Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 1

FIG. 18

		FIG. 7	FIG. 10	FIG. 14	FIG. 17
	FIG. 3	FIG. 6	FIG. 9	FIG. 13	FIG. 16
FIG. 1	FIG. 5	FIG. 8	FIG. 12		
FIG. 2	FIG. 4				

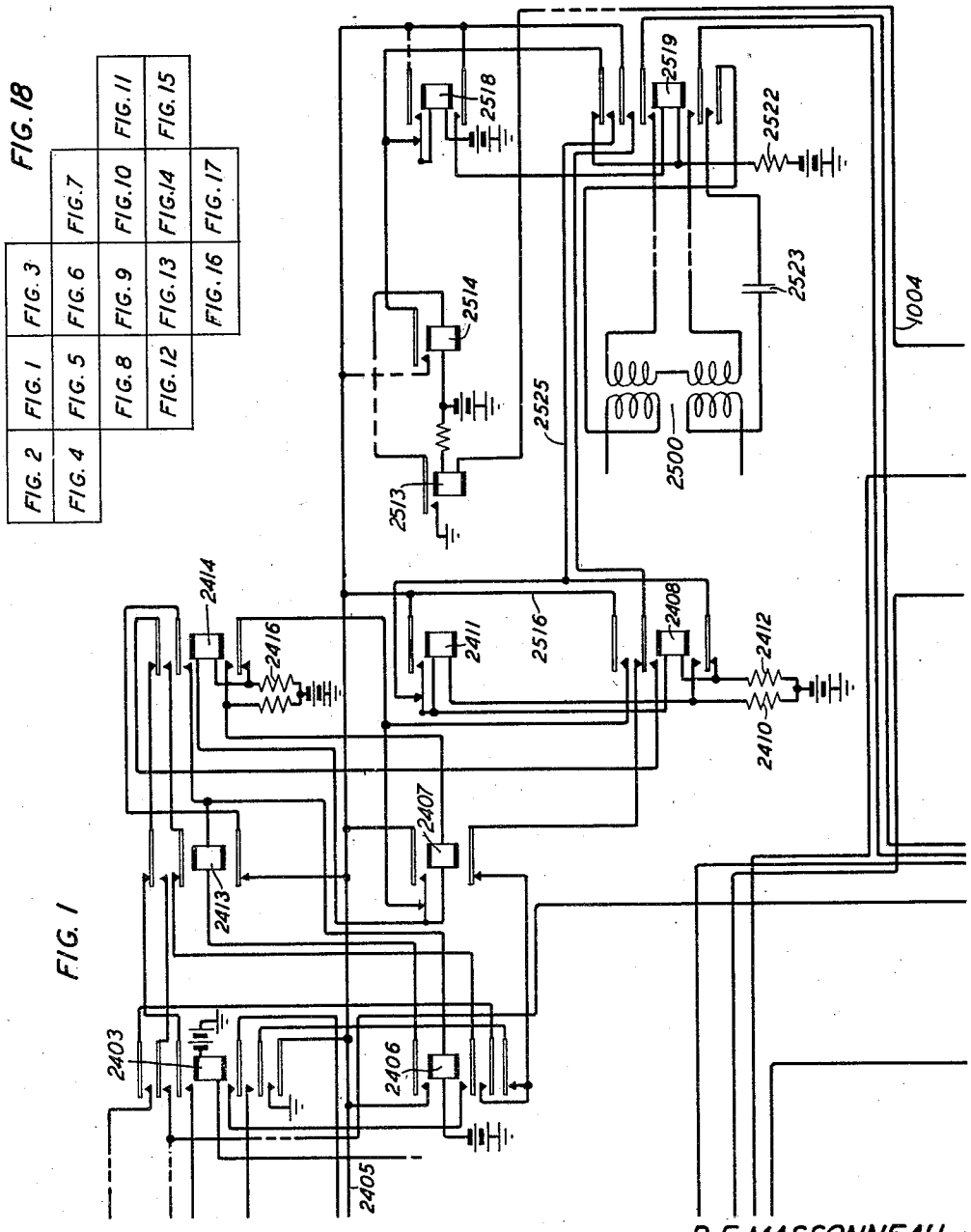

FIG. 1

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 2

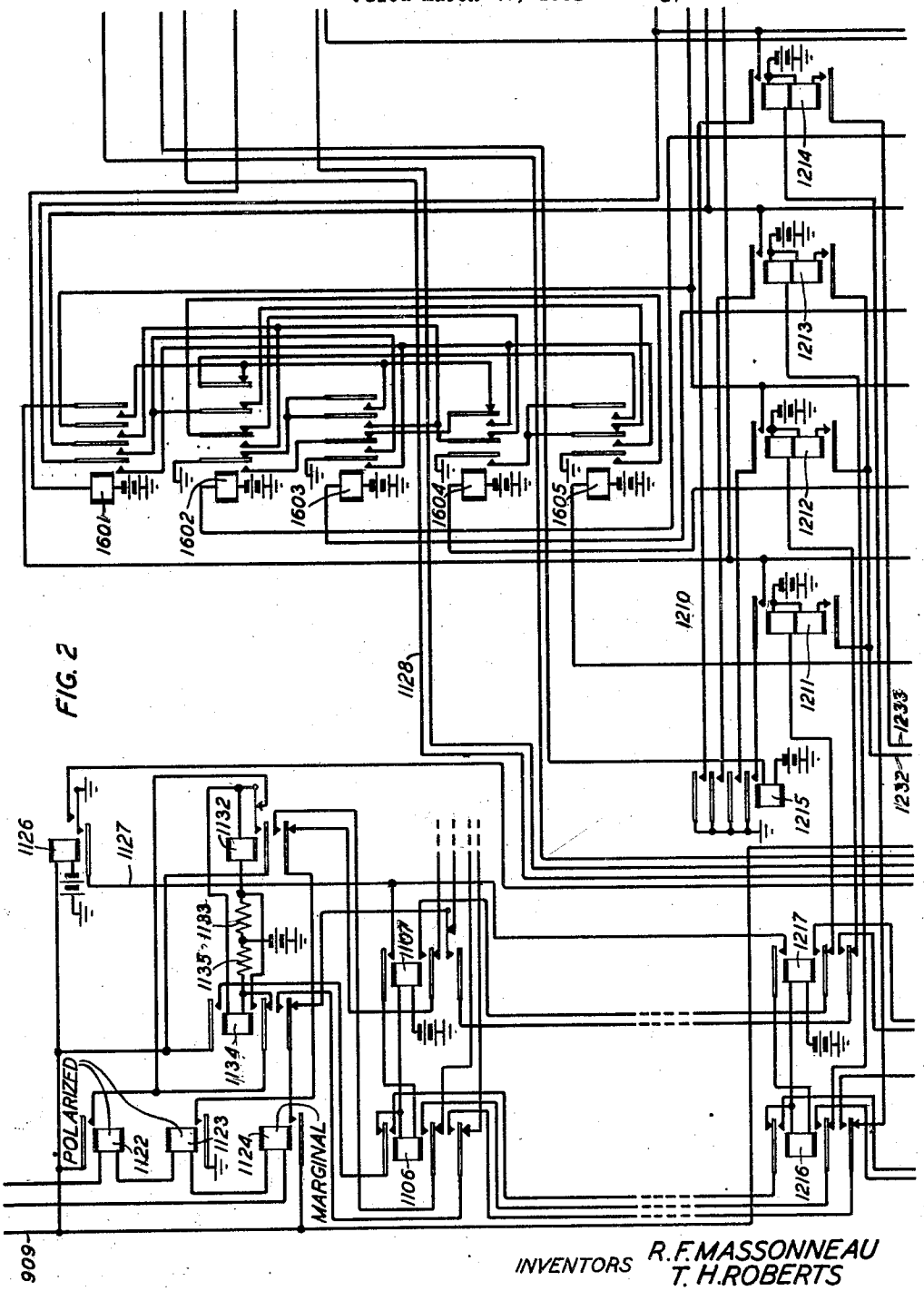

FIG. 2

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 3

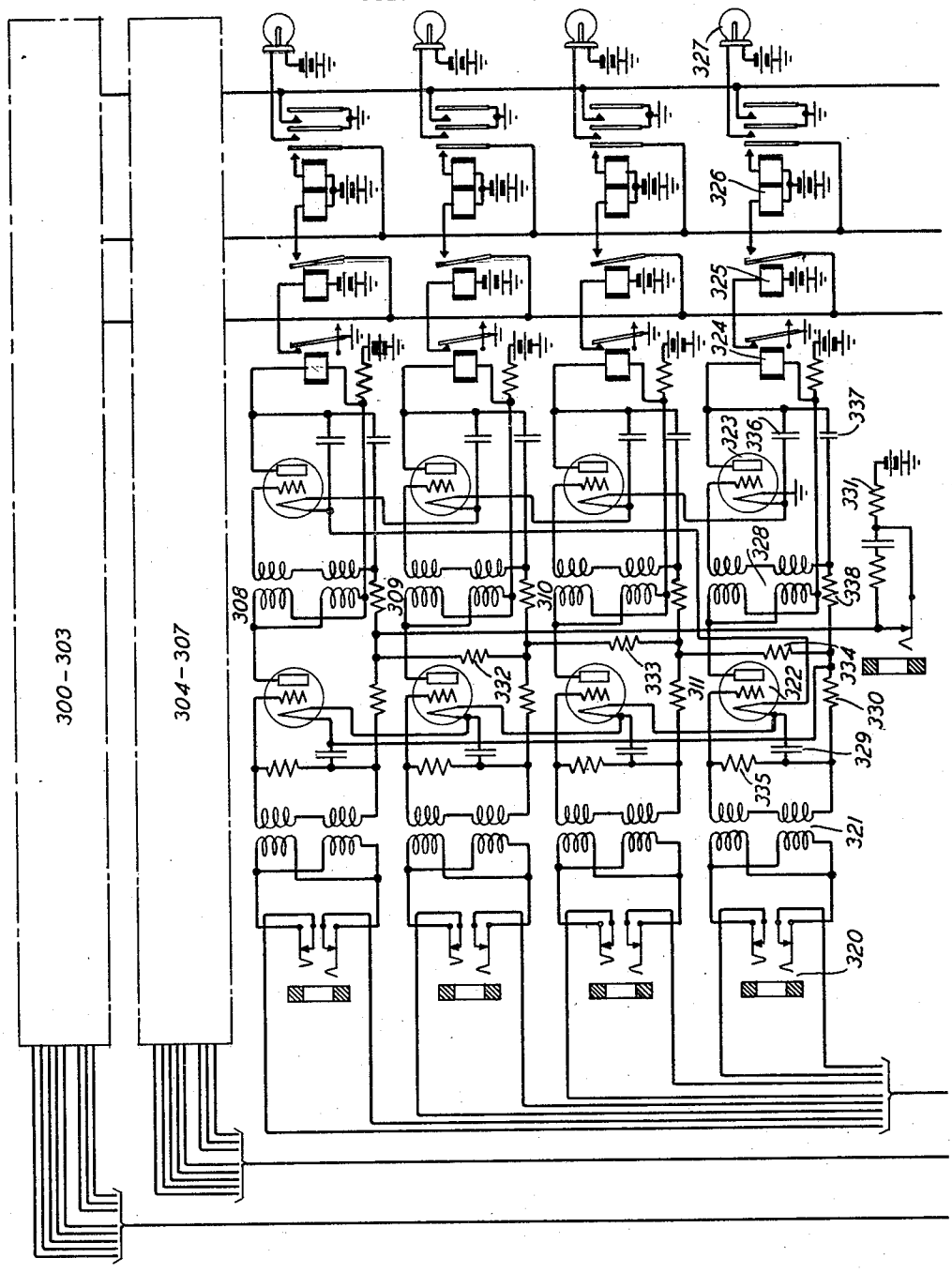

FIG. 3

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 4

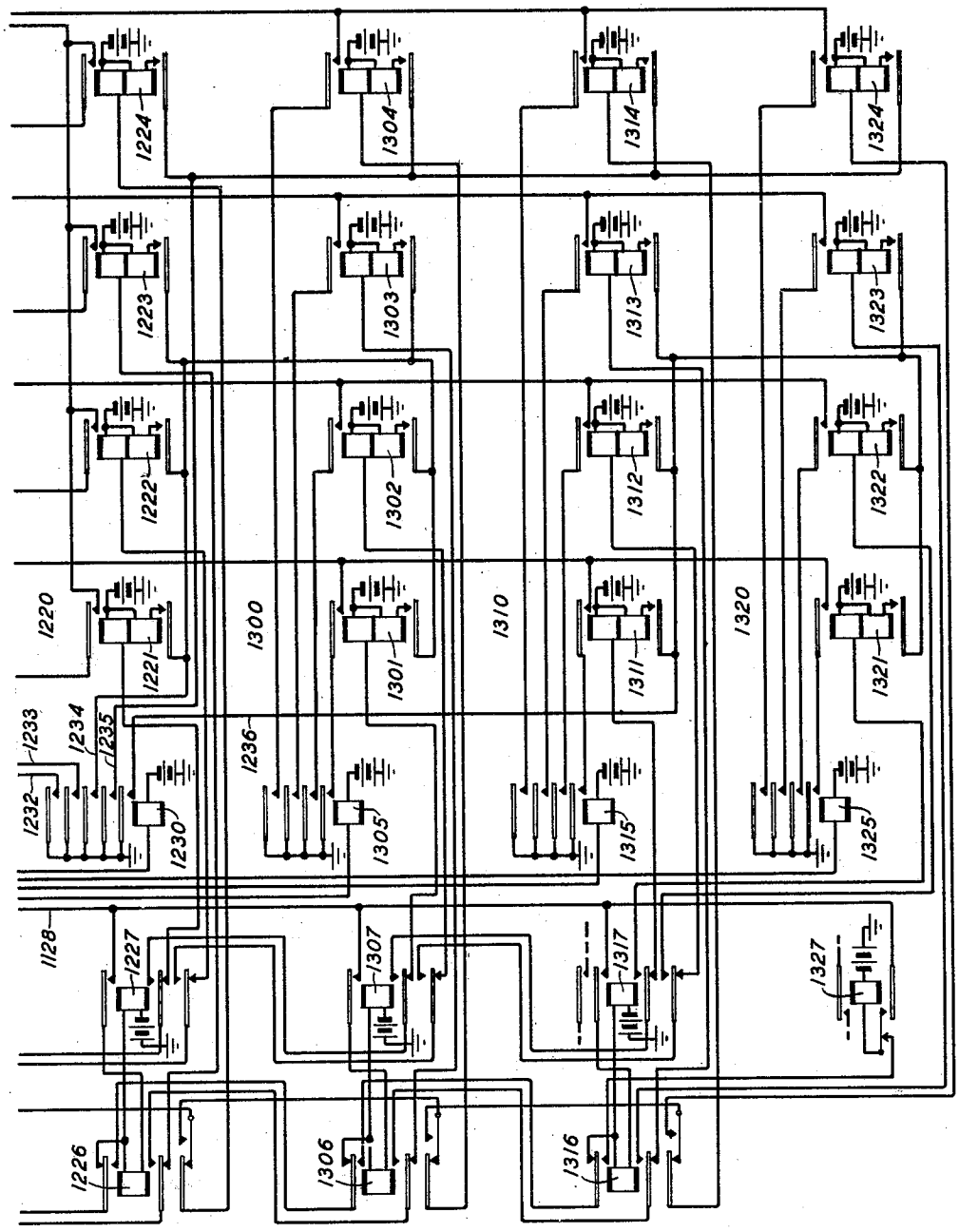

FIG. 4

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 5

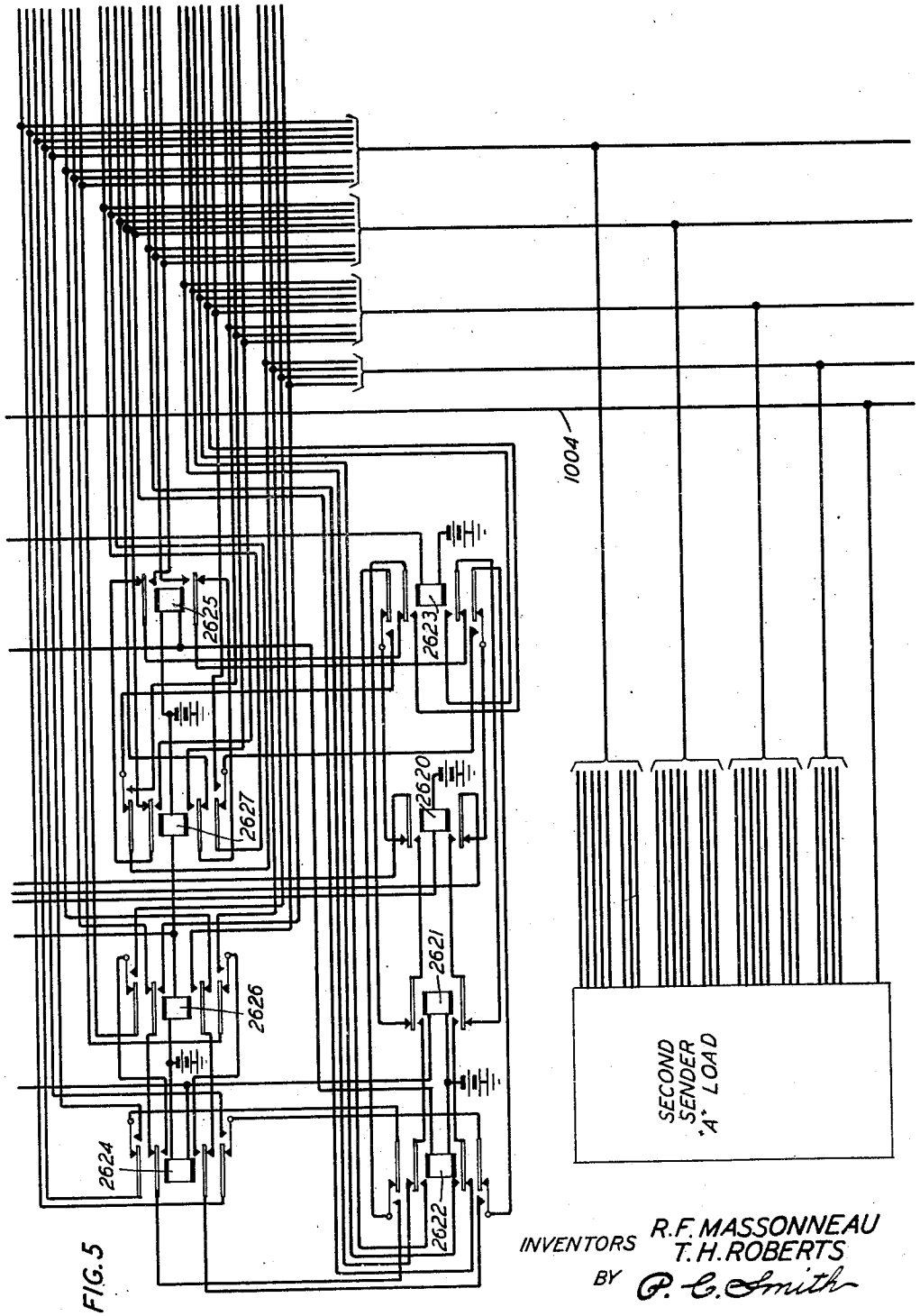

FIG. 5

INVENTORS R.F. MASSONNEAU
T.H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 6

