Sept. 18, 1945. A. B. CLARK 2,385,061

COMMUNICATION SYSTEM

Filed Jan. 1, 1943 5 Sheets-Sheet 1

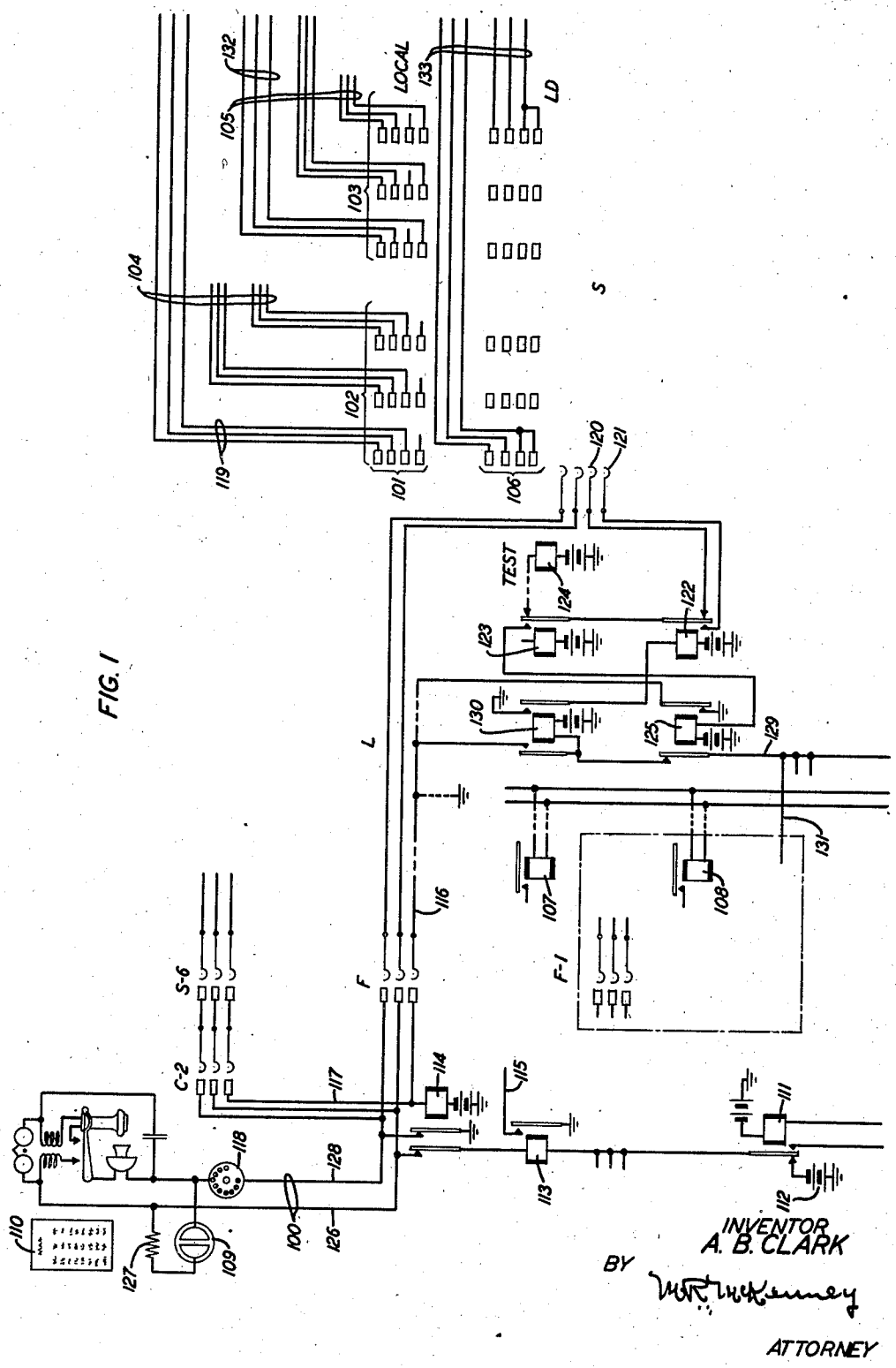

FIG. 1

INVENTOR
A. B. CLARK

BY

ATTORNEY

Sept. 18, 1945. A. B. CLARK 2,385,061

COMMUNICATION SYSTEM

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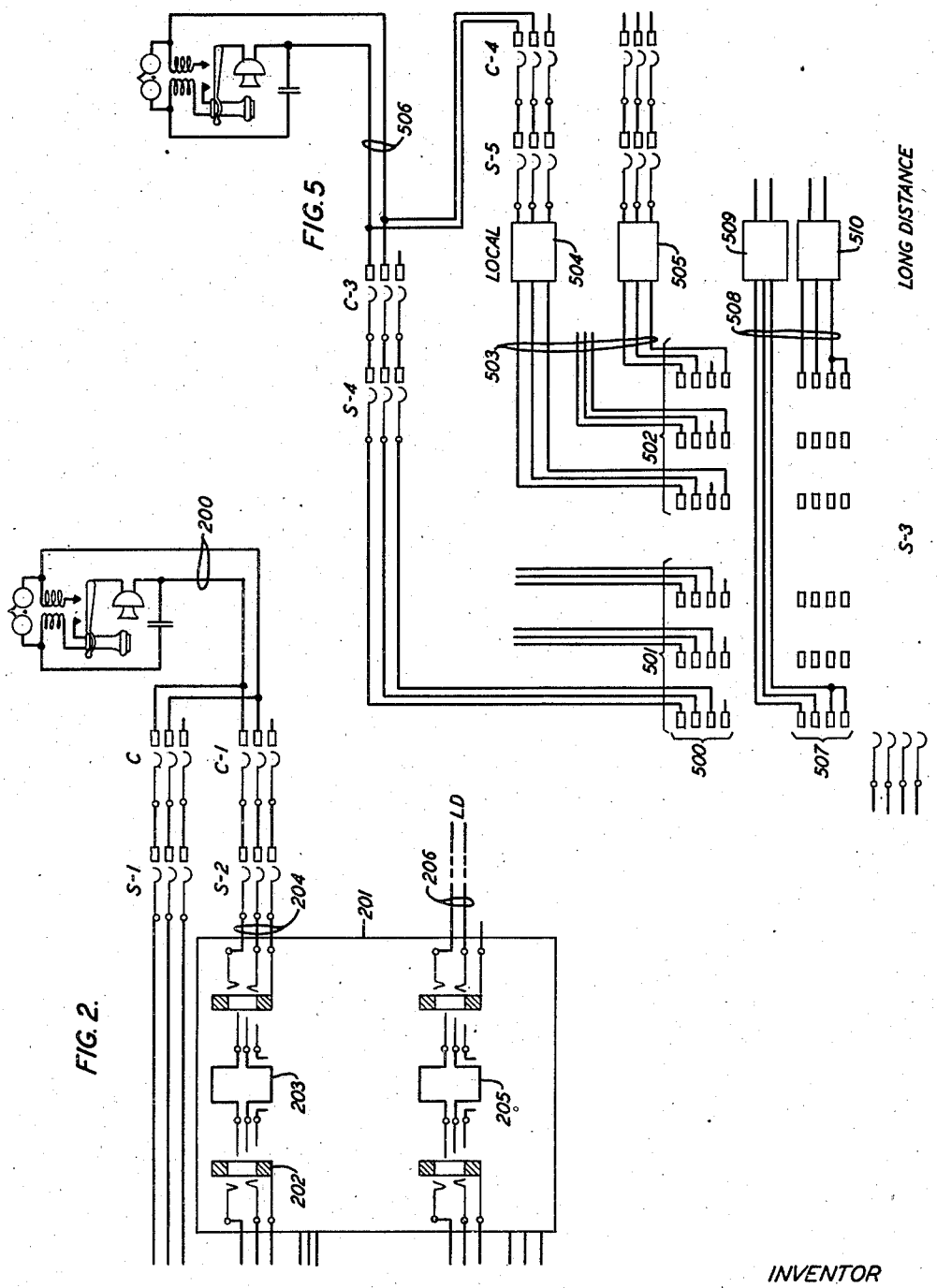

INVENTOR
A. B. CLARK
BY
ATTORNEY

Sept. 18, 1945. A. B. CLARK 2,385,061

COMMUNICATION SYSTEM

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FIG. 4.

