May 6, 1924.

1,492,995

F. LUBBERGER

TELEPHONE SYSTEM

Filed June 5, 1923

3 Sheets-Sheet 1

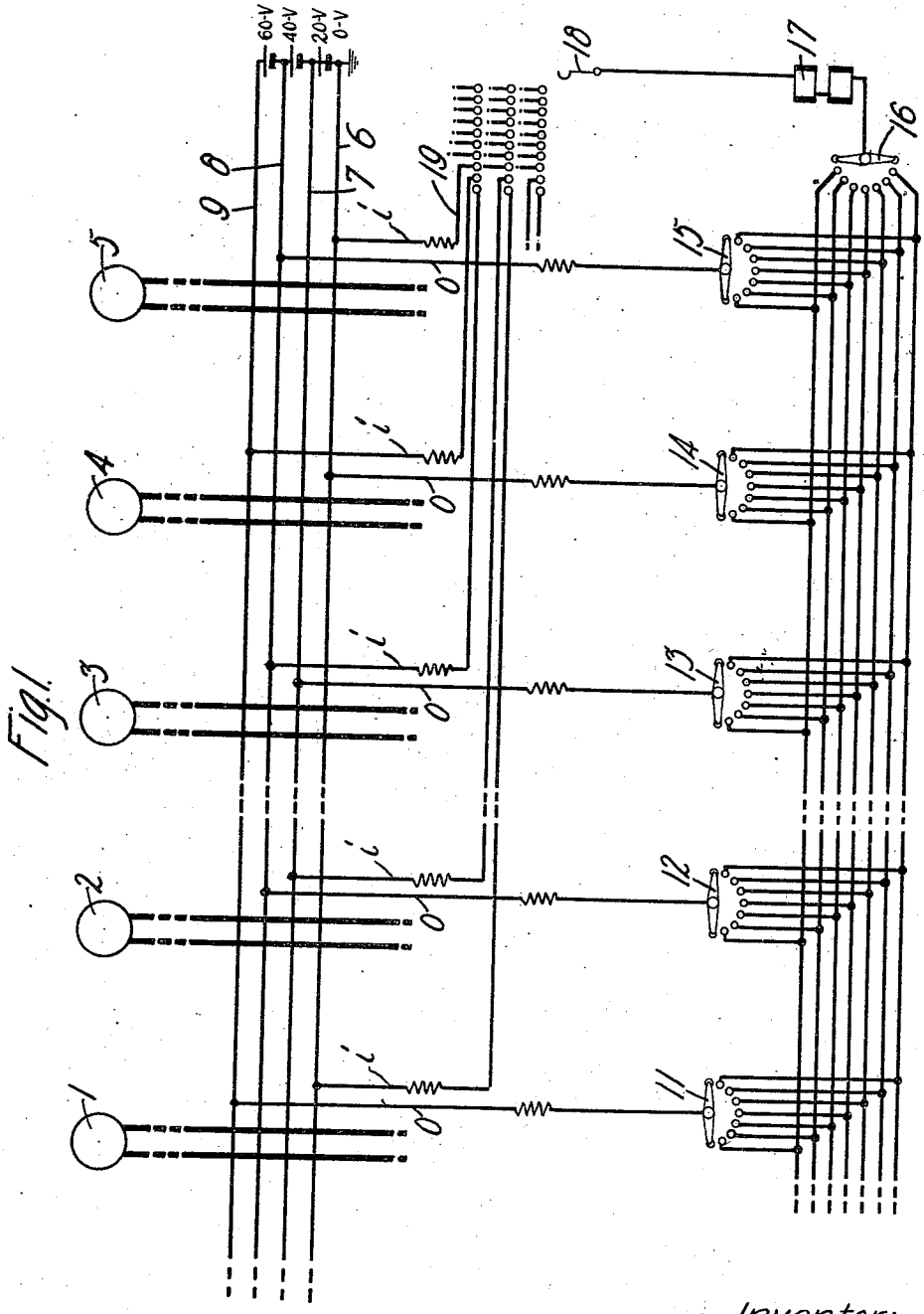

Fig. 1.

