

May 3, 1938.

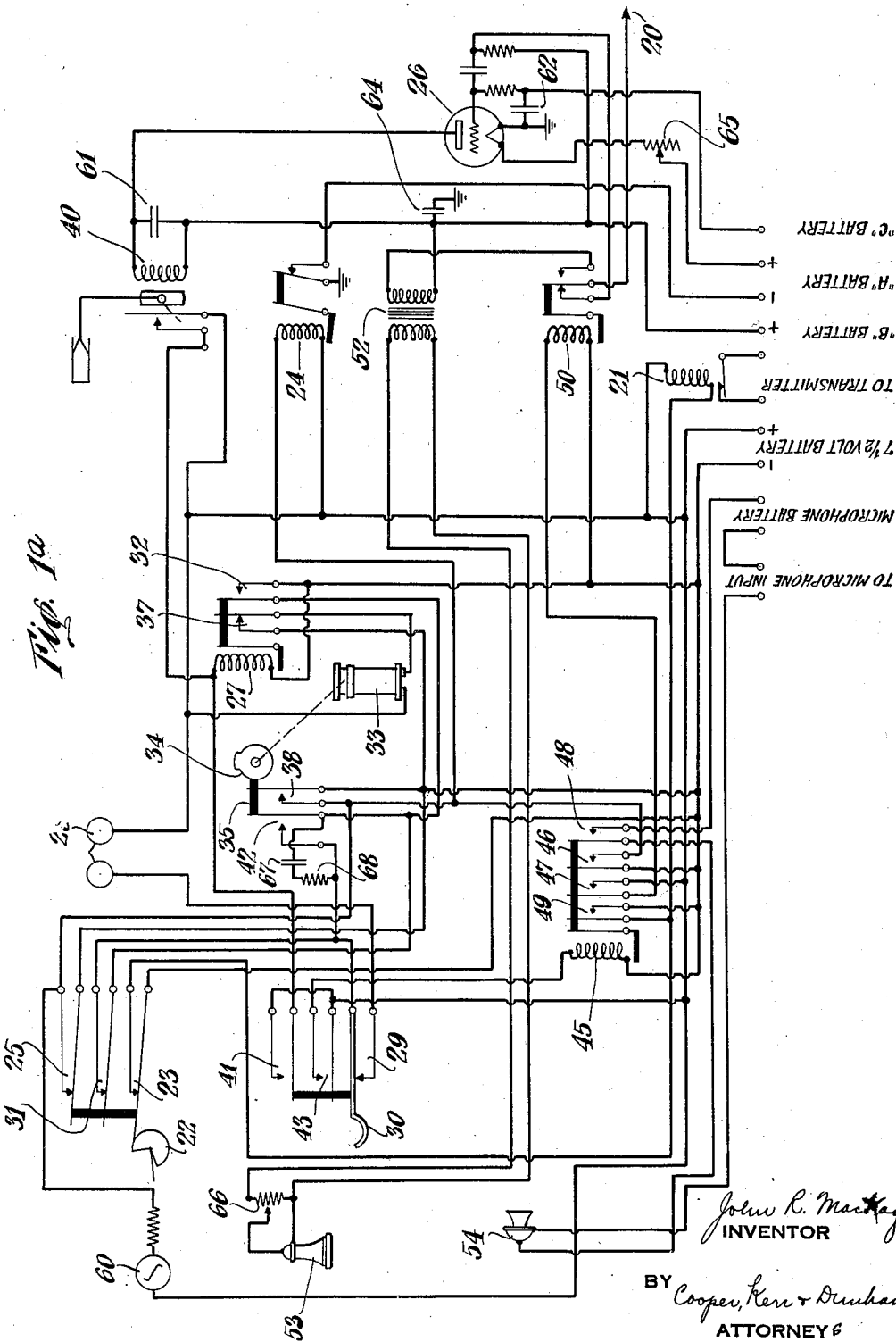
J. R. MacKAY

2,115,914

COMMUNICATING SYSTEM

Filed June 11, 1934

7 Sheets-Sheet 1



May 3, 1938.