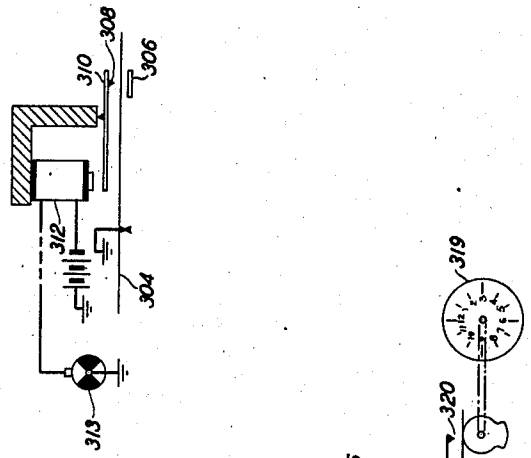
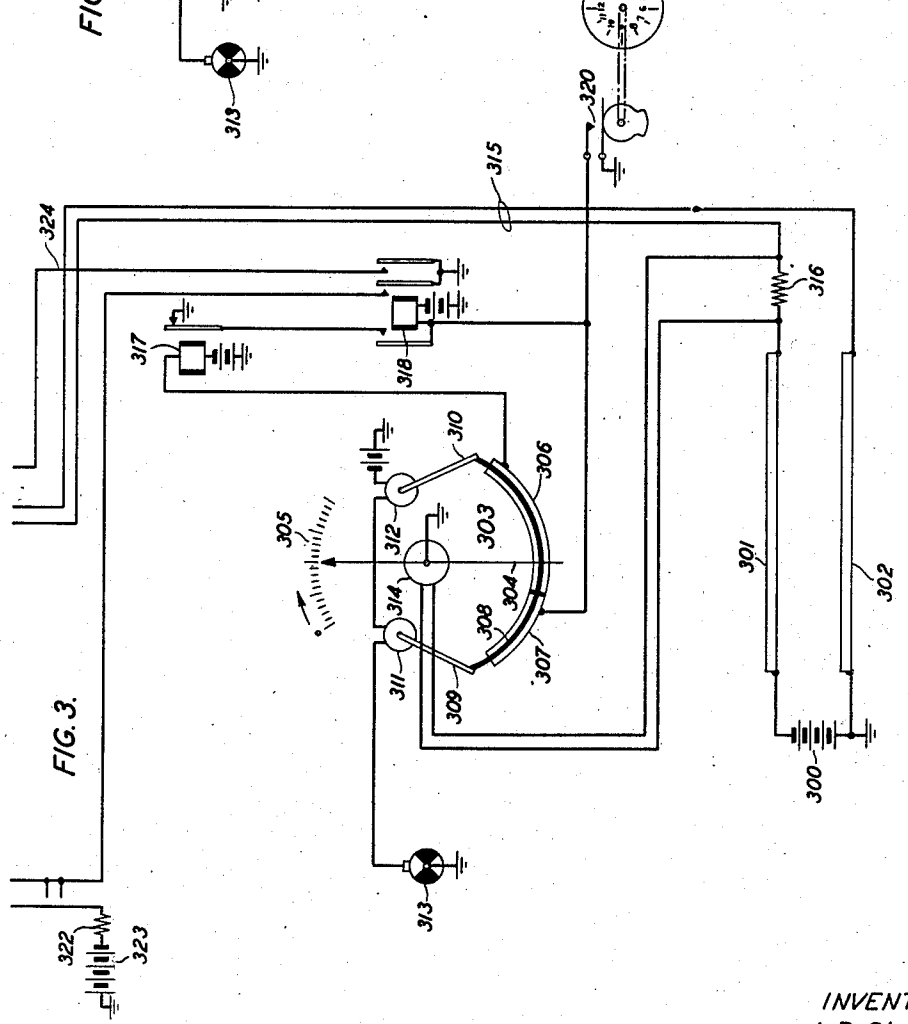


FIG. 3.



INVENTOR
A. B. CLARK
BY
ATTORNEY

Sept. 18, 1945. A. B. CLARK 2,385,061

COMMUNICATION SYSTEM

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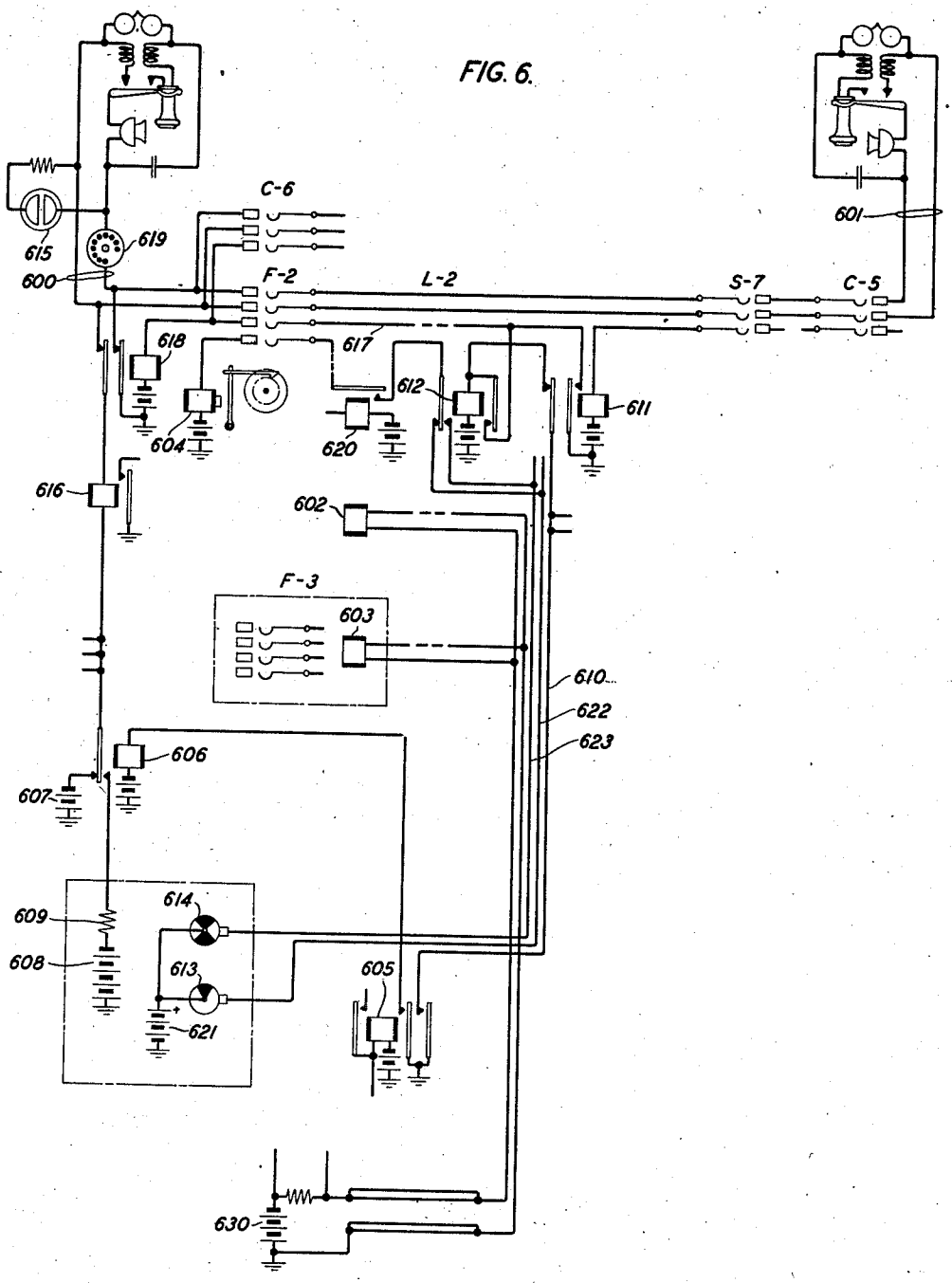
FIG. 6.



