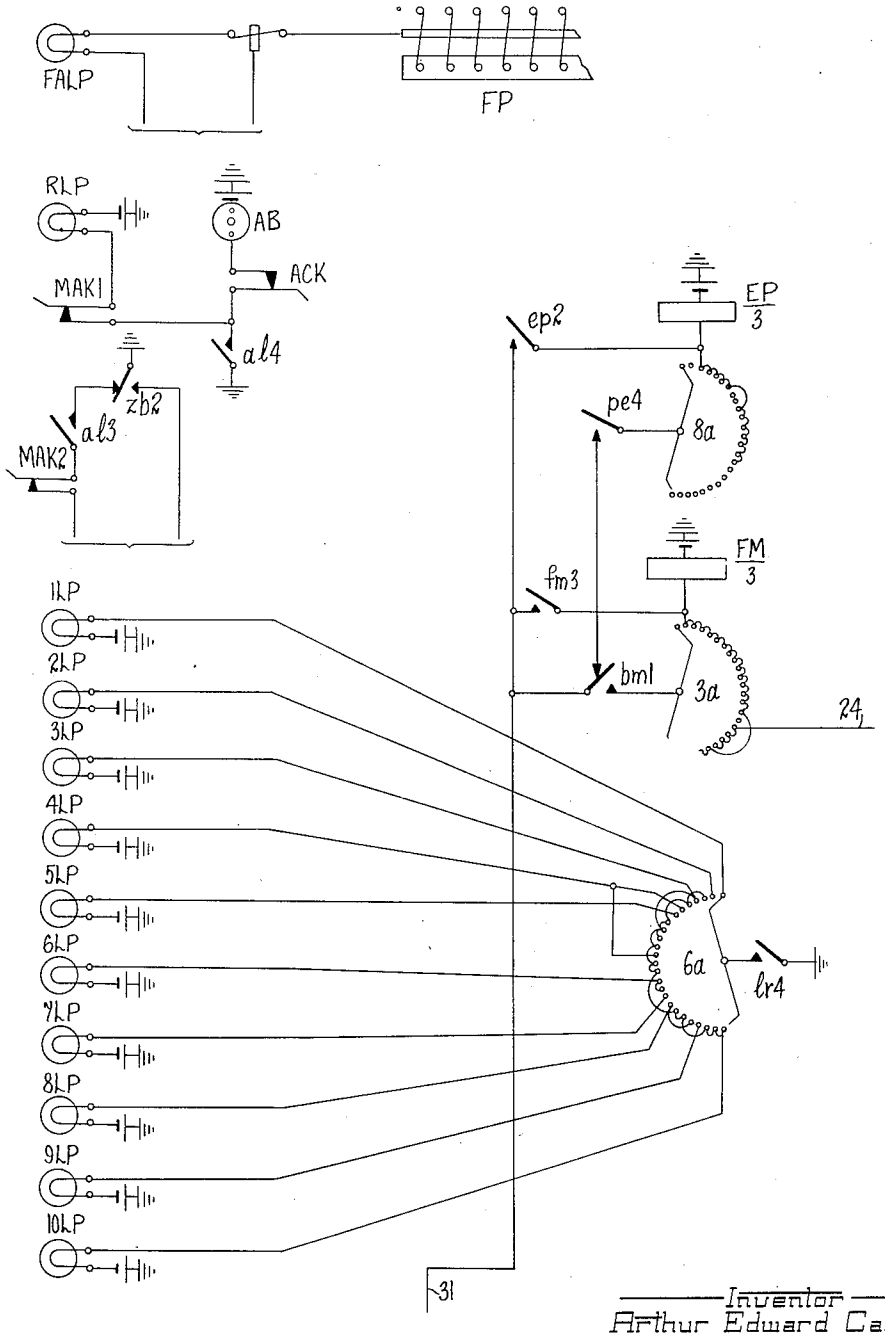
Aug. 22, 1933. A. E. CASWELL 1,923,662

TELEPHONE SYSTEM

Filed Feb. 12, 1932 6 Sheets-Sheet 1

Fig. 1.



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TELEPHONE SYSTEM

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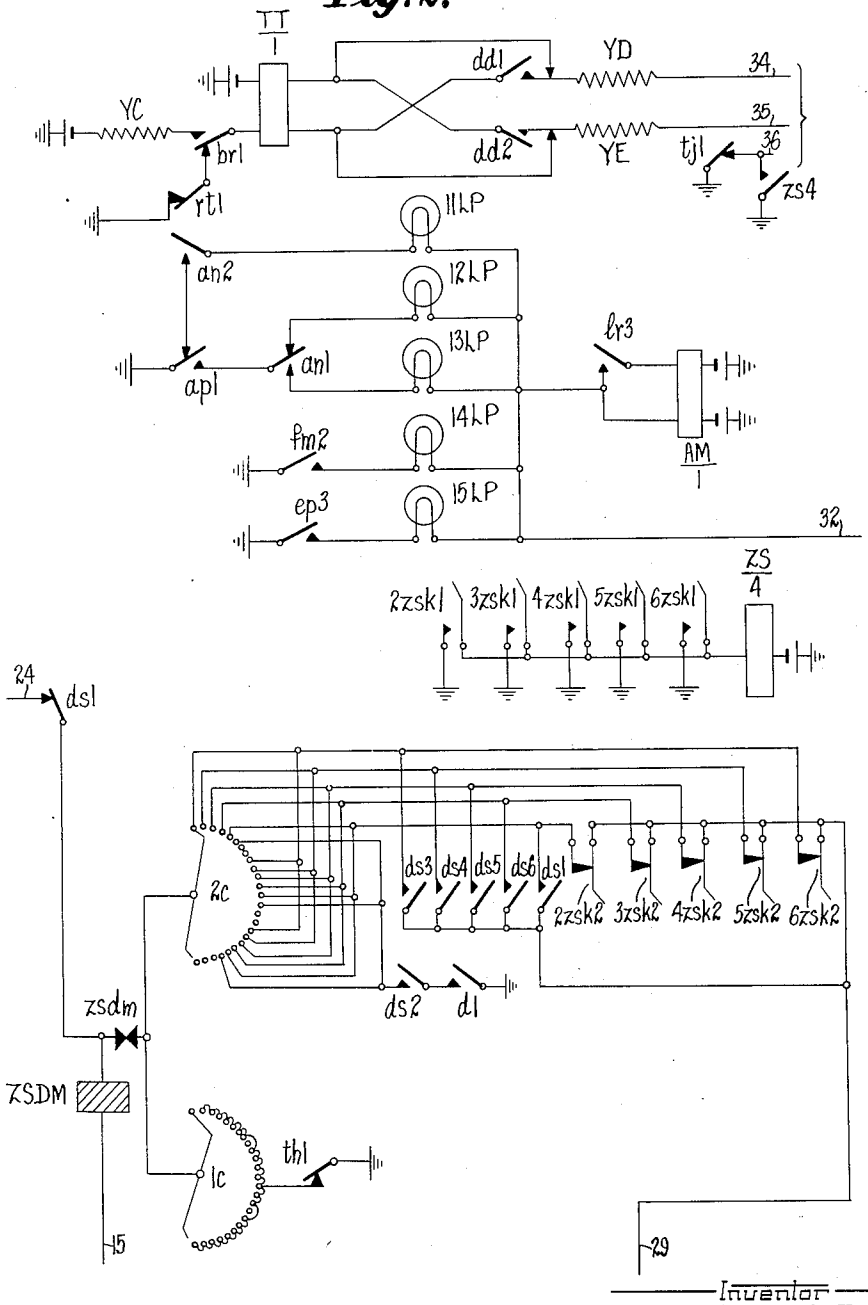
Fig. 2.