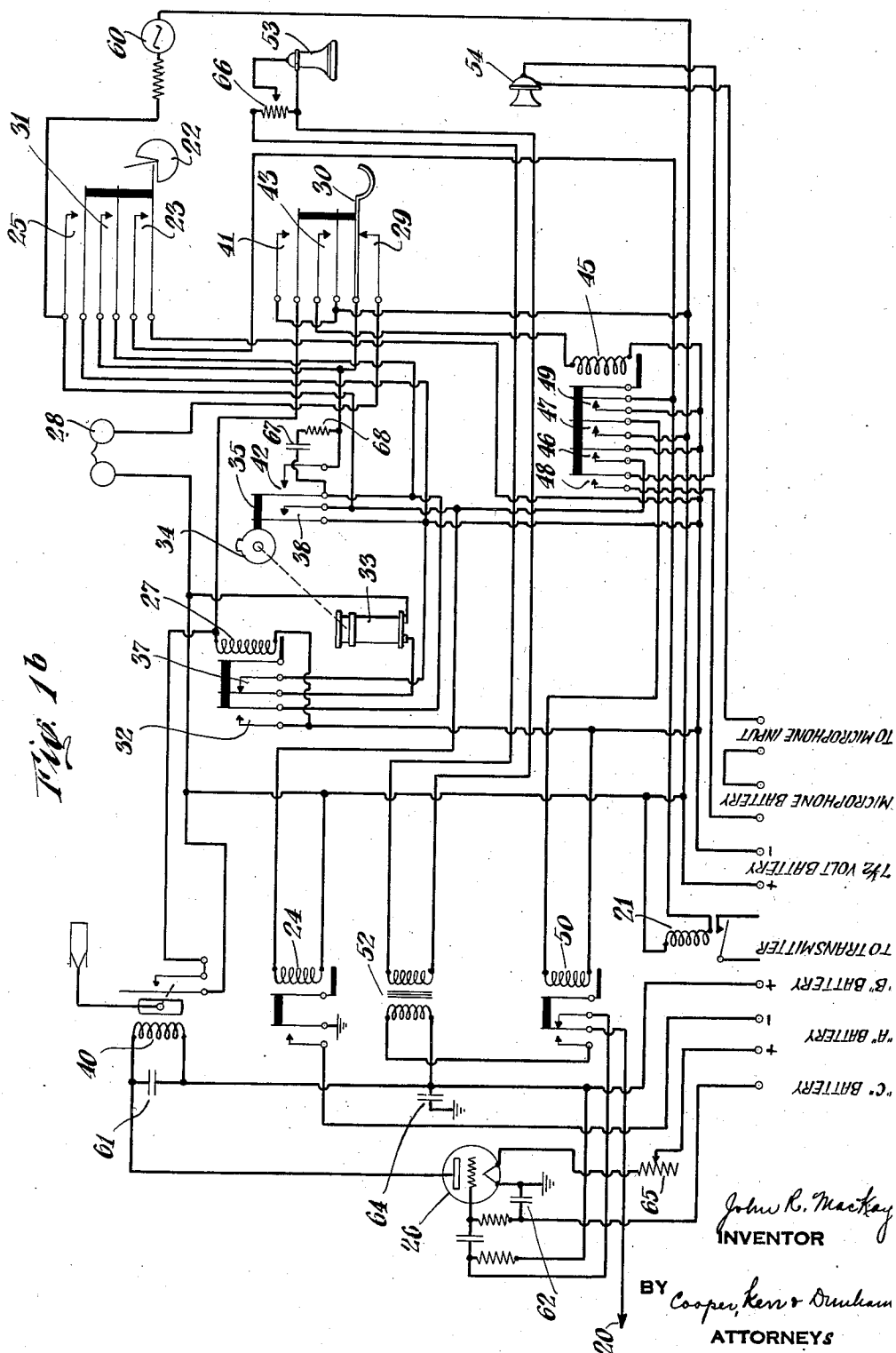
J. R. MacKAY

2,115,914

COMMUNICATING SYSTEM

Filed June 11, 1934

7 Sheets-Sheet 2



May 3, 1938.

J. R. MacKAY

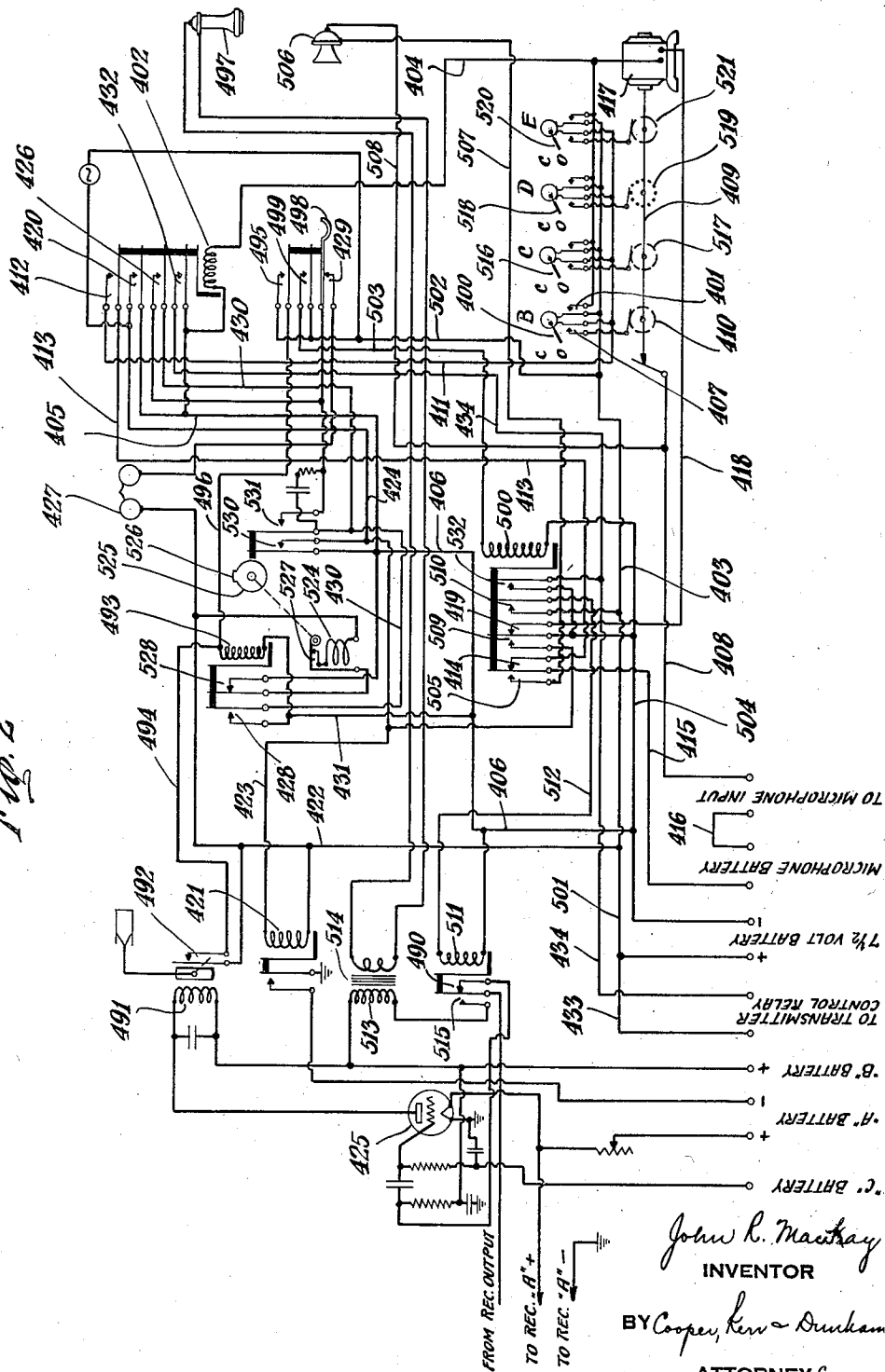
2,115,914

COMMUNICATING SYSTEM

Filed June 11, 1934

7 Sheets-Sheet 3

Fig. 2a



May 3, 1938.

