

Feb. 4, 1936.

R. L. STOKELY

2,029,683

TELEPHONE SYSTEM

Filed Aug. 3, 1934

7 Sheets-Sheet 1

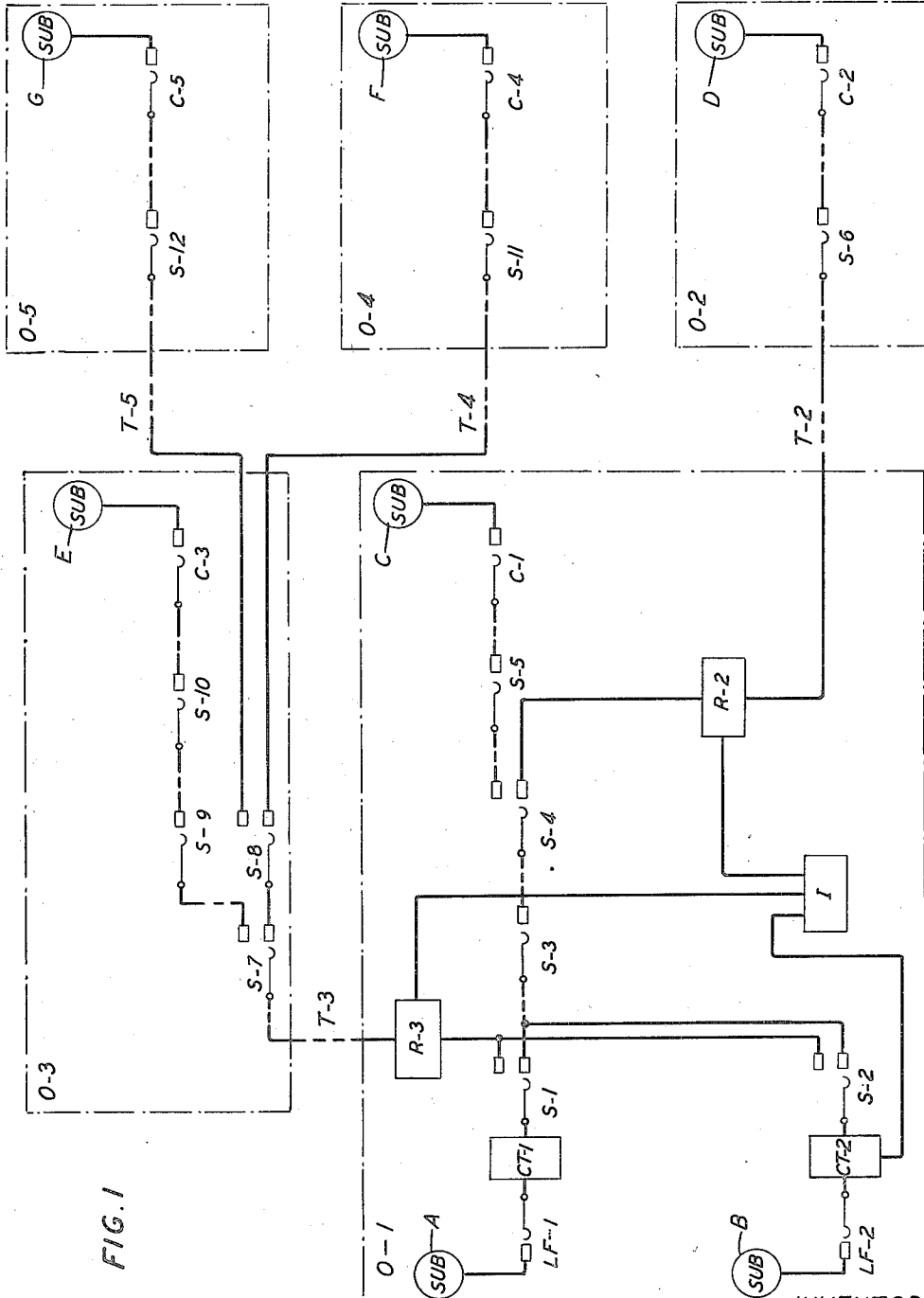


FIG. 1

INVENTOR
R. L. STOKELY
BY *McKenney*
ATTORNEY

Feb. 4, 1936.

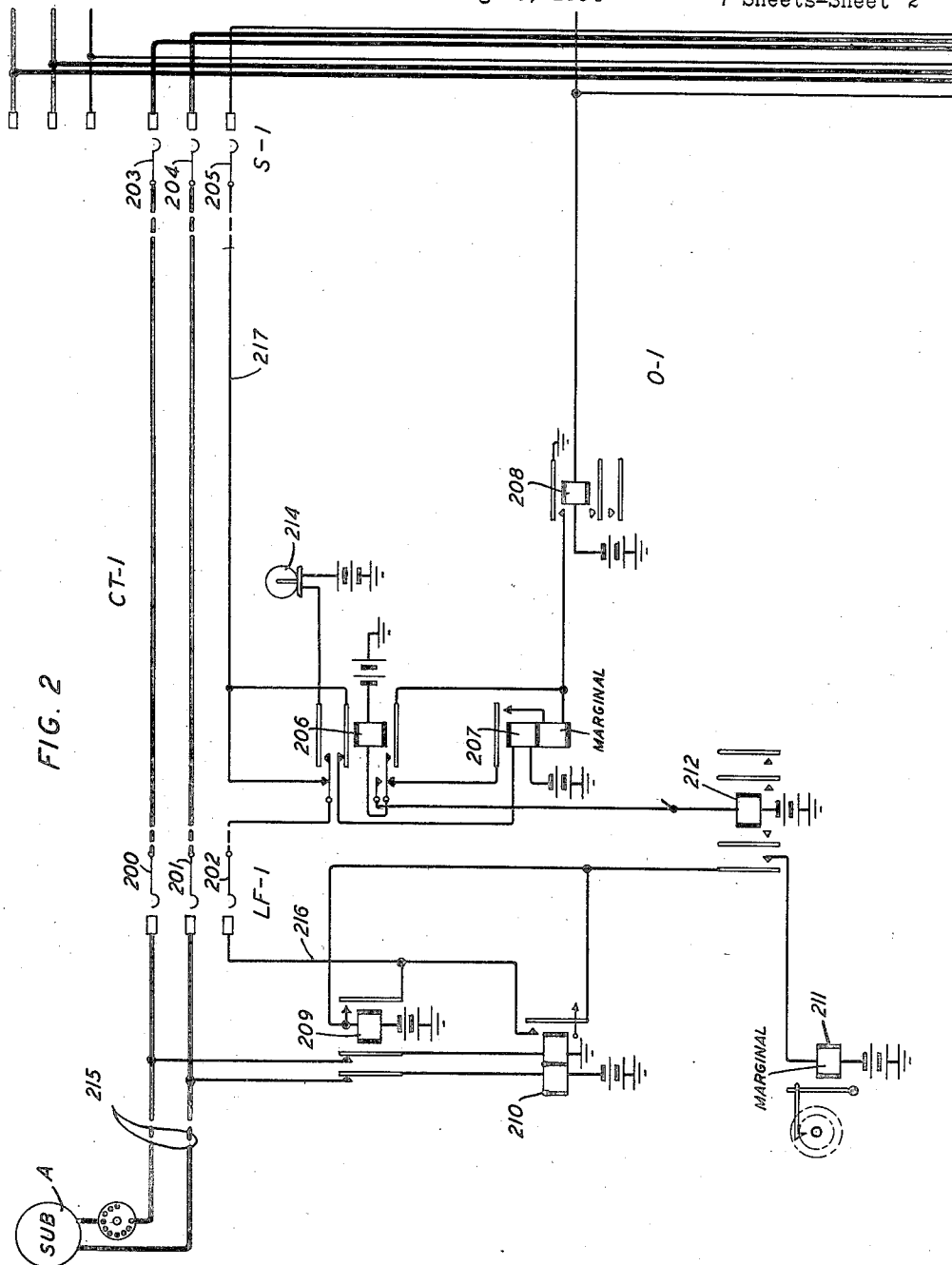
R. L. STOKELY

2,029,683

TELEPHONE SYSTEM

Filed Aug. 3, 1934

7 Sheets-Sheet 2



INVENTOR
R. L. STOKELY
BY *[Signature]*
ATTORNEY

Feb. 4, 1936.

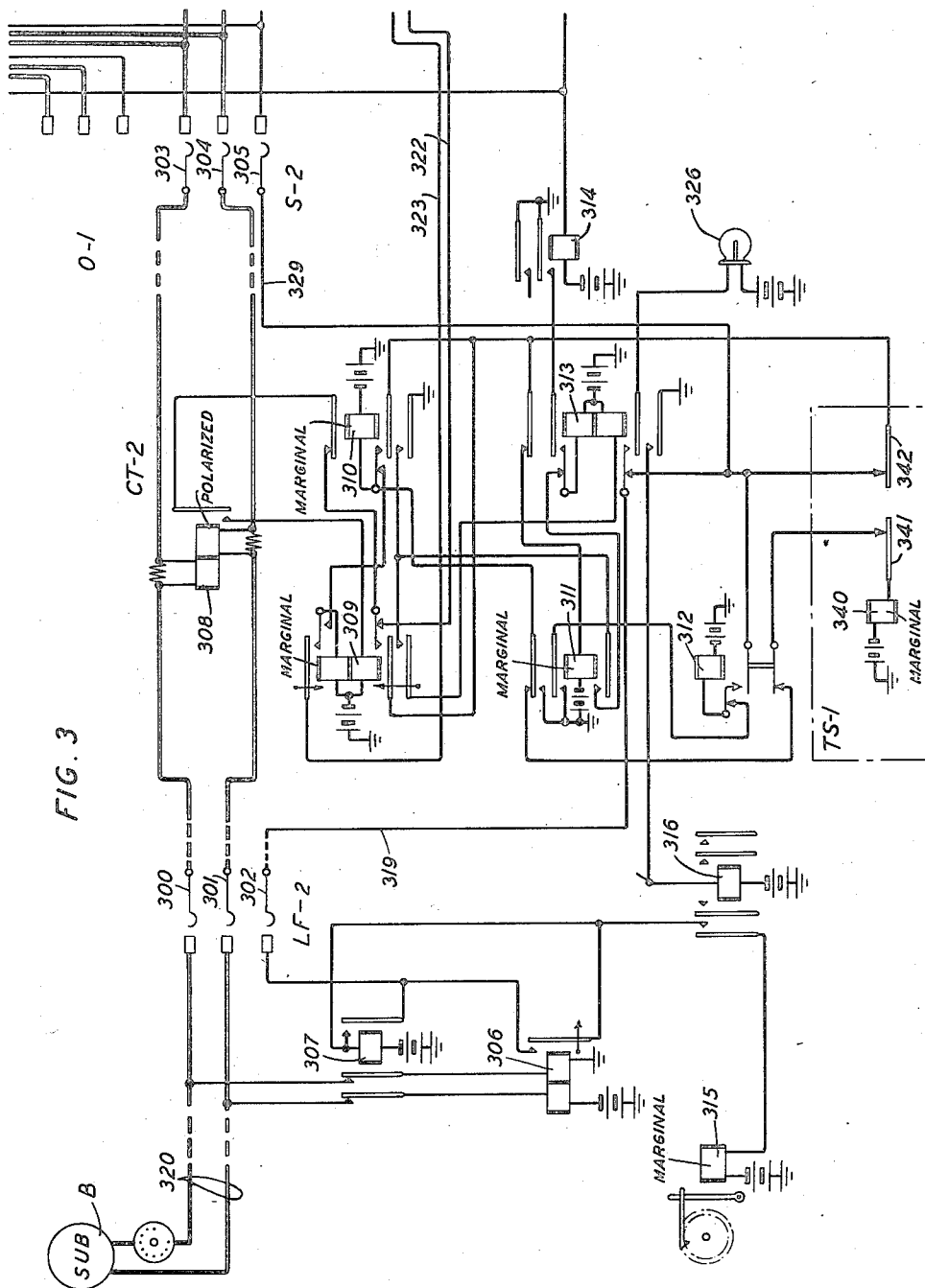
R. L. STOKELY

2,029,683

TELEPHONE SYSTEM

Filed Aug. 3, 1934

7 Sheets-Sheet 3



INVENTOR
R. L. STOKELY
BY *M. M. J. J. J.*
ATTORNEY

Feb. 4, 1936.

