

Jan. 9, 1934.

H. D. MacPHERSON

1,943,130

TELEPHONE SYSTEM

Filed Jan. 6, 1933

3 Sheets-Sheet 1

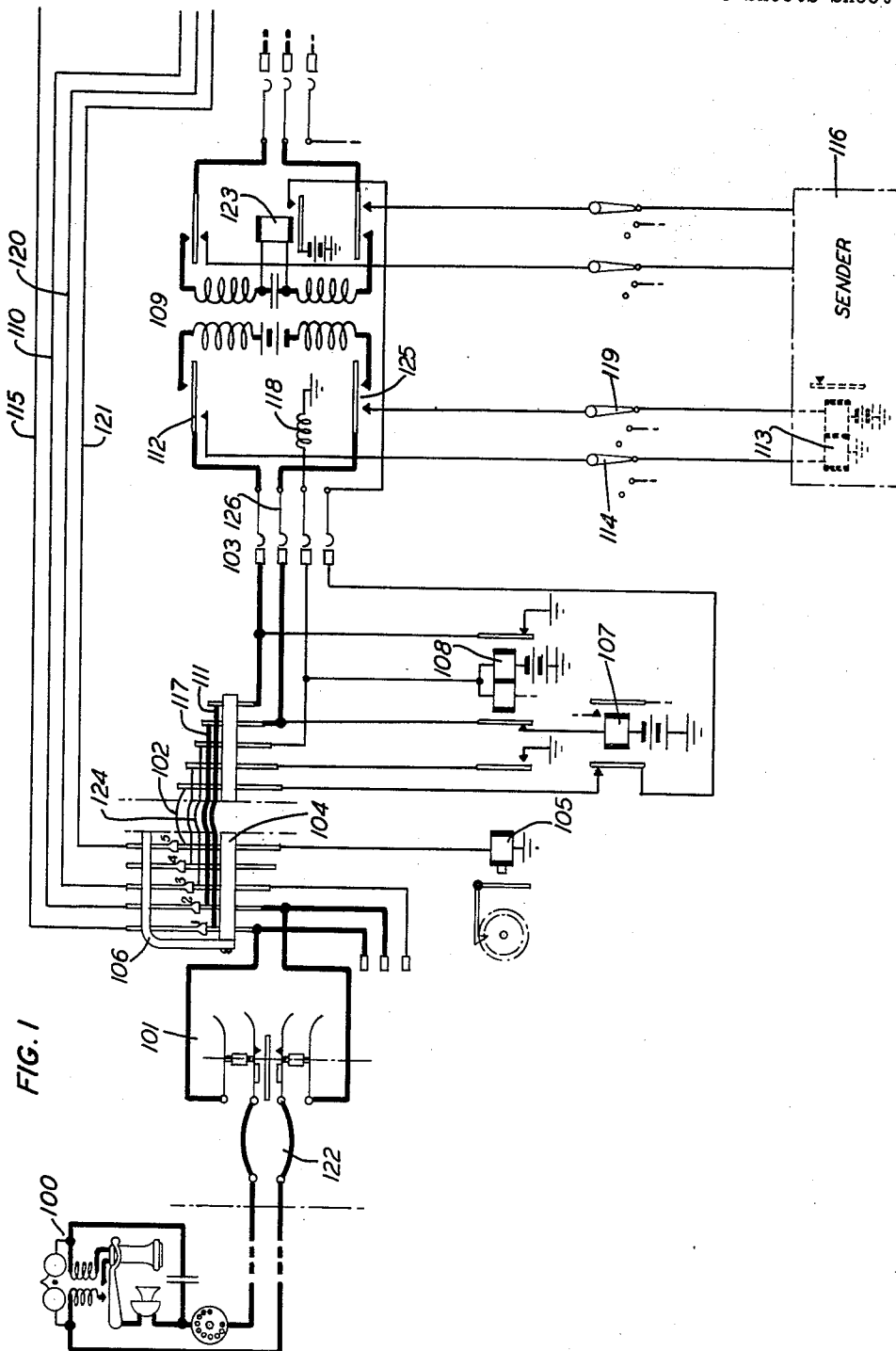


FIG. 1

BY

INVENTOR
H. D. MACPHERSON

P. C. Smith

ATTORNEY

Jan. 9, 1934.