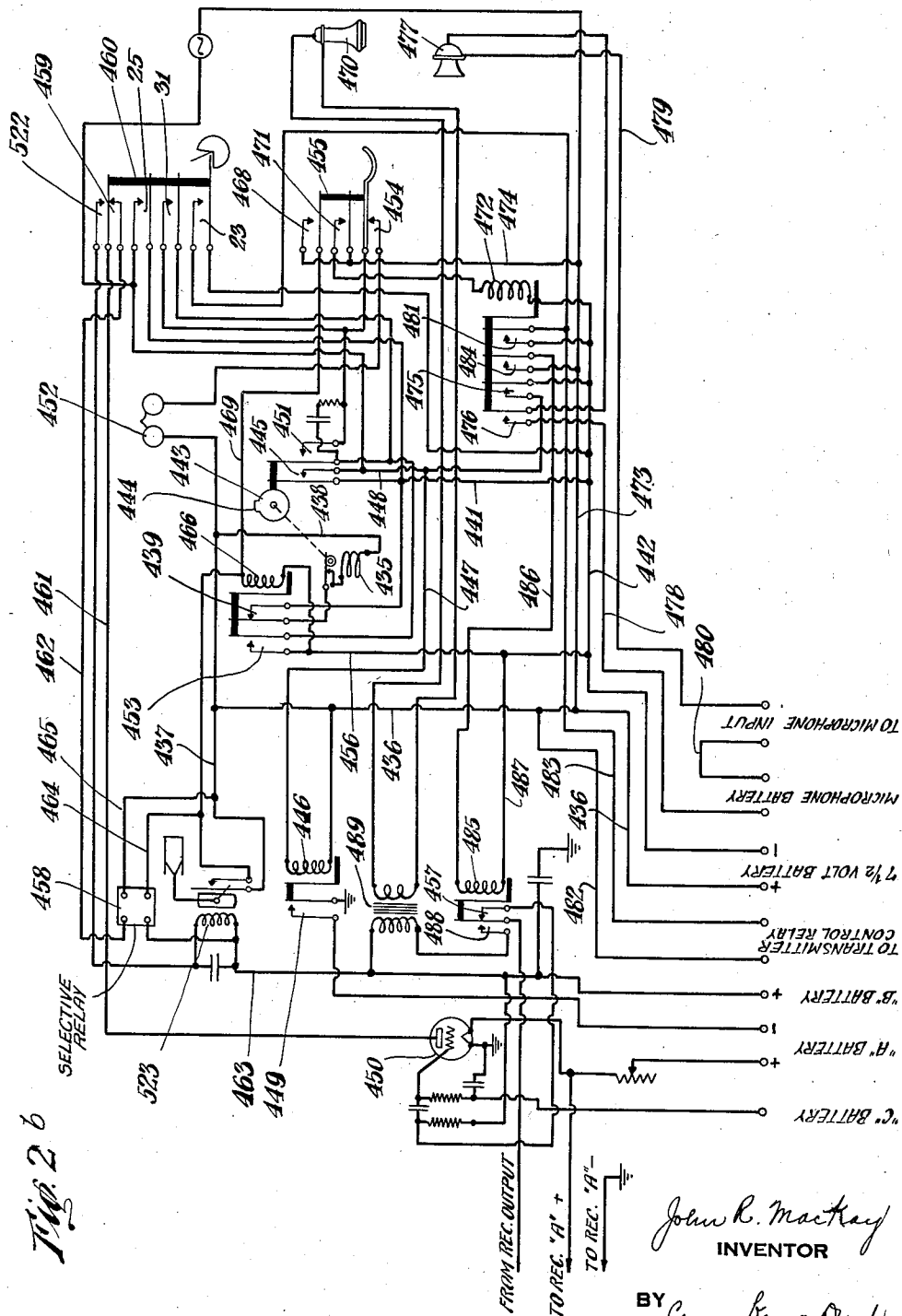
J. R. MacKAY

2,115,914

COMMUNICATING SYSTEM

Filed June 11, 1934

7 Sheets-Sheet 4



May 3, 1938.

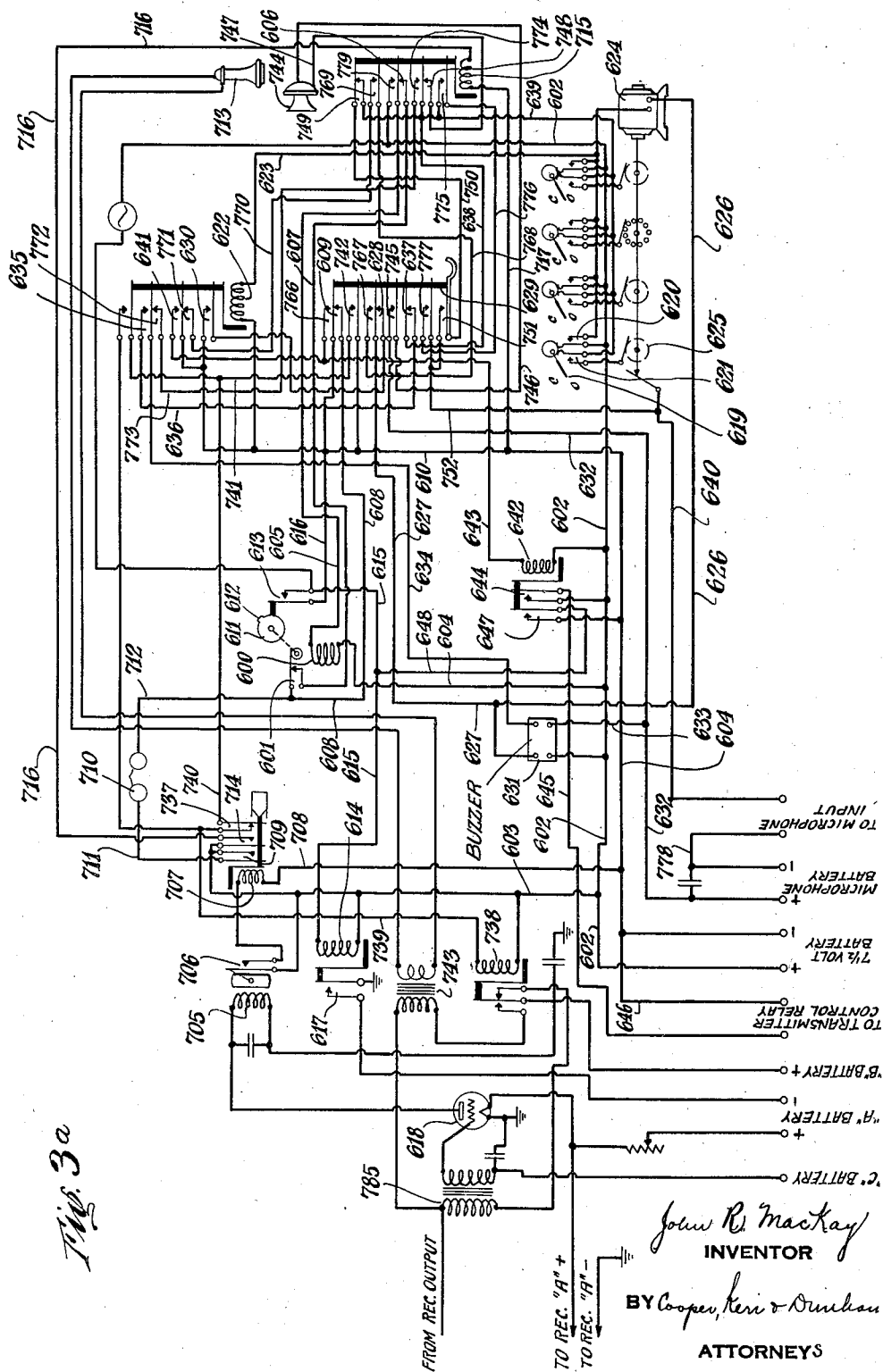
J. R. MacKAY

2,115,914

COMMUNICATING SYSTEM

Filed June 11, 1934

7 Sheets-Sheet 5



John R. MacKay
INVENTOR
BY Cooper, Kerr & Duncan
ATTORNEYS

May 3, 1938.