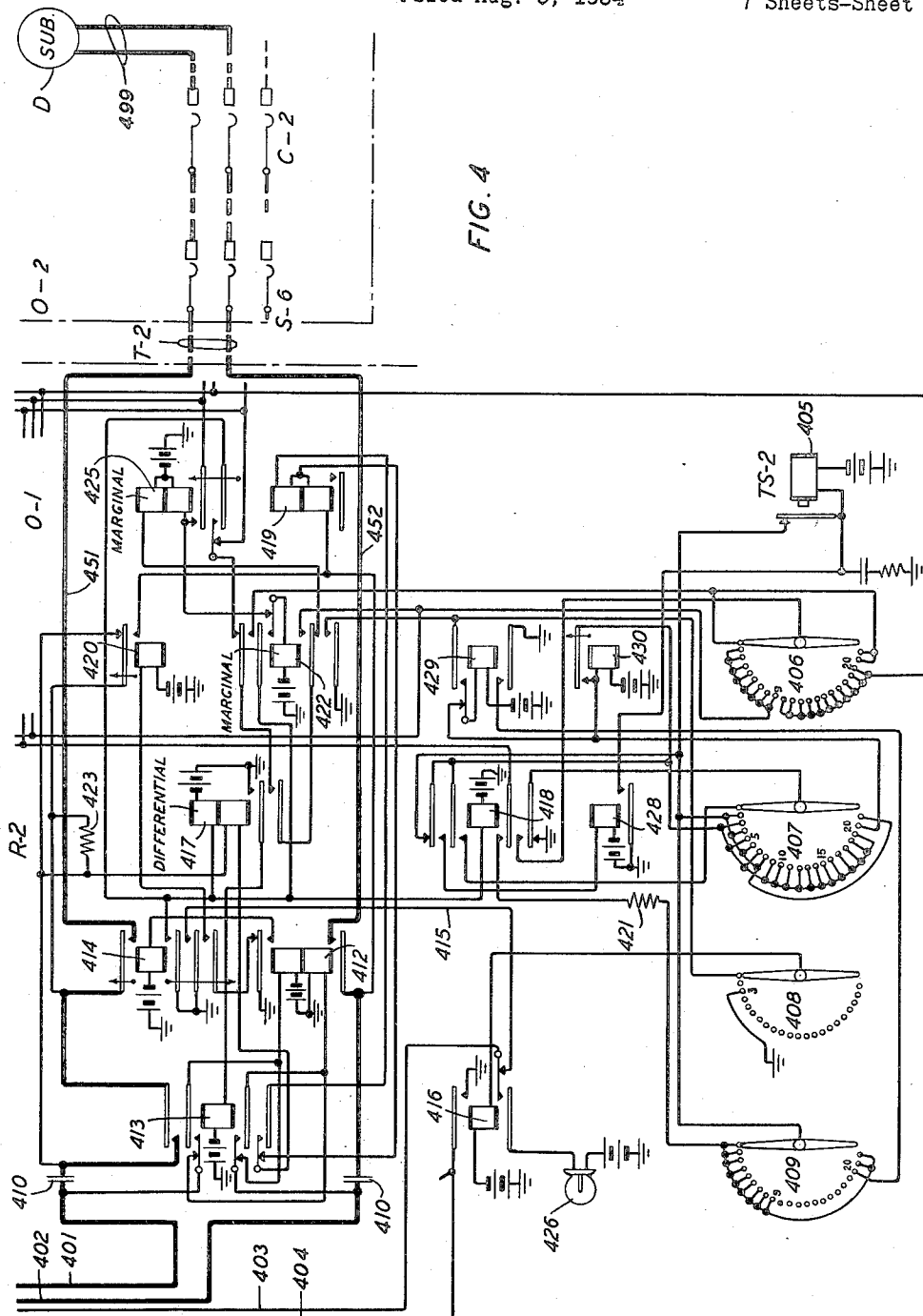
R. L. STOKELY

2,029,683

TELEPHONE SYSTEM

Filed Aug. 3, 1934

7 Sheets-Sheet 4



INVENTOR
R. L. STOKELY
BY
W. B. McFarney
ATTORNEY

Feb. 4, 1936.

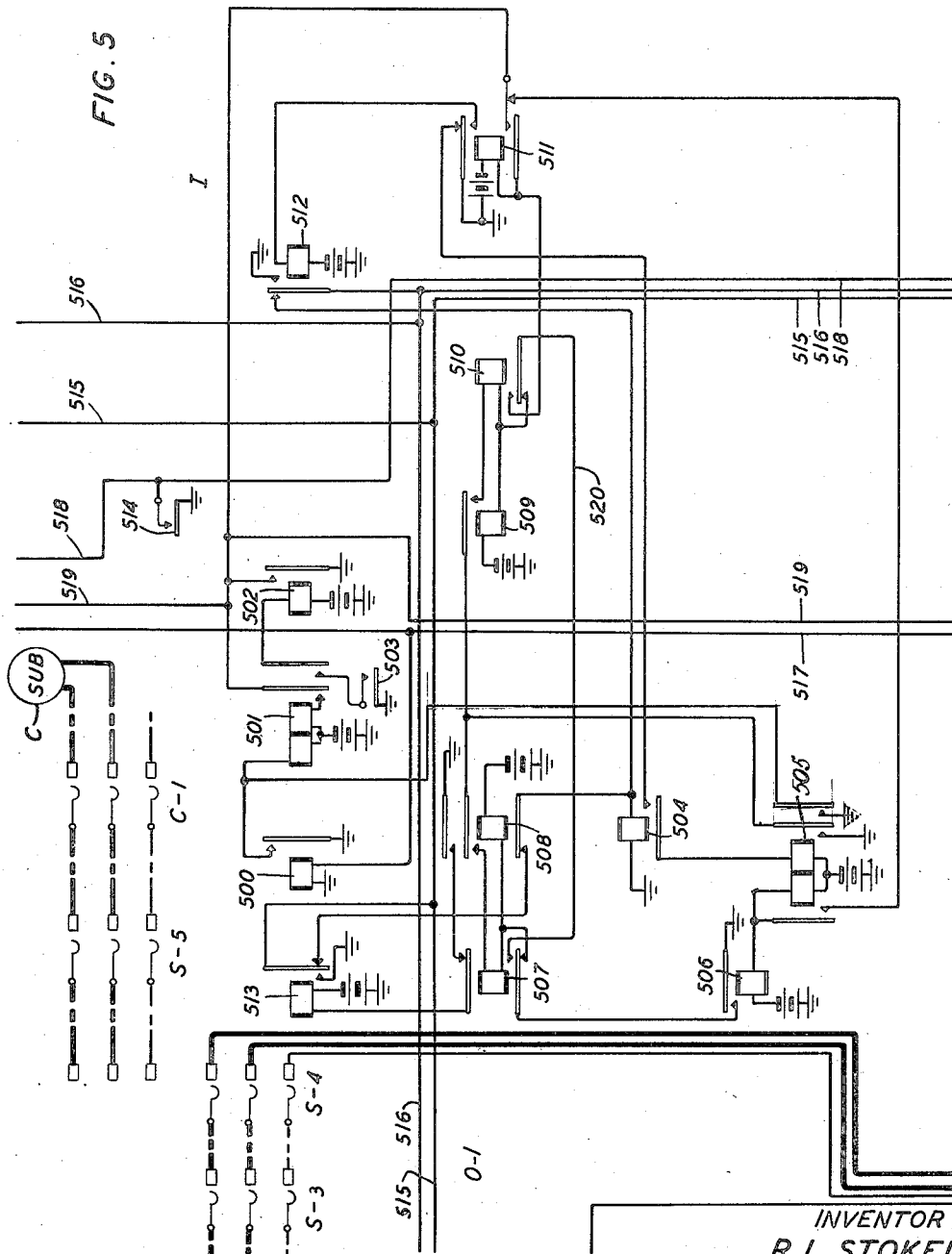
R. L. STOKELY

2,029,683

TELEPHONE SYSTEM

Filed Aug. 3, 1934

7 Sheets-Sheet 5



INVENTOR
R. L. STOKELY
BY *[Signature]*
ATTORNEY

Feb. 4, 1936.