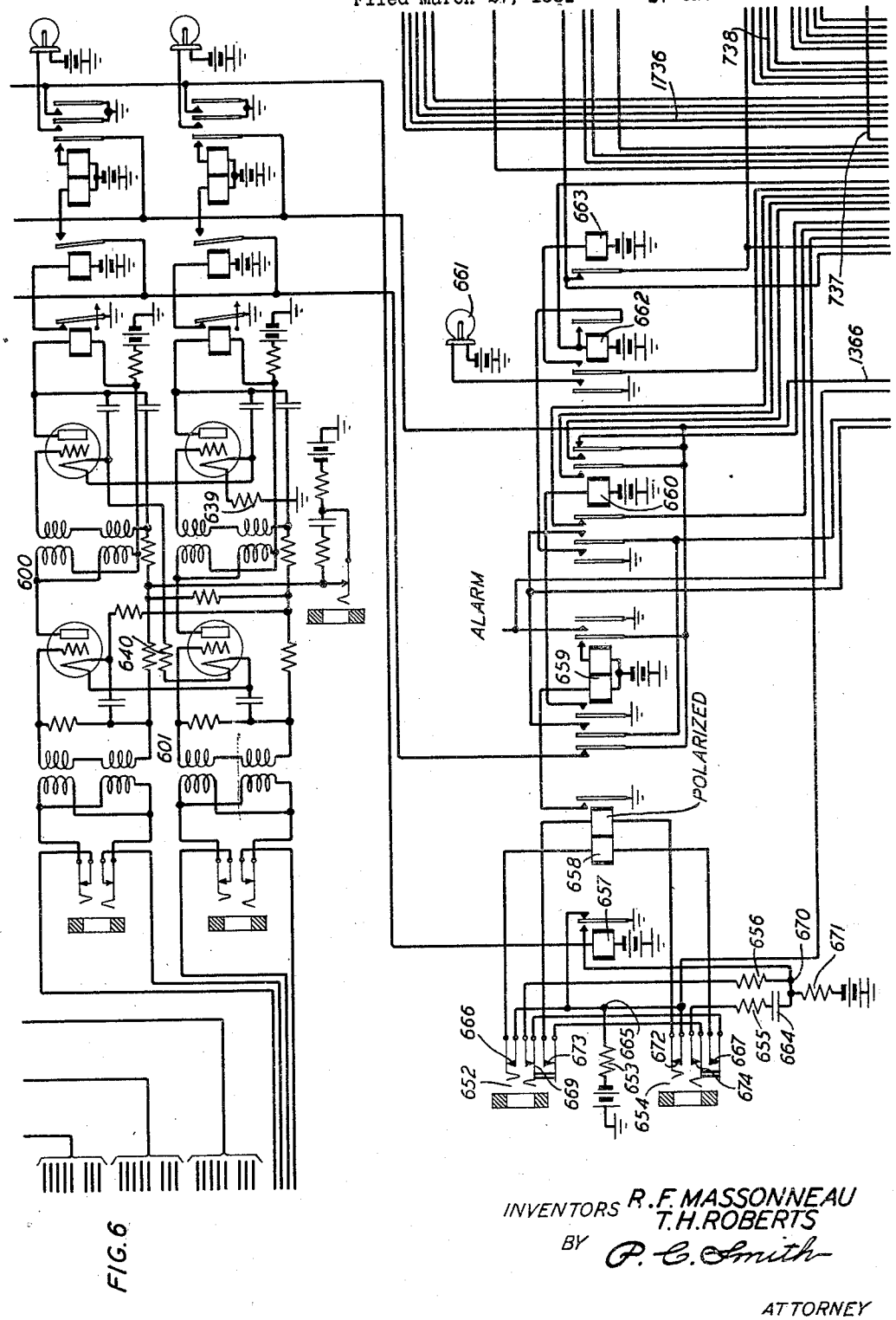

FIG. 6

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 7

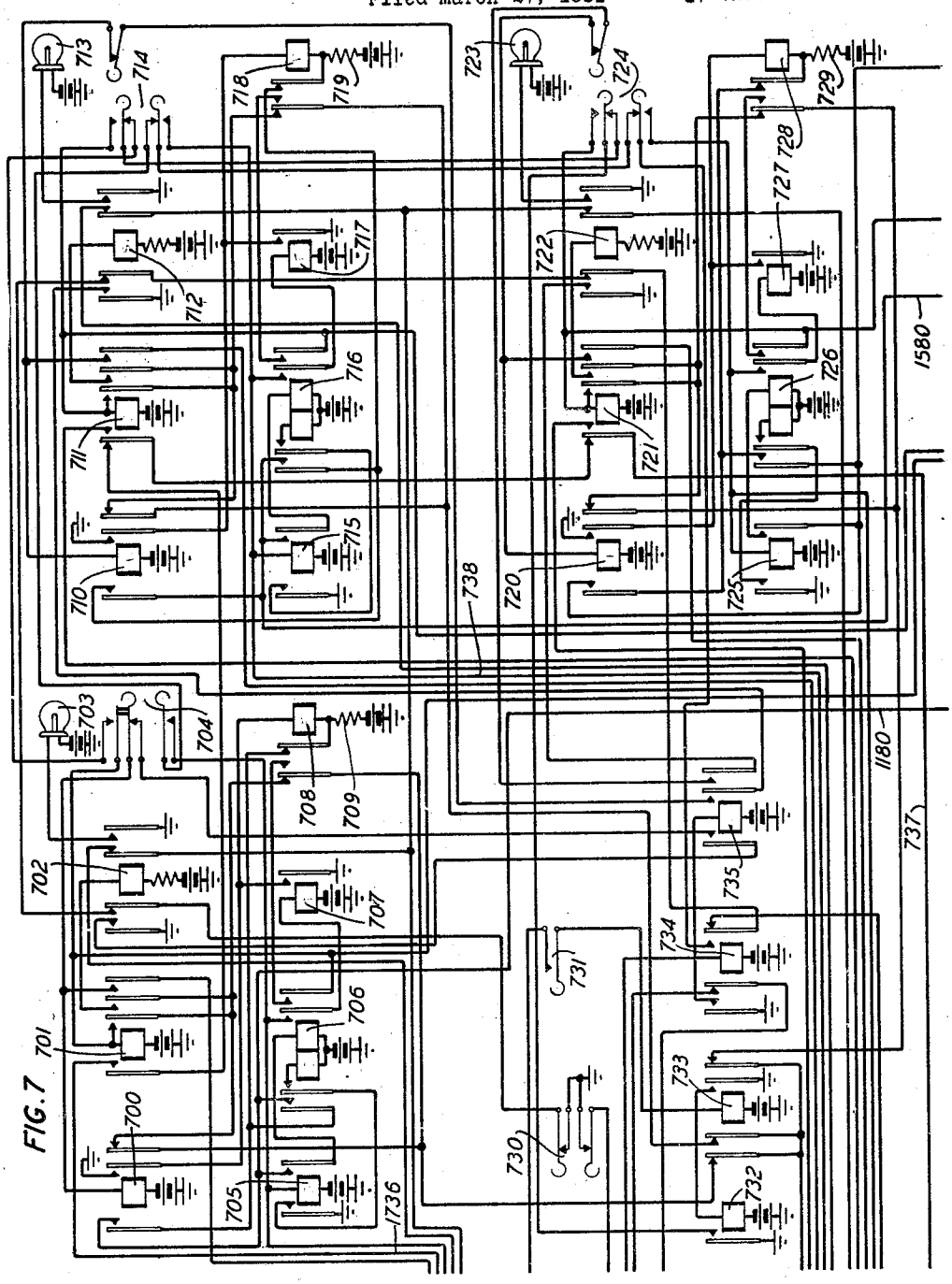

FIG. 7

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 8

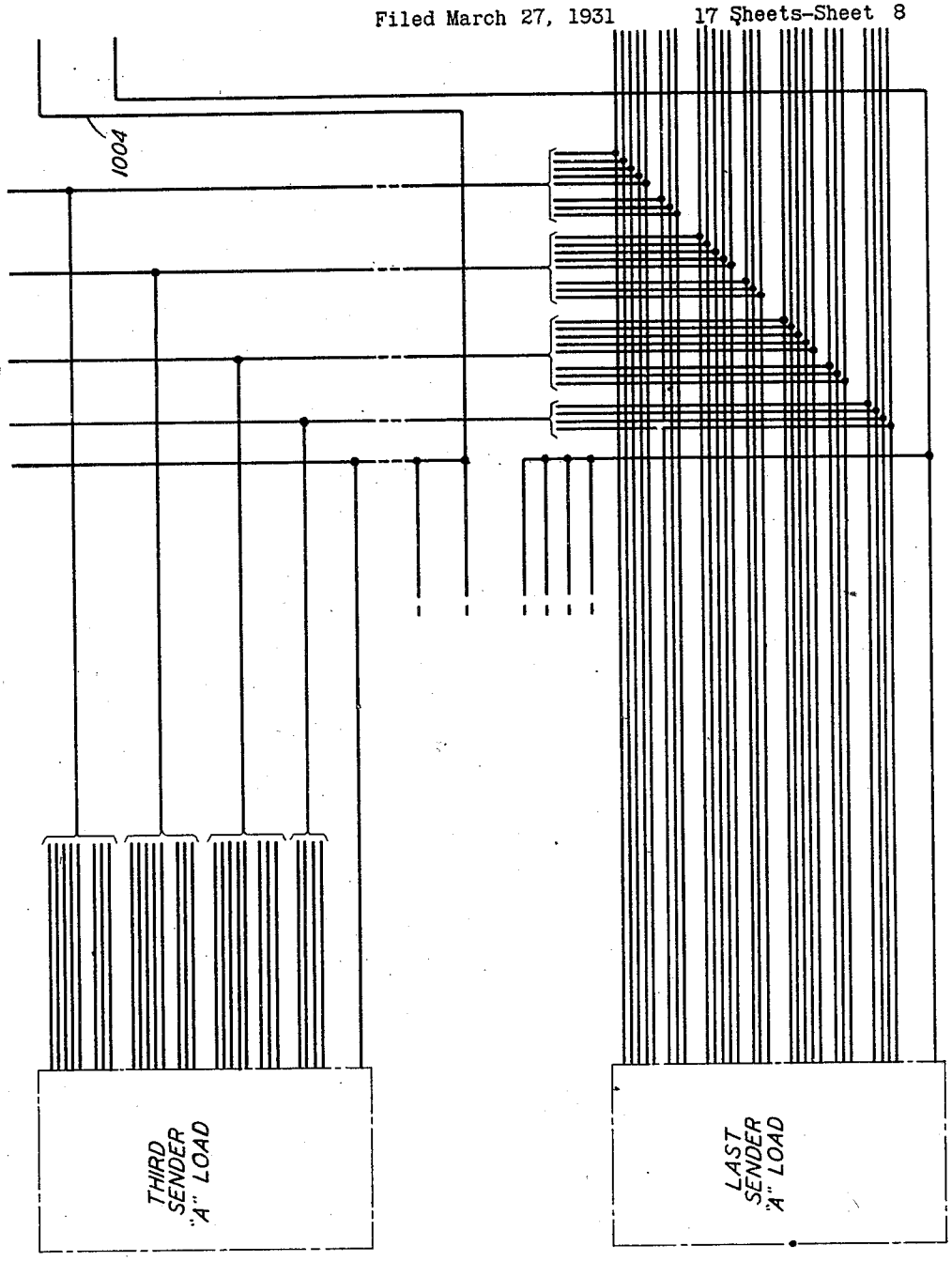

FIG. 8

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 9

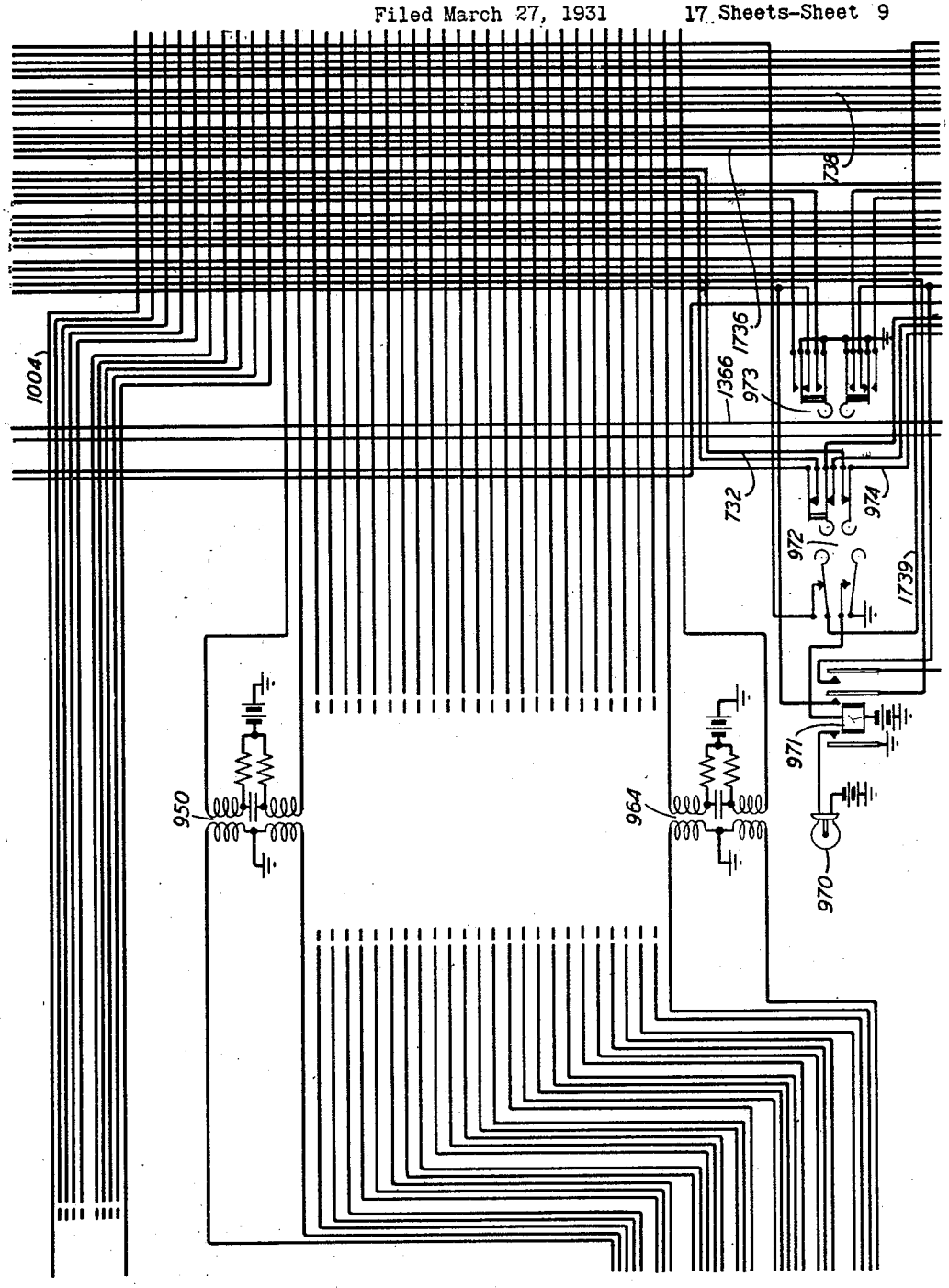

FIG. 9

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 10