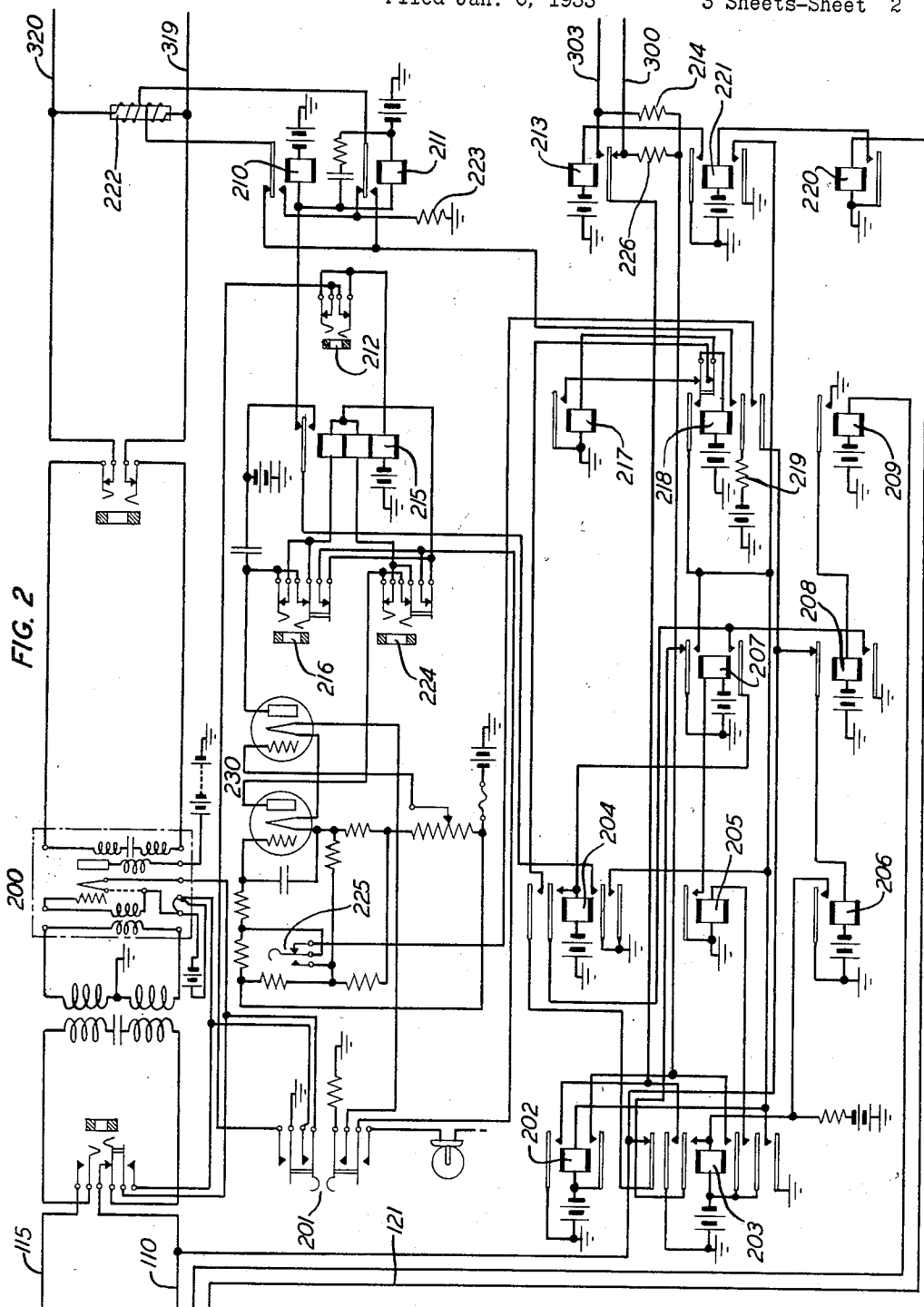
H. D. MacPHERSON

1,943,130

TELEPHONE SYSTEM

Filed Jan. 6, 1933

3 Sheets-Sheet 2



INVENTOR
H. D. MACPHERSON
BY
P. C. Smith

ATTORNEY

Jan. 9, 1934.