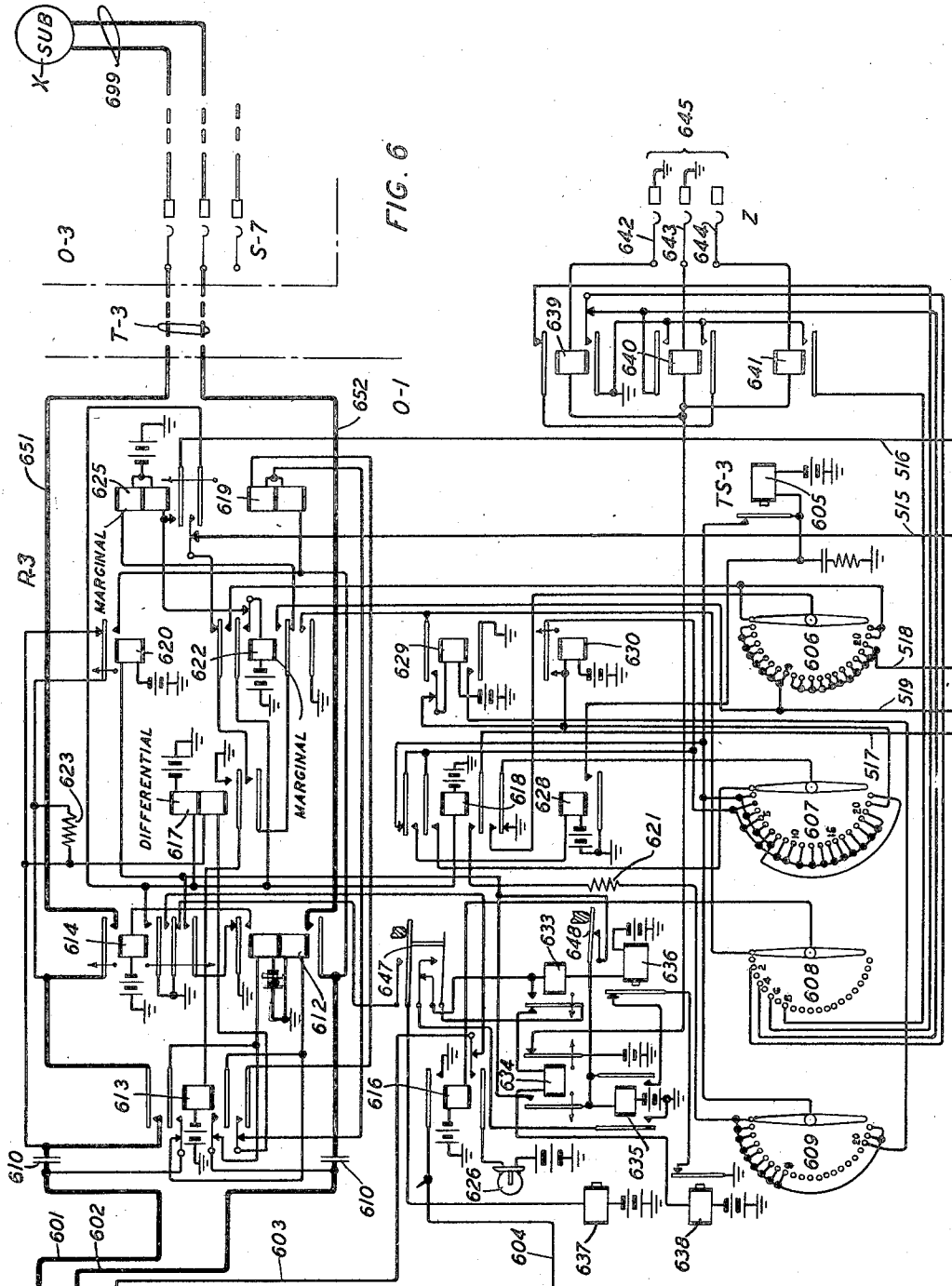
R. L. STOKELY

2,029,683

TELEPHONE SYSTEM

Filed Aug. 3, 1934

7 Sheets-Sheet 6



INVENTOR
R. L. STOKELY

BY

W. H. McManey

ATTORNEY

Feb. 4, 1936.

R. L. STOKELY

2,029,683

TELEPHONE SYSTEM

Filed Aug. 3, 1934

7 Sheets-Sheet 7

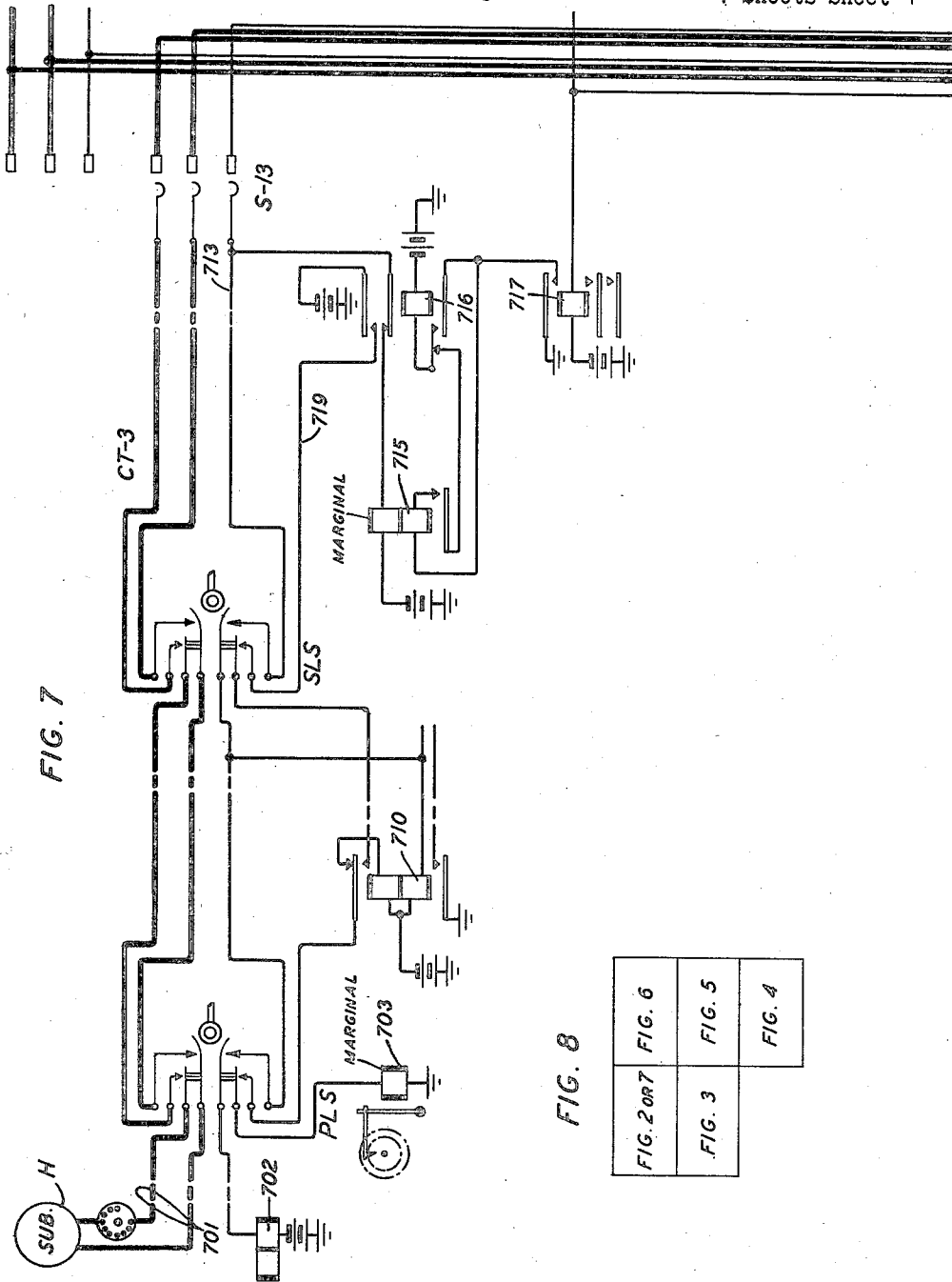


FIG. 8

FIG. 2 or 7	FIG. 6
FIG. 3	FIG. 5
	FIG. 4

INVENTOR
R. L. STOKELY
BY *[Signature]*
ATTORNEY

UNITED STATES PATENT OFFICE

2,029,683

TELEPHONE SYSTEM

Ray L. Stokely, Floral Park, N. Y., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application August 3, 1934, Serial No. 738,263

11 Claims. (Cl. 179—7.1)

This invention relates to telephone systems and more particularly to measured service telephone systems.

The object of the invention is to provide an economical arrangement for registering charges for telephone service in a multi-office system and to minimize the apparatus required for controlling the necessary charging operations.

In telephone systems employing impulse controlled selective switches for establishing connections between calling and called subscribers' stations, lines serving message-rate subscribers are equipped with meters, commonly referred to as message registers, for registering charges for completed outgoing calls. Where line-finders are provided for extending calling lines to idle first selectors, these meters are usually connected to the sleeve conductor of the line circuit in parallel with the cut-off relay. Where plunger type line-switches are employed, the meter for a one-party line is usually connected to the holding conductor of the line circuit and another meter is connected to the release conductor in case the line is a two-party line. Charging trunks are included in the connections, usually between the calling lines and the first selector switches, for controlling the operation of the associated meters. A well known form of such a trunk is arranged to connect a booster-battery potential to its sleeve conductor upon answer of the called subscriber, thereby operating the calling subscriber's meter to register a charge for the call. The arrangement may be such that the meter of a calling line is operated once only for a completed call, or is operated periodically during the continuance of a talking connection; the meter is usually operated at the beginning of each such measured period, and the succeeding periods of time may or may not differ in length from the initial period. In multi-office systems, the meter of a calling line may be operated a variable number of times as the charge for a completed call in accordance with the zone within which the called line is located with respect to the calling line. If such a system is also arranged for repeated charging, the number of meter operations for the initial period of conversation is varied according to the zone, and the number of meter operations for each succeeding period during which a talking connection is maintained may also be varied according to the zone within which the called station is located. The number of meter operations for a succeeding period of conversation may be the same as, or different from, the number of meter operations for an initial

period of conversation and may be independently varied, as may also the length of the initial and succeeding periods. In systems arranged for repeated charging and also for varying the charge in accordance with the zone in which a called line is located with respect to the calling line, it is well known to provide apparatus in an outgoing-trunk repeater for transmitting back to the charging trunk signals indicative of the zone to which the trunk extends; such signals may directly effect corresponding operations of the calling subscriber's meter, may be repeated by the charging trunk to effect such operation, or may be effective to establish in the charging trunk the proper conditions for subsequent use in controlling the meter operating circuit.

In a multi-office system arranged for zone and timed charging, there may be both flat-rate and message-rate subscribers, in which case it is necessary to so arrange the charging trunks and outgoing-trunk repeaters that local or minimum charge calls are registered only if originated over message-rate lines and so that extra charge calls are registered if originated over either flat-rate or message-rate lines.

According to this invention, such a system is provided with charging trunks for use in registering all calls originated over message-rate subscribers' lines, other charging trunks for use in registering extra-charge calls originated over flat-rate subscribers' lines, and outgoing-trunk repeaters having zone and timing apparatus therein for use in registering all interoffice calls. A feature of the invention resides in the association of timing apparatus with a message-rate charging trunk for use in registering local calls and in the arrangement whereby this timing apparatus is rendered ineffective on interoffice calls. A further feature resides in the provision of synchronously operated timing apparatus in the message-rate charging trunk and in the outgoing-trunk repeater to insure that the timing apparatus in the charging trunk does not cause false operation of the subscribers' meter on interoffice calls.

The drawings which form a part of this specification represent a telephone system, having both flat-rate and message-rate subscribers' lines, in which the invention is embodied. The invention is not limited in its application to the specific arrangements shown and other applications of the invention will readily occur to one skilled in the art.

Referring to the drawings, Fig. 1 is a partial

trunking layout of a multi-office telephone system;

Fig. 2 shows in an office O—1, a calling subscriber's station A, a line-finder LF—1, a flat-rate charging trunk CT—1, and a first selector S—1;

Fig. 3 shows in the office O—1, a calling subscriber's station B, a line-finder LF—2, a message-rate charging trunk CT—2, and a first selector S—2;

Fig. 4 shows a repeater R—2 in the office O—1 and a trunk T—2 extending to an office O—2; Fig. 4 also shows, in office O—2, an incoming second selector S—5, a connector C—2 and a subscriber's station D;

Fig. 5 shows in the office O—1 a second selector S—3, a third selector S—4, a fourth selector S—5, a connector C—1 and a subscriber's station C; Fig. 5 also shows in office O—1, an interrupter I for use with the repeaters and charging trunks;

Fig. 6 shows a repeater R—3 in office O—1, a trunk T—3 from office O—1 to an office O—3, an incoming second selector S—7 and a subscriber's station X which may be in office O—3 or in some other office;

Fig. 7 shows a calling subscriber's station H, a primary line-switch PLS, a secondary line-switch SLS, a flat-rate charging trunk CT—3 and a first selector S—13;

Fig. 8 shows the relative positions in which Figs. 2 to 7, inclusive, should be placed in order to form an operative arrangement.