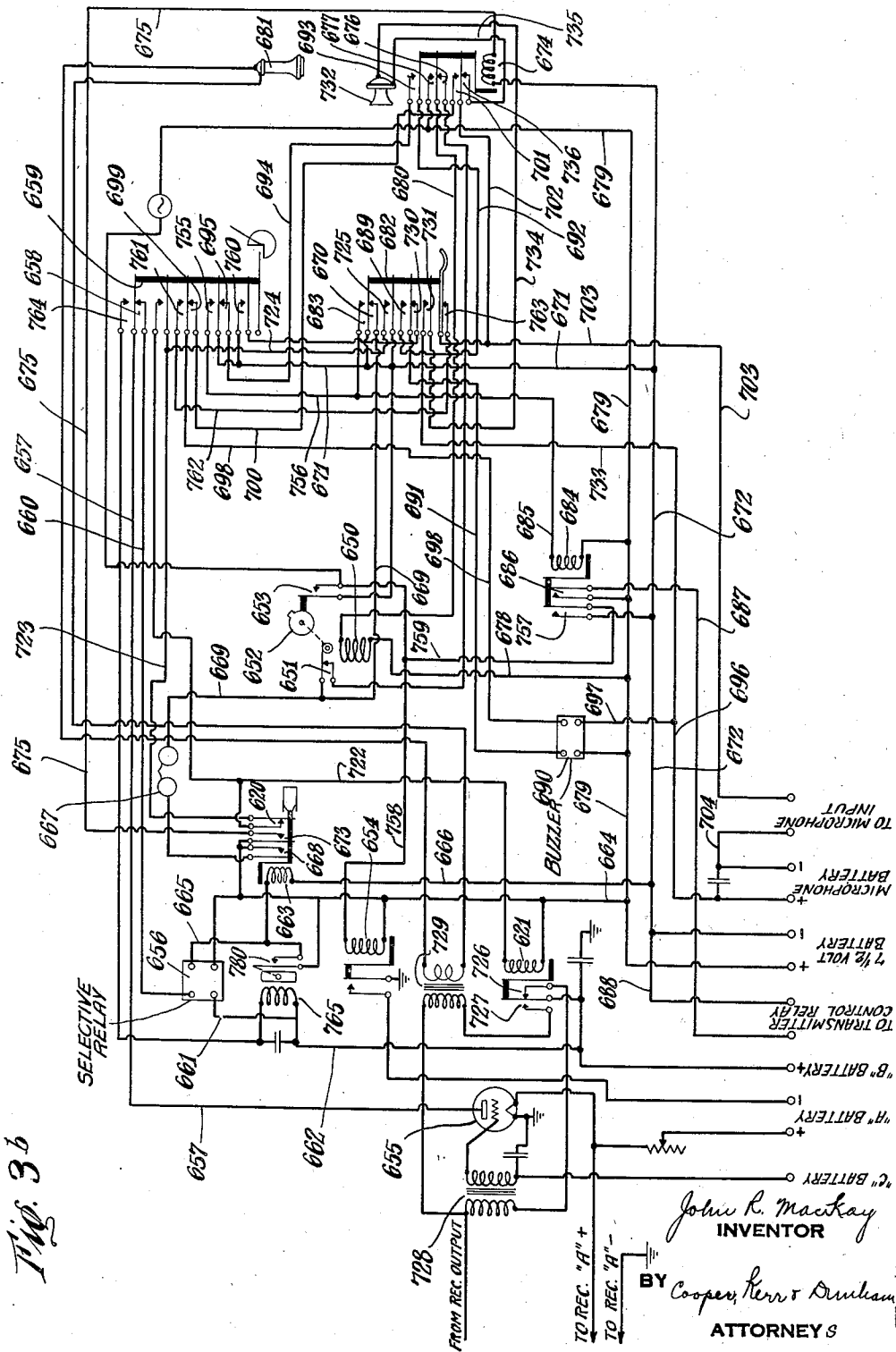
J. R. MacKAY

2,115,914

COMMUNICATING SYSTEM

Filed June 11, 1934

7 Sheets-Sheet 6



May 3, 1938.