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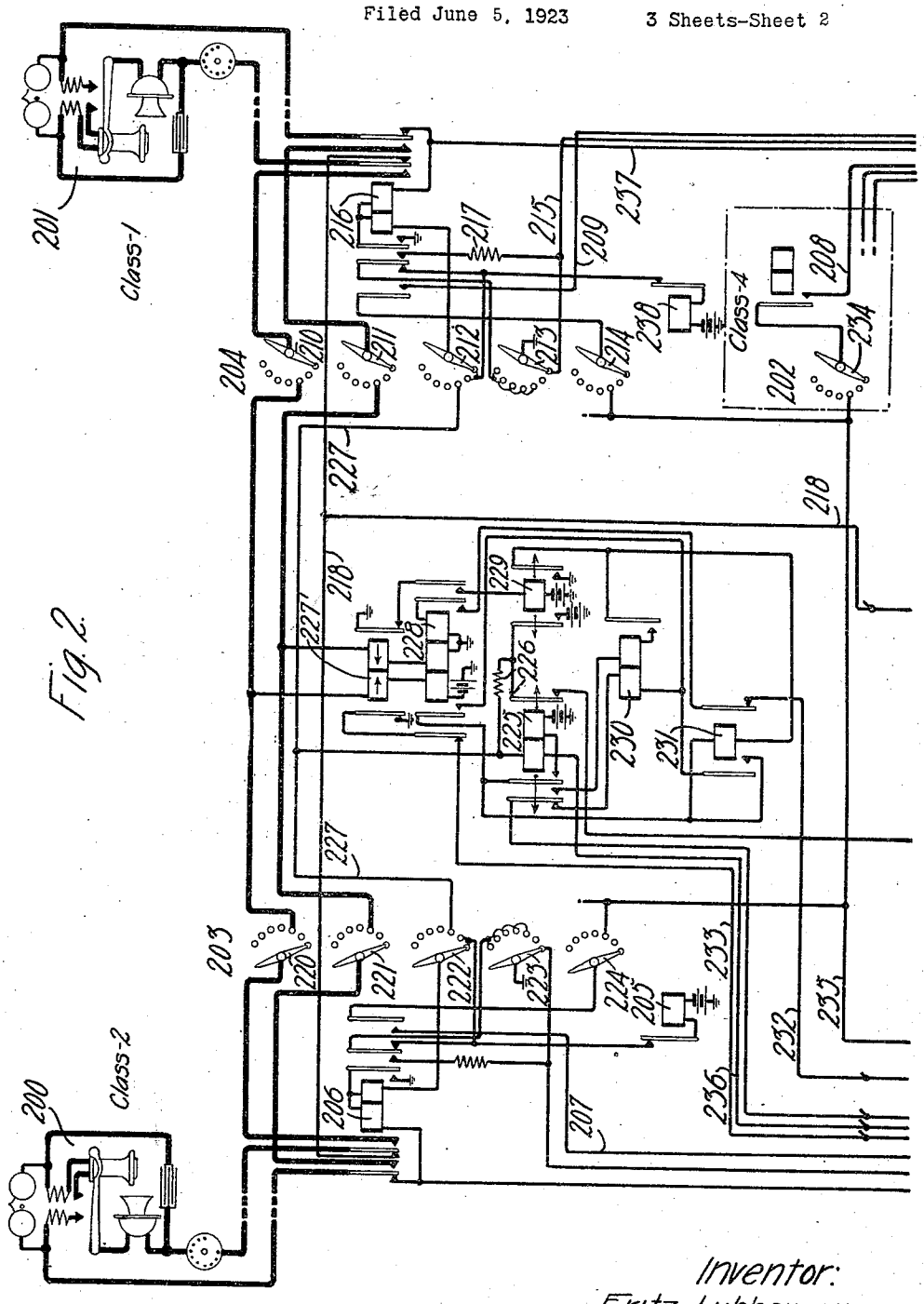

Fig. 2.

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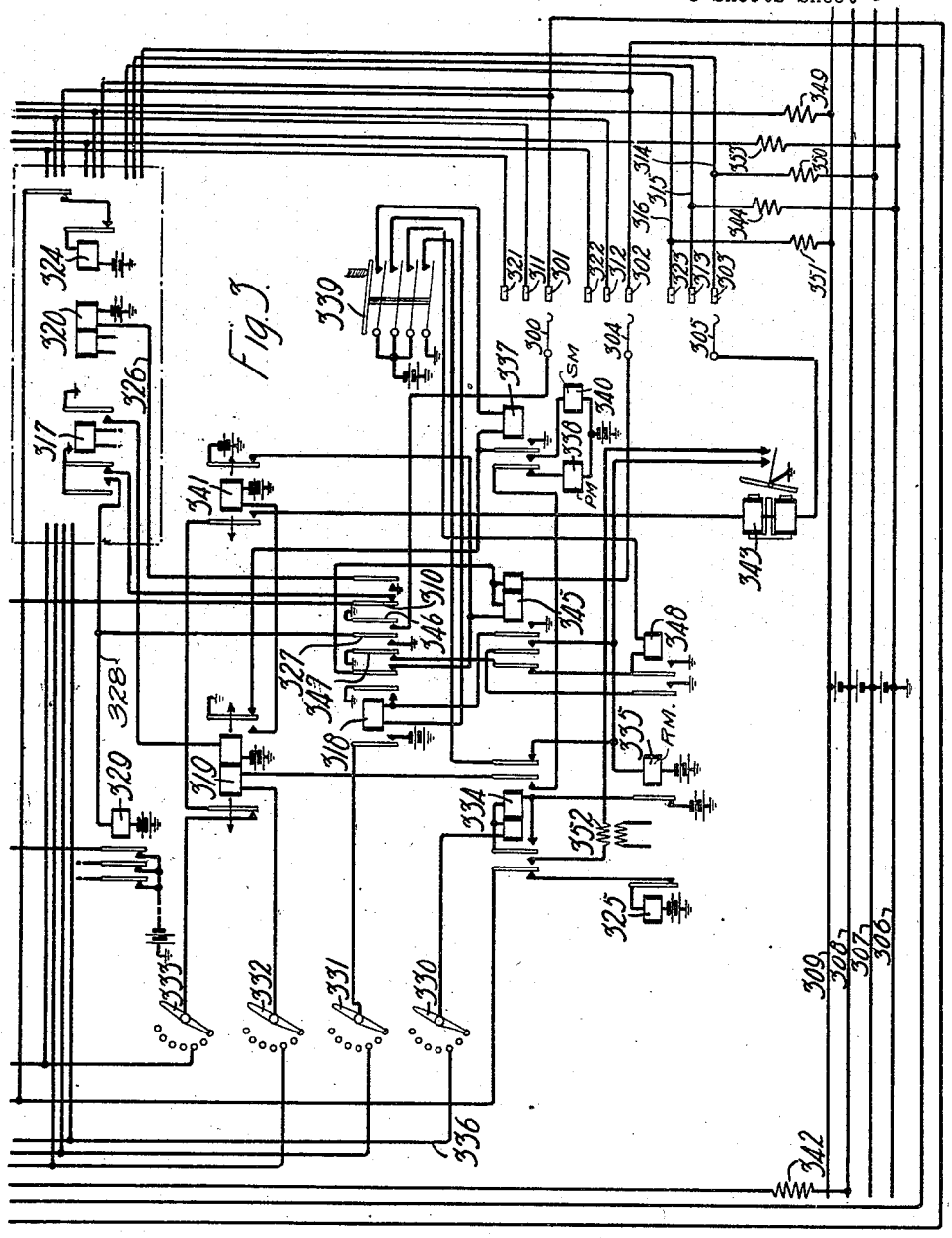