The system shown in Fig. 1 comprises the five offices O—1, O—2, O—3, O—4 and O—5, each of which includes subscribers' lines and automatic switching equipment for use in establishing connections between calling and called lines. The system is one in which all subscriber's telephone numbers comprise six digits, the first three of which serve to indicate the particular office in which the subscriber's line terminates. Each of the five offices shown represents a different zone for rate purposes. The office O—1 serves both flat-rate subscribers and message-rate subscribers, line-finder switches being provided for extending calling lines to first selectors. "A" represents a flat-rate subscriber's station, LF—1 represents a line-finder, CT—1 represents a flat-rate charging trunk between the line-finder LF—1 and the first selector S—1; B represents a message-rate subscriber's station, LF—2 represents a line-finder, CT—2 represents a message-rate charging trunk between the line-finder LF—2 and the first selector S—2; S—3, S—4, S—5 and C—1 represent local second, third and fourth selectors and a local connector, respectively, for use in completing local calls; R—2 represents an outgoing-trunk repeater individual to a trunk T—2 leading to office O—2 in Zone 2; R—3 represents an outgoing repeater individual to a trunk T—3 leading to office O—3 in Zone 3, and I represents an interrupter for use with the repeaters and charging trunks in charging flat-rate subscribers for interoffice calls and in charging message-rate subscribers for both local and interoffice calls. The office O—2 is represented by the incoming fourth selector S—5, the connector C—2 and a subscriber's station D. The office O—3, which is a tandem office, is represented by the incoming second selector S—7, the tandem third selector S—8, local third and fourth selectors S—9 and S—10, a local connector C—3, and a subscriber's station E; the tandem second selector S—2 gives access to groups of trunks leading to offices O—4 and O—5. The office O—4, which is in Zone 4, is represented by

the incoming fourth selector S—11, connector C—4 and subscriber's station F; and the office O—5, which is in Zone 5, is represented by the incoming fourth selector S—12, the connector C—5 and the subscriber's station G. Although not shown in the drawings, each of offices O—2, O—3, O—4 and O—5 includes switching equipment, similar to that shown for office O—1, for use in extending calling lines to first selectors and for completing local as well as incoming calls. Line switches might be employed in place of line-finders for extending calling lines to idle first selectors; a line switch trunking arrangement is shown in Fig. 7 of the drawings.

The line-finder switches LF—1 and LF—2 shown in Figs. 2 and 3 are of the well known Strowger type and are each represented schematically by one set of brushes and one set of terminals. The broken lines represent portions of the line-finders which have been omitted. For a detailed description of the operation of the line-finders LF—1 and LF—2, reference may be had to Patent No. 1,711,682 issued to H. Hovland, May 7, 1929.

The selector and connector switches shown in Figs. 2 to 7, inclusive, are also of the Strowger type. These switches are each represented schematically by a set of brushes and one or two sets of terminals of their terminal banks. The broken lines represent apparatus and connections for these switches which have been omitted. For a complete description of the operation of the selector and connector switches, reference may be had to pages 53 to 65, inclusive, of the second edition of "Automatic Telephony" by Smith and Campbell.

The charging trunks CT—1 and CT—3 are used only with flat-rate subscribers' lines and are arranged to operate the calling subscriber's meter only on interoffice calls. Registration is effected upon receipt of from 1 to 5 booster-battery pulses, from the repeater R—2 or R—3 over the sleeve conductor, when the called subscriber answers. These pulses are simultaneously relayed to operate the calling subscriber's meter.

The charging trunk CT—2 is used only with message-rate subscribers' lines and is arranged to charge for both local and interoffice calls. Registration on local calls is controlled by the usual polarized supervisory relay 308, whose windings are in series with the talking conductors of the trunk. When the called subscriber answers, this polarized relay operates to cause a booster-battery impulse to be transmitted to operate the calling subscriber's meter. A timing device TS—1 is provided for the purpose of providing repeated charging on local calls. This timing device, which measures time from the start of conversation and causes an operation of the calling subscriber's meter for each measured unit period of conversation, comprises a magnet 340, contact springs 341 and 342, and a clutch (not shown) for engaging mechanically operated timing gears. Upon the energization of magnet 340, the clutch engages the timing gears for measuring a predetermined time interval at the end of which the contacts 341 and 342 are opened. The opening of contact 342 causes the release of magnet 340 permitting the timing device to restore to normal position. Contact 342 closes as soon as the device begins its return to normal, but contact 341 remains open until the device reaches normal. If the talking connection is not released by or before the end of the meas-

ured interval, the device TS—1 repeats its cycle of operation. For a detailed description of the construction and operation of such a timing device, reference may be had to Patent No. 1,993,793, granted to E. D. Mead, March 12, 1935. Interoffice calls are metered upon receipt of booster-battery impulses transmitted from the repeater circuit and relayed to the calling subscriber's meter. When this trunk is associated with a repeater, the receipt of booster-battery impulses renders ineffective the apparatus used for charging on local calls.

The repeater R—2, associated with trunk T—2 leading to the office O—2, is arranged to repeat dial impulses over the outgoing trunk in the usual manner. When the called subscriber answers, the repeater transmits one, two, three, four, or five booster-battery impulses over the sleeve conductor to the charging trunk associated with the selector by which the repeater is seized. The booster-battery impulses are transmitted under control of the timing or charging switch TS—2 and their number is fixed for each repeater, dependent upon the zone in which the outgoing trunk terminates. That is, the switch TS—2 will be wired to transmit the required number of impulses for a particular zone. Upon receipt of booster-battery impulses by the trunks CT—1, CT—2 or CT—3, a circuit is closed for operating the calling subscriber's meter a corresponding number of times as a charge for the initial unit period of conversation which the switch TS—2 proceeds to count off under control of the interrupter I. If the conversation continues beyond this measured unit period, the calling subscriber's meter is again operated under control of switch TS—2 to charge for the additional unit period of conversation. The number of meter operations, and the length of the conversation period, will be fixed for each repeater according to the zone in which the outgoing-trunk terminates and according to whether the charge is for the initial or a subsequent period of conversation.

A table of six of the many possible charging plans which may be used for areas having five charging zones is shown in the patent to R. L. Stokely, No. 1,859,941 granted May 24, 1932. The wiring of the arcs of switch TS—2 of repeater circuit R—2 and the arcs of switch TS—3 of repeater circuit R—3, depends upon the plan employed for any particular area. The switches TS—2 and TS—3 are shown wired to fulfill the requirements of Plan 1 of the aforementioned table. According to this plan, the calling subscriber's meter is operated once for each five minute period of conversation for calls to Zone 1, twice for calls to Zone 2, three times for calls to Zone 3, four times for calls to Zone 4 and five times for calls to Zone 5.

The repeater R—3 is similar to the repeater circuit R—2 except that it is associated with trunks employed in completing calls to a plurality of offices and a variable number of impulses is transmitted to the charging trunk circuit from the repeater, dependent on the zone in which the office of the called line is located. In order to identify the zone in which the called subscriber is located, a two-motion one-hundred point tracer switch Z is employed. This switch operates as controlled by the impulse receiving relay 312 of the repeater to take a setting corresponding to the first two digits received by this relay. The first digit is repeated over the outgoing trunk to direct the incoming selector at the distant end of the trunk and is also

effective to elevate the tracer switch Z to a level corresponding to the digit dialed; the second digit is repeated over the trunk to effect the selection of a trunk to the office in which the called line is located and is effective to rotate the tracer switch Z to a set of terminals corresponding to the digit dialed. The tracer switch Z, associated with the repeater circuit R—3, therefore, identifies the zone in which the called subscriber's line is located, so that the proper charging information can be transmitted to the charging trunk.

The operation of the system shown in the drawings will be further described by assuming the origination and completion of calls from stations A, B and H. Assume, first, that a call is originated at the flat-rate station A shown in Fig. 2. Upon removal of the receiver at station A, the line relay 210 operates to cause the operation of an idle line-finder LF—1. The cut-off relay 209 is operated when the sleeve or test brush 202 of line-finder LF—1 engages the test terminal of line 215 and the line-finder stops with its brushes 200 and 201 in engagement with the terminals to which the conductors of line 215 are connected. The calling line 215 is thereby extended through the brushes of line-finder LF—1 to the associated first selector S—1. Holding ground potential is connected to the sleeve conductor 217 of selector S—1 in usual manner to hold the cut-off relay 209 and to prevent the return of the line-finder LF—1 to normal. The connection of ground potential to conductor 217 is also effective to energize the upper winding of relay 207 of trunk CT—1, but relay 207 is marginal and its winding is not sufficiently energized to cause the operation of its contact.

When the first digit of the number of the subscriber's station with which the calling subscriber desires connection is dialed, the selector switch S—1 is directly operated in response to the dial impulses received by its line relay (not shown) to cause the selection of an idle set of terminals in the corresponding level of the terminal bank. Assuming the selected set of terminals to be connected to the trunk to which the second selector S—3 is connected, the dialing of the next two digits of the called subscriber's number causes the selective operation of the second selector S—3 and a third selector S—4. If the called subscriber's line is in office O—1, the terminals selected by switch S—4 lead to a fourth selector S—5; and the dialing of the succeeding digits of the called subscriber's number causes the selective operation of selector S—5 and a connector C—1 to complete the connection between the calling station A and the called subscriber's station C. If idle, the called station is signaled and upon removal of the receiver at station C, the talking connection is established in well known manner. The calling subscriber, being a flat-rate subscriber, is not charged for a local call. When the subscribers at stations A and B replace the receivers, the switches involved in the connection all restore to normal in the usual manner.

If the called subscriber's line is in office O—2, the dialing of the first three digits of the called subscriber's number causes the successive selective operation of switches S—1, S—3 and S—4, the terminals selected by switch S—4 being connected in this case to the outgoing-trunk repeater R—2 (Fig. 4) associated with the trunk T—2 which terminates in office O—2. Upon extension of the calling line 215 through the brushes of

line-finder LF—1, selectors S—1, S—3 and S—4, to conductors 491 and 402 of repeater R—2, the line relay 412 is operated. Relay 412 closes a circuit for operating the slow-to-release relay 414. Relay 414 connects a holding ground potential through its middle lower front contact, over conductor 415, through the back contact of relay 416, over sleeve conductor 403, through the lower brushes of switches S—4, S—3 and S—1 to sleeve conductor 217 to hold the cut-off relay 209 and to prevent the return to normal of switches LF—1, S—1, S—3 and S—4. Relay 414 closes a circuit for operating relay 418 and a circuit for energizing the upper winding of relay 417; but relay 417 is not operated by the energization of its upper winding alone. Relay 414 also closes a bridge across the conductors of trunk T—2 to cause the operation of the line relay (not shown) of selector S—3 in office O—2; this bridge is traced from conductor 451 of trunk T—2 through the upper front contact of relay 414, back contact of relay 420, lower winding of relay 417, lowermost back contact of relay 413, lower winding of relay 419, and through the lower front contact of relay 412 to conductor 452 of trunk T—2. The current over trunk T—2 through the lower winding of relay 417 electromagnetically opposes the current through the upper winding of this relay so that relay 417 does not operate. The aforementioned operation of relay 418 closes a circuit from battery through the winding and interrupter contacts of stepping magnet 405 of timing switch TS—2, brush 409 and terminal 1, resistance 421, inner lower front contact of relay 418, over conductor 517 and through the winding of relay 500 of interrupter I to ground. The current in this circuit is not sufficient to operate stepping magnet 405 of switch TS—2 but is effective to operate relay 500 of interrupter I. Relay 500 closes a circuit for operating relay 501. Relay 501 connects the interrupter contacts 503 to the winding of relay 502, these contacts being closed once every second for approximately one half a second. As soon after relay 501 operates as contacts 503 are closed, relay 502 operates and closes a circuit through the right winding and inner front contact of relay 501 to hold relay 501 operated independently of relay 500. As long as relay 500 remains operated, relay 502 is operated once every second to connect ground to impulse conductor 519.