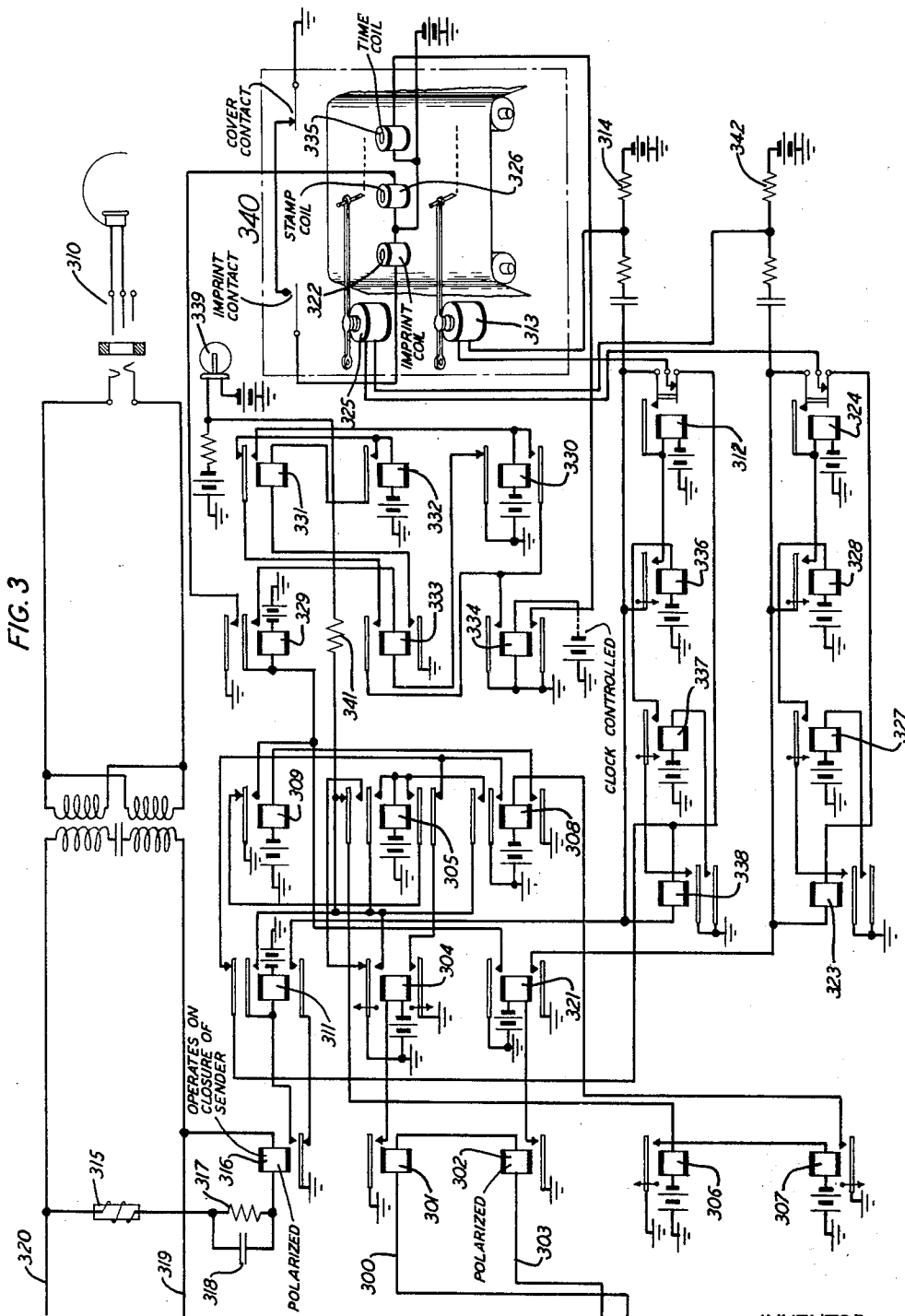
H. D. MacPHERSON

1,943,130

TELEPHONE SYSTEM

Filed Jan. 6, 1933

3 Sheets-Sheet 3



INVENTOR
H. D. MACPHERSON
BY
P. C. Smith

ATTORNEY

UNITED STATES PATENT OFFICE

1,943,130

TELEPHONE SYSTEM

Hugh D. MacPherson, West New Brighton, N. Y.,
 assignor to Bell Telephone Laboratories, In-
 corporated, New York, N. Y., a corporation of
 New York

Application January 6, 1933. Serial No. 650,370

6 Claims. (Cl. 179—175.2)

This invention relates to telephone exchange systems and is more particularly concerned with what is known as service observation equipment, that is, apparatus for studying the quality of service given on a particular subscriber's line and thus enable the investigation of complaints made from that line.

In such systems, where machine switching apparatus is employed at the central office for setting up connections, it sometimes happens that a subscriber will complain of poor service. The substance of these complaints embraces almost the entire range of telephone service and necessarily includes such items as alleged wrong numbers, don't answer calls, overcharges and the like, any or all of which may be due either to the improper use of the calling device or the faulty performance of the central office equipment. It becomes necessary, therefore, when a subscriber complains of poor service, to determine from actual observations on his line whether in fact poor service is actually being rendered and if so, to determine the cause.