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TELEPHONE SYSTEM

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Fig. 3.

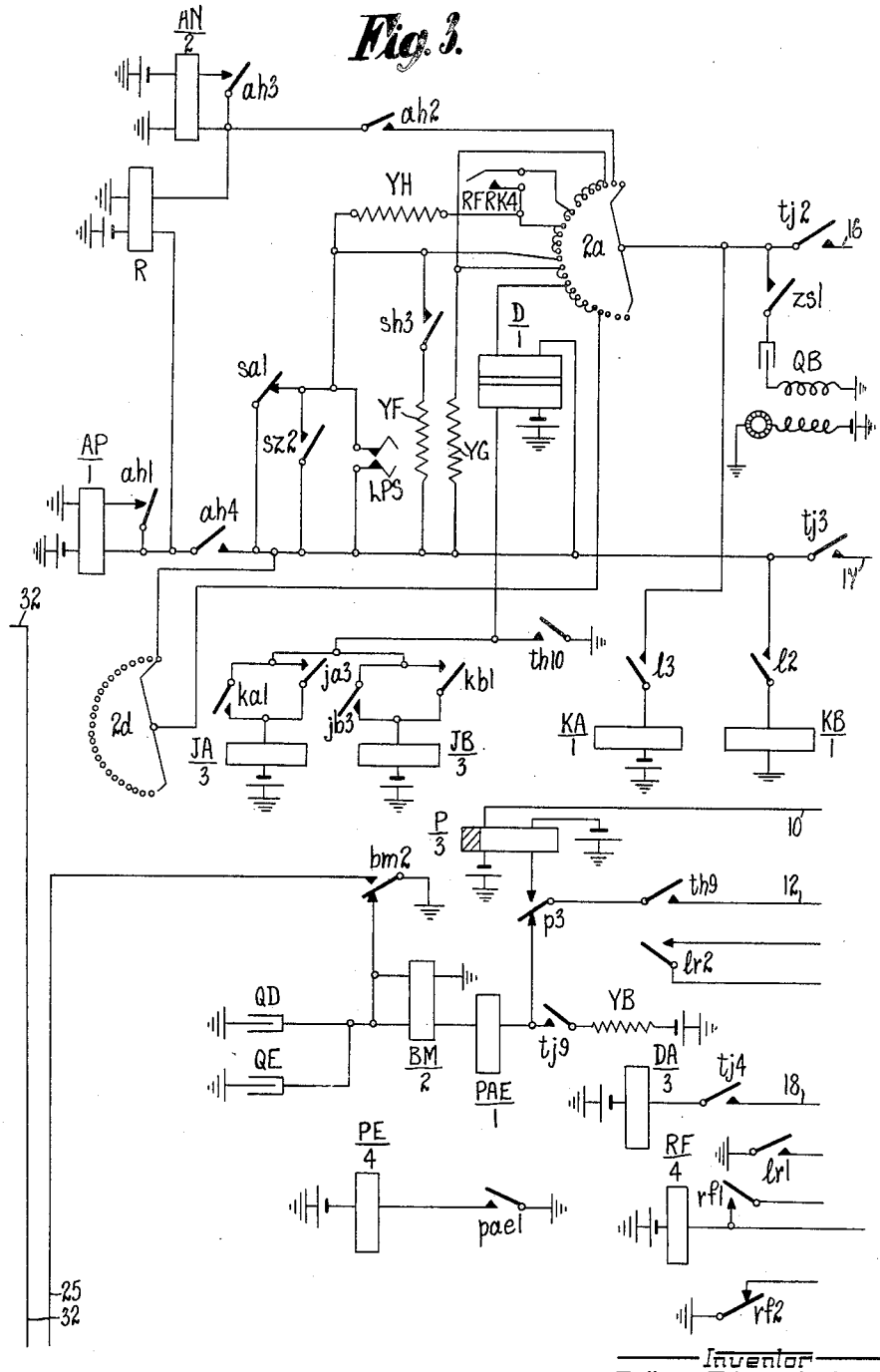

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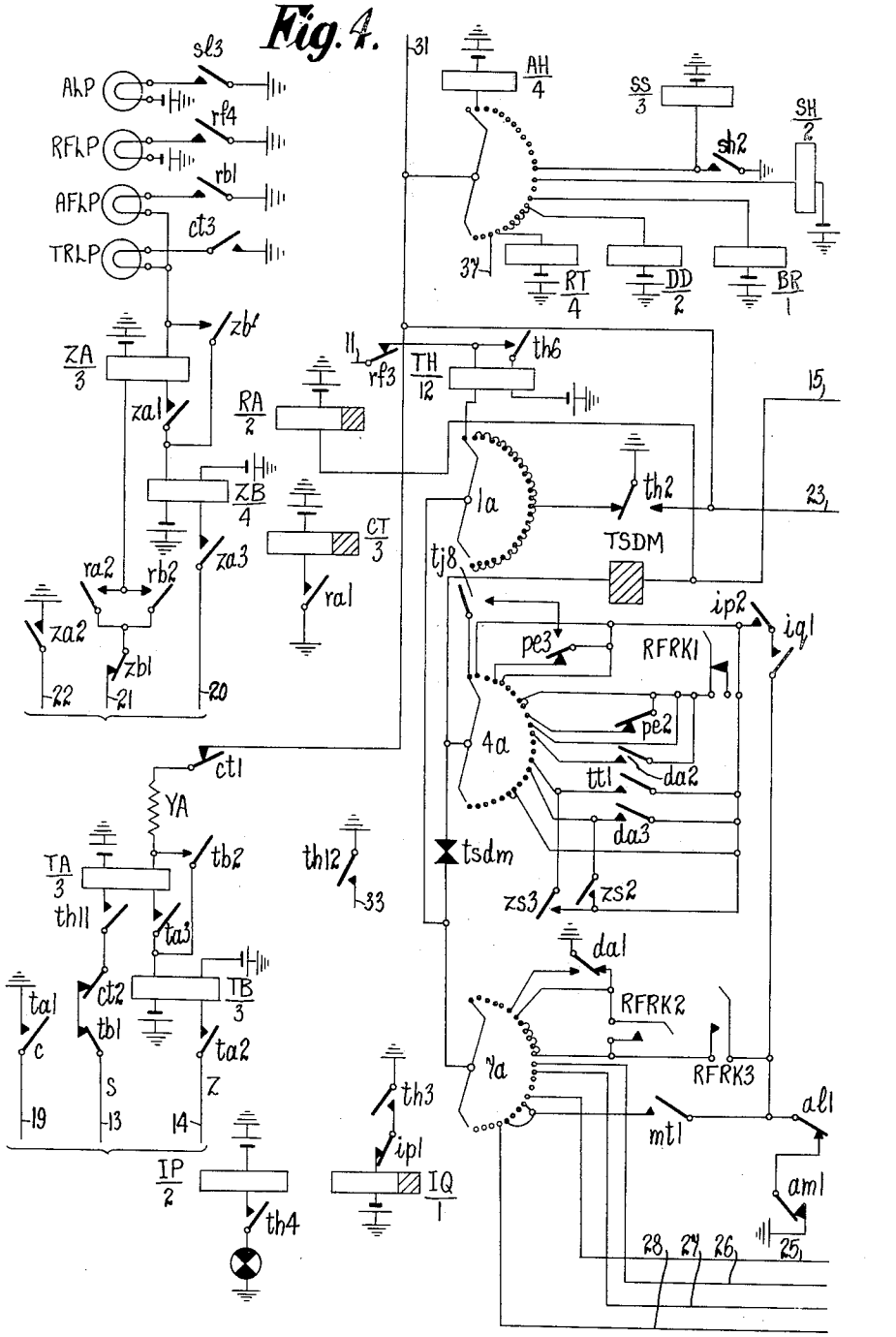
Fig. 4.