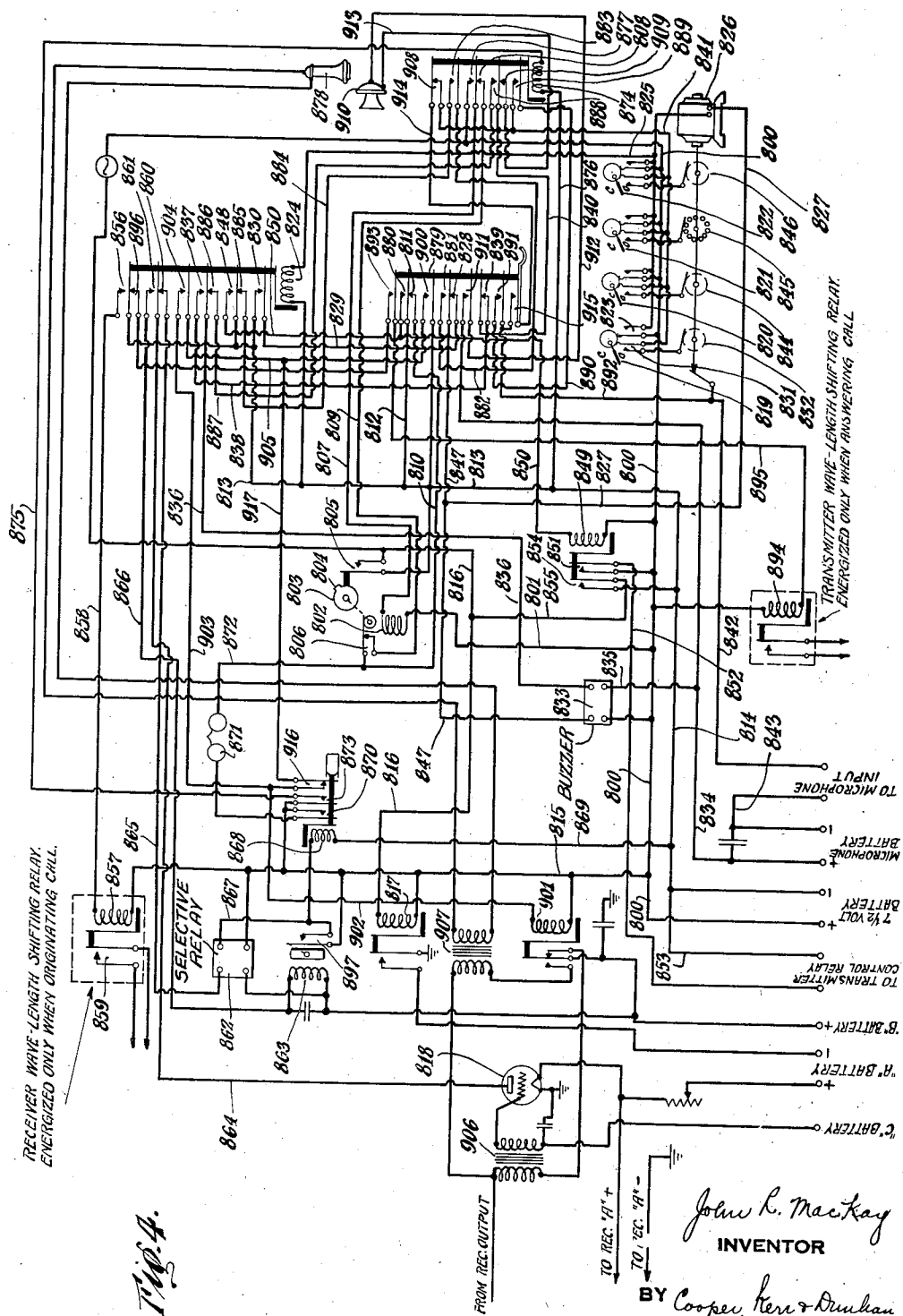
J. R. MacKAY

2,115,914

COMMUNICATING SYSTEM

Filed June 11, 1934

7 Sheets-Sheet 7



John L. MacKay
INVENTOR

INVENTOR

BY *Cooper, Kern & Drunkan*
ATTORNEYS

ATTORNEYS

UNITED STATES PATENT OFFICE

2,115,914

COMMUNICATING SYSTEM

John R. MacKay, West Caldwell, N. J., assignor
to Wallace & Tiernan Products, Inc., Belleville,
N. J., a corporation of New Jersey

Application June 11, 1934, Serial No. 730,127

30 Claims. (Cl. 250—9)

This invention relates to communicating systems. More particularly it relates to telephone systems and from a still more specific aspect it relates to radio telephone systems.

One of the objects of the invention is to provide a two-way radio telephone system in which the user at the calling station operates a call switch and the user at the called station receives a signal, as the ringing of a bell, thereupon lifts his telephone receiver from its hook, and thereby the user at the calling station is given a signal, as by means of a bell, indicating that his call has been put through, and the user at the calling station thereupon removes his telephone receiver from its hook, and two-way telephone conversation may then proceed as in the case of an ordinary communication over two land line telephones which have been properly connected.

A further object of the invention is to provide a radio telephone system in which the major portion of the apparatus employed is not energized at all times but only periodically at such desired intervals as will conserve the energy required to energize or activate such apparatus.

Further objects are to provide new combinations of instrumentalities and new sub-combinations thereof whereby the communication system is comparatively inexpensive to build and operate, comparatively simple in operation from the standpoint of the intelligence required to use it, and thoroughly reliable in its operation. Other objects and advantages will appear as some of the preferred forms of the invention are hereinafter disclosed.

Referring to the drawings which illustrate what I now consider to be preferred forms of the invention:

Figs. 1a and 1b are wiring diagrams of apparatus at two separated stations between which communication is to be established and maintained; station A (Fig. 1a) showing the call switch in its calling position and the energization of relays at that station resulting from such operation of the call switch; station B (Fig. 1b) showing the condition of the circuit and position of parts during normal operation with no signal being received and with the cam operated switch in its normally open position.

Fig. 2a is a wiring diagram of the apparatus at the master station of a different form of the invention.

Fig. 2b is a wiring diagram of the apparatus at one of a group of stations adapted to be selectively called from the master station of Fig. 2a.

Fig. 3a is a wiring diagram of the apparatus at

a master station in a somewhat modified form of system; Fig. 3a being in general respects similar to Fig. 2a.

Fig. 3b is a wiring diagram of the apparatus at one of a group of stations adapted to be selectively called from the master station shown in Fig. 3a.

Fig. 4 is a wiring diagram of a still further modified form of system; the wiring diagram shown in this figure being that of any one of a group of stations in a system.

Referring first to Figs. 1a, 1b in order to facilitate explanation, it will be assumed that station A is the calling station and that station B is the called station, it being understood that either station may be the calling or called station.

Before proceeding with the construction and electrical connections of the control system it should be understood that the conductor 20 is connected with the output, such as the plate circuit of the detector stage, of a suitable vacuum tube wireless receiving apparatus (not shown). This receiver may be of standard and well-known construction. So far as the features of invention disclosed in Fig. 1 are concerned it is immaterial what particular type of radio receiving apparatus be employed and connected to the conductor 20 provided the receiver is adequate for receiving radio telephone signals and converting them to sound frequency speech-representing currents and provided further that the receiver shall be capable of producing a suitable change in current in the conductor 20 in response to the desired received carrier frequency. It is to be understood further that the equipment at each station includes suitable radio transmitting apparatus (not shown) whose filament and plate supply are rendered operative upon energization of the transmitter control relay 21 so as to emit a desired carrier frequency and also properly to modulate it when telephone conversation takes place in the manner later to be described.

For two-way operation the control apparatus at station A is the same as that at station B.

The construction and connections may be satisfactorily explained by describing the operation of the system assuming that the user at station A desires to call the user at station B and thereafter converse with him as in customary use of two land line telephones connected for that purpose.

The user at station A throws his call switch 22 to calling position thereby causing the three normally open contacts of the call switch to become closed.

Operation of the call switch 22 to the calling position establishes the following circuit: from the positive side of a suitable power source, such for example as a $7\frac{1}{2}$ volt battery as indicated, through the transmitter control relay 21, through the now closed contacts 23 of the call switch 22, back to the negative side of the power source. Energization of the transmitter control relay 21 causes energization of the filament and plate supply of the radio transmitter (not shown) and the latter begins to transmit and continues to transmit a carrier wave of high frequency from station A.

Operation of the call switch 22 to the calling position also closes the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the relay 24, through the contacts 25 of the call switch, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 24 causes the tubes of the radio receiving apparatus at station A to be supplied with energy and also closes the filament circuit of the tube 26.

Operation of the call switch 22 to calling position also places the following signal circuit in condition to be energized if and when the relay 27 becomes energized: from the positive side of the $7\frac{1}{2}$ volt battery through the signalling device, in the present case a bell 28, through the contacts 29 of the hook switch 30, through the contacts 31 of the call switch 22, through the contacts 32 (now open) of the relay 27, back to the negative side of the $7\frac{1}{2}$ volt battery.