Furthermore, in the case of the more serious complaints such as alleged overcharges, it is desirable for the operating company to be in the position of proving to the satisfaction of a subscriber, by means of data automatically gathered when connections are being established and during the periods of conversation, that the telephone calls for which he is being charged were actually made from his station and that the charges for each of said calls are strictly in accordance with the prescribed rate for initial periods and overtime rates for each period after the first or whatever other charging arrangements are prescribed by the tariffs.

The object of this invention, therefore, is to provide a service complaint trunk which, when associated with a subscriber's line, automatically causes a permanent record to be made of signals indicating the start and finish of all calls, the dialing impulses and meter charging operations appertaining to each of said calls, together with an indication of the time when such signals are recorded. The observing operator who supervises the character of the service by listening on the trunk may be located either in the local office where the complaining subscriber's line terminates or in a distant office where the service observation trunks of a group of offices may have been centralized, as is now the well known practice.

In its broadest aspects, therefore, the invention comprises recording means connected to a service complaint trunk which are responsive to two-way

signals, that is, to signals from the subscriber's line in the form of dialing impulses, and signals to the subscriber's line in the form of service charge operations of the calling subscriber's meter. A pen register and a time stamp operate simultaneously on the receipt of a signal, after which the recording tape is moved ahead preparatory to receiving the impressions of additional signals, the tape moving only a short distance after each signal. During conversation, the tape recording mechanism remains stationary, but when the subscriber's meter is operated the circuits for operating the meter cause the operation of the pen register of said recording mechanism to mark the charge and the operation of the time stamp of said recording mechanism to indicate when the charge was made. A record of the time when the call is completed is also made.

A clearer conception of the scope and purpose of the invention may be obtained from a consideration of the following description taken in connection with the attached drawings in which;

Fig. 1 shows a calling subscriber's line arranged for simultaneous connection to an outgoing trunk and to a service complaint trunk extending to a central observation station;

Fig. 2 shows the outgoing portion of said complaint trunk;

Fig. 3 shows the incoming portion of said trunk at the central observation station;

Figs. 1, 2 and 3 should be arranged in consecutive order with respect to each other in order to disclose the invention completely.

Fig. 1 shows the subscriber's line 100 incoming to the central office from whence it extends through the main frame 122 and heat coil protectors 101 to the distributing frames 104 from whence it further extends to the banks of a line finder frame 103. When it is desired to make observations on the quality of service accorded to subscriber 100, for example, a service complaint trunk terminating in a shoe 106 is attached to the line at the incoming end of the distributing frame 104. By means of this shoe the service complaint trunk shown in Figs. 2 and 3 connects the line to be observed with the service observation station.

It will be assumed, therefore, that line 100 is the one on which observations are to be made and that, for this purpose, the service complaint trunk is attached to line 100 at the distributing frame in the manner above described. In part preparation for putting the trunk in a responsive condition for making observations, key 201 of the trunk is operated to close the filament circuit to the

monitoring amplifier 200, shown interposed between the talking conductors of the service complaint trunk. When, therefore, the subscriber 100 removes his receiver from the switch-hook, line relay 107 operates in the well known manner and, through the closure of its right contacts, starts the operation of the group and start circuit to cause a line finder of a line finder district selector 109 to operate and hunt for the terminals of the calling line on the line finder frame 103. At the time line relay 107 is operated, another circuit is closed in parallel with it extending from battery through the winding of relay 206, top contacts of relay 208, conductor 110, contact No. 2 of shoe 106, lower heat coil, subscriber's loop, upper heat coil, contact No. 1 of shoe 106, jumper conductor 111, right contacts of cut-off relay 108, to ground. Relay 206 operates and closes an obvious circuit to the winding of relay 203 which operates. Relay 203 closes a circuit from ground on its top middle contacts, back contact of relay 213, conductor 300, winding of relay 301, winding of relay 302, conductor 303, resistance 214, bottom inner contacts of relay 203, to battery. Relay 301 operates in this circuit but relay 302, being polarized, does not operate because the current flow is not in the required direction. Relay 301, in operating, performs functions hereinafter described.

Relay 203 locks over its top inner contacts to ground on the top back contact of relay 207, closes an obvious circuit to the winding of relay 205 and another to the winding of relay 202. Both of these relays operate; relay 205 further closing a circuit to operate relay 207 while relay 202 closes supplementary ground and battery supply to the trunk signaling conductors 300 and 303 to hold relay 301 operated should relay 203 release prematurely as described hereinafter.