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TELEPHONE SYSTEM

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Fig. 5.

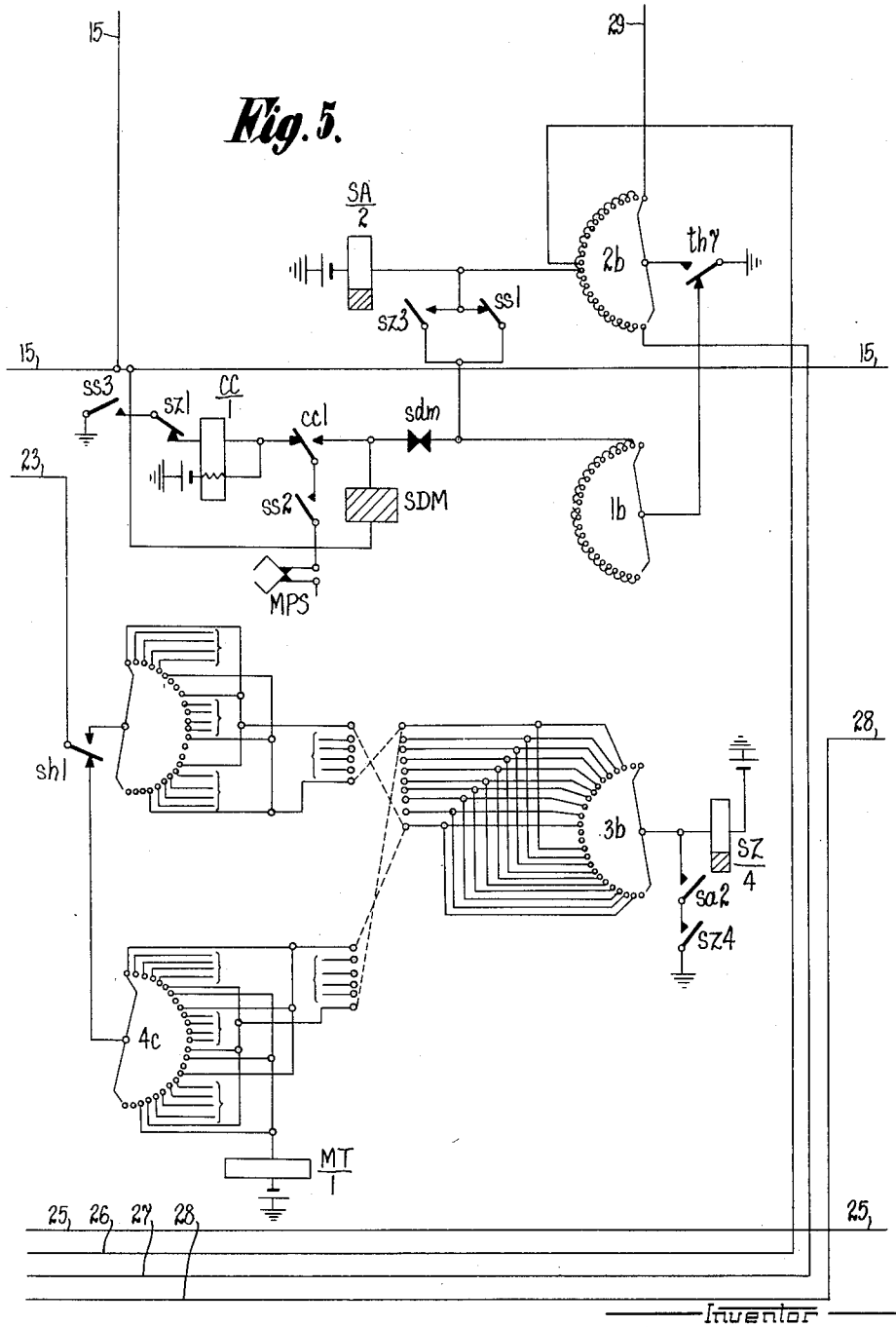

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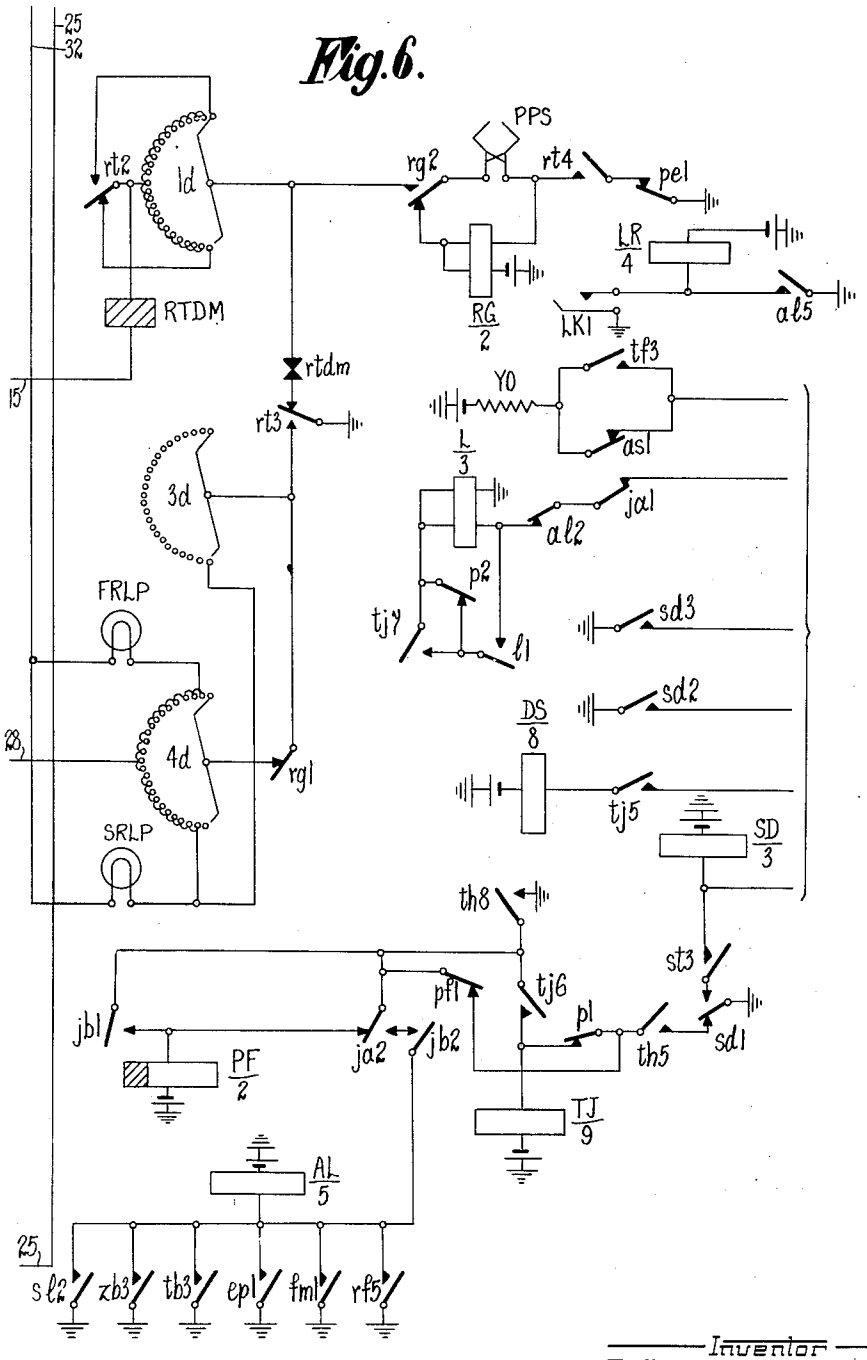
Fig. 6.