Inventor:
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Patented May 6, 1924. 1,492,995

UNITED STATES PATENT OFFICE.

FRITZ LUBBERGER, OF SCHMARGENDORF, GERMANY, ASSIGNOR TO SIEMENS & HALSKE, AKTIENGESELLSCHAFT, OF SIEMENSSTADT, NEAR BERLIN, GERMANY, A CORPORATION OF GERMANY.

TELEPHONE SYSTEM.

Application filed June 5, 1923. Serial No. 643,520.

To all whom it may concern:

Be it known that I, FRITZ LUBBERGER, a citizen of Germany, residing at Schmargendorf, Germany, have invented certain new and useful Improvements in Telephone Systems, (for which I have filed application in Germany Number S. 59,685, May 9, 1922), of which the following is a full, clear, concise, and exact description.

This invention relates to telephone systems and particularly to that type of system in which machine switching devices are employed and further in which separate speaking and setting routes are used.

The object of the invention is the provision of a flexible means for providing different classes of service.

Class of service arrangements in which the called lines are segregated in groups according to their classification have heretofore been employed but to the best of applicant's knowledge and belief no such system employing separate speaking and setting routes has been known.

It is therefore a further object of this invention to provide a class of service system in combination with a by-path machine switching telephone system.

A further object is to provide a system in which the class of service determination is a function of both the calling and the called lines.

A feature of the invention resides in a plurality of common conductors each maintained at a different but definite potential and to which the lines are differently connected. Each line in characterized by the connection of an incoming and an outgoing lead maintained at a predetermined potential. The class of service is then determined and the resulting operations are controlled through the connection of a calling line's outgoing lead through a common responsive device to the called line's incoming lead.

Thus all lines of a particular class are characterized by having an outgoing class of service lead of a particular potential and an incoming class of service lead of a particular potential, which may be higher, the same or lower than the outgoing class of service potential.

Another feature of this invention is the flexibility of the system, which lies in the fact that the class of service of any line may be changed by the simple expedient of changing its individual connections to the common potential leads.

Still another feature of this invention resides in the results which arise from making the class of service determination a function of both calling and called line. Thus there may be one class of lines which may establish connections to all other lines regardless of their class and to which all other class lines may establish connections. Again there may be lines which can only call and be called in their own class. Further there may be lines which can call lines of all other classes but can only be called by lines of a particular class. In fact the present invention lends itself to a wide field of usefulness inasmuch as a large plurality of classes of service may be provided with a very small amount of common apparatus and hence almost any particular class of service which may be desired is ready at hand. Thus, as will be fully explained hereinafter, with four potential leads there may be as many as sixteen separate and distinct classes of service and with five potential leads there may be twenty five different classes of service. It will thus be seen that the number of classes of service is the square of the number of potential leads.

Another feature is the class of service responsive device which comprises a simple polarized relay which for a single brief period during the establishment is serially included in a circuit between the calling line outgoing class of service potential lead and the called line incoming class of service potential lead. If the potentials on these two leads are equal so that the relay does not energize or if they are unequal and so arranged to cause a flow of current in one direction so that the relay becomes energized and tends to move its armature in one direction then the establishment of the connection is allowed to proceed but if the potentials on these two leads are so arranged that a flow of current in the other is caused then this relay becomes energized so as to move its

armature in the other direction with results which prevent the establishment of the connection.

In the drawings Fig. 1 is a schematic representation of the essential elements of the present invention while Figs. 2 and 3 taken together form a diagrammatic representation of a telephone system employing the present invention.

Fig. 1 is a diagrammatic representation of the essential elements of the present invention. Each telephone line in a system employing this invention may be provided with a particular class of service by the arrangement of certain two class conductors associated therewith, one of which we will designate *o* for outgoing and the other of which we will designate *i* for incoming. Thus, in the figure, the left hand circle with the heavy lines leading therefrom is intended to represent a telephone line provided with, say, class 1 service. This class of service is determined by the arrangement of its associated class conductors *o* and *i*.

A plurality of conductors carrying different potentials are provided common to all telephone lines to which the class conductors of the said lines are connected. Thus, conductor 6 may be at zero potential, conductor 7 may be at 20 volts potential, conductor 8 may be at 40 volts potential and conductor 9 may be at 60 volts potential. In the case of line 1, the outgoing class conductor *o* is connected to conductor 9 and the incoming class conductor *i* is connected to conductor 6.