By the operation of the call switch 22 to its calling position the radio transmitter at station A has been put into operation to cause to be emitted a high frequency carrier wave (in this case un-modulated); also the radio receiving apparatus at the calling station, i. e. station A, has been placed into operative receptive condition; and also the circuit of the bell 28 at station A has been placed in condition to advise the user at station A upon receipt of an answer back in the manner presently to be described.

Turning now to the apparatus at station B I shall first describe the connections and operation of periodically operating or cycling mechanism having for its principal purposes the conservation of apparatus and of energy required.

A motor 33 is provided for continuously rotating a cam 34 which periodically operates the cam switch 35. While this motor may assume a variety of different forms, I prefer at present to employ a motor of the magnetic type such as that described and claimed in the application of Charles F. Wallace, Serial No. 596,072, filed March 1, 1932 for Electric motor apparatus. The circuit of the motor is as follows: from the positive side of the $7\frac{1}{2}$ volt battery through the winding of the motor 33, through the normally closed contacts 37 of the relay 27, back to the negative side of the $7\frac{1}{2}$ volt battery. The motor 33 normally continues to run.

Closure of the contacts 38 of the cam switch 35 connects the relay 24 across the $7\frac{1}{2}$ volt battery. Energization of the relay 24, as stated, causes the tubes of the radio receiver to become energized, also the tube 26.

In short, the motor 33 and instrumentalities just described automatically and periodically cause the tubes of the radio receiver to become energized. By this means the consumption of energy is minimized and the life of the apparatus prolonged.

When the carrier wave of station A (i. e. the calling station) is received by the radio receiver

at station B (the called station) and the cam 34 has closed its cam switch 35, the plate current of the tube 26 energizes the relay 40 and closes the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the contacts of the relay 40, through the relay 27, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 27 closes its contacts 32 and opens its contacts 37. Opening of the contacts 37 breaks the circuit of the motor 33 so that the motor stops with the high spot of the cam 34 holding the contacts of the cam switch 35 closed.

Closure of the contacts 32 of the relay 27 causes the following circuit to be energized: from the positive side of the $7\frac{1}{2}$ volt battery, through the bell 28, through the contacts 29 of the hook switch 30, through the contacts 42 of the cam switch 35, through the contacts 32 of the relay 27 and back to the negative side of the $7\frac{1}{2}$ volt battery. The bell 28 therefore rings at station B, thereby notifying the attendant at that station that he is wanted on the telephone and the bell continues to ring until he lifts his receiver from its hook, or station A ceases to call. When the user at station B removes his receiver 53 from the hook of the hook switch 39, the contacts 29 are automatically opened and the bell circuit is thereby opened and the bell ceases to ring.

Removal of the receiver from its hook at station B closes the contacts 41 and 43 of the hook switch 30. Closure of the contacts 43 of the hook switch 30 causes the relay 45 to be energized through the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the contacts 43 of the hook switch 30, through the relay 45, back to the negative side of the $7\frac{1}{2}$ volt battery.

Closure of the contacts 41 of the hook switch 31 (which are in parallel with the contacts of the relay 40) maintains energization of the relay 27 so that subsequent deenergization of the relay 40 will not cause the contacts 37 of the relay 27 to close and cause rotation of the cam 34 by the motor 33. Though not essential to the proper functioning of the apparatus, it is desirable to prevent rotation of the motor 33 when communication takes place, so as to permit the telephone transmitter or microphone 54 to be mounted on the case which contains the motor, without objectionable background noise due to vibration.

Energization of the relay 45 causes its four sets of contacts to close.

Closure of the contacts 46 of the relay 45 completes the following circuit for the relay 24: from the positive side of the $7\frac{1}{2}$ volt battery, through the relay 24, through the contacts 46 of the relay 45, back to the negative side of the $7\frac{1}{2}$ volt battery. This circuit maintains the radio receiver at station B in operative condition.

Closure of the contacts 47 of the relay 45 establishes the following circuit for the relay 50: from the positive side of the $7\frac{1}{2}$ volt battery, through the contacts 47 of the relay 45, through the relay 59, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 50 disconnects one end of the conductor 20 (the other end of which is connected to say the detector output of the radio receiving apparatus, not shown) from the input or grid circuit of the tube 26, and connects the said end of the conductor 20 to the primary winding of the transformer 52. The secondary winding of the transformer 52, it will be noted, is connected to the telephone receiver or head piece 53. The tube system 26 is biased to cut-off, i. e. sufficient negative biasing poten-

tial is applied to the grid of the tube 26 to prevent the flow of plate current when no external potential is impressed upon the grid.

Closure of the contacts 48 of the relay 45 connects the microphone or transmitter 54 in series with the microphone battery and the microphone input to the radio transmitter (not shown).

Closure of the contacts 49 of the relay 45 establishes the following circuit through the transmitter control relay 21: from the positive side of the $7\frac{1}{2}$ volt battery through the transmitter control relay 21, through the contacts 49 of the relay 45, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of this transmitter control relay 21 causes the filament and plate supplies of the radio transmitter at station B to become operative and to transmit a high frequency carrier wave at a frequency different from that emitted at station A and to which the receiver at station A is tuned. Except that the frequency of the carrier emitted at station A is different from that emitted at station B and except for the fact that the radio receiving apparatus at station A is tuned to the carrier of station B, and the radio receiving apparatus at station B is tuned to the carrier frequency at station A, the apparatus and connections at stations A and B are identical.

Returning now to the calling station, i. e. station A, the carrier wave transmitted from the called station (station B) is received at station A and causes an increase in the plate current of the tube 26 to energize the relay 40, thereby closing the following circuit through the relay 27: from the positive side of the $7\frac{1}{2}$ volt battery, through the contacts of the relay 40, through the relay 27, and back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 27 closes the circuit of the bell 28 traced above in connection with station A. The ringing of this bell at station A indicates to the user at that station that his call has been completed and he now removes his telephone receiver or head piece 53 from its hook. This causes the bell circuit to be broken at the contacts 29 of the hook switch 30 and the bell at station A ceases to ring.

Removal of the receiver 53 from its hook at station A also closes the contacts 41, thereby maintaining energization of the relay 27, thereby preventing rotation of the motor 33, as above explained in connection with station B.

Removal of the receiver 53 from its hook at station A also closes the contacts 43 of the hook switch 30 to establish the circuit of the relay 45 as follows: from the positive side of the $7\frac{1}{2}$ volt battery through the contacts 43 of the hook switch 30, through the relay 45, and back to the negative side of the $7\frac{1}{2}$ volt battery.

This energization of the relay 45 closes the four pairs of contacts of that relay.