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UNITED STATES PATENT OFFICE

1,923,662

TELEPHONE SYSTEM

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Application February 12, 1932, Serial No. 592,462, and in Great Britain February 26, 1931

8 Claims. (Cl. 179—175.21)

The present invention relates to telephone systems and is more particularly concerned with what is known as routine testing apparatus, that is to say apparatus arranged to reproduce automatically the actual conditions of use for each unit in turn of a large group of similar pieces of apparatus. The invention while not definitely limited thereto is more specially applicable to the testing of so-called first code selectors which may be broadly defined as first numerical switches in a system employing register controllers. In such a system a first code selector is taken into use over an individual line switch or via a line finder switch when a subscriber calls and thereupon temporarily associates itself with a register controller adapted to respond to the impulses dialed by the calling party. In due course the register controller sends out corresponding trains of impulses, the first series serving to operate the first code selector, and when the connection has been completely set up the register controller is released. Such a first code selector is therefore considerably more complicated than a simple selector switch, and the routine tests must include some arrangements for testing also the apparatus for associating the register controller with the connection. It is the object of the invention to produce routine testing equipment which shall satisfactorily perform all the functions outlined above, though it will be understood that certain of the principles involved can equally well be applied to the testing of other kinds of apparatus.

The testing equipment may conveniently be divided into two parts, firstly the testing apparatus proper, and secondly the distributing switches by means of which the testing apparatus is associated with the particular piece of apparatus it is desired to test.

The present invention utilizes a distributor switch scheme of a form well-known to those skilled in the art, and it is therefore proposed not to describe this part of the apparatus but only to make such reference thereto as may be found necessary in the more detailed description of the routiner proper, or what may be termed the testing equipment of the routiner. Accordingly the scope of the accompanying drawings is confined to illustrations of the circuits employed in the testing equipment only.

In large telephone areas it is now usual to charge subscribers for the calls they make approximately in proportion to the distances over which the calls are made and in order to accomplish this the telephone area is divided into a number of sub-areas or zones. The circuit arrangements of the first code selectors in any exchange are such that the number of meter impulses applied to the meter lead when a call is being metered, or in other words the number of times the calling subscriber's meter is operated for any one call, will be determined by the zone to which the desired exchange belongs. The routiner must therefore be arranged to test this "multiple" or "zone" metering function of the first code selectors.

According to the invention, therefore, means are provided in the routiner for testing the multiple metering function of the apparatus under test.

The invention will be better understood from the following description of one method of carrying it into effect which should be taken in conjunction with the accompanying drawings. These show a routiner adapted to test first code selector switches of the type disclosed in the application of C. Gillings and F. T. Belas, filed 8th June 1931, Serial No. 542,714 and the general nature of the tests applied is the same as described in Patent No. 1,745,037 granted 28th January 1930 to J. E. Ostline.

Referring now to the drawings, Figs. 1 to 6, these should be arranged in numerical order in two rows under one another. They form a complete circuit of the testing equipment of the routiner. The operation of relay ST in the access equipment during the movement of the switch wipers to give access to the first of the first code selectors (or a succeeding one when a test has been made) will operate relay P, Fig. 3, of the routiner over its left-hand winding via conductor 10 to earth at armature *st*2, not shown. When relay ST of the access equipment releases at the end of the movement of the wipers the test start earth will operate relay TH, Fig. 4, of the routiner over its left-hand winding via the test start conductor 11 (provided the test switch TS is normal) over the following circuit: earth, test start conductor 11, armature *rf*3, left-hand windings of relay TH, first bank and wiper 1*a* of test switch TS, magnet interrupter springs *tsdm*, winding of the test switch driving magnet TSDM to battery via the winding of relay RA. Relay TH will lock over its right-hand winding to the test start earth conductor 11, via its own operated armature *th*6 and armature *rf*3, and at the same time armature *st*2 will disconnect relay P but the latter will hold due to its slug until relay TH operates and connects the right-hand winding of relay P to the private conductor 12 of the first code selector at

armature *th*9 so that if the latter selector is engaged relay P will be held on the busying earth. armature *p*1 prevents the operation of relay TJ, Fig. 6, without which (at armature *tj*8) the switch TS cannot step. If the lamp indicating key in the access equipment is operated, relay LR, Fig. 6, is operated to earth via lamp indicating key springs LK1 and at armature *lr*4 connects earth to the selector busying lamp 1LP, Fig. 1, which is wired to contact 1 of that bank of switch TS with which the wiper 6*a* engages. The three minute delay set is started by the operation of armature *th*11, Fig. 4. The operation of this type of delay equipment is well-known and will result in firstly, an earth pulse being applied to the S pulse conductor 13 and secondly an earth pulse being applied after a definite interval of time to the "Z" pulse conductor 14. When the Z pulse is applied relay TB will lock up and operate relay AL, Fig. 6, at armature *tb*3. The operation of armature *al*4 will ring the alarm bell AB, Fig. 1, and light the rack pilot lamp RLP. Armature *al*3 will bring in the main alarm, assuming that the main alarm cut-off key MAK is normal.