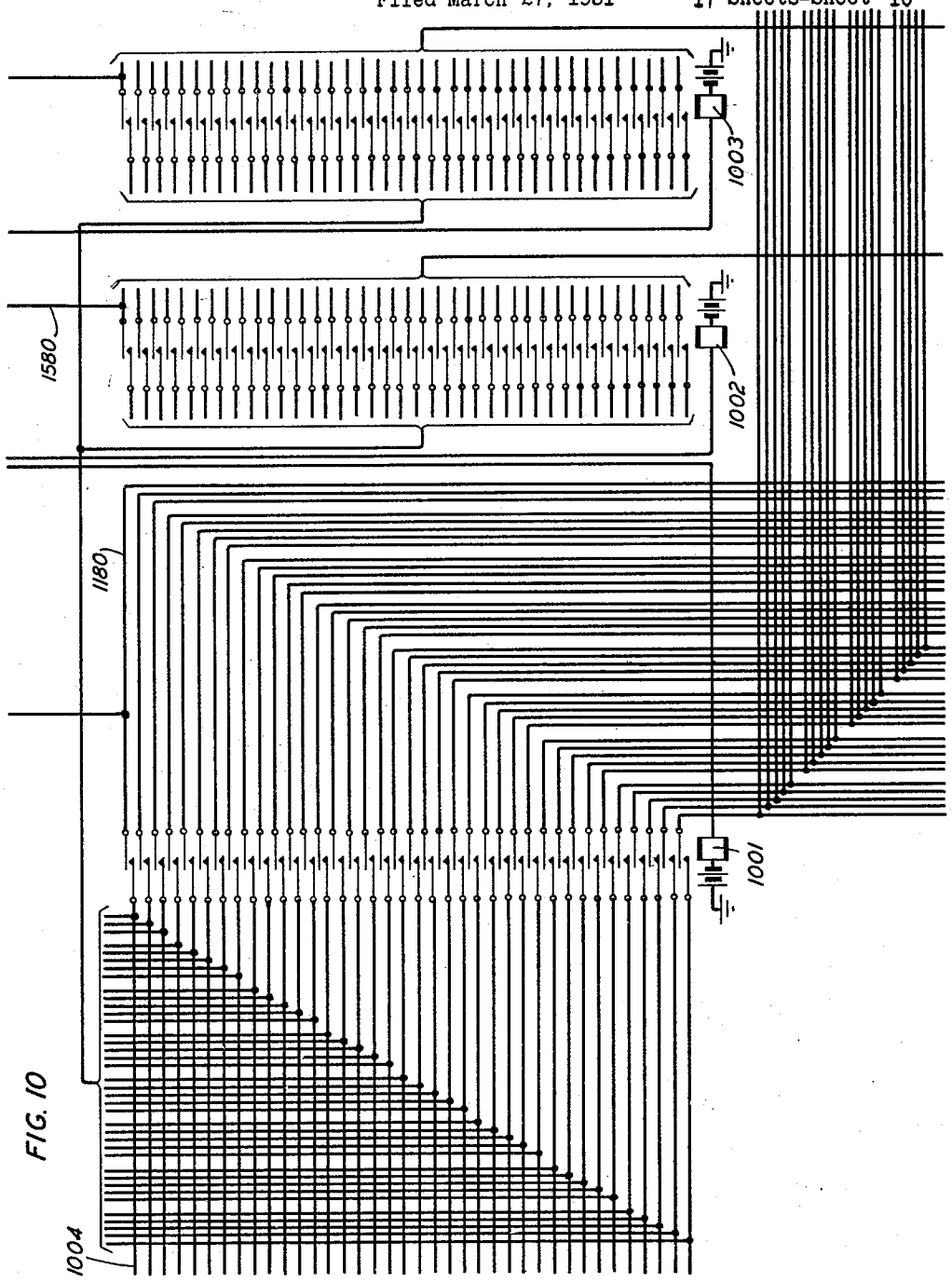

FIG. 10

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 11

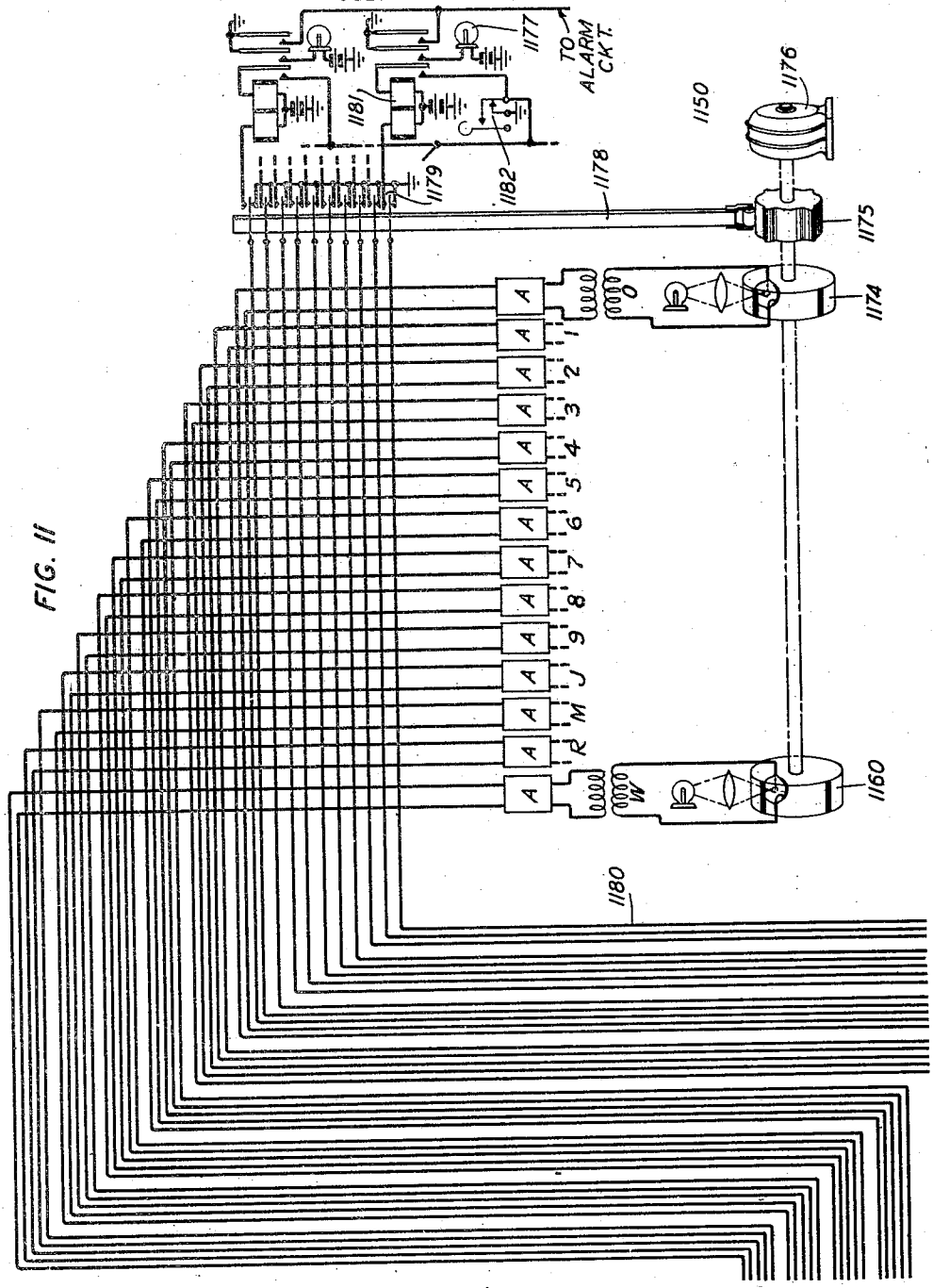

FIG. 11

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 12

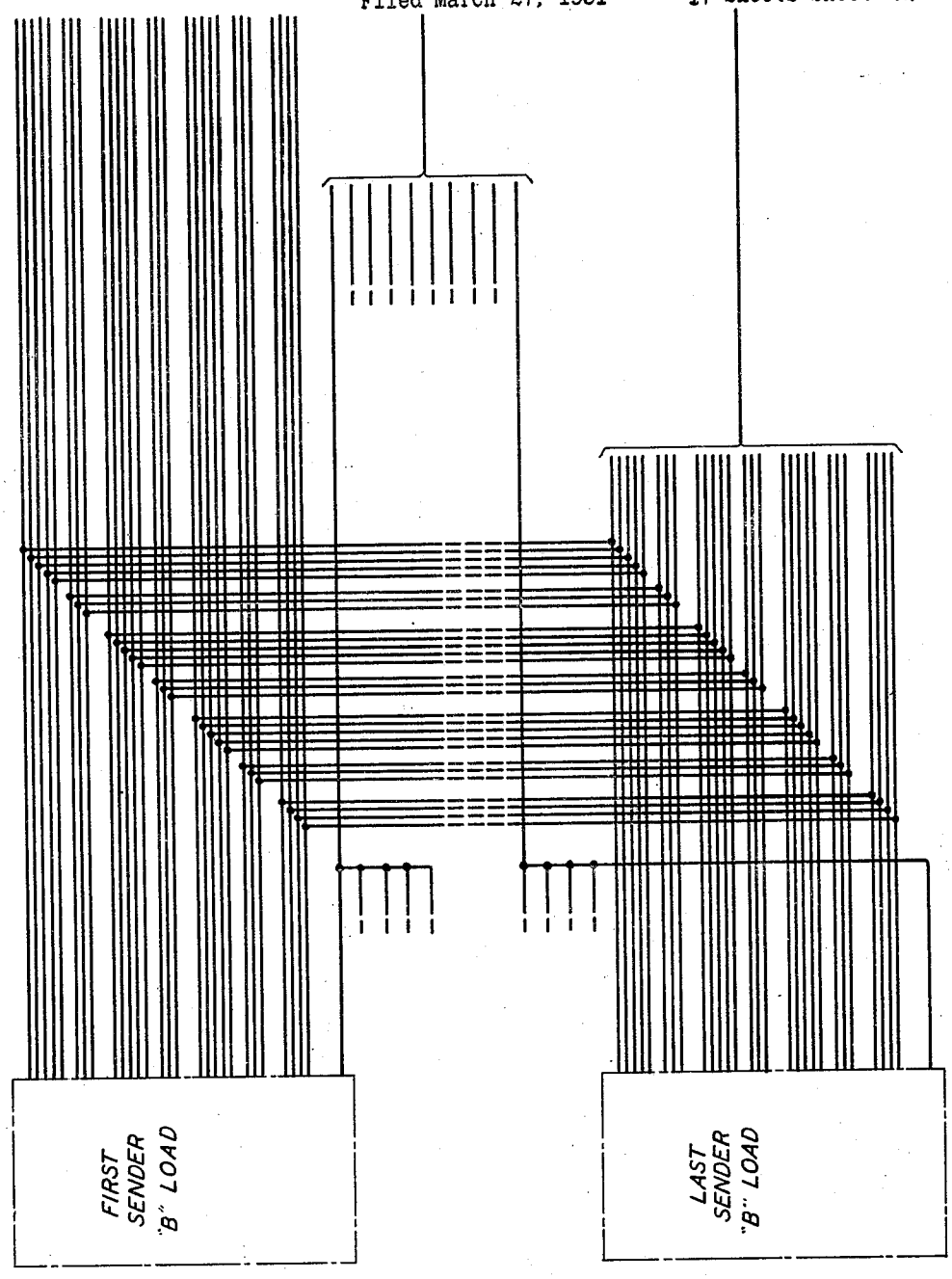

FIG. 12

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 13

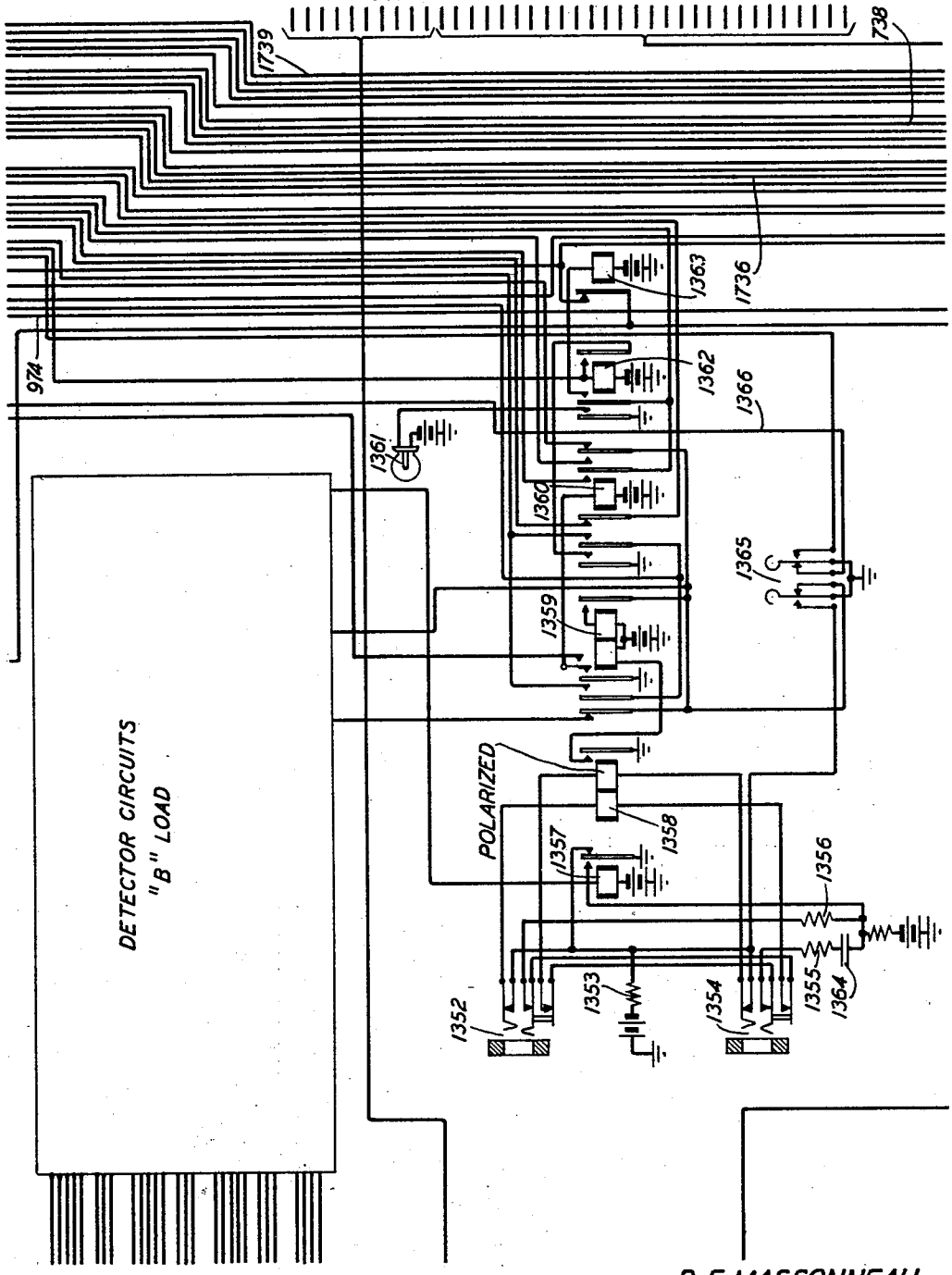

FIG. 13

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 14