In general, there are four classes of service provided, as represented by lines 1, 2, 3 and 4, respectively, and such four classes will take care of all ordinary telephone requirements, but this invention is not limited to the provision of four classes. Thus, a fifth class is illustrated in connection with line 5. It will be understood that with the four potential leads and with the two class conductors for each line that the maximum number of different classes possible is sixteen, since one class conductor may be connected to any one of the four potential conductors and the other class conductor may be likewise connected to any one of the four potential conductors. Should there be, say, five potential conductors, then the maximum number of different classes of service which could be provided would be five times five or twenty-five.

Each telephone line has associated with it a primary line switch by means of which the telephone line may be extended. There are also provided secondary line finder switches by means of which the telephone lines may be further extended. In Fig. 1 wiper 11 represents one of the wipers of the primary line switch associated with line 1, and wiper 16 represents one of the wipers associated with a secondary line finder switch for further extending line 1. Thus, upon the initiation of a call on line 1, the *o* class conductor of line 1 is extended through wiper 11 and thence over the first one of the idle trunk conductors illustrated to wiper 16 of the secondary line finder switch. Thereafter, the conductor *o* is extended through a polarized relay 17 to the brush 18 of a numerical switch. In a manner which will be described hereinafter, the numerical switch may be set in connection with any desired called line, whereupon the brush 18 will further extend the conductor *o* of the calling line to the conductor *i* of the called line, and polarized relay 17 will thus be included between two sources of potential which may or which may not be different.

It will be described hereinafter how upon the energization of relay 17 in one direction a certain result will be accomplished, and how upon the energization of polarized relay 17 in another direction or how upon the non-energization of relay 17 a different result will be accomplished. The result in one case will be the restriction of the service, and in the other case will be the successful completion of the connection.

If a connection is made whereby relay 17 is included in a circuit leading from a given potential to an equal potential, the result will be the non-operation of relay 17 and the consequent establishment of the desired connection. In this class will be calls which may be established from lines 1 to 4, from 2 to 3, from 3 to 2, from 4 to 5, from 4 to 1, and from 5 to 3.

If a connection is made whereby relay 17 is included in a circuit leading from a given potential to lower potential, then relay 17 will operate in one direction which will result in the establishment of the desired connection. In this class will be calls which may be established from 1 to 1, from 1 to 2, from 1 to 3, from 1 to 5, from 2 to 1, from 2 to 2, from 2 to 5, from 3 to 1, from 3 to 5, from 5 to 1, from 5 to 2, and from 5 to 5.

If a connection is made whereby relay 17 is included in a circuit leading from a given potential to a higher potential, then the operation of relay 17 will be in the opposite direction with the result that the desired connection will be barred. In this class will be calls which are attempted to be set up from lines 2 to 4, from 3 to 3, from 3 to 4, from 4 to 2, from 4 to 3, from 4 to 4 and from 5 to 4.

In order to bring out these distinctions more clearly, two tables are given as follows. In the first table the possibilities of connections from lines in the first column to other lines are set forth, and in the second table possibilities of connections being estab-

lished to the lines noted in the first column from other lines are given.

Can call	1	2	3	4	5
Class 1 lines	*	*	*	*	*
Class 2 lines	*	*	*		*
Class 3 lines	*	*			*
Class 4 lines	*				*
Class 5 lines	*	*	*		*

Can be called	1	2	3	4	5
Class 1 lines	*	*	*	*	*
Class 2 lines	*	*	*		*
Class 3 lines	*	*			*
Class 4 lines	*				
Class 5 lines	*	*	*	*	*

Thus, according to the first table, line 1 can call lines of any class of service whatsoever. Line 2, representing class 2 service, is restricted from calling a line provided with class 4 service but may call lines provided with any other class of service. According to the first table, lines provided with class 2 service and class 5 service are apparently the same and the difference only appears when the second table is examined and it is seen that class 2 service differs from class 5 service in that while class 5 service lines may be called by any other class of service lines, class 2 service lines are barred to class 4 service lines.

With this short description we will go to a description of the means employed in carrying out this invention.

Figs. 2 and 3 taken together, Fig. 3 being placed below Fig. 2, represent a telephone system employing the present invention. Here is illustrated an intraoffice connection in an exchange having a small capacity. In general the connection is established in the manner set forth in the patent to Franke #1,268,106, granted June 4, 1918; that is a by-path connection between the calling and called lines is first established by means of a numerical switch and then a talking connection is substituted by non-numerical switches and the originally established by-path is released.

In the drawings now under consideration two telephone lines 200 and 201 are shown and a third 202, is indicated. Each telephone line has its individual line switch here shown as rotary step-by-step switches having a normal position. Switch 203 is individual to line 200 and switch 204 is individual to line 201. Individual to the line there is also a switch stepping magnet and a relay which acts as a combined line, test and cut off relay. Thus line 200 is provided with its individual switch magnet 205 and relay 206. Also individual to the line are three terminals in a numerical switch by means of which the line is identified as a called line. Thus terminals 301, 302 and 303 forming a set and accessible respectively to brushes 300, 304 and 305 are individual to line 200. In like manner the set of terminals 311, 312 and 313 is individual to line 201 and the set of terminals 321, 322 and 323 is individual to line 202. Each line further has two class conductors individual to it, one known as the outgoing class conductor and the other known as the incoming class conductor. Thus line 200 has conductor 207, line 201 has conductor 209, and line 202 has conductor 208 as its individual outgoing class conductor, and line 200 has conductor 314, line 201 has conductor 315 and line 202 has conductor 316 as its individual incoming class conductor.