In the meanwhile the line-finder has been in operation and moved its brushes upward to find the terminals of the calling line on the line-finder frame 103 after connection with which relay 108 is operated and relay 107 released. The ground supply in the line-finder district selector which was closed through a circuit including a relay element 118 to operate relay 108 is further extended in parallel through jumper conductor 124, shoe contact No. 3, sleeve conductor 120, winding of relay 209 to battery. Relay 209 operates and closes an obvious circuit to operate relay 208 which, in operating, opens the circuit of relay 206 causing it to release, and further closes a circuit from ground through its bottom contacts, bottom contacts of relay 207, winding of relay 204, to battery, thereby operating this relay which, in turn, locks through its top inner contacts to operating ground on the contacts of relay 208.

The finding of the calling line by the line-finder district selector further causes the operation of relay 108 as already mentioned and, in consequence, the circuit including relay 107 and relay 203 is opened, thereby causing the release of both of these relays since the locking circuit of relay 203 is opened by the operation of relay 207. Hence, if relay 203 should release and open the previously described circuit of relays 301 and 303, as it will when the line-finder becomes connected to the terminals of the calling line, the previously described supplemental circuit from the contacts of relay 202 will preserve the circuit of these relays intact in order that relay 301 may perform the functions to be described hereinafter.

Simultaneously with hunting for the calling line, an idle sender 116 is selected and becomes

associated with the calling line in the well known manner. The attachment of the sender to the subscriber's line causes the pulsing relay 113 in the sender to be connected in the known manner over the subscriber's loop in readiness to receive dial impulses. Due to the attachment of the special complaint trunk to the subscriber's line, however, a supplementary circuit is closed in parallel to relay 113 which extends as follows: battery through the right winding of relay 113, sender selector connecting brush 119 and terminal, contacts 125, line-finder brush 126 and associated terminal, jumper conductor 117, shoe contact No. 2, conductor 110, top outer contacts of relay 203, top outer contacts of relay 204, inner upper normal contacts of relay 218, winding of relay 217, to battery. Relay 217 operates and, in turn, closes a circuit for operating relay 218 which extends from ground through its contacts, top normally made contacts of relay 218, winding of relay 218 to battery. Relay 218 operates, locks through its top alternate contacts to ground on the bottom outer contacts of relay 204 and the top front contacts of relay 207 and, over its bottom inner contacts closes a circuit extending from battery, through resistance 219, bottom inner contacts of relay 218, top back contacts of relay 210, bottom winding of retard coil 222, conductor 319, winding of polarized relay 316, parallel combination of resistance 317 and condenser 318, winding of retard coil 315, conductor 320, top winding of retard coil 222, back contacts of relay 211, resistance 223 to ground. The direction of this current is such as to operate relay 316 which, in operating, performs functions hereinafter noted. Through its bottom outer contacts, relay 218 connects conductor 110 through normal contacts of key 225 to the grid element of the dial impulse detector 230 for detecting the dialing of impulses transmitted over the subscriber's line.

In the meanwhile the operation of relay 301 closes an obvious circuit to operate relay 304. Relay 304 operated (1) closes a circuit from battery through lamp 339, resistance 341 to ground through the top front contacts of relay 304, thereby lighting said lamp to indicate that a call has been started on the line under observation, and further signal the observing operator to plug the receiver headset 310 into the trunk jack, (2) closes a circuit for relay 306 extending from battery through the winding of relay 306, top outer back contacts of relay 305, to ground through the top front contacts of relay 304. Relay 306 operated closes an obvious circuit for operating relay 307 while relay 307 operated closes an obvious circuit for operating relay 308. Relay 308 operated (1) closes a circuit from ground on the top front contacts of relay 304, top outer contacts of relay 308, winding of relay 305, to battery, and (2) over its bottom contacts, closes an obvious circuit for relay 309. Relay 305 operates and locks to operating ground through its top inner contacts, to ground on the top contacts of relay 304, and opens the circuit of relay 306 which, after an interval, releases and further causes the release of relay 307 while relay 307, when released, causes the release of relay 308. But before relays 306, 307 and 308 have time to release, however, a circuit is closed extending from ground through the top inner contacts of relay 308, top outer contacts of relay 311, normal contacts of relay 312, winding of pen register magnet 313, resistance 314 to battery. Magnet 313 operates and actuates the pen register mech-

anism in the well known manner in preparation for registering on the associated tape whatever impulses are transmitted over the subscriber's line as more fully described hereinafter.