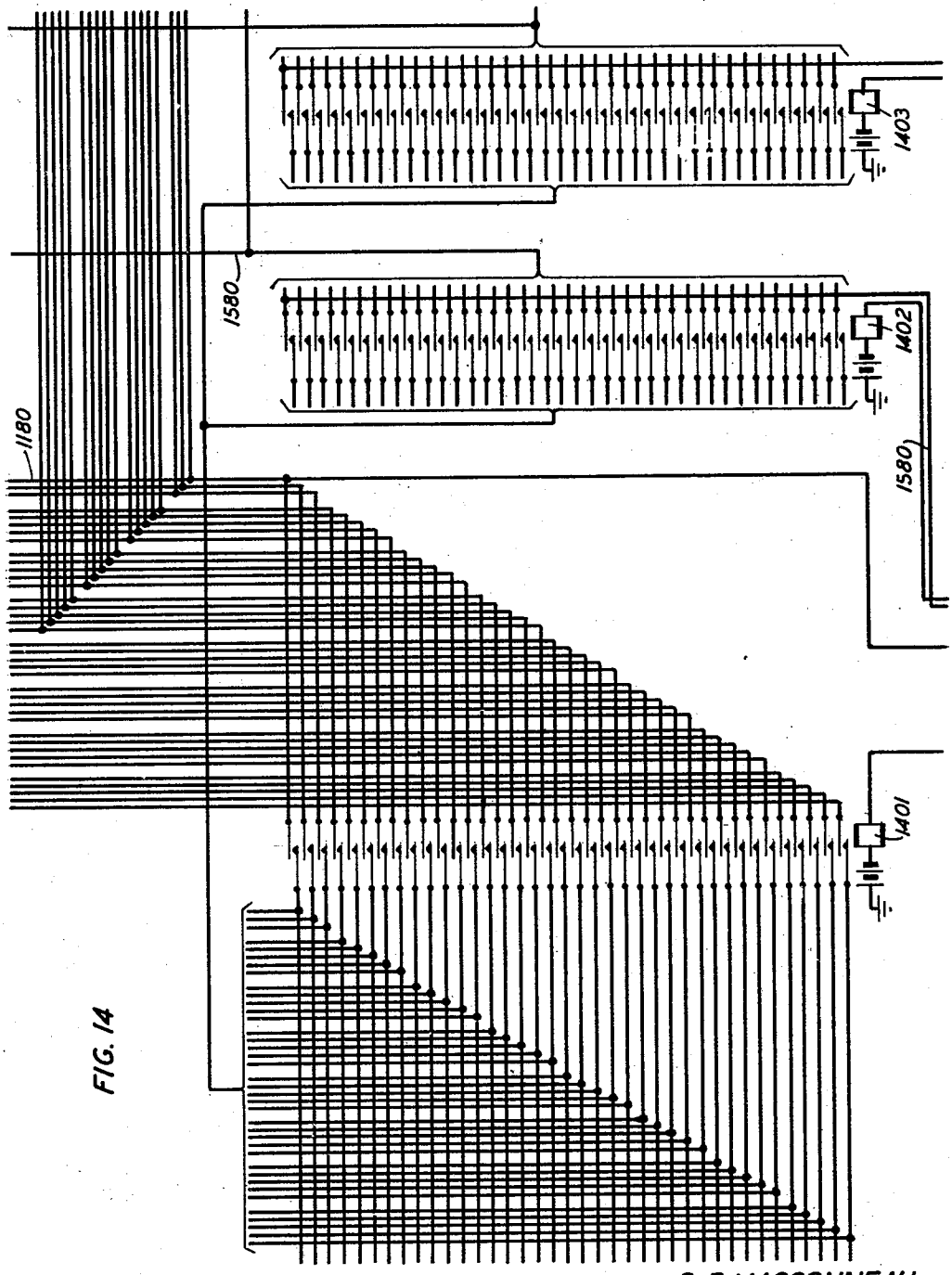

FIG. 14

INVENTORS R.F. MASSONNEAU
T.H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 15

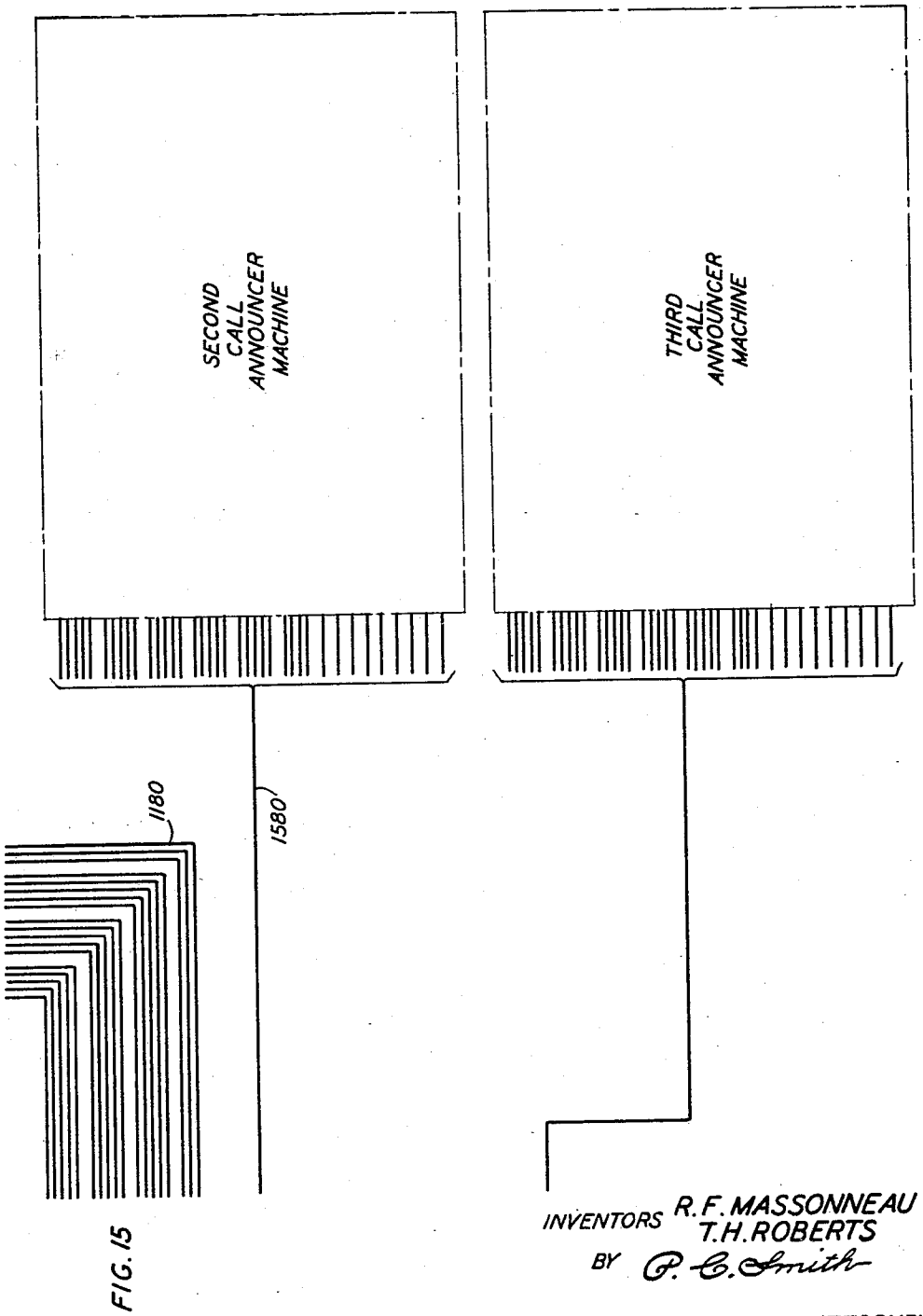

FIG. 15

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 16

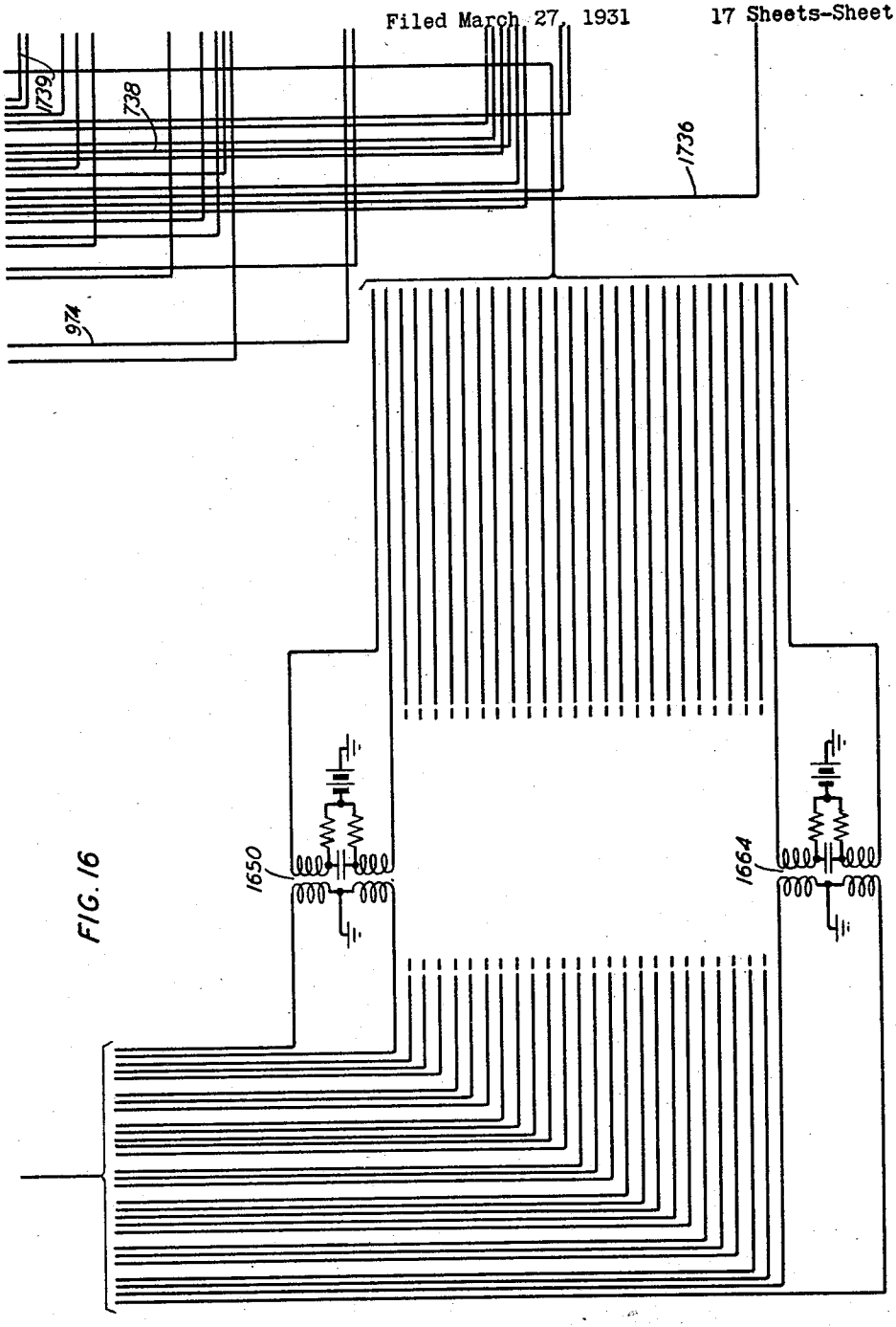

FIG. 16

INVENTORS R.F. MASSONNEAU
T.H. ROBERTS

BY P. C. Smith

ATTORNEY

Jan. 12, 1932. R. F. MASSONNEAU ET AL 1,841,197

TELEPHONE ALARM SYSTEM