In the manner described in connection with Fig. 1 there is provided, common to the lines of the exchange a plurality of potential leads to which the individual class conductors of the different lines are connected in different combinations. Thus in Fig. 3 there are the four potential leads 306, 307, 308 and 309. Lead 306 is at zero potential, being connected to ground, lead 307 may be at twenty volts potential, lead 308 may be at forty volts potential and lead 309 may be at sixty volts potential, though it should be understood that these particular values are merely provisional and illustrative of the invention and applicant is not to be restricted to the use of such values only. Now it will be noticed that lead 207 is connected to lead 308 and lead 314 is connected to lead 307 and hence line 200 is provided with class 2 service according to the classification explained in connection with Fig. 1. In like manner leads 209 and 315, individual to line 201 are connected to potential leads 309 and 306 respectively and thus line 201 is provided with class 1 service. Line 202 is provided with class four service through the connection of its leads 208 and 316 to potential leads 306 and 309 respectively.

In this system a line is marked as idle through the direct connection of ground to its terminal associated with brush 304 and marked as busy through the entire absence of ground potential or the connection of ground through a resistance to the same terminal. Thus line 201 shown in its idle condition is so marked through the maintenance of a connection from ground brush 213, conductor 215, terminal 312. At a certain stage of the operation of switch when brush 213 is on its second terminal conductor 215 will be free from ground and at this stage a connection being established to line 201 will be barred. Likewise when switch 204 is in any other position a connection, which will be established in a manner to be hereinafter described, will extend

from ground, brush 213 any one of its terminals from the third on, the middle left hand armature and front contact of relay 216, resistance 217, conductor 215 and thence to terminal 312 and in consequence whereof seeking connections will be barred.

When the subscriber at station 200 removes his receiver from its switchhook he will create a bridge across the line whereby a connection will be established from ground and battery, winding armature and back contact of magnet 205, switch brush 222 and its first contact, thence in series through the two windings of relay 206 the back contact and outer left hand armature of relay 206 through the loop of the line 200, inner left hand armature and back contact of relay 206 conductor 218, armature 310 and its back contact controlled by relay 318, back contact and inner left hand armature of relay 317 to ground. This connection results in the energization of relay 206, and upon the energization of relay 206 and not until then, the energization of magnet 205. Due to the high resistance of the left hand winding of relay 206 only relay 206 can become energized in the circuit established by the removal of the receiver at the substation and thus relay 206 acts as a line relay. Upon the movement of the armatures of relay 206 a circuit is established from ground, battery, winding armature and back contact of magnet 205, brush 222 and its first contact, right hand low resistance winding of relay 206, inner right hand armature and front contact of relay 206 to ground whereby relay 206 is maintained energized although its original energizing circuit is opened at its outer left hand armature. This circuit however now includes magnet 205 in a low resistance path and so magnet 205 becomes energized and thereby moves the brushes 220 to 224 inclusive onto their second contacts. Upon the energization of magnet 205 its energizing circuit is opened at its own back contact and therefore both magnet 205 and relay 206 become deenergized.

Now relay 206 becomes again energized in the original energizing circuit since the first and second contacts associated with brush 222 are connected together and so in the manner described magnet 205 will consequently be energized a second time and will move the brushes of switch 203 forward onto their third contacts. In a manner which will appear hereinafter if brush 222 does not at this point engage a terminal which has full battery potential thereon relay 206 will become deenergized. Assuming this to be the case then a circuit will be established from ground, brush 223, any one of its terminals including and from the third on, the middle right hand armature and back contact of relay 206, back contact, armature and winding of magnet 205 to battery and ground. Magnet 205 being thus included in a self interrupting circuit will move the brushes forward step-by-step until brush 222 encounters a terminal having full battery potential thereon. At this time a circuit will be established from ground and battery back contact and left hand armature of relay 329, back contact and right hand armature of relay 225 resistance 226, conductor 227, brush 222, through the two windings in series of relay 206 and thence over the original energizing circuit of relay 206. Relay 206 attracts its armatures and establishes itself in a locking circuit including its right hand low resistance winding, its inner right hand armature and front contact to ground. Thus relay 206 performs the function of a test relay to determine the busy or idle condition of the connecting link. Having thus chosen the first idle link relay 206 becomes energized and stops the further movement of the brushes of switch 203 by opening the circuit for magnet 205 at the middle armature and back contact of relay 206. This relay now, by locking in a circuit extending into the selected link, performs the function of a cut off relay since at its left hand armatures it disconnects the line 200 from the original energizing circuit of relay 206 and extends the line to brushes 220 and 221.

An idle link circuit being now selected the line from station 200 is now extended through the brushes 220 and 221, through the windings of differential relay 227′ and the left hand and middle windings of relay 228 to battery and ground on the one hand and to ground on the other. Relay 227′ being differentially wound does not become energized but relay 228 not being so wound does become energized whereupon a circuit is established from ground right hand armature and back contact of relay 227′, outer right hand armature and front contact of relay 228, winding of slow-to-release relay 229 to battery and ground. Relay 229 attracts its armatures and connects battery to resistance 226 independently of the armatures of relays 329 and 225 so as to maintain relay 206 energized under control of the calling subscriber. Since relay 206 is now connected through its low resistance winding to conductor 227 and on account of the resistance 226 another hunting individual line switch will pass this point as busy because another relay 206 will not energize in parallel with the low resistance right hand winding of the relay 206 which is holding the connection.