If the first code selector under test becomes free before the delayed alarm is actuated relay P will release when the earth is removed from the private conductor 12 and at armature *p*1 relay TJ will now be enabled to operate via armatures *pf*1 and *th*8 to earth, thereupon locking up via armature *tj*6. At armature *tj*9 the resistance YB, Fig. 3, relay PAE and lower winding of relay BM are connected in series to earth at resting armature *bm*2. Relay PAE will operate in this circuit and operate its relief relay PE at armature *pae*1, but relay BM cannot operate. At armature *pe*3 a circuit for stepping the switch TS is prepared. The circuit is now in the condition it would have been in had the first code selector been found free in the first instance.

Relay TH in operating at armature *th*4 has connected interrupted earth to relay IP, Fig. 4, and full earth via armature *ip*1 to relay IQ so that relay IP operates during the earth period, conveniently .75 second in duration, and relay IQ operates during the disconnect period which may be of the same duration, that is .75 of a second. Relay IQ however, will remain operated for a short period after the operation of relay IP due to the fact that its core is fitted with a slug and it is therefore slow to release, and during this time the magnet TSDM of the switch TS will be operated from earth, armatures *am*1, *al*1, *ig*1, *ip*2, *pe*3, *tj*8, first contact and wiper 4*a* of switch TS, winding of magnet TSDM, conductor 15 to battery via relay RA. When relay IQ releases the circuit of the magnet is broken at armature *iq*1 and the wipers of switch TS will therefore be stepped to the second position. At the second contact of the 5th bank on switch TS, relay AH will be operated from the earth at armature *th*2 and at the second contact of the second bank (Fig. 3) of switch TS, the relay combination AN, AP and retard R is applied to the negative and positive conductors 16 and 17 respectively leading to the first code selector under test. These relays and relay L, not shown, of the first code selector, form a bridge in which if balance is maintained relay L will operate but relays AN and AP will not since they are so wired that their windings oppose with the local currents via armatures *ah*1 and *ah*3. A fault, such as a disconnection in the negative conductor 16 will cause relay AN to operate and a similar fault in the positive conductor 17 will cause relay AP to operate. If the conductors are reversed both relays will operate. A resistance earth or battery on the negative conductor 16 will operate relay AN and on the positive conductor relay AP this therefore constituting a test for contact with other lines. A short circuit on the conductors would have caused a false busy condition to exist by operating relay L in the first code selector and is in any case tested later. Due to the operation of armatures *ap*1 and *an*1 or *an*2 according to the relay or relays operated, relay AM, Fig. 2, will operate in series with the appropriate lamp of the lamp 11LP, 12LP and 13LP and at armature *am*1 will disconnect the circuit of the magnet TSDM so that relay RA in series with it will not be operated. Armature *ra*1 being opened, relay CT will not operate in order to open the circuit of relay TA at armature *ct*2 which is being connected to the S pulse conductor 13 by armature *th*11. Thus the three minute delay set will come into operation resulting in the operation of relay TB which at armature *tb*3 will operate relay AL, and the latter at armature *al*5 will operate relay LR, Fig. 6, at armature *lr*3 the low resistance upper winding of relay AM is connected across its lower winding so that the appropriate fault lamp will light.

If the loop test is passed correctly, that is, if neither relay AP nor AN operate, the test switch TS will be moved to the 3rd position when relay IQ releases the next time. Relay AH will release and the relay and retard combination previously mentioned are now replaced by a resistance YG of suitable value connected across the conductors 16 and 17 by wiper 2*a* and bank contact of the switch TS. No switch test is made in this position of TS and the latter will therefore step on to the 4th set of contacts. The operation of the L and B relays, not shown, of the first code selector will have caused the private conductor 12 to be earthed and relay PAE to be short-circuited, via armatures *th*9 and *p*3 so that relay PAE restores and releases relay PE. The circuit of the magnet TSDM is completed in the 4th position of the wipers via resting contact of armature *pe*3 thus proving the guarding of the private conductor 12 by the first code selector, and if the latter has not taken place relays PAE and PE remain operated and the test switch TS is not stepped. After the delay period has expired the private guard lamp 3LP is lit and the alarm given. If the guarding on conductor 12 is satisfactory the wipers of switch TS are stepped over contact 5 to contact 6 by relays IP and IQ. Meanwhile the first code selector has been functioning normally and has caused its associated register controller finder switch to hunt for and seize a disengaged register controller. When this occurs relay K in the first code selector will operate and switch through the operating leads to the register controller thereby releasing relay I in the first code selector.

It should be mentioned that for facilitating the routining operation the armature of relay I in the first code selector is provided with a back contact to which is connected a so-called I relay conductor extending back to the routiner over the access switch system.

It should be mentioned also that the register controller may be taken into use via a so-called A digit selector, but it will be evident to those skilled in the art that for the purpose of the description of this invention reference to an A digit switch may be omitted, since its presence

will have no effect upon the functioning of the routiner under discussion.

Returning now to the routiner it will be seen that when relay I of the first code selector releases, earth will be connected to the I relay conductor 18 to operate relay DA via armature *tj*4 which at armature *da*1 steps the magnet TSDM via interrupter springs *tsdm*, wiper 7*a* and bank contact. If a register controller is not seized relay DA will not operate to step the switch TS so that after the expiration of the delay period the appropriate lamp 4LP will be lit and the alarm given.

No impulses are sent into the register controller in this position of the routiner so that after a certain interval a so-called forced release condition will obtain in this latter switch and will result, as is well-known, in the release of relay K of the first code selector. Relay I of the same switch will therefore re-operate and release relay DA of the routiner by disconnecting earth from the I relay conductor 18. The test switch TS is then driven to the 8th position via resting contacts of armature *da*1 and interrupter springs *tsdm*, wiper 7*a* and bank contact. Failure of the register controller to originate the forced release condition will maintain relay DA operated, the "register controller forced release" lamp 5LP will be lit and the alarm given. Assuming that the fault condition does not exist the wipers of the switch TS will now be stepped from the 8th to the 10th position by the interaction of the pulsing relays IP and IQ in order to provide a period for the release of the first code selector which will take place when the loop completed by wiper 2*a* and bank contact is broken in the 8th and 9th positions of the switch TS. With the latter switch in position 10 a circuit for relay L of the first code selector will be completed via a resistance YH which is of the correct resistance for testing the sensitivity of operation of the L relay. This resistance is connected across the conductors 16 and 17 via the wiper 2*a* and bank contact and armature *sa*1 which is normally short-circuiting the so-called loop pulse springs LPS. The private conductor 12 will be again earthed and relays PAE and PE released. At armature *pe*2 a circuit for the magnet TSDM is completed via bank contact and wiper 4*a* of the test switch so that upon the first release of relay IQ the test switch TS is stepped to the 11th position. The private guard lamp 3LP will again light should a fault occur. No test takes place in the 11th position so that switch TS will eventually step to the 12th position. When a disengaged register controller has been seized the switch TS will step to the 13th position in response to the operation of relay DA in a manner similar to that already described. Relay SS will now operate via the 13th bank contact and wiper 5*a* of switch TS, armature *th*2 to earth, and at armature *ss*2 connects relay CC, Fig. 5, to the so-called magnet pulse springs MPS which vibrate at the same speed, conveniently 10 pulses per second, but in phase opposition to the loop pulse springs LPS. At the same time armature *ss*3 connects earth to the side of the upper winding of relay CC via armature *sz*1. If this occurs when the magnet pulse springs MPS are closed relay CC will be short-circuited and will therefore only operate at the conclusion of the earth pulse, that is, when springs MPS open. Relay CC at armature *cc*1 switches the magnet pulse springs MPS to the so-called sender switch magnet SDM so that the wipers of the sender switch SS will be rotated under the control of the magnet impulse springs MPS.