When the last three digits of the called subscriber's number are dialed, the line relay 412 releases and reoperates in response to each dial impulse. Being slow in releasing, relay 414 remains operated during the receipt of each of these three trains of dial impulses. The release of relay 412, in response to the first impulse of each of these digits, closes a circuit for operating relay 420. Relay 420 being slow in releasing, remains operated until all of the impulses in a train corresponding to one digit have been received, the front contact of relay 420 being effective to short circuit the lower windings of relays 417 and 419 to insure the proper response of the selector and connector switches in office O—2 to the dial impulses repeated over trunk T—2 by the lower front contact of relay 412. The selector S—6 and connector C—2 are thereby directly advanced to complete the connection with the line 499 leading to the called station D. If the called line is idle, a ringing circuit is closed by the connector C—2 to signal the called subscriber and upon removal of the receiver at station B, the connector C—2 operates in well known manner to

reverse the current over trunk T—2 and thereby causes the operation of the supervisory relay 417 of repeater R—2. Relay 417 closes a circuit for operating relay 413; and relay 413 interchanges the connections between the windings of relay 412 and conductors 401 and 402 so that the current is reversed over the talking conductors of trunk CT—1 and the talking conductors of the calling line. Since the calling line is a flat-rate line, this reversal performs no useful function.

In operating, relay 417 also closes a circuit for operating relay 504 of the interrupter I; this circuit is traced from battery through the upper winding of relay 425, lower back contact of relay 422, lowermost front contact of relay 417, uppermost back contact of relay 422, lower back contact of relay 425, over conductor 515 to interrupter I, through the back contacts of relays 513 and 508, and through the winding of relay 504 to ground. Relay 504 operates but relay 425 being marginal does not operate at this time. Relay 504 closes an obvious circuit for energizing the right winding of relay 505. Relay 505 operates and with relay 502 operated a circuit is closed from battery through the winding of relay 506 in parallel with the left winding of relay 505, through the left front contact of relay 505, lower back contact of relay 511, to ground at the front contact of relay 502. Relay 506 operates and relay 505 is held operated independently of relay 504 until relay 502 again releases. Relay 506 closes a circuit for operating relay 508. Relay 508 closes a circuit for operating relay 513, opens the operating circuit for relay 504 and connects ground through its inner upper front contact to the winding of relay 507. With relay 513 operated, ground is connected directly to conductor 515 to cause the operation of relay 425. As soon as relay 502 releases, relay 506 releases thereby opening the short circuit across the winding of relay 507 so that relay 507 operates in series with relay 508 to ground at the front contact of relay 500. The operation of relay 507 causes the release of relay 513. When relay 425 operates, it locks through the front contact of its continuity springs to ground at the inner lower front contact of relay 414. Relay 425 closes a circuit for reoperating relay 504; this circuit is traced from battery through the lower winding of relay 425 in parallel with the winding of relay 422, through the inner lower front contact of relay 425, conductor 516, back contact of relay 512 and through the winding of relay 504 to ground. Relay 504 reoperates but relay 422 is marginal and does not operate at this time. Relay 504 causes the reoperation of relay 505. When relay 502 is next operated, relay 506 operates a second time. With both of relays 506 and 507 operated, a circuit is closed for operating relay 509; this circuit is traced from ground at the front contact of relay 506 through the front contact of relay 507, conductor 520, back contact of relay 510 and through the winding of relay 509 to battery. Relay 509 connects ground at the front contact of relay 500 to the winding of relay 510; and, when relay 502 next releases, the release of relay 506 opens the short circuit across the winding of relay 510 so that relay 510 is operated and relay 509 is held operated to the ground at the front contact of relay 500. Relay 510 connects conductor 520 to the winding of relay 511 and when relay 502 is next operated, relay 506 is reoperated to close a circuit for operating relay 511; this circuit is traced from ground through the front contact of relay 506, front contact of relay 507, conductor 75

520, front contact of relay 510 and through the winding of relay 511 to battery. Relay 511 locks through the front contact of its continuity spring to ground at the front contact of relay 502, opens the operating circuit through the right winding of relay 505 and also opens the holding circuit through the left winding of relay 505 so that relay 505 releases. The release of relay 505 causes the release of any of relays 506, 507, 508, 509 and 510 which are then operated. Relay 511 also closes a circuit for operating relay 512. The operation of relay 512 causes the release of relay 504 and connects ground over conductor 516 to the winding of relay 422 in parallel with the lower winding of relay 425 to hold relay 425 operated and to cause the operation of relay 422. It is apparent that approximately two seconds elapse from the time ground is connected to conductor 515 to operate relay 425 until ground is connected to conductor 516 to operate relay 422. This time interval is introduced to prevent the operation of the calling subscriber's meter, as hereinafter described, in case the supervisory relay 417 should be operated momentarily due to trunk or line busy signals.

When relay 422 is operated, as above described, it locks through the front contact of its continuity spring to ground at the inner lower front contact of relay 414. Relay 422 closes a circuit for operating relay 416 and opens the aforementioned locking circuit through the upper winding of relay 425. As soon as relay 502 again releases, relays 511, 512 and 425 release in succession, the current through the lower winding of relay 425 in series with the winding of relay 504 being insufficient to hold relay 425 operated. Since relay 425 starts to release while the contacts of relay 512 are being shifted, relay 425 releases soon enough to prevent reoperation of relay 504. With relay 422, operated, the next succeeding operation of relay 502 of interrupter I closes a circuit for operating the stepping relay 428 to initiate the advance of switch TS—2. The circuit for operating relay 428 is traced from ground at the front contact of relay 502, over conductor 519, inner lower front contact of relay 422, lowermost front contact of relay 417, uppermost front contact of relay 422, terminal 1 and brush of bank 406 (each brush of switch TS—2 being normally in engagement with terminal 1 as shown in the drawings), lowermost front contact of relay 418, brush and terminal 1 of bank 407, inner upper front contact of relay 418, and through the uppermost front contact of relay 418, to the winding of relay 428. Relay 428 closes a circuit for operating magnet 405 of switch TS—2; and when relay 502 disconnects ground from conductor 519, relay 428 and magnet 405 successively release. The release of magnet 405 advances the brushes of switch TS—2 into engagement with terminal 2 of each of the banks. The advance of switch TS—2 from normal position causes the release of relay 416. The next succeeding connection of ground to conductor 519 is effective to operate magnet 405 directly; the operating circuit is traced from conductor 519, through terminal 2 and brush of bank 406, lowermost front contact of relay 418, brush and terminal 2 of bank 407, through the interrupter contacts and winding of magnet 405 to battery. The magnet 405 releases as soon as its operating circuit is opened at its own contact without waiting for relay 502 to disconnect ground from conductor 519. With brush 407 in engagement with terminal 3, relay 428 again operates before the ground

is disconnected from conductor 519. The operation of relay 428 reoperates magnet 405 and when the ground is disconnected from conductor 519, relay 428 and magnet 405 release. Since terminals 2 to 9, inclusive, of bank 406 are strapped together, and terminals 2, 4, 6 and 8 of bank 407 are strapped together, and terminals 3, 5, 7 and 9 of bank 407 are strapped together, the switch TS—2 is advanced two steps per second under the control of relay 502 of the interrupter I and the stepping relay 428 of switch TS—2 until the brushes of this switch are in engagement with terminal 10. Relay 500 releases as soon as switch TS—2 has advanced beyond position 9 unless this relay is held operated by some other repeater to which it is common. Thereafter the circuit for operating stepping relay 428 is traced through strapped terminals 10 to 20, inclusive, and brush of bank 407 and through the brush and strapped terminals 10 to 20, inclusive, of bank 406 over conductor 518 to the interrupter contacts 514. Since the contacts 514 are closed once every thirty seconds for approximately half a second, relay 428 and magnet 405 are operated and released once every thirty seconds to advance the brushes of switch TS—2 step-by-step until these brushes are in engagement with terminal 21 at which time an interval of approximately and not less than five minutes has elapsed since the switch was moved out of normal position. When the brush of bank 409 reaches terminal 21, relay 509 of the interrupter I reoperates if not already operated. The next succeeding operation of relay 502 of interrupter I after brush 407 engages terminal 21 causes the operation of relays 429 and 430; the circuit for operating these relays is traced from ground at the front contact of relay 502 of interrupter I over conductor 519, through the inner lower front contact of relay 422, lowermost front contact of relay 417, uppermost front contact of relay 422, terminal 21 and brush of bank 406, lowermost front contact of relay 418, brush and terminal 21 of bank 407, thence through the winding of relay 429 and through the winding of the slow-to-release relay 430 to battery. Relay 429 locks to ground at the lowermost front contact of relay 422 and connects ground to terminal 20 of bank 409. Relay 430 extends its operating ground through its front contact and the uppermost front contact of relay 419 to operate stepping relay 428 and relay 428 closes the circuit for operating magnet 405. When ground is again disconnected from conductor 519, relays 430 and 428 release; and the release of magnet 405 advances the brushes of switch TS—2 from terminal 21 to terminal 22. As soon as ground is again connected to conductor 519, a circuit is closed over conductor 519 through the inner lower front contact of relay 422, lowermost front contact of relay 417, uppermost front contact of relay 422, terminal 22 and brush of bank 406, lowermost front contact of relay 418, brush and terminal 22 of bank 407, and through the back contact and winding of magnet 405 to battery. Magnet 405 opens its operating circuit and the release of magnet 405 advances switch TS—2 to normal.

The operation of relay 422, effective, as above described to initiate the advance of switch TS—2, was also effective to cause the operation of relay 416 before the switch advanced out of position 1. If the trunk T—2, with which the repeater R—2 is associated, extends beyond the first zone, relay 416 is reoperated one or more times during the advance of switch TS—2 to position 10. Since

the trunk T—2 extends into Zone 2, terminal 3 of bank 408 of repeater R—2 is connected to ground as shown in Fig. 4. If the trunk T—2 extended into Zone 3, terminals 3 and 5 of bank 408 would be connected to ground; if trunk T—2 extended into Zone 4, terminals 3, 5 and 7 of bank 408 would be connected to ground; and if the trunk T—2 extended into Zone 5, terminals 3, 5, 7 and 9 of bank 408 would be connected to ground. Relay 416 is reoperated each time the brush 408 encounters a grounded terminal. Since it was assumed that office O—2 is in Zone 2, only terminal 3 of bank 408 is shown connected to ground, so that relay 416 is operated a second time when the brushes of switch TS—2 are in position 3 and is not again operated unless the talking connection is maintained for more than five minutes, in which case the switch TS—2 is again advanced as hereinafter described.