Filed March 27, 1931 17 Sheets-Sheet 17

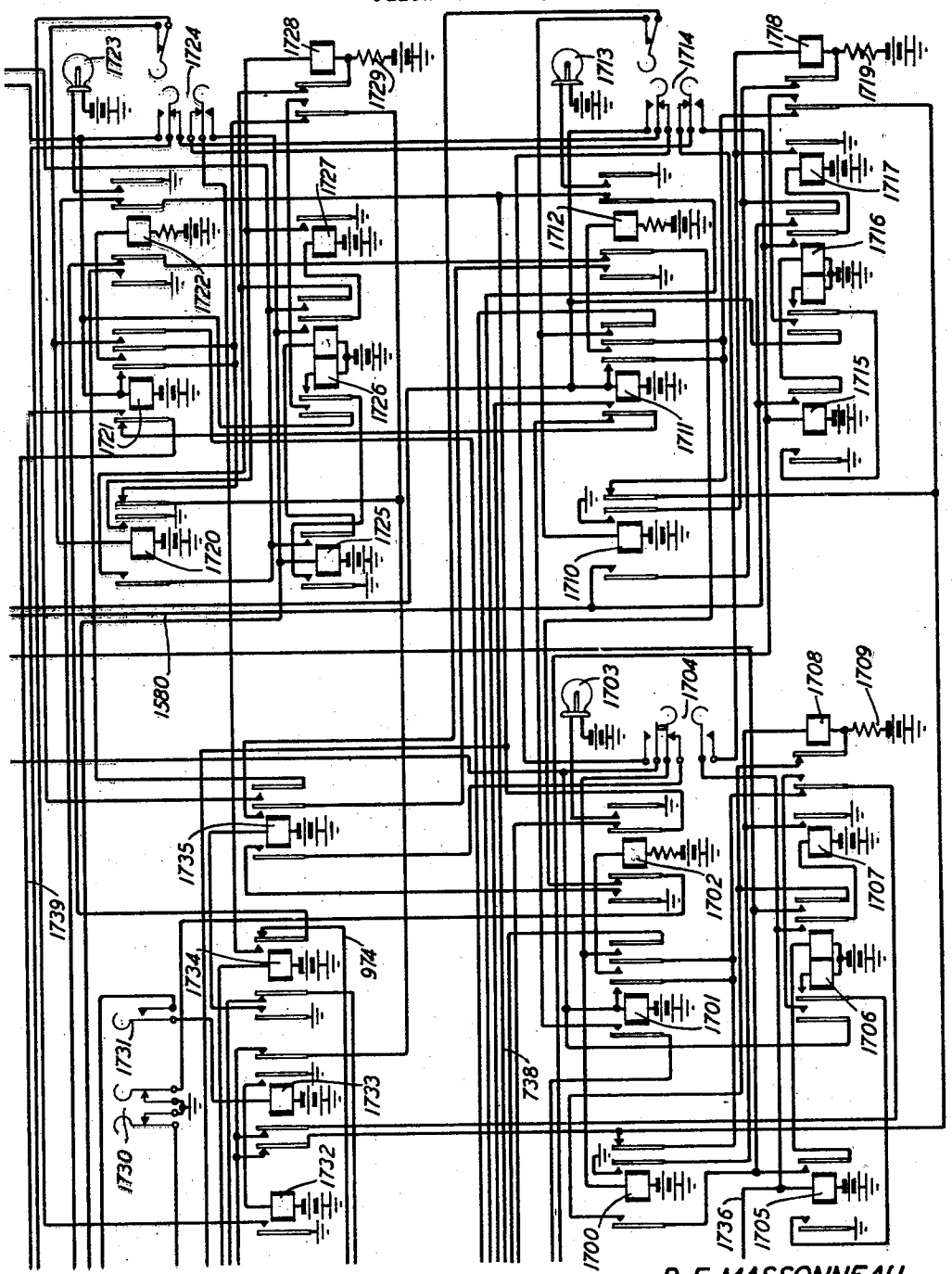

FIG. 17

INVENTORS R. F. MASSONNEAU
T. H. ROBERTS

BY P. C. Smith

ATTORNEY

Patented Jan. 12, 1932 1,841,197

UNITED STATES PATENT OFFICE

ROBERT F. MASSONNEAU, OF SCARSDALE, AND THOMAS H. ROBERTS, OF NEW YORK, N. Y., ASSIGNORS TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

TELEPHONE ALARM SYSTEM

Application filed March 27, 1931. Serial No. 525,664.