5 The pen register mechanism contemplated as a part of the signaling equipment of the service complaint trunk comprises two separate recording pen mechanisms with their associated actuating magnets 313 and 325. The associated pen
10 recorders register on the same tape, but on different lines thereof, the separate signals which each of them is designed to register. The pens are spaced sufficiently wide apart to permit the accommodation between them of a commercial
15 time stamp, schematically shown as 340, and the tape is of sufficient width to permit impressions from the three separate mechanisms so that, in the manner described hereinafter, the same tape will contain on one line thereof the pen impres-
20 sions made by the pen controlled through magnet 313, on the next the record of the time when some of these impressions are made and, on the third line, the record of the pen registrations made by the pen controlled through the magnet 325, the
25 middle space again having stamped thereon the time when these other registrations are made. The pen register 313 records the start and the termination of the call together with the dial impulses transmitted over the subscriber's line, while pen register 325 records the operation of
30 the subscriber's meter, all in accordance with the operations described hereinafter.

In the meanwhile, when relay 309 operated, a circuit was closed to the winding of relay 329.
35 Relay 329 operated, connects ground through its outer contacts to the stamp coil 326 of the time stamp to impress on the tape the time at which the call was started, and over its inner contacts, extends the ground from the front contact of relay 309 to the winding of relay 333 which, how-
40 ever, is now short circuited to ground on the back contact of relay 330. When relay 309 releases in the sequence of the release of relays 306, 307 and 308, the short circuiting ground through the con-
45 tacts of relay 309 is removed and relay 333 now operates over a circuit extending from ground at the back contact of relay 330, winding of relay 333, top inner contacts of relay 329 winding of relay 329 to battery. Relay 333 operates and locks
50 in series with relay 329 in the above circuit. Relay 333, over its top contacts, now connects the top front contact of relay 334 to the back contact of relay 331. Now relay 334 is connected directly to any suitable time-clock circuit such, for ex-
55 ample, as is maintained in a telephone office. From this circuit it receives impulses of 24-volt battery every six seconds. Hence, when relay 334 operates it completes a circuit from ground on its bottom contacts to the winding of the sec-
60 onds time coil 335 which, on operating, advances the seconds hand 6 seconds or one-tenth of a minute. Relay 334, when thus operated from the clock impulses, further closes another circuit which extends from ground on its top contacts,
65 top contacts of relay 333, back contact of relay 331, winding of relay 332 to battery. Relay 332 operates and closes a locking path through its contacts, winding of relay 331 to ground on the bottom contacts of relay 333. Relay 331 remains
70 short circuited in this locking circuit by ground over the top contacts of relay 334. When relay 334 releases at the termination of the clock controlled impulse, relay 331 operates in the locking circuit of relay 332. The next operation of relay
75 334 closes a circuit extending from ground on its

top contacts, top front contacts of relay 333, wind-
ing of relay 330 to battery. Relay 330 operates, locks to the top contacts of relay 334, and causes the release of relays 333, 329, 331 and 332 thus
80 providing an interval of 6 seconds which will be greater than the time between successive time stamping signals thereby insuring but one imprint of the time stamp on the tape. Should relay 309
85 operate a second time after once operating relay 329, this second closure to the winding of relay 329 will shunt down relay 333, opening the locking circuit of relays 331 and 332 thereby releasing them. Upon the release of relay 321, relay 333 reoperates and provides a circuit for operat-
90 ing relay 332 from relay 334 as previously described.

When relay 316 operates as described above, it closes an obvious circuit for operating relay 311. Relay 311 locks through its top inner contacts to ground on the top front contacts of relay 304
95 and, over its top outer contacts, opens the circuit of the pen register magnet 313, releasing said magnet and causing the pen to be lifted from the recording tape.