Each time that relay 416 operates, the sleeve conductor 403 incoming to the repeater R—2 is disconnected from conductor 415 and the positive pole of booster-battery is connected through lamp 426 and the lower front contact of relay 416, over sleeve conductor 403, through the sleeve brush of each of selectors S—4 and S—3, the sleeve brush 205 of selector S—1, over conductor 217, through the inner upper back contact of relay 206 and the upper winding of relay 207 to the negative pole of battery and over conductor 217, through the uppermost back contact of relay 206, through brush 202 of line-finder LF—1 and the locking contact and winding of the cut-off relay 209 to the negative pole of battery. The cut-off relay 209 is held operated and the current through the winding of marginal relay 207 is sufficient to operate this relay. Relay 416 also connects ground through its upper front contact to conductor 404, thereby causing the operation of the relay 208 which is common to a plurality of charging trunks. With relays 207 and 208 both operated, a circuit is closed through the lower winding and front contact of relay 207 for holding relay 207 and for operating relay 206. Relay 206 locks under control of relay 208 alone and opens both the operating and holding circuits of relay 207. Relay 206 also closes a circuit through its inner lower front contact for operating relay 212, which is common to a plurality of lines in office O—1. With both of relays 206 and 212 operated, the positive pole of booster-battery is connected through lamp 214, the upper front contact of relay 206 and brush 202 of line-finder LF—1 to sleeve conductor 216 of line 215, thence through front contacts of relays 209 and to the winding of meter 211. The cut-off relay 209 is held operated and the meter 211 is operated to register one unit of charge. When relay 416 releases, relays 208, 206 and 212 release and the meter 211 releases. Each operation of relay 416 is, therefore, effective to operate meter 211 and thus register one unit of charge. The connection of booster-battery to conductor 217 when relay 416 is operated would be effective to operate meter 211 but the connection of ground potential to conductor 403 by other selectors when hunting for an idle repeater would interfere with and possibly cause more than one operation of the meter. To prevent such interference, the operation of relay 206 disconnects conductor 217 from line-finder brush 202 and connects the booster-battery through lamp 214 to operate the meter.

If conversation has not been completed by the end of the initial five minute period, the fore-

going cycle of advancing the metering switch TS—2 is repeated. The meter 211 is thus re-operated one or more times at the beginning of each five minute period during which the talking connection is maintained as measured by switch TS—2. On the initial revolution it was necessary that the switch advance from terminal 20 to 21 under control of interrupter contacts 514 in order to insure that the initial conversational period for which the meter was operated would not be less than five minutes. But, on succeeding cycles the switch has already been synchronized with the interrupter and it is advanced immediately from terminal 20 to terminal 21 without waiting for the ground at interrupter contacts 514; the circuit for operating magnet 405 is traced from ground at the lower front contact of relay 429 through terminal 20 of bank 409 and the back contact and winding of magnet 405 to battery.

When the connection is released by the calling subscriber, the line relay 412 of repeater R—2 releases, thereby opening the loop across the outgoing conductors of trunk T—2 so as to release relay 417 of repeater R—2 and the line relay (not shown) of the connector C—2. The selector S—5 is thereupon immediately restored to normal in the usual and well known manner; and when the receiver is placed upon the receiver hook at the called station the connector C—2 is also restored to normal in the usual and well known manner. The release of relay 417 causes the release of relay 413; and the release of relay 412 causes the release of relay 414, whereby the holding ground is disconnected from sleeve conductor 415 so as to cause the release of the cut-off relay 209 and cause the selectors S—1, S—3 and S—4 and the line-finder LF—1 to be restored to normal in the usual and well known manner. Relay 414 also causes the release of relays 422 and 418; the release of relay 422 causes the release of relay 429 and the release of relay 418 causes the return of switch TS—2 to its normal position by closing circuits for operating the magnet 405. If the switch TS—2 is in any of positions 2, 4, 6, 8 or 22, the circuit for operating the magnet 405 is traced from battery through its winding and back contact, any one of terminals 2, 4, 6, 8 or 22 and brush of bank 407 to ground at the lower back contact of relay 418. If the switch is in any of positions 3, 5, 7 or 9 to 20, inclusive, the operating circuit for magnet 405 is traced from battery through its winding and back contact, upper back contact of relay 418, any one of terminals 3, 5, 7 and 9 to 20 and brush of bank 407, to ground at the lower back contact of relay 418. With the switch in position 21, a circuit is closed for reoperating relay 430; this circuit is traced from ground at the lower back contact of relay 418, through the brush and terminal 21 of bank 407, to battery through the winding of relay 430. With relay 430 operated, the circuit for operating magnet 405 to advance the switch TS—2 from position 21 to position 22, is traced from ground at the lower back contact of relay 418, brush and terminal 21 of bank 407, front contact of relay 430, upper back contact of relay 418, and through the back contact and winding of magnet 405 to battery. The switch TS—2 is advanced from terminal 22 to its normal position as hereinbefore described. Relay 430 releases as soon as the brush of bank 407 leaves terminal 21. The en-

tire trunk circuit is now normal and ready for service on another call.

If the station with which the subscriber at station A desires connection is in either of offices O—3, O—4 or O—5, the selector S—1 is directionally operated to select an idle trunk T—3 in a group extending to the office O—3. Since additional digits must be dialed before it is finally determined in which office the called line is located, the repeater R—3 which is associated with the selected trunk T—3 is provided with a two digit register switch Z, the line relay 612 of repeater R—3 being effective to repeat the impulses over trunk T—3 to control the completion of the desired connection and to repeat the first two trains of impulses to operate the register switch Z.

Upon extension of the connection from the calling line 215 through the brushes of line-finder LF—1 and selector S—1 over conductors 601 and 602 to the repeater R—3, the line relay 612 operates. Relay 612 closes a circuit for operating the slow-to-release relay 614. Relay 614 connects ground through its lowermost front contact and the back contact of relay 616, over sleeve conductor 603 and through the sleeve brush 205 of selector S—1 to sleeve conductor 217 to hold the selector S—1 and line-finder LF—1 in their operated position and to hold the cut-off relay 209 of line 215 all in the usual and well known manner. With relays 612 and 614 both operated, a bridge is connected across the conductors of trunk T—3 to operate the line relay (not shown) of the incoming selector S—7 to which the trunk T—3 connects in office O—3; this bridge is traced from conductor 651 of trunk T—3, through the upper front contact of relay 614, back contact of relay 620, lower winding of relay 617, lowermost back contact of relay 613, lower winding of relay 619 and through the lower front contact of relay 612 to conductor 652 of trunk T—3. The aforementioned operation of relay 614 also closes a circuit through the upper winding of relay 617 but the current through the lower winding of relay 617 is electromagnetically opposed to the current through its upper winding so that relay 617 does not operate at this time. The aforementioned operation of relay 614 also closes a circuit for operating relay 618. Relay 618 closes a circuit for operating relay 500 of the interrupter I; this circuit is from battery through the winding and back contact of stepping magnet 605 of charging switch TS—3, brush and terminal 1 of bank 609, resistance 621, inner lower front contact of relay 618, over the conductor 517 and through the winding of relay 500 to ground. The current in this circuit is not sufficient to operate the stepping magnet 605. The operation of relay 500 causes the energization of relay 501 so that ground is connected to conductor 519 once every second by the repeated operation of relay 502 under control of interrupter contacts 503.

The calling subscriber continues to dial all of the digits of the called station's number, the dial impulses being repeated by the repeater R—3 to control the selective operation of the selector S—7 and the operation of each of the succeeding switches employed in completing the desired connection. The release of relay 612 in response to the first impulse of each train opens the loop across the outgoing conductors of trunk T—3 and causes the operation of slow-to-release relay 620. Relay 620 short circuits the lower winding of relay 617 and the lower winding of

relay 619 to reduce the impedance across the outgoing conductors of trunk T—3 during transmission of outgoing impulses, relay 620 being designed to remain operated until all of the impulses in each train have been repeated. The release of relay 612 also closes a circuit for energizing relay 635; this circuit is traced from ground through the back contact of relay 612, lowermost front contact of relay 614, rotary off-normal springs 643 of switch Z, through the winding of relay 635 to battery. Relay 635 locks through its right front contact and the back contact of vertical-stepping magnet 636 to ground at the back contact of rotary-stepping magnet 638. Relay 635 closes a circuit for operating the slow-to-release relay 633 and vertical-stepping magnet 636 in series; this circuit is traced from ground at the left front contact of relay 635, through the back contact of the vertical off-normal springs 647, winding of relay 633 and winding of magnet 636 to battery. The energization of magnet 636 opens the aforementioned locking path for relay 635 and elevates the brushes of tracer switch Z to a position opposite the first level of the terminal bank. The actuation of the vertical off-normal springs 647 when the shaft of switch Z is raised out of normal position opens the above traced operating circuit for relay 633 and magnet 636, but a holding circuit is traced from battery through the winding of magnet 636, winding and front contact of relay 633, lower front contact of off-normal springs 647, to ground at the left front contact of relay 635. The purpose of locking relay 635 under control of the magnets 636 and 638 is to insure the complete operation of each of these magnets in the event that an impulse received by relay 612 is too short to cause the operation of either of these magnets. The reoperation of relay 612 at the end of the first impulse and the complete operation of magnet 636 cause the release of relay 635; and the release of relay 635 causes the release of magnet 636. The alternate release and reoperation of relay 612 in response to each of the succeeding impulses created by the dialing of one digit, causes the alternate operation and release of relay 635 and magnet 636 in like manner, the brushes of switch Z being thereby elevated to a corresponding level of the terminal bank. Relay 614 does not release during the response of relay 612 to dial impulses; and relay 633 remains operated until relay 612 reoperates after its response to the last impulse of the digit.

When the next digit is dialed by the calling subscriber, relay 612 again responds to repeat the impulses over trunk T—3 and to rotate the brushes of tracer switch Z to a corresponding position in the selected level. The release of relay 612 in response to the first impulse of this train closes the circuit for operating relay 635 as hereinbefore described. Relay 635 locks under control of magnets 636 and 638 and closes a circuit for operating relay 634 and the rotary-stepping magnet 638 in series; this circuit is traced from battery, through the windings of magnet 638 and relay 634, back contact of relay 633, lower front contact of the vertical off-normal springs 647, to ground at the left front contact of relay 635. The operation of rotary-stepping magnet 638 causes the advance of the brushes of tracer switch Z into engagement with the first set of terminals in the selected level. The above mentioned holding circuit for relay 635 prevents the release of this relay until magnet 632 is complete-

ly operated. With relay 634 operated, the winding of relay 635 is connected directly through the left front contact of relay 634 to the lowermost front contact of relay 614; relay 634 is slow in releasing and remains operated until all of the impulses in the train have been received so that relay 635 is alternately operated and released in response to each succeeding release and reoperation of impulse receiving relay 612. Each operation of relay 635 causes the operation of magnet 638, the brushes of switch Z being advanced step-by-step into engagement with the set of terminals which corresponds to the digit dialed. While the brushes are being rotated, relay 634 prevents the premature operation of any one of zone relays 639, 640 and 641 by disconnecting battery potential from their windings. Relay 634 releases, upon reoperation of relay 612 after receiving the last impulse of the train, thereby rendering the response of relay 612, to impulses created by further dialing, ineffective to cause the further advance of switch Z. The impulses created by the dialing of the remaining digits of the called subscriber's number are, however, repeated by relay 612 over trunk T—3 to control the completion of the connection with the called line.