The connection having now been extended to a link circuit will be further extended by means of a non-numerical switch indicated in Fig. 3 to the apparatus used in establishing the by-path connection. In a

system of this size two such connecting means may be supplied, one of which is indicated in full in Fig. 3 and the other of which is indicated in part in the small rectangle enclosed in the broken lines in the upper part of Fig. 3. The second of these is indicated for the purpose of showing the interrelation of the two and the several guards that are provided to prevent interference.

As will appear more fully hereinafter the motor magnets of the various non-numerical switches are connected in parallel. Thus magnet 325 having control of brushes 330, 331, 332 and 333 is connected in parallel with motor magnet 324 having control of similar brushes in the second group of apparatus.

Hereinbefore a circuit was traced through armature 310 of relay 318 to the inner left hand armature of relay 317 and thence to ground. Relays 317 and 318 are corresponding relays in these two groups of apparatus and when either one is energized this circuit is opened and the line relays of other calling lines are prevented from operating at that time. Relay 318, as will be seen hereinafter is a controlling relay which is energized for a short interval of time during which it is necessary that further operations of the circuit be temporarily halted. Thus the outer left hand armature of relay 317 and armature 327 of relay 318 are connected in parallel and both connect ground to conductor 328 to cause the energization of relay 329. Relay 329 is a multi-contact relay controlling a plurality of leads equal in number to the number of link circuits provided in this system. Thus the innermost left hand armature of relay 329 is seen to be connected into the apparatus associated with the particular link circuit here illustrated. In a similar manner the other armatures of relay 329 may be connected into the apparatus of other link circuits, so that when either relay 318 or 317 is energized and consequently relay 329 is energized, the battery connection to the test contacts of all link circuits is broken and the link circuits are marked during this instant as busy.

During the operation of relay 318 a circuit is established from ground, the outer right hand armature of relay 318, through the right hand winding of relay 320 to battery and ground to maintain the energization of this relay. In a similar manner during the energization of relay 317 a circuit is established from ground, the right hand armature of relay 317, the right hand winding of relay 319 to battery and ground to maintain the relay 319 energized during this interval. As will be seen hereafter, relay 319 controls an essential testing operation and since such testing operation must not be made while relay 317 for instance, of the second group of apparatus is operated, the operation of relay 317 provides means for holding up the testing operation in the circuit above illustrated.

It should be noted that the switch comprising wipers 330 to 333, inclusive is of that type having no normal position so that the wipers when once brought to rest remain at that point until moved in consequence of another call.

Upon the extension of the telephone line to the link circuit of Fig. 2 and the consequent energization of relay 228, a circuit is established from ground through the right hand winding of relay 228, the inner right hand armature and front contact of relay 228, armature and back contact of relay 231, conductor 232, outer left hand armature and back contact of relay 334, back contact armature and winding of magnet 325 to battery and ground. As has been mentioned hereinbefore, magnet 324 is energized in parallel with magnet 325 but we will assume that magnet 325 is successful in bringing its brushes into contact with the calling line circuit first and thus establishing the required connection. The establishment of the circuit just described places magnet 325 in a self-interrupting circuit and hence this magnet will energize and deenergize in sequence and move the brushes 330 to 333, inclusive, forward step by step. When the calling link circuit has been reached a circuit will be established from battery, back contact and armature of release magnet 335, the two windings of relay 334 in series, brush 330 and its third contact, conductor 336, outer left hand armature and back contact of relay 225, left hand winding of relay 230, front contact and inner left hand armature of relay 228, winding of relay 231, right hand armature and front contact of relay 229 to ground. In this circuit relays 334, 231 and 230 become energized. Relay 334 opens the energizing circuit of magnet 325 and relay 231 opens the energizing circuit of the other magnets 324 and 325. Through the movement of its inner left hand armature, relay 334 short-circuits its right hand high resistance winding and marks the link circuit seized as busy. At its inner right hand armature, relay 334 prepares an energizing circuit for the primary and secondary magnets of the numerical switch. Relay 231 locks in a circuit from ground, front contact and right hand armature of relay 229, winding of relay 231, front contact and left hand armature of relay 231, left hand winding of relay 230, back contact and outer left hand armature of relay 225 and thence to battery through the left hand winding of relay 334. In this circuit relay 231 becomes energized independent of the inner left hand armature of relay 228 so that upon the move-

ment of this armature during the sending of impulses, relay 231 will not be affected. The circuit is now in a stable condition awaiting the sending of impulses from the calling substation.

In order to connect to station 201, two trains of impulses will be sent. These impulses are in the form of short interruptions at the calling subscriber's loop circuit and they each result in the momentary deenergization of relay 228.

At each backward movement of the armatures of relay 228, a circuit is established from ground, back contact and left hand armature of relay 227', outer left hand armature and back contact of relay 228, conductor 233, brush 332, left hand winding of relay 319, the inner right hand armature and front contact of relay 334, the outer left hand armature and back contact of relay 337, winding of primary magnet 338 to battery and ground. In this manner magnet 338 becomes successively energized a number of times and moves the brushes 300, 304 and 305 forward in a primary direction a corresponding number of steps. Upon the first movement of the brushes 300, 304 and 305, the off-normal contact device 339 is actuated so that four pairs of contacts controlled thereby are all closed. At the end of this series of impulses and after a short interval slow-to-release relay 319 becomes deenergized whereupon a circuit is established from ground, the right hand armature and back contact of relay 319, winding of relay 337, the uppermost pair of contacts of off-normal device 339 to battery. Relay 337 thus becomes energized and through its inner left hand armature locks up in a circuit independent of the armature and contact of relay 319. Shortly thereafter the calling subscriber may send the second series of impulses whereupon magnet 340 will be energized instead of magnet 338 due to the switching of the circuit at the outer left hand armature of relay 337. Magnet 340 moves the brushes 300, 304 and 305 in a secondary direction a number of steps corresponding to the number of impulses in the train now sent out from the calling subscriber's substation. In consequence thereof the brushes 300, 304 and 305 are moved to connection with terminals 311, 312 and 313, respectively.