INVENTOR
A. B. CLARK
BY: M. V. McTamney
ATTORNEY

Sept. 18, 1945. A. B. CLARK 2,385,061

COMMUNICATION SYSTEM

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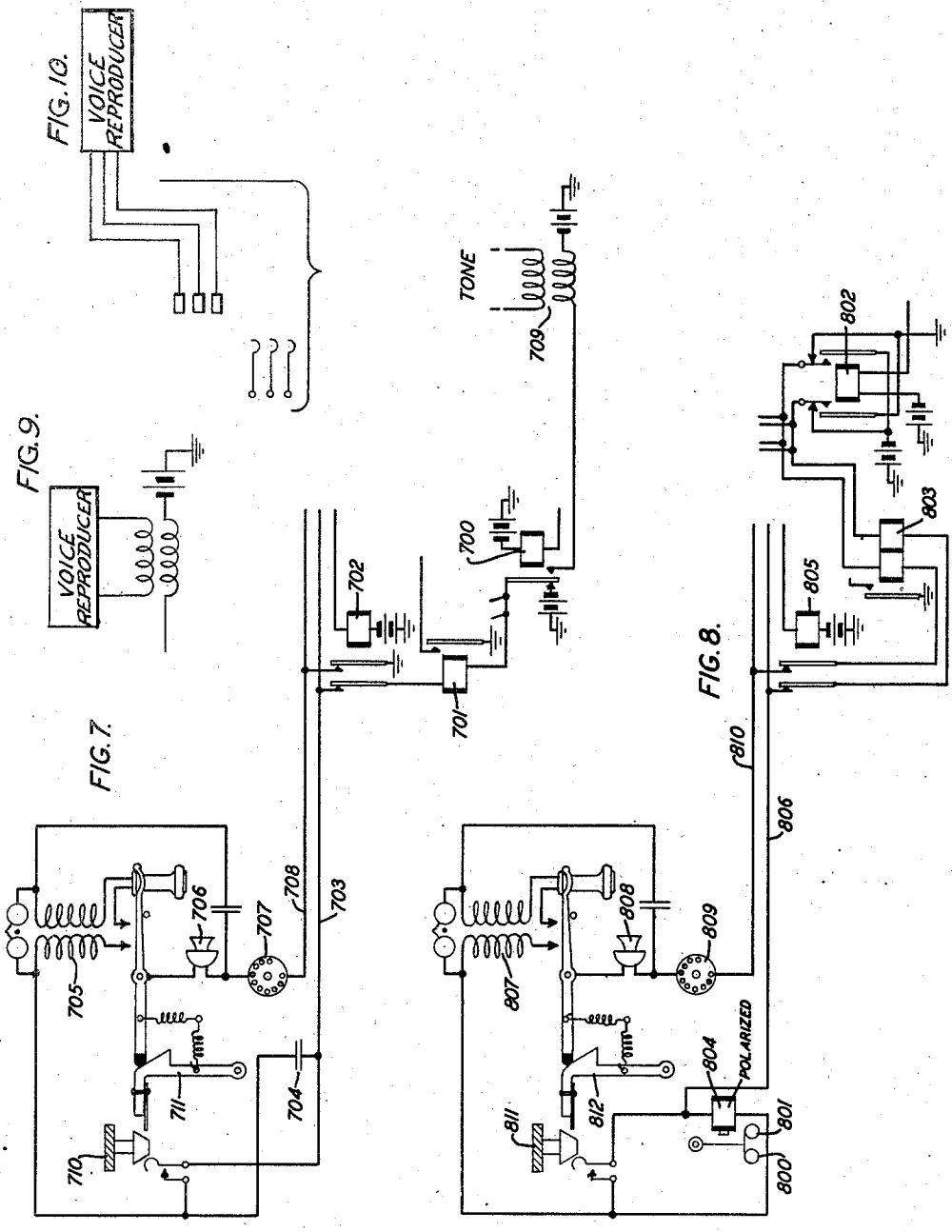

INVENTOR
A. B. CLARK
BY
W. J. C. McKenney
ATTORNEY

Patented Sept. 18, 1945

2,385,061

UNITED STATES PATENT OFFICE

2,385,061

COMMUNICATION SYSTEM

Alva B. Clark, Maplewood, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application January 1, 1943, Serial No. 470,964

15 Claims. (Cl. 179—7.1)

This invention relates to communication systems and particularly to systems in which the subscribers are charged in accordance with the service rendered to them.

An object of the invention is to furnish telephone service at a relatively low rate to subscribers who make their calls during periods of light load and at a relatively high rate if their calls are made during periods of heavy load.

Another object of the invention is to furnish telephone service to a restricted class of subscribers at a relatively low rate during periods of light load and at a relatively higher rate during periods of heavy load.

Another object is to determine automatically whether the office is operating under a light load or a heavy load and to dispose of each call accordingly to facilitate the assessment of the appropriate charge therefor.

Another object is to apprise the subscriber at any time whether he is entitled to make a call at the low or nominal rate he pays for his service or whether the call if made will be charged at a higher rate.

Another object is to make the lines of the restricted service subscribers available at all times for incoming calls from other subscribers without regard to existing load conditions.

Another object is to dispose of all calls by restricted subscribers on the high-rate basis if made either during certain predetermined hours or periods of the day or at any time when the office is heavily loaded and to dispose of such calls on the nominal or low-rate basis if made at any other time.