At this time the wipers 1*c* to 4*c* of the zone select switch ZS, Figs. 2 and 5, will be in their 6th position provided that none of the so-called zone select keys ZSK2 to ZSK6 have been operated. The movement of the wipers of ZS takes place on the initial operation of relay TH via armature *th*7 and wiper 2*b* and first bank contact of the sender switch SS, conductor 29, first five bank contacts and wiper 2*c* of switch ZS, interrupter springs *zsdm*, to winding of magnet ZSDM to battery over relay RA. A contact of that bank of the sender switch SS associated with wiper 3*b* has therefore been earthed from earth at armature *th*2, armature *sh*1, wiper 4*c* of switch ZS, 6th bank contact which is cross connected to a particular digit lead and thus to the bank contact of the switch SS. As the sender switch is being pulsed relay SA is operated at the second contact of the bank with which wiper 2*b* engages and at armature *sa*1 removes the short-circuit from the loop impulse springs LPS. The L relay of the first code selector is therefore impulsed until the wiper 3*b* of the switch SS reaches the contact marked by earth in a manner outlined above. Relay SZ will then operate and lock at armature *sz*4 via armature *sa*2, at armature *sz*2 the loop pulse springs LPS will be again short-circuited, at armature *sz*3 a circuit is completed to enable the sender switch driving magnet SDM to drive its wipers to the 13th contact, while armature *sz*1 allows relay CC to release. When the switch SS reaches its 13th position the earth from armature *th*7 is connected via wiper 2*b* and 13th bank contact, conductor 26, 13th bank contact and wiper 7*a* of switch TS, interrupter springs *tsdm* to the winding of the magnet TSDM so that the wipers will be driven to the 14th position, whereupon relay SH operates via the bank contact and wiper 5*a* of switch TS and armature *th*2 and at armature *sh*2 holds relay SS. At armature *sh*3 a high resistance YF is connected across the negative and positive conductors 16 and 17 to simulate the minimum leak resistance allowed in practice on any line and to test the impulsing of the L relay of the first code selector under these conditions. At armature *sh*1 earth from armature *th*2 is switched over from wiper 4*c* to 3*c* of switch ZS and since the 6th bank contact upon which wiper 3*c* will now be resting is cross connected to a particular digit lead connected to the bank of the switch SS with which wiper 3*b* engages it will be seen that the next digit will be sent into the register controller in an exactly similar manner to that just described. It should be noted that relay SA releases when the wiper 2*b* reaches the 13th contact and at armature *sa*2 allows relay SZ to restore in order to re-make the operating circuit of relay CC at armature *sz*1. The translation of the digits received by the register controller is such as to route the connection to a spare level reserved in a group or code selector for the routiner test line. After the second digit has been sent the sender switch SS rotates to its 25th contact and the test switch TS is steppped as before to its 15th position.

If due to any fault, connection is not made to the test line, relay TT, Fig. 2, will be unable to operate and the "test line seized" lamp 6LP will remain alight and alarm will be given. If the test line is found, however, and the first code selector connections are in order, relay TT will operate over conductors 34 and 35 in series with

relays D and I of the first code selector, whereupon the I relay will operate but not the D relay. In operating, relay I will remove earth from the "I relay conductor" 18 and allow relay DA of the routiner to restore. At armature *tt*1 the pulsing circuit to the magnet TSDM is closed via the bank contact and wiper 4*a*, resulting in the wipers of the switch TS being driven to the 16th position whereupon relay BR, Fig. 4, will operate via the 16th bank contact and wiper 5*a* of switch TS and at armature *br*1 connect negative battery to the positive test line conductor 35 via the lower winding of relay TT and armature *dd*2. This is to simulate either (*a*) the battery period of the well-known busy flash used for informing a calling manual operator of a busy condition or (*b*) the well-known operator hold condition which is set up by an operator who wishes to hold a connection after the calling subscriber has restored.

As a result of the negative battery being connected in the manner described no current will now flow in the circuit including relays D and I of the first code selector and relay TT in the routiner. In consequence relays TT and I restore so that relay DA will operate, and at armature *da*3 prepare the pulsing circuit of the magnet TSDM via bank contact and wiper 4*a* which will operate upon the next operation of armature *ip*2 and rotate the wipers of the switch TS to the 17th position when relay IQ restores.

It is apparent that in the event of the register controller failing to reach the test line it would be possible for the test switch to be stepped from the 15th to the 16th position by the action of an ordinary subscriber erroneously seizing the the test line. In this case the test switch would not pass the 16th contact (so keeping lamp 6LP alight) since the operator's hold feature would not be simulated on the line (other than the test line) reached by the register controller. In the event of the test switch successfully passing contact 16 relay DD operates via the 17th contact and wiper 5*a* of the switch TS and at armatures *dd*1 and *dd*2 reverses battery and earth which are connected via the windings of relay TT to the test line thereby operating the polarized relay D of the first code selector in order to prepare the metering circuit in the latter switch. The code which has been sent out from the register controller in the normal case will have operated the first code selector to a level which will result in one impulse being applied to the meter lead, that is to say, as for a unit fee area. Relay BM, Fig. 3, will operate over its lower winding in series with relay PAE when booster battery is applied to the private conductor 12 by the first code selector this constituting the meter impulse, and will lock over both its windings in series when the short-circuiting earth is removed from its upper winding by the operation of armature *bm*2. The same armature *bm*2 serves to prepare the circuit of the magnet TSDM via conductor 25 and bank contact and wiper 7*a* in order to step the wipers of the TS switch to the 18th position. Armature *bm*1 completes a circuit for the magnet ZSDM of the ZS switch from earth at armature *th*2, armature *bm*1, wiper 3*a* and bank contact of switch TS, conductor 24, resting contacts of armature *da*1, winding of the driving magnet ZSDM to battery via the winding of the release alarm relay RA. At the cessation of the metering period, relays BM and PAE will be again short-circuited, so that the circuit of the magnet ZSDM will be broken at armature *bm*1 and the wipers of the switch ZS will therefore be stepped to the 7th position. Relay MT will now operate via the 7th bank contact and wiper 4*c* of switch ZS, armature *sh*1, armature *th*2 to earth, and at armature *mt*1 prepares a circuit for the magnet TSDM via bank contact and wiper 7*a* and interrupter springs *tsdm* in order to step the wipers of the switch TS to the 19th position.

Any failure would result in the metering pulse not being received or relay BM not operating. This would leave the test switch in the 17th position, light the "meter fail" test lamp 7LP and after a delay period give the alarm. The test switch is allowed to pass through its 19th and 20th positions under the control of the pulsing relays IP and IQ.