It will be noted that relay 319 is slow to release and that it remains energized throughout the sending of a train of impulses. During the energization of relay 319, relay 341 is energized in a circuit extending from ground, the right hand armature and front contact of relay 319, winding of relay 341 to battery and ground. Relay 341 is also slow to release, therefore at the end of this last series of impulses, relay 319 will first become deenergized and relay 341 will retain its armatures in their actuated position for an instant thereafter. During this instant a test circuit including the polarized relay 343 hereinbefore mentioned is established.

At the beginning of the description of these two figures it was stated that station 200 was provided with class 2 service and that station 201 was provided with class 1 service and that therefore a connection could be established from one to the other. Thus in the present instance upon the release of relay 319 and prior to the release of relay 341, a circuit is established from potential lead 308, resistance 342, conductor 207, front contact and outermost right hand armature of relay 206, brush 224, conductor 235, brush 333, back contact and left hand armature of relay 319, left hand armature and front contact of relay 341, polarized relay 343, brush 305, terminal 313, resistance 344, potential lead 306. Since relay 343 is included in a circuit from a given potential of 60 volts to a loading potential of 0 volts and since this relay is arranged to respond only to current in a circuit from a lower to a higher potential, the establishment of the present circuit results in the non-operation of relay 343. The armature of relay 343 under the present condition would tend to operate in a clockwise direction but since it is normally held in this position it cannot move further and the net result is the non-operation of the relay.

Very shortly thereafter, relay 341 moves its armatures to their normal position whereupon a circuit is established from battery, the right hand armature and back contact of relay 341, back contact and next to the innermost right hand armature of relay 318, right hand winding of relay 345, brush 304, terminal 312, conductor 215, and thence to the first terminal associated with brush 213. If station 201 is idle, as we will assume it to be, brush 213 will rest on this first terminal and thus complete the circuit to ground, whereupon test relay 345 will become energized. If, as hereinbefore described, brush 213 is at another position then the resistance 217 will be included in the circuit and the current flowing through the test circuit will be insufficient to cause the energization of relay 345.

Upon the energization of the test relay 345 a circuit is established from ground, the front contact and inner left hand armature of relay 345, winding of relay 318 and through the off-normal contact device 339 to battery, whereupon relay 318 attracts its armatures and locks up in a circuit including its inner right hand armature and front contact, thereby becoming independent of the continued energization of relay 345.

Several results of the energization of relay 318 have been given hereinbefore and

so will not be repeated at this time. Additional results include the removal of the short circuit about the left hand high resistance winding of relay 345 at the next to the innermost right hand armature and back contact of relay 318, whereupon relay 345 may remain energized when resistance 217 is introduced into its circuit. Through the movement of its left hand armature, relay 318 connects battery through the brush 331, conductor 236, and thence through the left hand low resistance winding of relay 225 so as to raise the potential of conductor 227′ to the point where this link circuit may be seized by a hunting line switch. At the same time in order to prevent any other hunting line switch from seizing this circuit, relay 329 is energized in the manner hereinbefore described to remove battery potential from all other idle link circuits so that now among the link circuits the particular one here is the only one which may be seized. Simultaneously, therewith, a circuit is established from ground, armature 346, and its associated front contact, brush 300, terminal 311, conductor 237, both windings of relay 216 in series, brush 212 and its first contact, back contact, armature and winding of magnet 238 to battery. The connection of ground to conductor 237 causes the switch 204 to hunt in the manner hereinbefore described in connection with switch 203 and since the link circuit characterized by substantially full battery potential on test wire 227 is now the only one available, switch 204 will inevitably come to rest on its terminals.

As brush 213 passes on to its second contact the circuit for relay 345 is opened whereupon it releases its armatures. A circuit is now established from ground, armature 347 and its associated front contact, outermost left hand armature and back contact of relay 345, winding of relay 348, through the off-normal contact device 339 to battery. Relay 348 becomes energized in this circuit and locks up through its front contact and innermost left hand armature independently of the outermost left hand armature and relay 345.

When the line switch 204 of line 201 comes to rest on the terminals of the link circuit involved in this connection, cut-off relay 216 will become permanently energized whereupon a circuit will be established from battery, right hand armature and back contact of relay 341, the left hand high resistance winding and right hand low resistance winding of relay 345, brush 304 terminal 312, conductor 215, resistance 217, front contact and middle left hand armature of relay 216, third contact and wiper 213 to ground. The completion of this circuit is a signal that the connection has been completed between substation 200 and substation 201 and that the by path connection may be released. Hence relay 345 becomes energized and establishes a connection from ground front contact and outer left hand armature of relay 348, middle left hand armature and front contact of relay 345, winding of release magnet 335 to battery. Magnet 335 becomes energized and returns the brushes 300, 304 and 305 to normal and the off-normal device 339 opens its contacts with the result that relays 337, 318, 348, 345 and lastly magnet 335 become deenergized. During the energization of magnet 335 the holding circuit of relay 334 is opened and this relay returns to normal thus closing the circuit for magnet 325 so that the brushes 330 to 333 may be stepped into association with another link circuit upon the initiation of another call. During the energization of magnet 335 relay 230 which was held in series with relay 334 becomes restored so that upon the deenergization of magnet 335 neither of these relays become again energized. Thus relays 228, 229, 225 and 231 of the link circuit remain energized and all others are restored.