The invention in its broadest aspects contemplates a system in which a restricted service at a nominally low rate may be made available to the different classes of subscriber's lines, such as individual and party lines, lines of the flat-rate class, and message register lines. It is particularly attractive from a cost standpoint when applied to party lines on a flat-rate restricted basis. The savings to be realized in the cost of equipment and annular charges make it possible to offer a service to this class of subscribers which entitles them, for a relatively low flat-rate charge, to make an unlimited number of local calls, provided these calls are made when the office is operating under light load conditions, and which also entitles them to unrestricted service for incoming calls at all times. Moreover, these subscribers have the privilege of utilizing the facilities of the office at all times for making calls in unlimited numbers, subject to an additional charge for each call made when the office is operating under heavy load.

A feature of the invention, therefore, is a system in which the central office is provided with means for making continuous tests to determine the load condition of the office. The demarcation between light and heavy loads may be based on any one or on a combination of a number of conditions. In general, of course, it is chosen to mark the fact that the activity of the office has risen to a predetermined point beyond which the office is regarded as carrying a heavy load. In particular this transition from light to heavy load can be indicated in terms of busy equipment units, such as line finders, trunks, senders, etc. For example, it is possible to measure the amount of current drawn by the operated control relays when a given number of line finders are in concurrent use and to utilize this information in the central office controlling equipment to dispose of all calls thereafter from the restricted lines in such a way that an additional charge is assessed against the subscribers.

Another feature is a system in which local calls by a restricted line during light office load are completed in the usual manner without incident, and in which such calls, if made during heavy load periods, are automatically routed to an operator who completes them and makes out tickets for assessment at a higher rate.

Another feature is a system of the character above described in which calls made during the heavy load periods are completed automatically by the calling subscribers and in which tickets are prepared automatically to record the higher rate of charge to be assessed against the subscribers.

A further feature of the invention is a system in which the restricted service is applied to message register lines and in which the load condition of the office is utilized to determine the appropriate number of operations to be scored on the subscriber's register for each call made.

A still further feature is the provision of means for apprising the subscriber, either in advance or while he is in the act of calling, that the heavy load condition is prevailing and that the call he wishes to make will be charged at the higher rate.

The foregoing and other features of this invention will be described more fully in the following detailed specification.

In the drawings accompanying this specification:

Figs. 1, 2 and 3, when taken together, illustrate a portion of an automatic telephone system incorporating the features of the invention.

Fig. 1 shows one of a number of subscribers' lines and illustrates in conventional manner a line finder and first selector switch for establishing outgoing connections and selector and connector switches for setting up incoming connections;

Fig. 2 illustrates conventionally selector and connector switches for completing local calls to called subscribers' lines and also illustrates an operator's switchboard for assistance in completing these calls and for establishing long distance connections;

Fig. 3 shows a portion of the common power equipment in the central office together with measuring and timing devices for determining the load condition of the office;

Fig. 4 is a detail view of the load-measuring device;

Fig. 5 illustrates a modification of the system of Figs. 1, 2 and 3 in which automatic tickets are prepared for certain local calls and for long distance calls;

Fig. 6 illustrates a modification of the system to accommodate message register lines;

Fig. 7 shows an alternative arrangement for notifying the subscriber of the office load condition; and

Figs. 8, 9, and 10 show other alternative arrangements for apprising the subscriber of the load condition.

The present invention is applicable broadly to all types of communication systems such as telephone and telegraph systems in which it may be desirable to charge the individual subscribers for the service rendered in accordance with the load that is imposed upon the central office facilities. It is particularly applicable to automatic telephone systems and may be applied to these without limitation with regard to the types of switches and other controlling equipment used. For the purpose of illustration the invention is disclosed herein embodied in an automatic telephone system of the well-known step-by-step type. It is equally applicable, however, to systems of the panel and cross bar types in which register senders and markers are employed in the central office for controlling the switches to establish the desired connections.

As above mentioned, one of the important advantages of the present method of furnishing telephone service and assessing the charges therefor is the relatively low monthly rate that can be offered to subscribers who are willing in general to place their calls during periods when the central office is lightly loaded. For a flat monthly rate the subscribers of this class are entitled to make an unlimited number of local calls during light loaded periods and are also entitled to make as many calls as they wish at any time subject, however, to being charged at a higher rate for every call made when the office is operating under heavy loading conditions. Furthermore, the subscribers of this restricted class are entitled to receive incoming calls from other subscribers at all times.

This service may also be given to subscribers of the message register class. All calls made by these subscribers during light load periods are scored by operating the calling subscriber's message register a minimum number of counts for each call. However, if one of these restricted subscribers makes a call at a time when the office is heavily loaded, the charge therefor is increased by automatically operating the message register a greater number of counts.

Referring to Figs. 1, 2 and 3 of the drawings, a subscriber's line **100**, which is assumed to be a flat-rate restricted service line, either of the individual or party line type, is shown appearing in the bank of the line finder switch F; and the line finder F is joined by a link circuit L with a first selector switch S.

The selector switch S has a plurality of contact levels in its terminal bank, and some of these levels are preferably divided in two groups. For example, the level **101**, which serves to extend local calls, is divided into groups **102** and **103**. The trunks **104** appearing in the group **102** extend to succeeding selector switches, such as switch S—1, which serve in conjunction with connector switch C to complete the local call to a called subscriber's line **200**. The trunks **105** appearing in the second group of contacts **103** extend to an operator's switchboard **201** and the operators at this board, after receiving the necessary information from the calling subscribers, complete the desired local connections over selectors S—2 and connectors C—1 to the called subscribers' lines, such as the line **200**. As will be explained hereinafter the brushes of the selector S, having been positioned opposite the level of the terminals **101** for a local call, are caused to hunt either in the first group **102** or in the second group **103** according to whether the office at the time is lightly loaded or heavily loaded.

Other levels of the selector switch S, such as the level **106**, are devoted entirely to trunks leading to the operator's switchboard **201**. These trunks are chosen when the subscriber is dialing for a long distance call, and the operators at the board **201** or at some other switchboard receive the necessary information from the subscribers and assist in establishing the desired toll calls. For a more detailed description of a switch of this type reference is made to Wadsworth 2,249,067 of July 15, 1941.

The central office is also provided with a power or current supply equipment including the battery **300** and bus-bars **301** and **302**. The load on the central office at any particular moment, which will in general vary with the number of conversations taking place, may be determined by noting the extent to which certain equipment units are being used simultaneously. For example, the number of line finders in operated position or the number of trunks in simultaneous use may be taken as a measure of the load on the office. In a system of the panel or cross bar type the number of senders in simultaneous use is a fair indication of the extent to which the office is loaded. A convenient way of counting the number of equipment units in simultaneous use is to measure the amount of current drawn from the central office battery by these units. This may be accomplished by a current-measuring meter **303**.

The meter **303** includes a sensitive needle **304**, one end of which plays over the scale **305**. The other end of the needle plays over the metallic segments **306** and **307**, which are insulated from each other, but normally does not touch either of them. Normally the needle does not touch either of these segments, but at regular intervals it is tilted into circuit-making engagement with

one or the other of these segments by means of a bail 308 of insulating material. The bail 308 is supported on the armatures 309 and 310 of electromagnets 311 and 312, respectively. These magnets are energized repeatedly by an interrupter 313, and each time they energize the bail 308 moves the needle into engagement with either the segment 306 or segment 307, depending on the needle position, and holds it there until the interrupter again opens. A side view of one of the bail-operating magnets is shown more clearly in Fig. 4.