Should further metering occur, the magnet ZSDM will operate from armature *bm*1, and step its wipers to the 8th position thereby releasing relay MT. If this occurs during the pulsing of the test switch TS over the two preceding contacts, the test switch will remain in the 21st position, light the "incorrect metering" lamp 8LP and give the alarm. If no over-metering occurs, relay MT will remain operated in order to step the test switch wipers from the 21st to 22nd position through the medium of armature *mt*1.

In this position of the test switch TS relay RT, Fig. 4, will be operated via the 22nd bank contact and wiper 5*a* of the test switch, while the conductors 16 and 17 are short-circuited via wiper 2*a* and bank contact of the switch TS and wiper 2*d* and first bank contact of the so-called release timing switch RTS. Armature *rt*4 connects earth from armature *pe*1 to pulse springs PPS, which may be arranged to vibrate at conveniently 20 pulses per second, and which short-circuit relay RG, Fig. 6, during their make period. Relay RG operates on the short-circuit being removed and at armature *rg*2 switches the pulse springs PPS to the magnet RTDM of the pulse timing switch RTS. On the first step of the wipers of the latter switch the loop across the negative and positive conductors 16 and 17 is broken by the movement of wiper 2*d* from the first bank contact and the first code selector thereupon commences to release. This will result in earth being removed from the private conductor 12 so that relay PAE will operate to be followed by the relief relay PE which at armature *pe*1 breaks the circuit of relay RG and the magnet RTDM thus stopping rotation of the wipers of the switch RTS. Relay RG in releasing connects earth to wiper 4*d* of switch RTS and if the time of release of the first code selector has been within the correct limits the test switch is stepped to the 23rd position by this earth via wiper 4*d* and bank contact of switch RTS, conductor 28, 22nd bank contact and wiper 7*a* of the switch TS, interrupter springs *tsdm* and winding of driving magnet TSDM to battery via winding of relay RA, Fig. 4. If, however, the time of release had been either too fast or too slow the appropriate lamp of the two lamps FRLP and SRLP (fast release lamp and slow release lamp) would have been lit and relay AM operated. Earth from armature *th*2 will now be connected via the wiper 5*a* and 23rd bank contact of switch TS to conductor 37 to operate relay TF, not shown, in the access equipment so

that the access switch will be eventually stepped to find the next switch to be routined. Earth will also be removed from the test start conductor 11 by the operation of relay RF.

The routiner rotary switches return to their normal position and all operated relays release.

It will be advisable occasionally to put a more complete test on the first code selectors in order to test the metering for calls to different zones. This will not be included in the ordinary routining but at various intervals metering to a particular zone may be tested as follows:

In order to make the test it is only necessary to operate the appropriate zone select key *2zsk*, *3zsk*, *4zsk*, *5zsk* or *6zsk*. The correct routing of the call will already have been ensured by the cross connections from those banks of the zone selecting switch ZS which are engaged by wipers *3c* and *4c* to that bank of sender switch SS which is engaged by wiper *3b*. The cross connections cause the sender switch SS to send such a number into the register controller as will be translated by the latter switch in such a manner as to effect the routing of the call to the required office in the chosen zone. If an automatic exchange is available in the required zone the call will be routed to special equipment on a spare level or associated with a spare number. If no automatic exchange is available in the required zone the call will be routed over the ordinary junctions to a manual exchange and a special tone will be given to the manual operator when she replies by inserting the answering plug of a cord circuit into the answering jack. Having ascertained by the reception of the tone, that the call is from a routiner, the operator will insert the calling plug of the cord circuit into a special routiner jack having its tip and ring connected together to simulate for the routiner what may be termed a "called subscriber replies" condition.

In order to describe in greater detail tests applied by the routiner in cases of multiple or zone metering, it will be advisable to take a particular example, for instance, assume it is desired to routine zone 3. For this purpose the zone select key *3zsk* must be thrown. When the routiner start wire is earthed relay TH will operate and earth from armature *th7* will be connected to the contacts of that bank of switch ZS with which wiper *2c* engages, via springs of the non-operated zone select keys *2zsk2*, *4zsk2*, *5zsk2* and *6zsk2*. The fourth contact on the bank will be disconnected by the operation of springs 3ZSK2 and the wiper of the switch ZS will therefore come to rest in the fourth position. Relay ZS will also be operated via make contacts 3ZSK1 of the operated key and at armature *zs1* applies the special tone already mentioned which may conveniently take the form of number unobtainable tone to conductor 16 via condenser QB. Armatures *zs2* and *zs3* connect contacts 15 and 16 of the 4th bank of the switch TS to the pulsing circuit formed by armatures *ip2* and *iq1* so that the test switch TS will pass over the test line seized contacts. In addition armature *zs4* earths the private conductor 36 of the test line to busy the line against subscribers or other false calls.

The test will now proceed as in ordinary routing. The test switch TS will be rotated through the 15th and 16th positions without making any tests. In the 17th position of the test switch TS, relay D in the first code selector operates when the "called subscriber replies" condition is set up and the metering pulses are commenced. If the operator does not reply or if metering is not started relay BM will not operate and the test switch TS will not move from the 17th position. If, however, the operator replies and metering is commenced relay BM will operate and at armature *bm2* the test switch magnet TSDM is operated via bank contact and wiper *7a* of the test switch TS, and interrupter springs *tsdm* the wipers being, therefore, rotated to the 18th position. Armature *bm1* completes a circuit for the ZS switch magnet ZSDM via the bank contact and wiper *3a* of the test switch and on the termination of the metering pulse relay BM restores so that the magnet ZSDM steps the wipers of the switch ZS to the 5th position. There is now no earth on the 5th contact of that bank of switch ZS with which wiper *2c* engages since the sender switch SS is in its 25th position. Two more metering pulses (that is, three in all) should be received and relay BM will step the ZS switch wipers to the 7th position, whereupon relay MT will operate via the bank contact and wiper *4c* of switch ZS, armatures *sh1* and *th2* to earth. Relay MT will cause the test switch to step to the 19th position after which the pulse relays IP and IQ will step the test switch to the 21st position. If excess metering has taken place during this stepping, relay MT will have released, but if not the latter relay will still be operated and the test switch TS will be stepped to contact 22.

When routining incoming first code selectors, that is, those which terminate two wire junctions, relay DS, Fig. 6, will be operated in a manner similar to that described in relation to relay PE in my application Serial No. 534,829, filed 4th May 1931. No metering pulses are sent out from these switches but instead the current is reversed in the calling line to operate metering equipment on the other end of the junction. The routiner must therefore be capable of utilizing this battery reversal condition in order to test the metering function of the first code selector and this is effected by relay D in the routiner which is connected across the conductors 16 and 17 when the test switch is in its 17th, 18th, 19th, 20th and 21st positions.

Irrespective of which zone is being routined or which zone select key is off normal the first five contacts in the second bank of the switch ZS will be earthed via operated armatures *ds3*, 4, 5, 6, and 7, first contact and wiper *2b* of the sender switch SS, operated armature *th7* to earth so that the ZS wipers will be rotated to the 6th position when relay TH operates. When relay D operates the switch ZS moves to the 7th position due to the circuit of the magnet ZSDM being completed via interrupter springs *zsdm*, wiper *2c* and bank contact, armatures *ds2* and *d1* to earth. Relay MT now functions as previously described thus testing that the battery reversal has taken place. The speed of testing first code selectors may be increased if desired by eliminating the register controller forced release test. This is accomplished by operating the forced release cancel key RFRK, whereupon earth will be connected to the contacts 7 to 12 inclusive of the 7th bank of the switch TS so that the wipers of the latter switch will be quickly rotated over these contacts after which testing will proceed normally.