The called substation is signaled by the subscriber at substation 200 rapidly manipulating his receiver hook or by working his impulse dial. The making and breaking of the circuit including the source of talking current rapidly changes the potential across the condenser at substation 201 and the charge and discharge of this condenser causes the operation of the substation bell. This method of signaling the called subscriber has been found in practice to be successful and although other methods may be used in this system since this operation forms no part of the present invention then for the sake of simplicity such other methods will not be described.

When the called party answers talking current for both parties is supplied through the windings of relay 228. At the end of the conversation when both parties hang up their receivers relay 228 becomes deenergized and this is followed by the deenergization of relays 229, 231 and 225. Battery being removed from conductor 227, relays 206 and 216 return to normal.

A circuit is now established from battery winding, armature and back contact of magnet 205, back contact and middle right hand armature of relay 206 brush 223 to ground whereupon magnet 205 will drive the brushes 220 to 224 completely around until they reach normal position when brush 223 opens the circuit above described.

In a similar manner switch 204 is returned to normal.

In a manner entirely similar to that herein described a successful connection can be established between station 201 as a calling station and station 200 as a called station. Under such a condition the circuit for relay

343 would extend from potential lead 309, resistance 349, conductor 209, front contact and outer left hand armature of relay 216, brush 214 and its third contact, conductor 235, brush 333, back contact and left hand armature of relay 319, front contact and left hand armature of relay 341, relay 343, brush 305, terminal 303 (individual to line 200), conductor 314, resistance 350, to potential lead 307. Under this condition relay 343 is included in a circuit from a higher potential (60 volts) to a lower potential (20 volts) and hence will not operate.

If however, a call is attempted from substation 200 to line 202 relay 343 will be included in a circuit from potential lead 308, resistance 342, conductor 207, front contact and outer right hand armature of relay 206, brush 224 and its third contact conductor 235, brush 333, back contact and left hand armature of relay 319, left hand armature and front contact of relay 341, relay 343, brush 305 terminal 323 (individual to line 202) conductor 316 resistance 351 to potential lead 309 and since relay 343 is now included in a circuit from a lower potential (40 volts) to a higher potential (60 volts) it becomes energized. This has two results; first a connection is established from ground armature and contact of relay 343, secondary winding of busy tone transformer 352 front contact and outer left hand armature of relay 334, conductor 232 back contact and right hand armature of relay 231, front contact, inner right hand armature, and right hand winding of relay 228 to ground, whence by induction busy tone is transmitted to the calling station to apprise the subscriber thereat that a connection to line 202 cannot be had. Secondly the energization of relay 343 results in the establishment of a connection from ground, armature and front contact of relay 343 winding of release magnet 335 whereupon the release of the common apparatus takes place as before described.

Should a connection be set up between line 202 and line 200, relay 343 will be included in a circuit from conductor 306, resistance 353, conductor 208, brush 234, conductor 235, brush 333, back contact and left hand armature of relay 319, left hand armature and front contact of relay 341, relay 343, brush 305, terminal 303 (individual to line 200) conductor 314, resistance 350 to potential lead 307, whereupon relay 343 will become energized with the same results hereinbefore described.

Where the called line is found busy relay 345 fails to operate as hereinbefore set forth. As a result relay 318 remains unoperated and the line switch of the called line is not disturbed. The calling subscriber will after a while hang up his receiver thereby directly causing the deenergization of relay 228 and indirectly causing the deenergization of relay 334. The deenergization of the latter relay establishes a circuit from ground, battery, winding of release magnet 335, back contact and outer right hand armature of relay 334, lowermost contact of off normal device 339 to ground. The release magnet is energized and the connection is broken down in the manner hereinbefore described.

What is claimed is:

1. In a telephone system, a plurality of common conductors each connected to a source of current of a different potential, telephone lines, each said line having connection to a plurality of said common conductors to characterize said line as entitled to a specific class of service, means for interconnecting said lines and means included therein responsive to a connection including a source of current connected to the calling line and a source of current connected to the called line for determining the class of service between said lines.

2. In a telephone system, a plurality of common conductors each connected to a source of current of a different potential, telephone lines, each said line having connection to a plurality of said common conductors to characterize said line as entitled to outgoing service of a particular nature and incoming service of a particular nature, means for interconnecting said lines and means included therein responsive to a connection including a source of current connected to the calling line and a source of current connected to the called line for determining the class of outgoing service of the calling line and the class of incoming service of the called line.

3. In a telephone system, a plurality of sources of current each of a different potential, telephone lines, each said line having connection to certain of said sources of current to characterize said line as entitled to a definite class of service, means for interconnecting a calling and a called line and a relay included in said means responsive only to a connection from a source of current of a lower potential connected to said calling line to a source of current of a higher potential connected to said called line for preventing the interconnection of said calling and called lines.

In witness whereof, I hereunto subscribe my name this twenty-eighth day of April, A. D., 1923.

FRITZ LUBBERGER.