This invention relates to telephone systems and more particularly to systems in which connections are established by the joint operation of automatic and manual means.

One outgrowth of the development of automatic telephone practice has been the provision of means for informing a manual operator of the wants of a calling subscriber whose line terminates in a dial switching office. A convenient method and one which requires a minimum of equipment at the manual office is the provision of means at the automatic office for speaking the wanted number to the manual operator under the control of the recorded designation. In the commercial use of such a system it becomes necessary to provide spare equipment to care for emergencies and means for informing those in charge of the equipment when such emergencies arise.

An object of the present invention is the provision of efficient and economical means for insuring continuity of service in a system of the above type.

To this end switching means is provided under manual control for associating any machine with any load and under automatic control means for transferring a load on which difficulty arises to another predetermined machine. The switching operations whether manual or automatic are performed in synchronism with the operation of the machine. Means responsive to the speech currents generated by the machine is arranged to operate an alarm and to initiate the automatic switching operation in case of speech failure. Other features are also provided which will become apparent during the detailed description of the circuits.

These features of the invention will be more clearly understood from a consideration of the following description in connection with the drawings in which:

Figs. 1, 2, 4 and 5 show portions of one sender and a schematic representation of an additional sender;

Figs. 8 and 12 show additional senders;

Figs. 3, 6 and 13 show the speech detector circuits;

Figs. 7, 10, 14 and 17 show switching circuits for associating senders with the call announcer machines;

Figs. 9 and 16 show the repeating coil connections in the channels selectable by the senders;

Figs. 11 and 15 show the call announcer machines; and

Fig. 18 shows the manner in which the remaining figures should be arranged.

The circuits shown in Figs. 1, 2, 4 and 5 have been taken from the tandem sender disclosed and claimed in the application of T. H. Roberts, Serial No. 485,434, filed September 30, 1930, and the same numerical designations have been used as in that application to facilitate reference thereto.

The senders of an office are divided into two groups for connection with the call announcer machine. For convenience these two groups may be known as the A load and the B load. Each sender is provided with a set of relays, operable in accordance with the setting of the registers, which connect the fundamental circuit to one of fourteen different channels over each of which a different element of a subscriber's designation is received. These fourteen channels are connected in multiple to all of the senders of one load and are selectable in accordance with the registered designation to cause the pronouncement of such designation.

In order to insure satisfactory service at all times three call announcer machines are provided, that is, one more than the number of loads. Each call announcer machine includes fourteen announcer units which feed speech currents out over fourteen speech channels. Ordinarily each of the loads is carried by a different machine and the third machine is out of service for the purpose of adjustments and repair or merely in reserve.

As will be described hereinafter, switching means is provided for connecting the two sender loads with any one or two of the call announcer machines. A set of switching relays is provided for each possible combination of sender load and machine, together with means for creating these combinations either manually or automatically. The arrangement is such that, while any combina-

tion may be brought about manually, only a combination predetermined by the existing conditions can be set up automatically. For convenience these switching units have been shown as including a multi-contact relay for connecting the fourteen selectable channels of the load with the fourteen speech channels of the machine as well as extending the synchronizing conductors to the senders. However, the substitution of a plurality of simple relays for the multi-contact relays would be an obvious expedient.

In the establishment of a connection through the use of a call announcer it is essential that continuous reiterated pronouncements of the digits be available to the sender since the failure of any channel would mutilate the designations including that digit. Therefore, a speech detecting device has been connected in multiple with each selectable channel of each load. This device is primarily an amplifier and a rectifier in combination with a delay arrangement, effective as long as the pronouncements are made at the proper intervals to hold operated a slow relay which controls an alarm device. It also initiates the operation of the switching circuits. If speech ceases on any channel, no matter what the cause, the load is transferred to the other machine that is working. The load is transferred to a machine then in use rather than to the idle machine because of the delay necessary in starting the idle machine and the possibility that it may not be ready for operation. However, the alarm informs the attendant that the transfer has occurred and he may then start the reserve machine and connect one load to it.

The call announcer machine comprises fourteen speech generating elements, one for each of the numerical digits and one for each of the four letters used as stations designations. Each unit comprises a light source, a lens for focusing the light on a slit (not shown), a photographic record of the pronouncement of the corresponding digit, a photoelectric cell for translating the record into electrical speech currents and one or more amplifiers to raise the volume of the speech currents to the usual conversational level. The photographic record is mounted on a drum for rotation between the light source and the photoelectric cell, and in practice two records are mounted over slits on the outer margins of the same drum. The drums are of such size that the record of the pronouncement is repeated a number of times, during each revolution of the drum, and the film is apaque between the pronouncements. These dark spaces permit the reenforcement of the drum and are of such length as to simulate the natural intervals between spoken words. The cam wheel 1175 carried by the same shaft as the drums operates an interrupter mechanism which connects ground to a plurality of synchronizing leads during the interval when the speech record is passing between the light source and photoelectric cell, and disconnects ground therefrom during the silent intervals. These leads are extended in multiple to groups of senders where the intermittent ground controls the successive establishment of the speech circuits in synchronism with the pronouncements by the machine. Branches of one of these leads are also extended to the switching circuits to control the switching operations.

Briefly the operation of the sender, in extending a connection through the use of the call announcer machine, is as follows: When the sender has been selected and associated through a district selector with a sender at the originating office, ground is connected to conductor 909 and a circuit is established from the relay call indicator impulser of the originating sender through relays 1122, 1123 and 1124 in series. Following the establishment of this circuit, the impulser sends out code impulses in the well known manner, operating relay 1122 intermittently to control the transfer relays, by controlling relays 1132 and 1134, and operating relays 1123 and 1124 in accordance with the registered designation, to cause the recording of that designation on the registers of the tandem sender. Since only the numerical designation of a subscriber's line, including the stations digit, is transmitted by call announcement, the code registers have been omitted and the corresponding transfer relays, with the exception of relays 1106 and 1107.

Assuming that the numerical designation of the wanted number is 2245—R, relays 1211 and 1212 of the stations register 1210 and relays 1221, 1302, 1313 and 1324 of the thousands, hundreds, tens and units registers respectively will be operated. When the transfer relays associated with the tandem units register have been operated, the operation of the decoder is initiated and the office code is translated into a setting for the selection control registers which determines the operation of the selectors at the tandem office in selecting a trunk outgoing to the wanted office. The decoder also causes the operation of the class relay which determines the manner in which the call must be completed at the distant office. In the case of a call to be completed at a manual office to which the designation is to be transmitted by means of call announcements, the sender prepares a talking circuit which includes condenser 2523 and the left windings of repeating coil 2500. When the hundreds digit has been received and the class relay, indicating the call announcer class of call, has been operated, relay 2403 is also operated. This relay connects ground to conductor 2405 and prepares circuits for controlling the transmission of

the call announcement. The call announcer machine intermittently connects ground to conductor 1004 over conductor 1180 as above described. When the trunk to the distant office has been found and the sender sequence switch advances to prepare the circuit for testing the trunk, conductor 1004 is extended to the winding of relay 2513 and relay 2513 operates intermittently. When the test circuit to the outgoing trunk has been established, the circuit controlled by relay 2513 is extended to the winding of relay 2514 which now also operates intermittently. When the operator is ready to receive the designation, grounded conductor 2405 is connected to the front contact of relay 2514 and, when relay 2514 operates, over the normal contact of relay 2518 to the winding of that relay and battery. Relay 2518 operates and locks directly to conductor 2405. Relay 2518 prepares a circuit for relay 2519 which is ineffective until relay 2514 releases at the beginning of the silent interval, because of the shunt over the back contact of relay 2519. When this shunt is opened, relay 2519 operates connecting the right windings of repeating coil 2500 to the armatures of relay 2620 whence it is directed to one of the speech channels in accordance with the operation of relays 2620 to 2627. Relay 2519 also completes the circuit through the left windings of repeating coil 2500 and connects the armature of relay 2514 over the outer upper front contact of relay 2519 to the upper normal contact and winding of relay 2411, resistance 2410 and battery. Relays 2411 and 2408 are operated and released under the control of relay 2514 and the operation and release of relay 2408 cause a similar cycle of operations by relays 2414 and 2407, while relay 2414 controls a pair of counting relays 2406 and 2413. When relays 2408, 2411, 2407, 2414, 2406 and 2413 are all non-operated, a circuit is closed from battery through the winding of relay 1601 to grounded conductor 2405. The grounding of conductor 2405 connected ground to the front contacts of the operated relays of the thousands register 1220 so that the relays 1602 to 1605 are operated in combination in accordance with the operation of relays 1221 to 1224. The operation of relay 1601 therefore connects relays 2620 to 2625 over its contacts to the circuits controlled by relays 1602 to 1605. Since it was assumed that relay 1221 was operated alone, relay 1605 will have been operated and the circuit of relays 2622 and 2625 completed. Therefore the talking circuit through the right windings of repeating coil 2500 is extended over the back contacts of relay 2620, back contacts of relay 2623, front contacts of relay 2622, back contacts of relays 2624 and 2626 to the No. 2 unit of the call announcement machine. As relays 2406, 2407, 2408, 2411, 2413 and 2414 are operated and released, they successively close circuits for relays 1305, 1315, 1325 and 1215. These relays supply ground to the armatures of the corresponding register relays and therefore operate relays 2620 to 2625 in combination to cause the pronouncement of the remaining digits. Relays 2626 and 2627 are operated in parallel with relay 1215, when the stations digit is to be pronounced, to direct the talking circuit to the channels over which the stations letters are being spoken. When the last digit has been pronounced, the locking circuit of relay 2518 is opened and relay 2519 is released, disconnecting the sender from the selectable channels. The sender is thereupon released and the talking connection established. The operation of the sender circuits is disclosed and described in detail in the above identified Roberts application.

In describing the operation of the switching mechanism, it will be assumed either that the call announcer feature is to be set into operation for the first time or that it is to be restarted following a shut down, that is, that none of the machines are working and are therefore connected to neither load. It will also be assumed, for the purpose of illustration, that the A load is to be connected to the No. 1 call announcer machine which is the one shown in Fig. 11. Motor 1176 will be started into operation, rotating the drums 1160 to 1174 and cam 1175. Next key 972 is operated by moving it from left to right. This opens a number of normally closed circuits which are employed in the automatic transfer of the loads and connects ground through the winding of relay 971 to battery. Relay 971 lights lamp 970 as a guard lamp and prepares a circuit for holding certain relays operated in the switching circuits. The A—1 key 704 individual to the combination of the A load with the first machine is then operated and finally start key 973. Keys 972 and 704 are self-locking, but key 973 must be held operated until the A—1 lamp 703 lights as an indication that the A load and the No. 1 machine have been connected together. The operation of key 973 closes a circuit for relay 734 which in turn operates relay 735. It also operates relay 1734 in turn operating relay 1735. A chain circuit is now closed to insure that only one machine will be connected to a load at a time. This circuit may be traced from battery through the winding of relay 705, lower operated contact of key 704, lower normal contact of keys 714 and 724, right front contact of relay 734, left back contacts of relays 722, 712 and 702, normal contact of key 730 to ground. Keys 714 and 724 are individual to the combination of the A load with the No. 2 and No. 3 machines respectively.