When the subscriber's dial is transmitting im-
100 pulses into the sender in the well known manner, the dial recording circuit 230 causes the operation and release of relays 210 and 211 through the control of relay 215 in the known
105 manner, thereby reversing the direction of current through relay 316. Relay 316 releases during the open period of the impulse. In its released condition, it closes a circuit from ground through its back contacts, bottom contacts of relay 311, winding of relay 338, normal contacts
110 of relay 312, winding of pen register magnet 313 resistance 314, to battery. The pen register operates to register the impulse and relay 338 operates in series with said magnet. Relay 338 closes an obvious circuit for relay 337 which op-
115 erates and the latter further extends a circuit from ground on the inner contacts of relay 338, contacts of relay 337, winding of relay 336 to battery. Relay 336 operates and connects the
120 impulsing ground on the back contacts of relay 316 to the winding of relay 312. If, now, at the time relay 312 operates, the impulse has not yet terminated so that relay 316 is still released, the connection from ground on the back contact
125 of this relay is extended through the contacts of relay 312 to the winding of this relay. Relay 312 holds through its top contacts to ground on the back contacts of relay 316 and, after having
130 made its top contacts, further opens its normal contacts to release magnet 313 of the pen register. If, on the other hand, the impulse should
135 terminate at any time after the circuit to the pen register magnet is closed, the circuit of said magnet is opened at the back contacts of relay 316 in consequence of which the pen is released
140 from the tape, relay 338 is released and the time counting chain comprising relays 337 and 336 is not operated. In this manner, insurance is provided against any abnormality by which
145 relay 316 might remain on its back contact for too long a period, in which event the circuit to the pen register magnet would remain closed thereby causing wastage of registering tape which, through a clock mechanism responsive to the operation of the magnet, advances the tape
150 when the magnet is operated.

As each impulse is transmitted, relay 316 correspondingly releases and reoperates and, in turn, causes an operation and release of the pen register magnet 313 for recording on the tape

the impulses thus received; the operation continuing until all the dial impulses have been transmitted and thus recorded.

After the dialing is completed and the called line is properly selected, ringing takes place in the known manner. If the called party answers, relay 123 of the district selector is operated in the known manner which then closes a circuit from battery through its contacts, bottom brush and associated terminal on line finder bank 103, back contact of relay 107, jumper wire 102, winding of message register 105, to ground. This battery closure in the district selector also closes a parallel circuit through shoe contact No. 5, conductor 121, winding of relay 220 to ground. Relay 220 operates and closes an obvious circuit to operate relay 221 which, through its upper contacts, closes a circuit to operate relay 213. Relay 213 operates and reverses the direction of current flowing in a previously traced circuit including relays 301 and 302, and in which reversal, resistance 226 replaces the resistance 214. The current in this circuit now flows in a direction to operate relay 302. Relay 302 operated closes a circuit for operating relay 321. Relay 321 operated closes a circuit extending from ground through its lower contacts, winding of relay 323, normal contacts of relay 324, winding of the second pen register magnet 325, resistance 342, to battery. Magnet 325 operates and causes its cooperating pen mechanism to register on the same tape, but on a different line thereof, an impulse which records the fact that the calling line message register has been properly operated.

Over its top contacts relay 321 further closes a circuit from ground to the winding of relay 329 causing this relay to operate and start that series of operations by which the time stamp is operated at the time pen register 325 records the message registration, the operations being identical to those previously described and started when relay 309 was operated at the start of the call. Relay 323 causes the operation of relays 327, 328 and 324 in the same way and for a similar purpose as relay 338 caused the operation of relays 339, 340 and 312.

During conversation, no records are made, but the fact that the service operator has the receiver headset connected to the talking conductors of the complaint trunk and which conductors, through amplifier 200 are, in turn, bridged to the talking conductors of the established connection between the two subscribers, enables the operator to verify the quality of the transmission or whether, in fact, the proper called subscriber was reached in accordance with the dialed impulses.

On the completion of the call, the restoration of the calling subscriber's receiver to the switch-hook and the consequent release of the line finder district selector 109 opens a previously described circuit including the winding of relay 209 which in releasing, releases relay 208. Relay 208 in turn releases relay 204, which further causes relay 202 to release. The release of relay 202 opens the circuit including relays 301 and 302. Relay 301 releases, in turn releasing relay 304. Relay 305, however, does not release at this time, it being provided with a locking circuit through its bottom contacts to ground on the back contacts of relay 309. A circuit is now closed for relay 306 extending from battery through its winding, top outer front contacts of relay 305,

top back contacts of relay 304 to ground. Relay 306 operates, in turn, operating relay 307. Relay 307 closes an obvious circuit for relay 308 which likewise operates and causes, in turn, the operation of relay 309. The operation of relay 309 opens the locking circuit of relay 305 which releases, in turn releasing relay 311. It further operates relay 329 which, in its turn, causes the operation of the time stamp 340 over a previously described circuit to register the time of the termination of the call. The circuit of pen register magnet 313 is now completed from battery, resistance 314, winding of magnet 313, normal contacts of relay 312, top back contacts of relay 311, top inner contacts of relay 308 to ground. The magnet operates and causes the pen to register the termination of the call. The release of relay 305 opens the circuit of relay 306 which, after an interval, releases. Relay 306 releases relay 307. Relay 307 releases relay 308, which, in turn, releases relay 309 thereby restoring the trunk to normal.