The needle 304 is operated over the scale by an operating magnet 314, the energization of which is proportional to the current flowing in the circuit 315 from the battery bus-bars 301 and 302 to the operated line finders F—1, etc. Each finder that is in an operated condition has an energized relay supplied with current over the common circuit 315. If, for example, finders F and F—1 are busy, relay 107 in the finder F and relay 108 in the finder F—1 are drawing current from the battery 300 over the circuit 315, and the voltage drop across the resistor 316 causes the needle 304 to move to a position representative of the number of finders in operation.

As long as the central office is operated under a light load the needle 304 occupies some position above the metallic segment 306. Each time the interrupter 313 closes, the magnets 311 and 312 tilt the needle 304 into engagement with segment 306, and an obvious circuit is closed for operating the relay 317, although the relay 317 is without effect at this time. However, when the office load reaches a predetermined point, the needle 304 passes beyond the segment 306 and over the segment 307 representing the heavy load. The next time the interrupter 313 closes, the needle 304 is tilted onto segment 307, and a circuit is closed from battery through the winding of relay 318, segment 307, needle 304 to ground. Relay 318 operates and locks through its armature and contact to ground through the back contact of relay 317. Relay 318 remains locked as long as the office is in a heavy load condition and serves, as will be explained hereinafter, to control the switching equipment in such a manner that calls made by subscribers of the restricted class will be subject to charging at a higher rate. When the load on the office subsequently recedes below the predetermined point, the needle 304 again passes over the segment 306. On the next closure of the interrupter 313, relay 317 is operated to release the relay 318, thus restoring the central office circuits to the flat-rate basis.

In connection with this type of service it may be desirable to select certain fixed hours or other periods of the day and to charge the subscribers of the restricted class on a higher rate for all calls made within these periods as well as for calls which they make when the office is in its heavy load condition. This may be accomplished by any suitable clock mechanism 319. For example, if the hour from 9 until 10 in the morning is chosen as a busy hour, the clock mechanism 319 will close the contacts 320 during this period, thus operating the relay 318 without regard to the actual load on the office. When the busy hour passes, the clock 319 reopens the contacts 320, and the relay 318 is now restored to the sole control of the load-measuring instrument 303.

In order that a party who has subscribed for this special service may know at any time he is about to make a call whether the call will be covered by his flat monthly rate or whether it will be subject to an extra charge, his substation is equipped with some suitable signaling device. The subscriber's line 100, for example, is equipped at the substation with a glow lamp 109 which lights as a signal whenever the central office is heavily loaded. The subscriber, seeing the lighted lamp 109, knows that if he makes a call at such a time that he will be charged therefor at some predetermined rate. If, as hereinbefore noted, certain predetermined hours or other periods of the day are designated as heavy load periods during which all calls by special rate subscribers will be subject to extra charge, each subscriber's station in this class is also provided with a suitable schedule 110 of the heavy load periods. For his regular flat monthly rate, therefore, a subscriber in this class is entitled to make an unlimited number of local calls, provided he makes them outside the hours or periods designated in the schedule 110 and provided further that he does not call at any time when the lamp 109 is lighted. Nevertheless, the facilities of the central office are available to him at all times, and he may place as many calls as he wishes subject, of course, to the extra charge for calls made when the office is in a heavy load condition.

The operation of the system illustrated in Figs. 1 to 3 will now be described. Assume first that the central office is lightly loaded and that the subscriber of line 100 wishes to make a call to the subscriber of another line 200 in the local area. Since the office is lightly loaded, the meter needle 304 is hovering somewhere above the segment 306, and relay 318 is in its released condition. With relay 318 released, the relay 111, which is common to the subscribers' lines of the special class, is also in a released condition. When, therefore, the calling subscriber removes his receiver from the switchhook, a circuit is closed from the negative pole of battery 112, which in reality is the same as the central office battery 300, back contacts of the common relay 111 through the winding of the subscriber's line relay 113, normal contacts of cut-off relay 114 thence over conductor 126 of the subscriber's line 100 and returning over conductor 128 to ground through the normal contacts of relay 114. The current flowing in this circuit operates the line relay 113, but it should be noted that the voltage of battery 112 is not sufficient to light the lamp 109, notwithstanding the fact that the lamp is normally connected across the circuit including the battery. The line relay 113 closes the usual line finder start circuit 115, and the line finders, including the finder switch F, are set in operation to find the calling subscriber's line 100. When the line has been found, the finder stops, and ground potential is applied to the sleeve conductor 116, causing the operation of the cut-off relay 114. Relay 114 disconnects the line relay 113 from the tip and ring conductors of the calling line, and the start circuit 115 is opened. The ground potential is also extended by way of the sleeve conductor 117 of the line to render the line busy to incoming calls in the terminal banks of the connector switches C—2.

The calling subscriber now proceeds to manipulate his dial 118 to operate the selector switch S to select a level of terminals 101 having access to trunks which serve for establishing local connections. Inasmuch as the office is lightly loaded at this time the calling subscriber is not subject to an extra charge and should be permitted to complete the call himself without the interven-

tion of an operator. To this end the selector switch S, which is provided with two test brushes 120 and 121, performs its automatic trunk hunting operation in the first group 102 of the selected level 101 by testing the trunks of this group with its test brush 120, the test circuit extending through the normal contacts of relays 122 and 123 to a suitable test relay 124. When the first idle trunk is found, such as the trunk 119, the connection is extended through to the succeeding selector switch S—1. The calling subscriber continuing to maniplate his dial positions the selector S—1 and the succeeding connector C to complete the connection to the desired subscriber's line 200. Following the selection of the idle trunk 119 relay 123 is operated, and a ground potential is returned in the well-known manner over the sleeve conductor to operate the relay 125. Relay 125 applies holding ground potential to the sleeve conductor 116 to hold the line finder and cut-off relay during the existence of the connection.

As long as the finder F is held in the connection thus established, the relay 107 is maintained in an energized condition by current flowing from the central office battery over the circuit 315. The voltage drop across the resistor 316 as a result of current flowing to the relay 107 is an indication that the finder F is engaged.

At the end of the conversation the subscribers replace their receivers, ground potential is removed from the holding conductors, relays 123, 125, 107 and 114 release, and the switches are restored to their normal positions.

As the load on the office increases, the number of finder switches F, F—1, etc. in concurrent use increases correspondingly, and the current drawn by the relays 107, 108, etc. increases the voltage drop across the resistor 316 until the needle 304 of the meter 303 passes beyond the light load segment 306 and over the heavy load segment 307. The next time the interrupter 313 closes, a circuit is completed for operating relay 318, which locks to the contacts of relay 317 and causes the operation of relay 111. Relay 111 disconnects the line relays of the lines in the special class from central office battery 112 and connects them through the resistor 322 to the relatively high voltage battery 323. If the special class of lines is large enough to warrant it, a plurality of relays similar to relay 111 are provided, one for each of a group of lines of the special class, and these relays are all operated in parallel over the circuit closed at the inner right contact of relay 318. Relay 318 also applies ground potential to conductor 324, which has a multiple branch extending to each of the line finder selector links L serving the lines of the special class. The multiple branch 129 extending to the link L associated with finder F is connected to the armature of relay 125. If the link L is idle at this time, the grounded branch circuit 129 is further extended through the winding of relay 130 to battery, causing the operation of relay 130. In like manner branch circuit 131 extends to the link including line finder F—1 and causes the operation of the relay corresponding to relay 130 if the link is idle at the time. And the same is true of all other links serving the calls of the special service line. If, on the other hand, the link L is busy at the time relay 130 operates, relay 125 is in an energized condition, and the application of ground potential to the conductor 324 does not cause the operation of relay 130. Similarly the relays of all other busy links corresponding to relay 130 are unaffected.