It will have been seen that false metering such as insufficient or over metering is tested during the metering testing period, but it should be pointed out that if, due to a fault, a metering pulse is given at any other time than that during which metering should normally take place, relay FM, Fig. 1, will operate via the operated

armature *bm*1 and wiper 8*a* and bank contacts of the switch TS and will lock via armature *fm*3 to earth at armature *th*2. Armature *fm*1 operates relay AL in order to give an immediate alarm and stop the test switch, while armature *fm*2 lights the "false metering" lamp 14LP. The particular lamp in the group of fault lamps, 1LP to 10LP, connected to the 6th bank of switch TS which will light when relay LR operates will also serve to give an indication of the period of test at which the false metering occurs.

Should the earth on the private conductor 12 be removed at any time other than when it is removed by the routiner relays PAE and PE will operate and result in the operation of relay EP, Fig. 1, via armatures *th*2, *bm*1 and *pe*4, wiper 8*a* and bank contact of switch TS, winding of relay EP which thereupon locks via armatures *ep*2 and *th*2 to earth. Armature *ep*1 operates relay AL in order to originate the alarm while armature *ep*3 lights the "no earth on P wire" lamp 15LP.

Should a routiner switch magnet become energized for an excessive period relay RA will remain operated in series with the magnet and at armature *ra*2 initiate the so-called 9 seconds delay set and an alarm will be given.

What I claim is:—

1. Testing apparatus for testing a selector switch of the type used in automatic telephone systems, which switch is arranged to transmit metering impulses in accordance with the position it is set in, said apparatus including means for transmitting impulses to set said switch in a position to transmit metering impulses, and means in said apparatus operated by said metering impulses to test for the correct transmission of said metering impulses.

2. Testing apparatus for testing a selector switch of the type used in automatic telephone systems, which switch is arranged to transmit metering impulses in accordance with the position it is set in, the different positions of said switch corresponding to the different zones in the telephone system, said apparatus including means for transmitting impulses to set said switch in different positions corresponding to the different zones to transmit metering impulses the number of which varies dependent upon the position the switch is set in, means in said apparatus modified in accordance with the number of impulses transmitted to set said switch in a certain position, and said modified means thereafter operated in response to said metering impulses for continuing the test of said switch only in case the number of metering impulses sent back by said switch corresponds to the zone represented by the impulses transmitted to set said switch.

3. Testing apparatus for testing a selector switch of the type used in automatic telephone systems, which switch is arranged to transmit metering impulses in accordance with the position it is set in, the different positions of said switch corresponding to the different zones in the telephone system, said apparatus including means for transmitting impulses to set said switch in different positions corresponding to the different zones to transmit metering impulses the number of which varies dependent upon the position the switch is set in, means in said apparatus modified in accordance with the number of impulses transmitted to set said switch in a certain position, said modified means thereafter operated in response to said metering impulses for continuing the test of said switch only in case the number of metering impulses sent back by said switch corresponds to the zone represented by the impulses transmitted to set said switch, an alarm relay in said apparatus, and means for operating said alarm relay in case the number of metering impulses fail to correspond to the zone represented by the impulses transmitted to set said selector switch.

4. Testing apparatus for testing a selector switch of the type used in automatic telephone systems, means in said apparatus for transmitting impulses to said selector switch, a meter impulse responding switch and a sender switch in said apparatus, means jointly controlled by said meter responding switch and said sender switch for determining the number of impulses transmitted to said selector switch, said selector switch operated to a certain position in accordance with the number of impulses transmitted thereto and arranged to transmit metering impulses back to said apparatus in accordance with the position it is set in, and means in said apparatus operated in response to said metering impulses for operating said meter responding switch in accordance with the number of metering impulses transmitted to check the metering operation of said selector switch.

5. Testing apparatus for testing a selector switch of the type used in automatic telephone systems, which selector switch is arranged to transmit metering impulses in accordance with the position it is set in, the different positions of said selector switch corresponding to the different zones in the telephone system, a meter impulse responding switch, a sender switch having a wiper and bank contacts accessible thereto, means in said apparatus for operating said meter responding switch to mark one of the bank contacts of the sender switch in accordance with a certain zone, means in said apparatus for transmitting impulses to said selector switch and for simultaneously operating the wiper of said sender switch one step for each impulse transmitted, means for stopping further transmission of said impulses in response to said wiper engaging said marked bank contact, said selector in response to said impulses being set in a certain zone position to transmit back to said apparatus a certain number of metering impulses, and impulse responding means in said apparatus operated in response to said metering impulses for further operating said meter responding switch in accordance with the number of metering impulses transmitted to check the metering operation of said selector switch.

6. Testing apparatus for testing a selector switch of the type used in automatic telephone systems, which selector switch is arranged to transmit metering impulses in accordance with the position it is set in, the different positions of said selector switch corresponding to the different zones in the telephone system, a sender switch and meter switch in said apparatus, means for transmitting impulses to said selector switch, means for operating said meter switch to hunt for and stop said meter switch in a position corresponding to the zone position the selector switch is to be operated to, means jointly controlled by said meter switch in the position it is stopped in and said sender switch for determining the number of impulses transmitted to said selector switch, said selector switch operated to the zone position corresponding to the said stopped position of said meter switch in response to the number of impulses transmitted thereto to transmit metering impulses back to said apparatus, a

meter checking relay in said apparatus, means in said apparatus operated in response to said metering impulses for operating said meter switch to a different position for each meter impulse transmitted, and a circuit including a predetermined position in said meter switch completed for operating said relay in response to transmission of the correct number of metering impulses.

7. Testing apparatus for testing a selector switch of the type used in automatic telephone systems, which selector switch is arranged to transmit metering impulses in accordance with the position it is set in, the different positions of said selector switch corresponding to the different zones in the telephone system, a sender switch and a meter switch in said apparatus, a plurality of keys in said apparatus, each key corresponding to a particular zone, means for operating said meter switch to hunt for and stop in a position corresponding to an operated one of said zone keys, means jointly controlled by said meter switch in the position it is stopped in and said sender switch for determining the position to which said selector switch is to be set in, said selector switch being operated to the position corresponding to the zone key operated to transmit metering impulses back to said apparatus, and impulse responding means in said apparatus operated in response to said metering impulses for further operating said meter switch to check the metering operation of said selector switch.

8. Testing apparatus for testing a selector switch of the type used in telephone systems, which switch is arranged to be set in different positions corresponding to different zones and to transmit metering impulses in accordance with the zone position it is set in, means in said apparatus operated by said metering impulses to test for the correct transmission of said metering impulses, a tone source for generating a distinctive tone, and means in said apparatus for connecting said tone source to said selector in case said selector is operated to a position extending the connection to a manual exchange.

ARTHUR EDWARD CASWELL.