Closure of the contacts 46 of the relay 45, which contacts are in parallel with the contacts 25 of the call switch 22 insures that the relay 24 shall be kept energized until conversation has ceased and even though the call switch 22 may have been returned to its "off" position.

Closure of the contacts 49 of the relay 45, which contacts are in parallel with the contacts 23 of the call switch 22, insures that the transmitter control relay 21 shall be kept energized until conversation has ceased and even though the call switch 22 may have been returned to "off" position.

Closure of the contacts 47 of the relay 45 connects the relay 50 across the $7\frac{1}{2}$ volt battery.

Energization of the relay 50 disconnects one

end of the conductor 20 (the other end of which is connected to say the detector output of the radio receiving apparatus not shown) from the input or grid circuit of the tube 26 and connects the said end of the conductor 20 to the primary winding of the transformer 52.

Closure of the contacts 48 of the relay 45 connects the microphone 54 to the microphone battery and to the microphone input of the radio transmitter (not shown).

Telephone conversation may now be carried on between stations A and B as in the case of persons conversing over ordinary land line telephones which have been properly connected, i. e. each person may interrupt the other and in all respects converse in the usual manner.

When conversation has ceased, the users at stations A and B merely hang up their receivers or head pieces 53 on the hooks of the hook switches 30 and the user at station A throws his call switch 22 to the "off" position (if the last mentioned switch has not already been moved to the "off" position) and the parts are all automatically restored to their normal positions.

The tracing of the circuits above and the various sequential actions that automatically take place should not lead to the impression that the system is complicated in its mode of operation.

Recapitulating: When the operator at either station desires to call the other station, all that he does is to throw his call switch to calling position. This automatically causes the bell to ring at the called station and when the attendant at the called station removes his telephone receiver from its hook the bell rings at the calling station, the user at the calling station then removes his receiver from its hook and two-way conversation then proceeds. After conversation has ceased each user at his station hangs up his receiver on its hook and the user at the calling station throws his calling switch to the "off" position.

The motor 33 and its associated apparatus and circuits conserve the energy supplied to the system and may be adjusted or set to operate periodically the cam switch 35 at any intervals desired depending upon the conditions of service. I have found that in many cases it is advantageous to have the motor 33 operate the cam switch at say 5 to 15 minute intervals, i. e. with intervals of 5 to 15 minutes between successive operations of the cam switch 35. If, as I prefer, the Wallace motor above referred to is employed, the total energy consumption is kept comparatively low since that motor will operate continuously for about a year on five ordinary dry cells.

The relay 40 is preferably of a type which closes slowly and opens quickly. This desired operation may be effected by a dash-pot controlled armature or by other suitable means. Such relays of the dash-pot type are commonly used in other circuits such as land line telephone circuits and may readily be acquired in the open market. By providing a relay of this type, the likelihood of false operation due to interfering signals or static is greatly reduced. The system is so designed and operated that the relay 40 will respond to the prolonged carrier received from the other station (A or B) and that carrier will persist and cause closure of the contacts of the relay 40. On the other hand, an interfering signal or static will be of such comparatively short duration that the relay 40 will not be energized for a sufficient length of time to cause its contacts to close in response to such interfering signal or static. It will be understood that the relay 40 will not respond to a suc-

cession of energizations each insufficient to cause its contacts to close because upon each interruption of the energizing current the relay quickly returns to its fully open position. Interrupted continuous wave code signals, for example, would produce interrupted current in the relay 40 and none of the current impulses would be likely to be of sufficient duration in point of time as to cause the relay 40 to respond sufficiently long to close its contacts. As stated, other suitable forms of retarded relays may be employed.

While not essential, I prefer to provide a pilot light at each station to indicate when the call switch at that station has been operated to its calling position and to indicate the operation of the motor 33 at that station. The pilot light 60 is shown connected at one side to the positive side of the $7\frac{1}{2}$ volt battery and its other side to the contacts 25 and 38 in parallel and thence to the negative side of the $7\frac{1}{2}$ volt battery. By virtue of these connections the pilot light 60 will light when the call switch 22 at its station is moved to calling position, and the pilot light will light also whenever the contacts 38 are closed by the cam switch 35 at that station. The pilot light blinks or flashes in response to periodic closure of the cam switch contacts 38, thus providing a visual monitoring of the apparatus.

The particular circuit illustrated includes a suitable by-pass condenser 61 across the relay 40, a by-pass condenser 62 to complete the high frequency path of the grid circuit of the tube 25 and a by-pass condenser 64 which by-passes the "B" battery. A rheostat 65 is shown for the purpose of controlling the filament current of the tube 25. A volume control potentiometer 66 is shown shunted across the head piece or telephone receiver 53; it being understood that this may be dispensed with and suitable volume control provided elsewhere in the radio receiving apparatus if desired.

A condenser 67 and resistance 68 shown connected across the contacts 42 provide a means for suppressing sparking or arcing at these contacts which are included in the circuit of the bell 28.

In Figs. 1a and 1b, as stated, I have not shown either the radio receiving or the radio transmitting apparatus employed at each station. It will be understood that radio waves of one carrier frequency emanate from the radio transmitting set of station A, are received by the radio receiving set at station B, and are translated thereby and supplied to the conductor 20 at station B. It will also be understood that radio waves of a different carrier frequency emanate from the radio transmitting set at station B, are received by the radio receiving set at station A and are translated thereby and supplied to the conductor 20 at station A.

In the forms of invention thus far described, an unmodulated carrier wave is employed for calling the desired station. My invention embraces other methods of effecting the calling; for example, in certain forms of invention herein-after described, use is made of a modulated carrier for effecting the calling.

In Figs. 2a and 2b, I have diagrammatically illustrated another form of my invention, in which a master station represented by Fig. 2a is enabled to call selectively any one of a number of individual stations which, for convenience, may be termed "slave" stations, so that any selected one of such slave stations may be called without apprising the operators at any of the other slave stations that the call is being made. In this particular form of the invention any of the slave

stations may call the master station, but they cannot inter-communicate with each other.

In this form of the invention, the master station employs one carrier frequency which is modulated in such fashion as to impart to it the desired selective characteristic to which a selected slave station will respond. In the particular arrangement illustrated provision is made for selectively calling any desired one of four slave stations from the master station; it being understood that the system may be used in connection with more or less of such slave stations.

The master station (Fig. 2a) embodies apparatus much of which will be now recognized in view of the description of the foregoing embodiments of the invention; it, however, departs in some respects, as will appear.