Assume now that while the office is thus subjected to the heavy load condition the subscriber of line 100 desires to make a local call to the subscriber of line 200. At this time relay 111 is energized as above explained, and a circuit is traceable from the high potential battery 323, resistance 322, front contacts of relay 111 through the winding of line relay 113, contacts of cut-off relay 114, conductor 126, resistor 127, lamp 109, conductor 128 to ground at the contacts of relay 114. The voltage applied to the lamp 109 over this circuit causes it to glow, but the current flowing is insufficient to operate the line relay 113. Similar circuits are closed for the lamps on all other lines of this class which have their line relays connected in multiple to the armature of the common relay 111. The subscriber of line 100, noting the glowing lamp 109, understands that the call, if made at this time, will be subject to an extra charge. If he decides, nevertheless, to proceed with the call, he removes his receiver whereupon a low resistance bridge is closed across conductors 126 and 128. This bridge short-circuits the lamp 109 to extinguish it and also permits sufficient current to flow through the resistance 322 to operate the line relay 113. Relay 113 closes the start circuit 115, and the finder F of an idle link is set in operation to find the calling line. When the finder reaches the calling line terminals, it stops, and ground potential is applied in the well-known manner to the sleeve conductor 116 to operate cut-off relay 114. Relay 114 releases line relay 113, and relay 130, which is energized at this time over conductor 324, locks in a circuit from battery through its winding and front contacts to the grounded sleeve conductor 116. When relay 130 operated, it closed an obvious circuit for the operation of relay 122, and the relay 122 shifts the test relay from its normal connection with the test brush 120 into connection with the alternative test brush 121 of the selector S.

Since the calling subscriber wishes to converse with the subscriber of line 200 he manipulates his dial as before to position the brushes of selector S opposite the level of terminals 101. Following the selection of the level 101 the switch S steps automatically in its trunk hunting movement over all sets of terminals in the group 102 regardless of their condition and tests the terminal sets in the second group 103 for an idle trunk 105 leading to the operator's switchboard 201. If the first trunk 132 is idle at the time, the switch S selects it and extends the calling subscriber's line through to the answering jack 202 before an operator. As soon as the switch S completes its trunk hunting operation relay 123 is operated in any suitable manner, and ground potential on the sleeve conductor is extended by way of brush 121 and the front contacts of relays 122 and 123 to the winding of relay 125. Relay 125 operates to apply holding ground potential to the sleeve conductor 116 and to open the operating circuit of relay 130. Relay 130, however, remains locked to the grounded sleeve conductor. The operator answers the call with her cord circuit 203, asks the calling party for his number and also for the called subscriber's number. She then connects her cord 203 to a trunk 204 and by means of a dial or key-set operates the selector S—2 and connector C to complete the connection to the called line 200. Having obtained this information from the calling subscriber and knowing that the call is subject to a charge, since it was routed to her over the

trunk group 105, she makes out the necessary ticket from which the charge is subsequently applied to the subscriber's monthly bill.

Inasmuch as the calls of the special class lines are routed to an operator when the office is under heavy load the signal lamps at the subscribers' stations may be dispensed with if desired. That is to say, the subscriber would make his call without knowing whether it was subject to the extra charge or not. If it were, the operator, on answering the call, would advise him of that fact, at which time he could elect either to continue with the call or to abandon it.

Since the tickets charging these calls to the special rate subscribers are made out on the basis of oral information given to the operator at the time the calls are made, the usual number checking equipment may be provided if desired for verifying the calling line numbers given to the operator.

After the subscribers have finished conversing they replace their receivers, the operator takes down her cord circuit 203, and the operated switches release to their normal positions. The removal of ground potential from the sleeve conductors causes the release of relays 125, 130 and 122. However, if the office is still in a heavy load condition relay 130 is again operated over conductor 324, and relay 122 reoperates to prepare the link L for the next call.

Should the subscriber of line 100 wish to make a toll or long distance call he may do so at any time without regard to the load condition prevailing in the local office. To obtain the long distance operator he initiates the call in the usual manner and dials a digit to position the brushes of switch S opposite the level of terminals 106 in which appear trunks 133 leading to a toll operator's position at the switchboard 201. In the level 106 the test terminals of all circuits in both groups 102 and 103 are arranged to be tested either over brush 120 or 121 for determining their busy or idle condition. Therefore the switch S tests the trunks in this level as a single group and selects the first idle one therein. The operator at the board 201 answers the call with her cord 205, obtains the necessary information, makes out the appropriate ticket and extends the connection over the long distance circuit 206.

If desirable, all local calls made by the special class of lines may be completed on an automatic basis without the assistance of an operator. To this end the calls which fall within the flat-rate charge are completed as above described. However, all local calls made during the heavy load periods and all toll calls made at any time are completed on an automatic ticket basis. Referring to Fig. 5 for an understanding of this plan, the selector S—3, which corresponds to selector S in Fig. 1, is provided with divided levels, such as the level 500, having first and second trunk groups 501 and 502 therein. The trunks appearing in the first group 501 extend to selectors S—4 and conectors C—3 by means of which the calling subscriber completes his local calls unassisted when the office is under light load. When, however, the office is under heavy load, the switch S—3 hunts in the second group 502 on a local call and seizes an idle one of the trunks 503. Each of the trunks 503 is equipped with an automatic ticket printing mechanism 504—505 and terminates in local selector switches S—5. These local selectors have access through connectors C—4 to the local subscribers' lines, such as the line 506. When the calling subscriber dials for a long distance or toll connection, the switch S—3 hunts in the level 507 and chooses any idle one of the trunks 508 therein extending to the distant point. Each of the trunks 508 is also equipped with an automatic ticket printing mechanism 509—510.

It will be understood, of course, that the office is also equipped with suitable means for determining the identity of the calling line whenever a connection is extended to one of the automatic ticket printing trunks, and this information is utilized for the purpose of controlling the ticket printing mechanism. For a better understanding of a system in which calling lines are identified and tickets are printed to charge the calls against the subscribers reference may be had to the application of J. W. Gooderham, Serial No. 448,782, filed June 27, 1942.

From the foregoing descriptions it will be understood that calls made by the special flat rate subscribers may also be routed automatically to an operator or to an automatic ticket printing circuit during selected periods of the day. If, for example, it is decided that the hour from 9 to 10 in the morning is a busy hour period and justifies a higher rate for subscribers of the special class, the winding of relay 318 is connected to the clock operated contacts 320 in addition to its connection to the load measuring instrument 303. With this clock connection the contacts 320 close and remain closed from 9 until 10 o'clock, and during this period the relay 318 remains continuously energized.

Although the lines of the special class are subject at times to extra charges, they are accessible for incoming calls at all times and without any extra charge either to the special rate subscribers or to the subscribers making the incoming calls. These incoming calls are completed in the usual manner over the regular selector and connector switches S—6 and C—2.