During the next pronouncement, ground is connected over contact 1179, by cam 1175 acting on interrupter 1178 to conductor 1180, right contact of relay 705, right winding of

relay 706 and battery. Relay 706 locks through its left winding and inner left contact to ground at the left contact of relay 705. Relay 706 also connects relay 707 to the operating circuit of relay 705, and relay 707 is also operated. Relay 707 closes an obvious circuit for relay 708, but ground over conductor 1180 and the outer left contact of relay 706 is connected to resistance 709 over the inner back contact of relay 708 in shunt of the winding of that relay. When cam 1175 opens the contact 1179 at the beginning of the silent period and ground is disconnected from conductor 1180, relay 708 operates and further opens the shunt around its winding. With relay 708 operated, a circuit is closed in parallel from battery through the windings of relays 701 and 1001, over the outer right contact of relay 706, front contact of relay 708, outer left contact of relay 733, back contact of relay 663 to ground at the lower contact of key 730. Relay 1001 connects the speech channels of the first call announcer machine to the selectable channels of the A sender load. It also connects the ten synchronizing leads from the machine to the senders of the A load. Each synchronizing lead is multiplied to five or more senders where it controls the operation of the sender in synchronism with the operation of the announcer machine.

Relay 701 locks over its inner right contact and the right back contact of relay 700 to the back contact of relay 733 and thence over its operating circuit to ground. Relay 701 also connects relay 702 over its middle right contact to its locking circuit, operating relay 702. Relay 702 lights lamp 703 to indicate that the connection has taken place. Relay 702 also opens the circuit of relay 705. When the A—1 lamp 703 is lighted, the start key 973 is released. Relays 734, 735, 1734 and 1735 are thereupon released. The release of relay 705 opens the locking circuit of relay 706 and that relay releases. Relay 706 in turn releases relays 707 and 708. Relays 701, 702 and 1001 are held operated under the control of relays 700, 708 and 733.

Assuming that the B load is now to be connected with the second call announcer machine, the B—2 key 1714 is operated followed by the start key 973. As before key 973 operates relays 734, 735, 1734 and 1735. With relay 1734 operated a circuit is closed for relay 1715 over the operated contact of key 1714, normal contact of key 1724, right front contact of relay 1734, back contacts of relay 1722, 1712 and 1702 to ground at the right contact of key 1730. When the second call announcer machine connects ground to the synchronizing conductor, which may be represented by conductor 1580, relay 1716 operates, locking under the control of relay 1715, operating relay 1717 and, when the synchronizing ground is removed, relay 1718. Relays 1718 and 1716 operate relays 1402 and 1711 in parallel over the outer left contact of relay 1716, left front contact of relay 1718, outer left contact of relay 1733, back contact of relay 1363 to ground at the left contact of key 1730. Relay 1711 locks under the control of relay 1710 to the energizing circuit above traced and operates relay 1712 which lights the B—2 lamp 1713 to indicate that the B load has been connected to the second call announcer machine. Start key 973 is thereupon released and relays 1715, 1716, 1717 and 1718 release. Key 972 is also restored to render the automatic transfer arrangement effective.

If it had been desired to connect both loads to the first machine, key 972 would have been restored following the association of the A load with the first machine, releasing relay 971 and extinguishing lamp 970 and the connection would have taken place automatically. With key 972 normal and relay 701 operated to indicate that the A sender load is connected with the No. 1 machine, a circuit is closed from battery through the winding of relay 1705 in the B—1 switching unit, conductor 1736, left front contact of relay 701, left contacts of relays 711 and 721, conductor 737, lower normal contact of key 972, conductor 974, right back contact of relay 1734, left back contacts of relays 1722, 1712 and 1702, to ground at the right contact of key 1730. Relay 1705 closes a circuit for operating relay 1706 during the next pronouncement, which in turn causes the operation of relays 1707 and 1708. With relays 1706 and 1708 operated, relays 1701 and 1401 are operated in parallel and the B load is connected with the first machine.

As pointed out hereinbefore the failure of pronouncement on any channel would mutilate the speaking of a designation and must be guarded against, and for this purpose a detector circuit is connected in parallel with each of the selectable channels in both the A and B loads. These detector circuits are the same for all channels and the circuit 311 may be taken as typical. It consists of monitoring jack 320 coupled by means of a repeating coil 321 to an amplifying tube 322 and then through repeating coil 328 to a rectifying stage including tube 323. Relay 324 is connected to the output of tube 323 and is held operated by the amplified and rectified current flowing in the plate circuit of tube 323. In order to prevent the release of relay 324 during the silent intervals between pronouncements, relay 324 has been made slow to release and in addition a delay circuit has been used in connection with tube 323 to delay the decay of the speech current and reduce the interval during which the relay must remain operated. Relay 324 in turn holds relay 325 operated.

Condenser 329 has been inserted between the grid and filament of the amplifier tube

to minimize cross-talk between the different channels. Resistance 330 supplies the grid bias voltage through resistances 331 to 334 and is made very high in value so that condenser 329 may be effective. Resistance 335 which is also of high value is connected across the input of the amplifier tube to maintain a definite impedance for the purpose of preventing oscillations. Condensers 336, 337 and resistance 338 together provide a delay arrangement by which the plate current reacts on the grid of tube 323, resulting in the retardation of the decrease of the plate current during the silent intervals between pronouncements and the shortening of time during which the slow to release character of relay 324 must be effective. This delay arrangement is disclosed and claimed in a patent to C. P. Stocker, No. 1,818,018, granted Aug. 11, 1931. Resistances 332, 333 and 334 also serve to provide proper grid bias voltage for the set of four detector circuits, in which the filament circuits of the eight tubes are connected in series. For the last set, including only two channels, the resistances 639 and 640 are used in place of the filaments of the other four tubes.

Assuming that the voice currents have ceased on the channel to which detector circuit 311 is attached, after an interval measured by the delayed decay of the current and the slow releasing time of the relay 324, relay 325 releases closing a circuit from battery through the left winding of relay 326, back contact of relay 325, left back contact of relay 659, conductor 1366, to ground at the right normal contact of key 1365. Relay 326 locks through its right winding and inner right contact to this same ground, lighting lamp 327 to indicate on which channel the pronouncement failed. It also connects ground over its outer right contact through the winding of relay 657 to battery.

Relay 657 initiates the operation of relay 658. Battery is connected through resistance 653 to the junction point 665 and thence over the contact 666 of jack 652 through the left winding of relay 658, contact 667 of jack 654, contact 669 of jack 652, resistance 656 to junction point 670 which is also connected to battery through resistance 671. A second path connects points 665 and 670 which may be traced over contact 672, right winding of relay 658, contact 673, contact 674, resistance 655 and condenser 664. With relay 657 normal, ground is connected over the back contact of that relay to point 665, in shunt of battery through resistance 653, so that current flows from battery through resistance 671 to ground at the back contact of relay 657 through the left winding of relay 658 and this current is in such a direction as to hold the contact of the polarized relay 658 open. When relay 657 is operated as above described, ground is disconnected from point 665 and connected to point 670 in shunt of battery through resistance 671. Therefore, the circuits through the windings of relay 658 are reversed and current flowing through the left winding is now in a direction to close the contact of relay 658, but the reversal of the potential on the condenser 664 causes the condenser to discharge and then recharge in the opposite direction. These discharge and charging currents are in a direction to oppose the direct current flow through the left winding of the relay 658 and thus the closure of the contact of relay 658 is delayed. When it finally closes, an obvious circuit is completed for relay 659 which locks through its right winding to ground over conductor 1366. The operation of relay 659 disconnects ground from the operating circuits of the relays corresponding to relay 326 in all the channels of the A load. The delayed operation of relay 659 is for the purpose of permitting any additional channels which may be in trouble to operate their relays corresponding to relay 326, but to prevent the operation of these relays in channels not in trouble during the time that the load is being transferred to the other machine.

Relay 659 connects ground to the alarm circuit and closes an obvious circuit for relay 660. Relay 660 closes a circuit from battery through the winding of relay 662, left back contact of relay 1360, outer right front contact of relay 660 to grounded conductor 1366. Relay 662 locks under the control of relay 660 and lights lamp 661 to indicate that the A load is in trouble. Relay 659 also closes a circuit from ground at the left normal contact of key 1365, right back contact of relay 1360, outer left front contact of relay 659, normal contact of key 972, left back contact of relay 734, right back contact of relay 1702, outer right contact of relay 701 to the winding of relay 700 in the A—1 switching circuit and battery. Relay 700 prepares a circuit for relay 708 but also connects conductor 1180 over the left contact of relay 700 to the back contact of relay 708 and resistance 709 in shunt of the winding of relay 708, so that no action takes place until ground is removed from conductor 1180 at the beginning of a silent interval. With relays 700 and 708 both operated the holding circuit of relays 701, 702 and 1001 is opened and these relays release disconnecting the A load from the No. 1 machine. A circuit is thereupon closed from battery through the winding of relay 715 in the A—2 switching circuit, conductor 738, left front contact of relay 1711, left back contact of relay 1721, conductor 1739, upper left normal contact of key 972, right back contact of relay 734, left back contacts of relays 722, 712, and 702, to ground at the upper contact of key 730. Relay 715 operates relay 716 over conductor

1580 of the second call announcer machine, after which relay 717 is operated, followed by relay 718 when ground is removed from conductor 1580. The joint operation of relays 718 and 716 closes a circuit for relay 711 in parallel with relay 1002 over the outer right contact of relay 716, front contact of relay 718, inner left contact of relay 733, back contact of relay 663 to ground at the lower contact of key 730. Relay 711 locks over the back contact of relay 710 and the back contacts of relays 733 and 663 to key 730 and operates relay 712 which opens the operating circuit for relay 715, and relays 715, 716, 717 and 718 release. The A—2 lamp 713 is lighted to indicate that the A load is connected with the No. 2 machine.

If the trouble, because of which a load has been automatically transferred from one machine to another, has arisen between the contacts of the switching relays and the sender, so that the trouble is transferred to the second machine, the correponding relay or relays of the B load detector circuits, indicated by the rectangle of Fig. 13, will be released and operated resulting in the operation of relay 1357 in the manner above described for relay 657. Relay 1357 causes the delayed operation of relay 1358 followed by the operation and locking of relay 1359. Relay 1359 also sounds an alarm and operates relay 1360. If the trouble originates on the B load, relay 1360 operates relay 1362 to light lamp 1361, but since the trouble originated on the A load and was transferred, relay 1360 cannot operate relay 1362 since the circuit of that relay is opened at the contact for relay 660 individual to the A load. With relays 662, 660 and 1360 operated, a circuit is closed from battery through the winding of relay 663, inner left contact of relay 662, inner right front contact of relay 1360, inner right front contact of relay 660 to grounded conductor 1366. Relay 663 in operating opens the circuit previously traced by which relays 711, 712, 1002 were held operated after the A load had been transferred to the No. 2 machine. Relay 1002 therefore releases and disconnects the A load thus removing the trouble from the B load. The relays of Fig. 13 function in a similar manner in case of failure on the B load to transfer the load or to disconnect it if the trouble is also transferred.

After the trouble has been located, in order to restore the speech channel detector circuits to normal, key 1365 must be operated, opening the holding circuits for relays 659 and 1359 and the relays corresponding to relay 326 in each channel which was in trouble. When the speech channels again start to function the relays like relay 326 are released in turn releasing relay 657 and relay 657 moves its armature from its front to its back contact. In so doing it transfers ground from point 670 to point 665 shunting battery through resistance 653 and reversing the flow of current to the left winding of relay 658. It also causes the discharge and recharging of condenser 654 in the original direction. This current opposes the effect of the direct current circuit through relay 658 and delays the release of the relay 659. Key 1365 must be held operated until relays 659, 660 and 662 have been released as indicated by lamp 661 being extinguished because of this delayed opening of the operating circuit of relay 659, which gives sufficient time for all of the relays in the detector channels to operate.

If the load is to be transferred from one machine to another for routine purposes, the key individual to the load-machine combination to be changed is restored to normal and the key individual to the load-machine combination to be established is operated, followed by the operation of the start key 973. As before the operation of key 973 operates relays 734, 735, 1734 and 1735. Assuming that the A load is to be transferred from the No. 1 machine to the No. 3 machine, key 704 will have been released and key 724 operated. A circuit is then closed from battery through the winding of relay 700, normal contact of key 704, front contact of relay 735, front contact of relay 702 to ground. Relay 700 operates and opens the holding circuit for relays 701 and 1001, but these relays remain held over the back contact of relay 708. Relay 700 prepares a circuit for relay 708 but connects conductor 1180 in shunt of that relay so that relay 708 does not operate until ground is removed from the conductor at the beginning of the silent period. With both relays 700 and 708 operated, relays 701, 702 and 1001 release, disconnecting the A load from the first machine. When relay 702 closes its back contact, a circuit is completed from battery through the winding of relay 725, lower operated contact of key 724, right front contact of relay 734, back contacts of relays 722, 712 and 702 to ground at key 730. Relay 725 operates in the same manner as described for relay 705, resulting in the operation of relay 1003 to connect the A load with the third machine. Relays 721 and 722 are also operated and the A—3 lamp 723 lighted to identify the combination.