The terminals 645 to which the brushes 642, 643 and 644 of tracer switch Z are advanced and which correspond to and represent the traffic route over which a connection is being extended, are distinctively connected to indicate the zone into which the traffic route extends. Each of the three terminals in a set in the bank of switch Z may be connected to ground potential or left unconnected. When relay 634 releases, after the tracer switch Z is set, battery potential is reconnected to the windings of zone relays 639, 640, and 641; relay 639 operates if brush 642 is in engagement with a terminal connected to ground, relay 640 operates if brush 643 is in engagement with a terminal connected to ground, and relay 641 operates if brush 644 is in engagement with a terminal connected to ground. For the particular trunking system represented in Fig. 1, none of the zone relays will be operated for a call to Zone 1; relay 639 alone will be operated for a call to Zone 2; relays 639 and 640 will be operated for a call to Zone 3; relay 640, alone, will be operated for a call to Zone 4; and relays 640 and 641 will be operated for a call to Zone 5. The arrangement is easily modified to take care of more zones. As shown in Fig. 6, the terminals with which brushes 642 and 643 are in engagement are both connected to ground to indicate a call to Zone 3 and relays 639 and 640 both operate and relay 641 remains normal.

When connection with the line 609 of the called station is completed and the called subscriber answers, the current is reversed over the conductors of trunk T—3 by the operation of a supervisory relay in the connector (not shown) in the usual and well known manner thereby causing the operation of the polarized supervisory relay 617 of repeater R—3. Relay 617 closes a circuit for operating relay 613; and relay 613 reverses the current over conductors 601 and 602 and the calling line loop. Since the call originated at a flat-rate subscriber's station, the reversal of current over conductors 601 and 602 is without effect. With relay 613 operated, both windings of relay 619 are included in the bridge across conductors 651 and 652 thereby improving the transmission through condensers 610 during talking. The aforementioned operation of relay 617 also closes a circuit for operating relay 504 of inter-

rupter I; this circuit is traced from battery, through the upper winding of relay 625 of repeater R—3, lower back contact of relay 622, lowermost front contact of relay 617, uppermost back contact of relay 622, back contact of the continuity springs of relay 625, over conductor 515, through back contacts of relays 513 and 508, and through the winding of relay 504 to ground. Relay 625 is marginal and does not operate until relay 513 connects ground directly to conductor 515, the operation of relay 513 being effected as hereinbefore described. Relay 625 then locks through the front contact of its continuity springs to ground at the inner lower front contact of relay 614. With relay 625 operated, the lower winding of this relay is connected, in parallel with the winding of relay 622, over conductor 515, through the back contact of relay 512 to the winding of relay 504. Relay 504 is thus reoperated but relay 622 is marginal and does not operate until the interrupter I functions as hereinbefore described to cause the operation of relay 512. When relay 512 operates, it connects ground to conductor 515 to hold relay 625 and cause the operation of marginal relay 622. Relay 622 locks through the front contact of its continuity springs to ground at relay 614. The operation of relay 622 initiates the advance of timing switch TS—2, relays 616, 618, 628, 629, 630, resistance 621, magnet 635, and banks 606, 607, 608 and 609 all being similar in operation and function to the correspondingly numbered elements of repeater R—2 in Fig. 4. The brush of bank 608 is connected to the winding of relay 616, so that this relay is operated when relay 622 operates before the switch TS—3 moves out of normal position. Terminals 2, 4, 6 and 8 of bank 608 are connected to the contacts of zone relays 639, 640 and 641 so that relay 616 operates twice per revolution of switch TS—3 for a call to Zone 2; thrice per revolution for a call to Zone 3; four times per revolution for a call to Zone 4; and five times per revolution for a call to Zone 5. Each operation of relay 616 connects ground over conductor 604 to cause the operation of register control relays such as 208 and connects the positive pole of booster-battery through lamp 626 over conductor 603, to cause the operation of relays 207, 206 and 212 and meter 211 as hereinbefore described. The subscriber's meter 211 is thereby operated three times for the first five minutes of conversation and three times for each additional period on the call to Zone 3. If the called line were in Zone 2, the meter would be operated twice for each five minutes of conversation as measured by switch TS—2; if the called line were in Zone 4, the meter would be operated four times for each five minutes of conversation as measured by switch TS—3; and if the called line were in Zone 5, the meter would be operated five times for each five minutes of conversation.

If a call is originated at the message-rate subscriber's station B, the line 320 is extended by the operation of a line-finder LF—2, through brushes 300, 301 and 302 to the message-rate charging trunk CT—2. The selector S—2 associated with trunk CT—2 responds to the impulses created by the dialing of the first digit of the number of the subscriber with whom connection is desired. A local call is completed through selectors such as S—3, S—4, S—5 and a connector C—1; a call into Zone 2 is completed through selectors S—3, S—4, a repeater R—2, a selector S—6 and a connector C—2; and calls to Zones 3, 4 and 5 are completed through a re-

peater R—3, a selector S—7 and succeeding selectors and a connector in accordance with the trunking arrangement shown in Fig. 1. The holding circuit for the cut-off relay 307 of line 320 is traced through its front contact, brush 302 of line-finder LF—2, conductor 319, back contact of the continuity springs of relay 313, to sleeve conductor 329 of selector S—2, thence to holding ground potential at the connector on a local call or at an outgoing repeater if the call is an interoffice call. The timing switch TS—1 being normal, the winding of relay 311 is connected through the uppermost back contact of relay 313 and the contact 342 of timing switch TS—1 to sleeve conductor 329. Relay 311 is marginal and does not operate unless and until booster-battery is connected to sleeve conductor 329 as hereinafter described.

If the call is a local call, the usual reversal of current by the operation of a supervisory relay in the connector when the call is answered causes the operation of the polarized relay 308 of trunk CT—2. Relay 308 closes a connection from the lower winding of relay 309, through the front contact of relay 308, upper back contact of relay 310, back contact of the continuity springs of relay 309, over conductor 322, to conductor 515 of interrupter I, thence through the back contact of relay 513, lower back contact of relay 508, and through the winding of relay 504 to ground. Relay 504 operates but relay 309 is marginal and does not operate at this time. Relays 504, 505, 501, 502, 506 and 503 and contacts 503 of interrupter I are effective as hereinbefore described to cause the operation of relay 513. Relay 513 connects conductor 515 directly to ground thereby causing the operation of the marginal relay 309 of trunk CT—2. Relay 309 closes a locking circuit which is traced through the front contact of its continuity springs, contact 342 of the timing device TS—1 to the holding ground potential connected to sleeve conductor 329. With relay 309 operated, the upper winding of relay 309 and the windings of relay 310 and clutch magnet 340 are all connected in parallel to conductor 323, thence over conductor 516, through the back contact of relay 512 and winding of relay 504 to ground. Relays 309 and 504 are thereby held operated but relay 310 and magnet 340 are marginal and do not operate in series with relay 504. Relays 502, 505, 506, 507, 509 and 510 now operate to measure an interval of one and one half seconds at the end of which relays 511 and 512 are operated. Relay 512 connects ground to conductor 516 for half a second thereby causing the operation of relay 310 and clutch magnet 340 of trunk CT—2. Relay 310 and clutch magnet 340 are held operated independently of relay 309 through the front contact of the continuity springs of relay 316 in series with contact 342 of timing device TS—1 over sleeve conductor 329 to holding ground potential. Relay 310 opens the holding circuit through the lower winding of relay 309, but the holding circuit through the upper winding of relay 309 is effective to hold relay 309 operated until relay 512 of interrupter I releases, the resistance of the winding of relay 504 (to which conductor 516 is connected when relay 512 releases) being sufficient to cause the release of relay 309. The circuit through the winding of relay 504 is opened soon enough by the release of relay 309 to prevent the reoperation of relay 504. Relay 310 closes a circuit through its lowermost front contact and the lowermost front contact of relay 309 for energizing

the lower winding of relay 313. In operating, relay 313 connects its upper winding to a front contact of relay 314, closes a circuit for operating the meter control relay 316 and connects the positive pole of booster-battery through lamp 326 and the inner lower front contact of relay 313, over sleeve conductor 319 to cause the operation of meter 315. When relay 309 releases, relay 313 is released thereby disconnecting the booster-battery from sleeve conductor 319 and causing the release of relay 316 and meter 315. The release of relay 316 prevents meter 315 from being held operated by the holding ground potential when relay 313 releases.

If the connection is released before five minutes have been measured by device TS—1, holding ground potential is disconnected from sleeve conductor 329 (due to the release of the line relay of the connector or repeater) causing the release of relay 310 and magnet 340. The timing device is thereupon restored to normal without completing the measurement of a five minute interval. If, however, the talking connection is maintained, contacts 341 and 342 of the timing device are opened at the end of five minutes thereby causing the release of relay 310 and magnet 340. The release of magnet 340 causes the immediate reclosure of contacts 342 but contacts 341 are held open until the timing device reaches its normal position thereby preventing the reoperation of magnet 340 and the reengagement of the driving clutch in any other than normal position. If the talking connection is continued beyond five minutes, the continued operation of relay 309 causes the reoperation of relay 309 and the above described cycle of operations is repeated to cause another operation of meter 315 and the measurement of another five minute interval.

If the trunk CT—2 is employed in completing an interoffice connection through either one of repeaters R—2 or R—3, the connection of booster-battery to sleeve conductor 329 by the operation of relay 416 of a repeater R—2 or relay 616 of a repeater R—3 is effective to operate the marginal relay 311 of trunk CT—2 and the connection of ground to conductor 404 of a repeater R—2 or conductor 604 of a repeater R—3 causes the operation of relay 314. The operation of relay 311 prevents the operation of magnet 340 of timing device TS—1, or causes the release of the timing device TS—1 if already moved off-normal as hereinbefore described. Relay 311 closes a circuit for operating relay 312. Relay 312 locks over the sleeve conductor 329 to prevent the operation of magnet 340 when relay 311 releases. Relay 311 also closes a circuit for operating relay 310. Relay 310 locks over sleeve conductor 329 and closes a circuit through the upper winding of relay 313; relay 313 operates and closes a locking circuit to the front contact of relay 314. The operation of relay 313 causes the release of relay 311, connects booster-battery to sleeve conductor 319, and closes the circuit for operating relay 316 as hereinbefore described. Since the operation of relay 311 occurs while conductor 323 is connected to ground at the front contact of relay 512 of interrupter I, and if relays 308, 309 and 310 have operated before relay 311 is operated by booster-battery potential, relay 313 will have been operated due to the energization of its lower winding as hereinbefore described. The energization of relay 316 holds relay 313 operated until the booster-battery is disconnected from conductor 329. When relay 416 of repeater R—2 (or relay 75

616 of repeater R—3) releases, relays 314 and 313 are released but relays 310 and 312 are held over sleeve conductor 329 by ground potential until the connection is released. Each succeeding operation of relay 416 (or 616) causes the reoperation of relays 311 and 314 followed by the operation of relays 313 and 316 and meter 315. Since the operation of relay 313 connects booster-battery through lamp 326 to sleeve conductor 319 each time booster-battery is connected to sleeve conductor 329, the temporary connection of ground potential to the terminal with which brush 305 is in engagement by another selector cannot cause more than one operation of meter 315 for each operation of relay 416 (or 616).