This special service may also be made available to subscribers' lines of the message register class, if desirable. The general circuit arrangements for this purpose are illustrated in Fig. 6. The subscribers' line 600 appears in the line finder switch F—2 which, together with selector S—7 and connector C—5, serves to extend the line 600 to called subscribers' lines, such as the line 601. Other lines of this class appear in the finder F—2 and in the finder F—3, and the heavy load condition of the office may be determined by the number of relays 602, 603, simultaneously operated.

If the office is working under a light load at the time a call is made on the line 600, message register 604 of this line is operated a minimum number of times to charge for the call. However, if the office is under heavy load when the call is made, the circuits are automatically prepared to operate the register 604 at a higher rate or a higher number of times. As in Fig. 3, the load condition of the office is measured by a meter, and a relay 605 is operated whenever the office is under a heavy load. Relay 605 operates the common relay 606 which disconnects the battery 607 from the line relays and connects these relays to the high potential battery 608 through the resistor 609. Relay 605 also closes a circuit from the ground through its armature and contact, conductor 610 through the normal contacts of relay 611, provided the link L—2 is idle, through the winding of relay 612 to battery. Thus if the link L—2 is idle at the time the office is in a heavy load condition, relay 612 operates

and, as will be explained later, shifts the message register operating circuit from the slow interrupter 613 to the faster interrupter 614. Similarly the grounded conductor 610 extends over multiple paths to all other idle links to cause the operation of relays corresponding to relays 612.

Assume now that the subscriber of line 600 makes a call while the office is in the light load condition. At this time relays 605, 606, 612 and the corresponding relays in other links are de-energized. Since relay 606 is released the glow lamp 615 is dark because the battery 607 is insufficient to operate it. The subscriber knows, therefore, that the call he is about to make will be charged at the lower rate. When he removes his receiver, his line relay 616 operates in an obvious circuit, the line finder F—2 finds his line, and ground potential is applied to the sleeve conductor 617 to operate the cut-off relay 618. Relay 618 releases the line relay 616. The subscriber now operates his dial 619 to position the switches S—7 and C—5 to complete the connection to the called line 601. Following the operation of switch S—7, relay 611 operates and opens the operating circuit of relay 612, to prevent the latter from energizing in case ground potential is subsequently applied to conductor 610.

At some convenient time relay 620 is operated to complete the message register operating circuit. This circuit may be traced from the positive pole of battery 621 through the slow interrupter 613, conductor 622, back contacts of relay 612, front contacts of relay 620, brush and contact of finder F—2 to the winding of message register 604 to the negative pole of battery. Under the control of the slow interrupter 613 the register 604 may be operated at a slow rate or a minimum number of times as desired.

Assume now that the office is in a heavy load condition when the subscriber of line 600 initiates his call. The relay 606 being operated at this time, a circuit is closed from the battery 608, resistor 609, contacts of relay 606, winding of relay 616, thence over the line through the glow lamp 615 and over the other side of the line to ground at the cut-off relay contacts. The subscriber sees the lamp glowing and knows that he will be charged at a higher rate. When he removes his receiver, the relay 616 operates to initiate the movement of the line finder F—2, and the lamp 615 is extinguished. As before, the subscriber manipulates his dial 619 to operate the switches S—7 and C—5 to complete the connection. When switch S—7 is operated, relay 611 energizes and opens the operating circuit of relay 612. Relay 612, however, having been previously operated by the relay 605, remains energized in a locking circuit from battery through its winding and contact to the grounded sleeve conductor 617. Subsequently when the relay 620 is operated, a message register operating circuit is closed through the fast interrupter 614. This circuit may be traced from the positive pole of battery 621, interrupter 614, conductor 623, front contacts of relay 612, contacts of relay 620 and thence through the message register 604. Under the control of interrupter 614 the register 604 is operated either at a faster rate or a higher number of times to charge the call against the subscriber.

As in the case of flat-rate lines the message rate lines are entitled to receive all incoming calls made at any time without extra charge either to the message rate subscribers of the special class or to the calling subscribers. These calls are completed in the usual manner over selector switches and connector switches C—6.

In the alternative signaling arrangement shown in Fig. 7 the subscriber determines the office load condition or the rate of charge enforced by listening to an audible tone in his receiver before initiating a call. If the office is lightly loaded when the subscriber removes his receiver and listens, a circuit is closed from battery through the back contacts of auxiliary relay 709, winding of line relay 701, contacts of cut-off relay 702, conductor 703, condenser 704, winding 705 of the induction coil, switchhook contacts, transmitter 706, dial 707, conductor 708 to ground at the contacts of relay 702. Because of the presence of condenser 704 in this circuit relay 701 does not operate. The subscriber hearing no tone in his receiver knows that he is entitled to make a call for the lower or basic rate. On the other hand, if the office is heavily loaded, relay 709 is in an operated condition, and the circuit above traced extends through the front contacts of relay 709, winding of tone coil 709 to battery. As before, relay 701 does not operate because the condenser 704 is included in the circuit. Tone current does flow over the circuit, however, and the subscriber receives a characteristic tone in his receiver, which serves as a signal to him that the call, if made, will be subject to an extra charge.

If the subscriber, having removed his receiver from the switchhook, decides to continue with the call, regardless of the office load condition, he operates the key 710. With the receiver switchhook in its alternate position the depressed key 710 locks to the displaced lever 711. The contacts of the key 710 close a short-circuit around condenser 704 thus permitting the line relay 701 to operate. The relay 701 initiates the call in the manner already explained. At the end of the conversation the subscriber replaces the receiver on the switchhook and the lever 711 permits the key 710 to restore to its normal position, removing the short-circuit from the condenser 704.

In the alternative form of the signaling arrangement shown in Fig. 8 the subscriber at the substation is apprised of the load condition or the rate of charge prevailing by means of a target signal showing either one of two colored discs 800 and 801. If the office is lightly loaded, the auxiliary relay 802 at the central office is in its normal position, and current is supplied through the line relay 803 over the line loop in a given direction through the polarized target signal 804. When the subscriber removes his receiver, the circuit for the target signal is closed from the negative pole of battery through the left normal contacts of auxiliary relay 802, right winding of line relay 803, contacts of cut-off relay 805, conductor 806 through the winding of signal 804, winding 807 of the induction coil, switchhook contacts, transmitter 808, dial 809, conductor 810, contacts of relay 805, left winding of relay 803, normal contacts of relay 802 to ground. The polarized signal 804 operates its armature in one direction and exposes a particular one of the colored targets 800 or 801 which signifies the light load condition. The line relay 803 does not operate in series with the resistance of the signal winding 804. Therefore the removal of the receiver to determine the prevailing office load or rate of charge does not cause the unintended operation of a line finder switch in the central office. If, on the other hand, the office is heavily loaded or the higher rate of charge

is in effect, relay 802 is in its operated condition, and current flows over the line in the opposite direction causing the signal 804 to display the other colored disc which signifies the existing condition.

In either event, if the subscriber decides to continue with the call, he then operates the key 811. The key 811 is locked by the displaced lever 812 and at is closed contacts completes the short-circuit around the signal device 804. The removal of the resistance of the signal winding 804 from the circuit permits the line relay 803 to operate and initiate the call. When the subscriber later replaces his receiver on the switchhook, key 811 is restored, and the target signal 804 is again included in the circuit.