What is claimed is:

1. In a telephone system, a calling subscriber's line having switching control means and a call charging device, a called subscriber's line, means controlled by said switching control means to establish and disestablish a connection from said calling line to said called line, means for operating said charging device upon the response of said called subscriber, and a service complaint trunk associable with said calling line, said trunk having a tape recording means comprising means for recording signals transmitted by said switching control means, means for recording signals indicative of the operation of said charging device and means for recording the time when said signals are recorded.

2. In a telephone system, a calling subscriber's line having an impulsing device and a call charging device, a called subscriber's line, a service complaint trunk associable with said calling line, means responsive to the initiation of a call on said calling line to transmit a start signal to said trunk, means controlled by said impulsing device to establish a connection from said calling line to said called line and to transmit impulsing signals to said trunk, means for operating said charging device and for transmitting a charging signal to said trunk upon the response of said called subscriber, means responsive to the termination of the connection by the calling subscriber to transmit a termination signal to said trunk and recording means in said trunk for making a permanent record of all of said signals.

3. In a telephone system, a calling subscriber's line having an impulsing device and a call charging device, a called subscriber's line, a service complaint trunk associable with said calling line, means responsive to the initiation of a call in the calling line to transmit a start signal to said trunk, means controlled by said impulsing device to establish a connection from said calling line to said called line and to transmit impulsing signals to said trunk, means for operating said charging device and for transmitting a charging signal to said trunk upon the response of said called subscriber, means responsive to the termination of the connection by the calling subscriber to transmit a termination signal to said trunk and a recording means in said trunk comprising means for making permanent records of said signals and a time recording means for mak-

ing a record of the time when certain of said signals are recorded.

4. In a telephone system, a calling subscriber's line having an impulsing device and a call charging device, a called subscriber's line, a service complaint trunk associable with said calling line, means responsive to the initiation of a call in the calling line to transmit a start signal to said trunk, means controlled by said impulsing device to establish a connection from said calling line to said called line and to transmit impulsing signals to said trunk, means for operating said charging device and for transmitting a charging signal to said trunk upon the response of said called subscriber, means responsive to the termination of the connection by the calling subscriber to transmit a termination signal to said trunk, and a recording means in said trunk comprising a first pen register for recording said start, impulsing and termination signals, a second pen register for recording said call charging signal and a time stamp for recording the time when said start, call charging and termination signals are recorded.

5. In a telephone system, a calling subscriber's line having an impulsing device and a call charging device, a called subscriber's line, a service complaint trunk associable with said calling line, means responsive to the initiation of a call in the calling line to transmit a start signal to said trunk, means controlled by said impulsing device to establish a connection from said calling line to said called line and to transmit impulsing signals to said trunk, means for operating said charging device and for transmitting a charging signal to said trunk upon the response of said called subscriber, means responsive to the termination of the connection by the calling subscriber to transmit a termination signal to said trunk, and a recording means in said trunk comprising a

single tape, a first pen register for recording on said tape said start, impulsing and termination signals, a second pen register for recording on said tape said call charging signal and a time stamp for recording on said tape the time when said start, call charging and termination signals are recorded.

6. In a telephone system, a calling subscriber's line having an impulsing device and a call charging device, a called subscriber's line, a service complaint trunk associable with said calling line, means responsive to the initiation of a call on said calling line to transmit a start signal to said trunk, means controlled by said impulsing device to establish a connection from said calling line to said called line and to transmit impulsing signals to said trunk, means for operating said charging device and for transmitting a charging signal to said trunk upon the response of said called subscriber, means responsive to the termination of the connection by the calling subscriber to transmit a termination signal to said trunk, a recording means in said trunk comprising a single tape, a first and a second pen register and a time stamp, means responsive to said start signal for operating said first pen register and said time stamp to record on said tape the time when the connection is initiated, means thereafter responsive to said impulsing signals to reoperate said first pen register to record said impulsing signals on said tape, means responsive to said call charging signal to operate said second pen register, and said time stamp to record on said tape the time when said called subscriber responds and means thereafter responsive to said termination signal to reoperate said first pen register and said time stamp to record on said tape the time when the connection is terminated.

HUGH D. MACPHERSON. 115

45	120
50	125
55	130
60	135
65	140
70	145
75	150