When the called subscriber replaces the receiver on the receiver hook, the reversal of current through the windings of relay 308 causes its release. If the call is a local call, further advance of timing device TS—1 is thus prevented. When the holding ground potential is disconnected from conductor 329, relays 310, 311 and 312 release, if operated, the line-finder LF—2 and selector S—2 being restored to normal in usual manner.

To illustrate the application of the invention to a system employing line-switches in place of line-finders, Fig. 7 may be substituted for Fig. 2. The primary line-switch PLS and secondary line-switch SLS shown in Fig. 7 may be of the well known Keith type. For a complete description of the construction and operation of such switches, reference may be had to pages 44 to 50, inclusive, and pages 83 to 89, inclusive, of the second edition of "Automatic Telephony" by Smith and Campbell. Only the holding winding of the magnet 702 of line-switch PLS is shown. The meter 703 is provided for operation to record the charge for calls other than local calls. The line relay and plunger magnet of the secondary line-switch SLS are not shown.

Upon removal of the receiver at station H to originate a call, the line 701 is extended through its primary line-switch PLS to a secondary line switch SLS. The upper winding of relay 710 is, thereupon, connected in series with the winding of the meter 703. Relay 710 is sufficiently energized by the current in this circuit to close its lower front contact, but its upper contacts remain in their normal positions. The meter 703 is marginal and does not operate in series with the winding of relay 710. The closing of the lower contacts of relay 710 causes the operation of the secondary line-switch SLS, thereby extending the connection over trunk CT—3 to the first selector S—13. The holding ground potential, connected in well known manner to sleeve conductor 713, completes the operation of relay 710 due to the energization of its lower winding and maintains the energization of the holding winding of the magnet 702 of line-switch PLS. The complete operation of relay 710 disconnects its upper winding from the winding of meter 703 and connects the winding of meter 703 to conductor 719 of trunk CT—3. Relay 715 is marginal and the energization of its upper winding when holding ground potential is connected to sleeve conductor 713 is insufficient to cause the operation of this relay.

On a local call none of the relays in the trunk CT—3 is operated, no operation of meter 703 being required. But on an interoffice call for which a charge should be made, the operation of a relay 416 or 616 in a repeater R—2 or R—3 through which the call is completed, causes the operation of relay 717 and connects booster-bat-

tery to sleeve conductor 713 in place of ground potential to operate relay 715. The operation of relays 715 and 717 causes the operation of relay 716. Relay 716 locks under control of relay 717 alone, causes the release of relay 715, and connects battery to sleeve conductor 719 to cause the operation of meter 703. When the relay 416 (or 616) of the repeater releases, relay 717 and meter 703 release. Each time that booster-battery potential is connected to sleeve conductor 713 by the repeater through which the connection is completed, the meter 703 is operated. Upon release of the connection the magnets of line-switches PLS and SLS are released and relay 710 releases.

The invention is not limited in its application to the particular switching and trunking arrangements hereinbefore described and is applicable to interoffice systems employing other types of switches and different trunking schemes.

What is claimed is:

1. In a multi-office telephone system, subscribers' lines, means including a charging trunk for extending a calling one of said lines to a called line in the same office, means including said charging trunk and an outgoing trunk for extending said calling line to a called line in another office, a meter for said calling line, means in said charging trunk for operating said meter, timing apparatus associated with said charging trunk for controlling said meter operating means only on local calls, and timing apparatus associated with said outgoing trunk for controlling said meter operating means on interoffice calls.

2. In a multi-office telephone system, subscribers' lines, means including a charging trunk for extending a calling one of said lines to a called line in the same office, means including said charging trunk and an outgoing trunk repeater for extending said calling line to a called line in a different office, a meter for said calling line for registering charges for completed calls in accordance with their duration and the location of the called line, means in said charging trunk for operating said meter, timing apparatus associated with said charging trunk for controlling said meter operating means only on local calls, and timing apparatus associated with said outgoing-trunk repeater for controlling said meter operating means on interoffice calls.

3. In a multi-office telephone system, subscribers' lines serving message-rate subscribers, message-registers for the message-rate lines, switching means for use in completing talking connections between calling and called lines, charging trunks for controlling the operation of said message-registers, one of said trunks being included in each connection, outgoing trunks for use in completing interoffice calls, timing apparatus in each of said charging trunks for measuring off periods of time during which the charging trunk is included in a talking connection, timing apparatus for each of said outgoing trunks for measuring off periods of time during which the outgoing trunk is included in a talking connection, means in said charging trunk controlled by the timing apparatus therein for operating the calling subscriber's message-register at the beginning of each measured period of time during which the charging trunk is included in a talking connection, and means in said charging trunk controlled by the timing apparatus of an associated one of said outgoing trunks for rendering the timing apparatus of said charging trunk ineffective and for operating the calling subscriber's

register at the beginning of each measured period of time during which said outgoing trunk is included in a talking connection.

4. In a multi-office automatic telephone system, subscribers' lines, automatic switches for use in completing a talking connection between a calling line and a called line, a meter for said calling line, a charging trunk included in the connection between the calling line and the first of said switches, said charging trunk comprising means for counting off intervals of time as long as the talking connection is maintained, meter operating means, and means for rendering said meter operating means operatively effective at the beginning of each of such intervals, an outgoing-trunk repeater in the connection between the first of said switches and said called line, said repeater comprising means for counting off intervals of time as long as the repeater is connected in an established talking connection, means for transmitting one or more charging impulses at the beginning of each of such intervals, means for varying the number of impulses transmitted in accordance with the office in which the distant end of the trunk terminates, and means in said charging trunk responsive to charging impulses received from said repeater for controlling said meter operating means in accordance with said impulses.

5. In a multi-office telephone system, subscribers' lines, means including a charging trunk for extending a calling one of said lines to a called line in the same office, means including said charging trunk and an outgoing trunk for extending said calling line to a called line in another office, a meter for said calling line, means in said charging trunk for operating said meter, timing apparatus associated with said charging trunk for controlling said meter operating means on local calls, timing apparatus associated with said outgoing trunk for controlling said meter operating means on interoffice calls, and means in said charging trunk for rendering the timing means therein ineffective to control said meter operating means on interoffice calls.

6. In a multi-office telephone system, subscribers' lines, means including a charging trunk for extending a calling one of said lines to a called line in the same office, means including said charging trunk and an outgoing trunk for extending said calling line to a called line in another office, a meter for said calling line, means in said charging trunk for operating said meter, timing apparatus associated with said charging trunk for controlling said meter operating means on local calls, and timing apparatus associated with said outgoing trunk for controlling said meter operating means on interoffice calls, the timing apparatus in said charging trunk being synchronized with the timing apparatus in said outgoing trunk to prevent the control of said meter operating means by the timing apparatus of the charging trunk on interoffice calls.

7. In a multi-office telephone system, flat-rate subscribers' lines and message-rate subscribers' lines, a meter for each of said lines, means for completing connections between calling and called lines in the same office, means including a group of outgoing trunks for completing connections from both flat-rate and message-rate lines to called lines in another office, meter operating means arranged to operate the meter of a calling flat-rate subscriber's line only on interoffice calls, and meter operating means arranged to operate the meter of a calling message-rate subscriber's line on both local and interoffice calls.

8. In a multi-office telephone system, flat-rate subscribers' lines and message rate subscribers' lines, a meter for each of said lines, charging trunks for use in completing calls originated by flat-rate lines, other charging trunks for use in completing calls originated by message-rate lines, outgoing trunks for use in completing calls originated by both flat-rate and message-rate lines, timing means in each of said message-rate charging trunks for controlling the operation of the meters of calling message-rate lines on local calls, and timing means associated with each of said outgoing trunks for use in controlling the operation of the meters of calling flat-rate lines and the operation of the meters of calling message-rate lines.

9. In a multi-office telephone system, message-rate subscribers' lines, flat-rate subscribers' lines, a meter for each of said lines, charging trunks for use in controlling the meters of said message-rate lines, other charging trunks for controlling the meters of said flat-rate lines, means including said charging trunks for extending connections from calling to called lines, outgoing trunks for use in completing interoffice calls, apparatus for each of said outgoing trunks operative in response to the completion of a talking connection for measuring off intervals of time during which the talking connection is maintained and for transmitting metering signals at the beginning of each of said intervals, means in each of said charging trunks, both flat-rate and message-rate, responsive to metering signals received from any one of said repeaters for effecting corresponding operations of the meter of an associated calling line, timing means in each of the message-rate charging trunks for measuring off intervals of time during which the trunk is included in a completed talking connection, and means in each of the message-rate charging trunks for controlling the operation of the meter of an associated calling line, said last mentioned means being under the control of the timing apparatus in the charging trunk on a local call and under the control of the timing apparatus of the outgoing trunk on an interoffice call.

10. In a multi-office telephone system, subscribers' lines, means including a charging trunk for extending a calling one of said lines to a called line in the same office, means including said charging trunk and an outgoing trunk for extending said calling line to a called line in another office, a meter for said calling line, means in said charging trunk for operating said meter, timing apparatus associated with said charging trunk for counting off conversational-unit periods of time during which a talking connection is maintained through said charging trunk on local calls, and timing apparatus associated with said outgoing trunk for counting off conversational-unit periods of time during which a talking connection is maintained over said outgoing trunk, said meter operating means being under the control of said timing apparatus in the charging trunk on local calls and under the control of said timing apparatus in the outgoing trunk on interoffice calls.

11. In a multi-office telephone system, subscribers' lines, means including a charging trunk for extending a calling one of said lines to a called line in the same office, means including said charging trunk and an outgoing trunk for extending said calling line to a called line in another office, a cut-off relay for said calling line connected to the sleeve conductor of said charg-

ing trunk, means for connecting a holding ground potential to said sleeve conductor to operate said cut-off relay, conversation-timing apparatus associated with said charging trunk, conversation-timing apparatus associated with said outgoing 5 trunk, a meter for said calling line, a source of meter operating potential in said charging trunk, a multi-contact relay common to said lines and having a set of contacts individual to each of 10 said lines, means controlled on local calls by said timing apparatus of the charging trunk and on

interoffice calls by said timing apparatus of the outgoing trunk for temporarily connecting said meter operating potential to said sleeve conductor in place of said holding ground potential and for simultaneously causing the operation of said 5 multi-contact relay, the operation of said multi-contact relay being effective to connect said meter to said sleeve conductor in parallel with said cut-off relay while said meter operating potential is connected to said conductor. 10

RAY L. STOKELY.