If for any reason it becomes desirable to cancel the automatic switching feature, key 972 is operated, or left operated after the loads have been connected to the machines. With key 972 operated, relay 971 is operated and lamp 970 lighted to indicate that the load cannot be automatically transferred. Key 972 opens the circuits for operating relays 700, 710, 720, 1700, 1710, 1720 which releases the load from the machine and also opens the circuits of relays 705, 715, 725, 1705, 1715 and 1725 which initiate the connection of the load to the other operating machine. Relay

971 connects ground from key 730 to the armatures of relay 733 for holding the switching relays in parallel with the back contact of relay 663 and closes a similar circuit from ground at key 1730 to the armatures of relay 1733 in parallel with the back contact of relay 1363.

The synchronizing cam 1175 which causes the intermittent connection of ground to the synchronizing leads extending to the senders also causes the connection of these leads during the silent period to battery through the left winding of relays such as relay 1181. If one of these leads, for example, conductor 1180 becomes permanently grounded, either from the sender or at some other point, relay 1181 is operated when connected to conductor 1180 and locks through its right winding and contact and key 1182 to ground. Relay 1181 lights the lamp 1177 individual to the conductor involved and also connects ground to the alarm circuit causing an alarm to be sounded. After the difficulty has been corrected, key 1182 is operated to release relay 1181.

If the synchronizing leads should become open or grounded so that the normal progress of the switching operation is impossible, means is provided for performing the switching operation independent of the synchronizing means. Assuming that the B load has been connected to the No. 2 machine as above described and that the machine No. 3 has been started and it is necessary to make an emergency switch to the No. 3 machine, key 1714 will be released and keys 1724, 1730 and key 973 operated. Keys 1730 and 973 do not lock and must be held until the B—2 lamp 1713 is extinguished. The operation of key 1730 opens the holding circuit for relays 1711, 1712 and 1402 so that the B load is immediately disconnected from the No. 2 machine and lamp 1713 is extinguished. Key 1730 is now released and key 1731 operated together with key 973. Key 1731 is also non-locking and must be held operated until the B—3 lamp 1723 lights. The operation of keys 973 and 1731 closes a circuit from battery through the winding of relay 1733, key 1731 to ground at the lower contact of key 973. Relay 1733 in turn operates relay 1732 which closes a circuit over the upper operated contact of key 1724 through the windings of relays 1721 and 1403 in parallel to battery. Relay 1721 operates relay 1722 which lights lamp 1723 indicating that the load has been connected with the machine. Key 1731 is thereupon restored permitting relay 1733 to release and reclose the holding circuit for relay 1721 after which the start key may be released. These operations cause the immediate transfer of the load without waiting for the closure or opening of the synchronizing lead.

The repeating coils 950, 964, 1650 and 1664, which are typical of the repeating coils appearing in all selectable channels, are employed to improve the impedance relationship between the output of the amplifier and the sender circuits. The ground connected to the sender side of the repeating coil discharges any charge which might tend to accumulate and to prevent the transmission of noises to the manual operator. The battery connected to the machine side of the repeating coil connects with ground in the amplifier circuit and provides a flow of direct current over the contacts of switching relays to break down any contact resistance which may be present.

What is claimed is:

1. In a telephone system, means for generating speech currents representative of an element of a telephone designation, and means responsive to said speech currents for causing an alarm to be sounded if said generating device ceases to generate said speech currents.

2. In a telephone system, a plurality of simultaneously operating generating devices for generating speech currents corresponding to each of the possible elements of telephonic designations, and means responsive to said speech currents for causing an alarm to be sounded should any one of said generating devices cease to generate said speech currents.

3. In a telephone system, means for repeatedly generating speech currents representative of an element of a telephone designation, and means responsive to said speech currents for causing an alarm to be sounded if said speech currents cease for longer than a predetermined time.

4. In a telephone system, a plurality of simultaneously operating generating devices for repeatedly generating speech currents corresponding to each of the possible elements of telephonic designations, and means responsive to said speech currents for causing an alarm to be sounded should any of said speech currents cease for longer than a predetermined time.

5. In a telephone system, means for generating speech currents representative of an element of a telephonic designation, means for amplifying and rectifying said speech currents, and means controlled by said rectified speech currents for causing an alarm to be sounded if said speech currents cease.

6. In a telephone system, means for generating speech currents representative of an element of a telephone designation interrupted by short silent intervals, means for amplifying and rectifying said speech currents, means for delaying the decay of said rectified currents to shorten said silent intervals, and means controlled by said rectified speech currents for causing an alarm to be sounded if said speech currents cease.

7. In a telephone system, means for gen-

erating speech currents representative of an element of a telephone designation interrupted by short, silent intervals, means for amplifying and rectifying said speech currents, means for delaying the decay of said rectified currents to shorten said silent intervals, and means controlled by said rectified speech currents for causing an alarm to be sounded if said speech currents cease, said means being unresponsive to said shortened silent intervals.

8. In a telephone system, means for generating speech currents representative of an element of a telephone designation, means including vacuum tube devices for amplifying and rectifying said speech currents, and means controlled by said rectified speech currents for causing an alarm to be sounded if said speech currents cease.

9. In a telephone system, means for generating speech currents representative of an element of a telephone designation interrupted by short, silent intervals, means for amplifying and rectifying said speech currents, means for delaying the decay of said rectified currents to shorten said silent intervals, and a slow to release relay controlled by said rectified speech currents for causing an alarm to be sounded if said speech currents cease.

10. In a telephone system, means for generating speech currents representative of an element of a telephone designation interrupted by short silent intervals, means for amplifying and rectifying said speech currents, means for delaying the decay of said rectified currents to shorten said silent intervals, and a slow to release relay controlled by said rectified speech currents for causing an alarm to be sounded if said speech currents cease, said relay being unresponsive to said shortened silent intervals.

11. In a telephone system, a device for generating speech currents representative of the elements of telephonic designations comprising a speech channel for each of said elements, a plurality of senders, channels corresponding to each of the elements of telephonic designations and selectable by said senders in accordance with recorded designations, means for connecting said selectable channels with said speech channels, means individual to each selectable channel responsive to said speech currents, and means under the control of said responsive means for sounding an alarm if such speech current ceases on any channel for longer than a predetermined period.

12. In a telephone system, a device for generating speech currents representative of the elements of telephonic designations comprising a speech channel for each of said elements, a plurality of senders, channels corresponding to each of the elements of telephonic designations and selectable by said senders in accordance with recorded designations, means for connecting said selectable channels with said speech channels, means individual to each selectable channel for amplifying and rectifying said speech currents, means responsive to said rectified speech currents, and means under the control of said responsive means for sounding an alarm if said speech currents cease on any channel for longer than a predetermined period.

13. In a telephone system, a device for generating speech currents representative of the elements of telephonic designations comprising a speech channel for each of said elements, a plurality of senders, channels corresponding to each of the elements of the telephonic designations and selectable by said senders in accordance with recorded designations, switching means for controlling the connection of said selectable channels with said speech channels, means individual to each channel responsive to said speech currents, and means under the control of said responsive means for actuating said switching means.

14. In a telephone system, a plurality of groups of senders, a plurality of devices for generating speech currents representative of telephonic designations, means for causing the association of said groups of senders with said devices in any desired combination, and means for automatically displaying an indication of the sender and device in each combination.

15. In a telephone system, a plurality of groups of senders, a plurality of devices for generating speech currents representative of telephonic designations, means for causing the association of said groups of senders with said devices in any desired combination, and means effective responsive to said connection for automatically displaying an indication of the sender and device in each combination.

16. In a telephone system, a plurality of groups of senders, a plurality of devices for intermittently generating speech currents representative of telephonic designations, means for causing the association of said groups of senders with said devices in any desired combination, means for rendering said associating means effective only during the intervals between the intermittently generated voice currents and means automatically responsive to the the completion of said association for displaying an indication of the sender and device in each combination.

17. In a telephone system, a plurality of groups of senders, a plurality of devices for generating speech currents representative of telephonic designations, manual means for causing the association of said groups of senders with said devices in any desired combination, and automatic means responsive to faulty operation of one of said devices for transferring the associated group of senders

into association with a predetermined other device.

18. In a telephone system, a plurality of groups of senders, a plurality of devices for intermittently generating speech currents representative of telephonic designations, means for causing the association of said groups of senders with said devices in any desired combination, means effective responsive to said connection for automatically displaying an indication of the sender and device in each combination, and means for rendering said associating means effective only during the intervals between the intermittently generated speech currents.

19. In a telephone system, a plurality of groups of senders, a plurality of devices for intermittently generating speech currents representative of telephonic designations, manual means for causing the association of said groups of senders with said devices in any desired combination, automatic means responsive to faulty operation of one of said devices for transferring the associated group of senders into association with a predetermined other device, and means for rendering said associating and transferring means effective only during the intervals between the intermittently generated speech currents.

20. In a telephone system, a plurality of groups of senders, a plurality of devices for generating speech currents representative of telephonic designations, manual means for causing the association of said groups of senders with said devices in any desired combination, automatic means responsive to a trouble condition in connection with one of said devices for transferring the associated group of senders into association with a predetermined other device, and means effective if said trouble condition is also transferred to said predetermined other device for disconnecting said group of senders from said other device.

21. In a telephone system, a plurality of groups of senders, a plurality of devices for generating speech currents representative of telephonic designations, manual means for causing the association of said groups of senders with said devices in any desired combination, automatic means responsive to faulty operation of one of said devices for transferring the associated group of senders into association with a predetermined other device, and means for rendering said automatic means ineffective.

22. In a telephone system, a plurality of groups of senders, a plurality of devices for intermittently generating speech currents representative of telephonic designations, means for causing the association of said groups of senders with said devices in any desired combination, means for controlling said associating means to render it effective only during the intervals between the intermittently generated voice currents, and means for rendering said associating means effective independent of said controlling means.

23. In a telephone system, a plurality of groups of senders, a plurality of devices for intermittently generating speech currents representative of telephonic designations, manual means for causing the association of said groups of senders with said devices in any desired combination, automatic means responsive to faulty operation of one of said devices for transferring the associated group of senders into association with a predetermined other device, means for controlling said associating means to render it effective only during the intervals between the intermittently generated voice currents, and means for rendering said associating means effective independent of said controlling means.

24. In a telephone system, a device for generating speech currents representative of the elements of telephonic designations comprising a speech channel for each of said elements, a plurality of senders, channels corresponding with each of the elements of telephonic designations and selectable by said senders in accordance with recorded designations, means for associating said selectable channels with said speech channels, and means effective if speech ceases on any of said speech channels to disconnect all of said speech channels from said selectable channels.

25. In a telephone system, a plurality of devices for generating speech currents representative of the elements of telephonic designations comprising a speech channel for each of said elements, a plurality of senders arranged in groups, a plurality of sets of channels corresponding to each of the elements of telephonic designations, the channels of each set being selectable by a particular group of senders in accordance with recorded designations, means for associating each of said sets of said selectable channels with the speech channels of one of said devices, and means effective if speech ceases on any speech channel of one of said devices to disconnect the associated set of selectable channels from said device and associate it with another device.

26. In a telephone system, a plurality of devices for generating speech currents representative of the elements of telephonic designations comprising a speech channel for each of said elements, a plurality of senders arranged in groups, a plurality of sets of channels corresponding to each of the elements of telephonic designations, the channels of each set being selectable by a particular group of senders in accordance with recorded designations, means for associating each of said sets of said selectable channels with the speech channels of one of said

devices, and means effective if speech ceases on any speech channel of one of said devices to disconnect the associated set of channels from said device and associate it with a device which has been associated with another set of selectable channels.

27. In a telephone system, a plurality of devices for generating speech currents representative of the elements of telephonic designations comprising a speech channel for each of said elements, a plurality of senders arranged in groups, a plurality of sets of channels corresponding to each of the elements of telephonic designations, the channels of each set being selectable by a particular group of senders, means for associating each of said sets of said selectable channels with the speech channels of one of said devices, and means effective if speech ceases on any speech channel of one of said devices to disconnect the associated set of channels from said device and associate it with a predetermined other one of said devices.

28. In a telephone system, a plurality of devices for generating speech currents representative of the elements of telephonic designations comprising a speech channel for each of said elements, a plurality of senders arranged in groups, a plurality of sets of channels corresponding to each of the elements of telephonic designations, the channels of each set being selectable by the senders of a particular group in accordance with recorded designations, means for causing the association of said sets of selectable channels with said devices in any desired combination, means effective if speech ceases on any speech channel of one of said devices to disconnect the associated set of channels from said device and associate it with a device which has been associated with another set of selectable channels, and means for indicating the identity of the set of selectable channels and the device which have been connected together.

In witness whereof, we hereunto subscribe our names this 23d day of March, 1931.

ROBERT F. MASSONNEAU.
THOMAS H. ROBERTS.