A further alternative is to provide a voice-recording mechanism in the central office which will give the subscriber an oral announcement when he undertakes to make a call while the office is heavily loaded or during one of the predetermined busy periods. This could be accomplished, for example, as shown in Fig. 9, by connecting the transformer 709 of Fig. 7 to a suitable voice reproducer. Another method, shown in Fig. 10, would be to connect one of the trunks 105 to a voice reproducer which would make the announcement as soon as the subscriber had dialed the first digit.

As above explained, the features of the present invention are also applicable to automatic telephone systems of the type in which central office register senders are used for controlling the switches. Well-known systems of this type are those employing panel selector switches and cross bar selector switches. If the invention is incorporated in systems of this kind, the class information with respect to subscribers entitled to the special service is established in the register sender when the call is made by any of the well-known methods now in use. Also the load condition on the office may be communicated to the senders. With this information the sender is able to determine whether the call should be completed to the called subscriber's line without incident or whether it should be treated specially by routing it to an operator or to an automatic ticketing circuit.

For the purpose of illustrating the principles of the invention applicant has described it with particular reference to subscribers' lines of the flat-rate and message-rate classes. It will be understood, however, that it applies to all classes of lines and that it contemplates the extension of the special service to all subscribers of an office.

The central office batteries 300 and 630 furnish current for the talking connections and also for operating the various controlling relays. For simplicity of illustration the battery is shown conventionally in a number of different locations throughout the drawings, but it will be understood that this method of illustration is used merely to facilitate an understanding of the circuit operation. It may be also noted that batteries 323, 608 and 621 are special sources for operating the signal lamps at the subscribers' stations and for operating the message registers.

What is claimed is:

1. The combination in a telephone system of a central telephone office, subscribers' lines terminating in said office, means for establishing conversational connections between said lines, means for measuring the load on said office, the operation of said measuring means bearing a predetermined relation to the total number of conversational connections concurrently established, and means controlled by said load measuring means for determining the rate of charge to be made against said subscribers.

2. The combination in a telephone system of a central telephone office, subscribers' lines terminating in said office, means for establishing conversational connections between said lines, measuring means for determining whether said office is operating under a light load or a heavy load, the operation of said measuring means bearing a predetermined relation to the total number of connections concurrently established, and means controlled by said load measuring means for determining whether the subscribers are to be charged at a relatively low rate or at a relatively high rate.

3. The combination in a telephone system of a central telephone office, subscribers' lines terminating in said office, means for establishing conversational connections between said lines, measuring means for determining whether said office is operating under a light load or a heavy load, the operation of said measuring means bearing a predetermined relation to the total number of connections concurrently established, means for appraising a subscriber of said load condition at the time he wishes to make a call, and means controlled by said load measuring means for determining whether the subscriber shall be charged at a relatively low rate or at a relatively high rate.

4. The combination in a communication system of a central office, subscribers' lines terminating in said central office, means for establishing a variable number of concurrent communication connections between subscribers' lines, variably operable means for measuring the load on said office, the operation of said measuring means at any given time bearing a predetermined relation to the total number of concurrent connections then established, and means controlled by said load measuring means for determining the rate of charge to be made against said subscribers.

5. The combination in a telephone system of a central telephone office, subscribers' lines terminating in said office, equipment units in said office for setting up conversational connections between said lines, variably operable means for measuring the load on said office, the operation of said measuring means being proportional to the total number of equipment units in simultaneous use at any particular time, and means controlled by said load measuring means for changing the rate of charge made against said subscribers.

6. The combination in a communication system of a central office, subscribers' lines terminating in said office, switching units in said office for establishing communication connections between said lines, a source for supplying current to all switching units in use, variably operable means for measuring the load on said office, the operation of said measuring means being proportional to the current supplied from said source to the engaged switching units, and means controlled by said measuring means for changing the rate of charge made against said subscribers.

7. The combination in a communication system of a central office, subscribers' lines terminating in said office, controlling units in said office for controlling the establishment of communication connections between said lines, a source for supplying current to said controlling units, vari-

ably operable means for measuring the load on said office, the operation of said measuring means being proportional at all times to the total current supplied to said controlling units, and means controlled by said measuring means for varying the rate of charge in accordance with the load on said office.

8. The combination in a measured service telephone system of a central telephone office, subscriber's lines terminating in said office, switching means in said office for setting up conversational connections between said lines, means for charging a subscriber at any one of a plurality of different rates, means dependent on the number of concurrent conversations at any particular time for selecting the rate of charge, and means for apprising a subscriber making a call of the prevailing rate of charge.

9. The combination in a measured service telephone system of a central telephone office, subscribers' lines terminating in said office, switching means in said office for setting up conversational connections between said lines, means for charging a subscriber at any one of a plurality of different rates, means dependent on the number of concurrent conversations at any particular time for selecting the rate of charge, and signal means at each subscriber's station for apprising him of the rate at which he will be charged in the event he makes a call.

10. The combination in a telephone system of a central telephone office, subscribers' lines terminating in said office, equipment units in said office for setting up conversational connections between said lines, measuring means variably operated in accordance with the number of equipment units in simultaneous use at any particular time for measuring the load on said office, means for charging the subscribers at different rates dependent on the office load, and signal means controlled by said load measuring means for apprising any subscriber of the rate at which he is being charged.

11. The combination in a measured service telephone system of a central telephone office, subscribers' lines terminating in said office, switching means in said office for setting up conversational connections between said lines, measuring means variably operated in accordance with the number of simultaneous conversations taking place at any particular time for measuring the load on said office, means for charging the subscribers at any one of a plurality of different rates, means controlled by said load measuring means for selecting the rate of charge, and means controlled by said load measuring means for apprising any subscriber of the prevailing rate of charge.

12. The combination in a measured service telephone system of a central telephone office, subscribers' lines terminating in said office, switching means in said office for setting up conversational connections between said lines, means for charging a subscriber at any one of a plurality of different rates, means dependent on the number of concurrent conversations at any particular time for selecting the rate of charge, signal means at each subscriber's station and operable over his line from the central office for indicating to him the rate of charge prevailing at any time, means controlled by the subscriber for rendering said signal means effective without initiating a call in the central office, and means controlled by the subscriber for disabling said signal means and for initiating a call over his line after he has been apprised of the prevailing rate of charge.

13. The combination in a telephone system in which a subscriber is charged at a low rate for calls made when the office is lightly loaded, of means for determining the office load condition, means under the sole control of said subscriber for completing a call when the office is lightly loaded, an operator's position, means effective when the office is heavily loaded for routing said subscriber's call automatically to said operator who answers it and prepares a ticket charging the subscriber at a higher rate, and means controlled by the operator for completing said subscriber's call.

14. The combination in a telephone system in which a subscriber is charged at a low rate for calls made when the office is lightly loaded, of means for determining the office load condition, means for completing under the sole control of the subscriber all calls made during both light and heavy load periods, and means effective when the office is heavily loaded for preparing tickets automatically to charge the subscribers at a higher rate for each call.

15. The combination in a telphone system in which a subscriber is charged at a low rate for calls made when the office is lightly loaded, of means for determining the office load condition, means for completing under the control of the calling subscribers local calls and toll calls made during either light or heavy load periods, means effective when the office is heavy loaded for preparing tickets automatically to charge the subscribers at a higher rate for all local calls, and means effective without regard to the load condition of the office for preparing tickets automatically to charge the subscribers at predetermined rates for all toll calls.

ALVA B. CLARK.