Let it be assumed that the user at the master station A desires to call station B. The call switch 400 corresponding to station B or call B, is thrown to calling position, thereby closing contacts 401 to establish the following circuit through the relay 402: from the positive side of a source of energy, in this instance a $7\frac{1}{2}$ volt battery, through the wires 501, 403, through the contacts 401 of the call switch 400, through the wire 404, through the relay 402, through the conductors 405, 406, back to the negative side of the $7\frac{1}{2}$ volt battery. Operation of the call switch 400 to calling position also causes closure of the contacts 407 to establish the following circuit: from one side of the microphone input through the conductor 408, through the shaft or common connection 409 of a series of current interrupting devices, through the particular current interrupting device 410 (corresponding to call B), through the contacts 407, through the conductor 411, through the contacts 412 of the relay 402, through the conductor 413, through contacts 414 (now closed) of the relay 500, through the conductor 415 to the microphone battery, which in turn is connected at 416 to the other side of the microphone input.

Closure of the contacts 401 by throwing the call switch 400 to the calling position, also closes the following circuit of a motor 417: from the positive side of the $7\frac{1}{2}$ volt battery through the conductor 403, through the contacts 401 (now closed), through the motor 417, through the conductor 418, through the contacts 419 (now closed), back to the negative side of the $7\frac{1}{2}$ volt battery.

The motor 417, when energized, rotates circuit-interrupting devices (in the present case four in number), of which one, 410, has been referred to. Each of these four circuit-interrupting devices so operates as to produce the particular interrupting characteristic corresponding to the call of the particular selected slave station.

Energization of the relay 402 in the manner described, also closes the contacts 432 to energize the transmitter control relay (not shown) as to cause the radio transmitting apparatus to become operative; the circuit being as follows: from the $7\frac{1}{2}$ volt battery, through the conductor 433, through the transmitter control relay, through the conductor 434, through the contacts 432 (now closed), through the conductors 405, 406, back to the negative side of the $7\frac{1}{2}$ volt battery.

As thus far described, operation of the call switch 400 to calling position has called the radio transmitting apparatus at the master station (A) into operation and the transmitting apparatus is

now emitting a carrier frequency modulated in accordance with the particular characteristic of the current-interrupting device 410.

Energization of the relay 402 at the master station, as above described, causes the radio receiving apparatus at the master station to be placed in condition to receive. Closure of the contacts 420 of the relay 402 causes the following circuit, including the relay 421, to be closed: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 422, through the relay 421, through the conductor 423, through the conductor 424, through the contacts 420, through the conductors 405, 406, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 421 closes the filament circuits of the tube 425 and also of the receiving apparatus at the master station. Energization of the relay 402 also closes the contacts 426 to place the circuit of the bell 427 in condition to be fully closed to ring the bell if and when the contacts 423 are also closed; the bell circuit being as follows: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 422, through the bell 427, through the contacts 429 (now closed), through the contacts 426 (now closed), through the conductor 430, through the contacts 428 (now open), through the conductor 431, back to the negative side of the $7\frac{1}{2}$ volt battery.

Turning now to the particular called station B, I shall first describe the circuit of the Wallace motor, which was described in connection with the preceding forms of my invention, and which is preferably embodied in the form of invention now being described. The motor circuit is: from the positive side of the $7\frac{1}{2}$ volt battery through the conductors 436 and 437, through the conductor 438, through the motor 435, and then through the contact 439, through the conductors 441 and 442, back to the negative side of the $7\frac{1}{2}$ volt battery.

The high spot 444 of the motor driven cam 443 periodically closes the contacts 445 to energize the relay 446 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 436, through the relay 446, through the conductor 447, through the conductor 448, through the contacts 445 (closed when the high spot of the cam is in operative position), through the conductors 441 and 442, back to the negative side of the $7\frac{1}{2}$ volt battery. Thus, by the operation of the motor 435, the relay 446 is periodically energized. When the relay 446 is energized it closes contacts 449 to energize the filament of the tube 450 and likewise the filaments of the radio receiving apparatus at station B, so as to place the same in operative or receiving condition. The high spot 444 of the motor driven cam 443 also periodically closes contacts 451 so as to energize the circuit of the bell 452 if and when the contacts 453 are also closed; the bell circuit being as follows: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 436 and 437, through the bell 452, through the contacts 454 (now closed) of the hook switch 455, through the cam operated contacts 451, through the contacts 453 (now open), through the conductor 456 back to the negative side of the $7\frac{1}{2}$ volt battery. As thus far described it has been assumed that no signal is being received at station B.

In connection with the foregoing description of the master station A, Fig. 2a, it was explained that the operation of the call switch 400 at the master station causes the radio transmitting ap-

paratus at that station to emit the carrier frequency modulated in accordance with the particular slave station it was desired to call, i. e. under the assumption made, station B. When such modulated signal is received at station B it is impressed upon the grid circuit of the tube 450 through the contacts 457, and causes an increase in plate current of the tube 450 (during the intervals in which the receiving apparatus at station B is operative) to energize a selective relay 458 in the following circuit: from the plate of the tube 450, through the conductor 461, through the contacts 459 (now closed) of the call switch 460, through the conductor 462, through the selective relay 458, through the conductor 463 to the plate source or B battery. The relay 458 is one which is mechanically tuned so as to be responsive to the modulating frequency transmitted from the master station and corresponding to or representing the call of station B. This relay may, for example, be of the tuned vibrating reed type. It will respond, as stated, to the frequency of modulation representing station B but will not respond to other modulation frequencies, whereby the desired selection is obtained. When the relay 458 is energized it closes the circuit across the conductors 464 and 465 to establish the following energizing circuit for the relay 466: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 436, 465, through the now closed contacts of the relay 458, through the conductor 464, through the relay 466, through the conductor 456, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 466 causes the contacts 439 to open so that the motor 435 will stop (or not continue to run) when the high spot 444 has operated the cam switch 443. In other words, the reception of the signal to which station B is selectively responsive causes the motor 435 to stop with the high spot 444 of the cam 443 in the position in which the contacts 445 and 451 are closed. Energization of the relay 466 also causes the contacts 453 to close whereby the circuit of the bell 452, traced above, is closed to cause the bell to ring.

When the user at station B hears his bell 452 he removes his receiver or head-piece 470 from the hook of the hook switch 455 thereby automatically opening the contacts 454. This opening of the contacts 454 interrupts the circuit of the bell 452 and the bell ceases to ring. Removal of the receiver or head piece 470 from the hook switch also causes the contacts 471 to be automatically closed to energize the relay 472 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 436, through the conductor 473, through the conductor 474, through the hook switch contacts 471 (now closed), through the relay 472, through the conductor 442, back to the negative side of the $7\frac{1}{2}$ volt battery.

Removal of the receiver or head piece 470 from its hook causes closure of the contacts 468 of the hook switch 455 to maintain energization of the relay 466 so that subsequent deenergization of the relay 458 will not cause the relay 466 to become deenergized and thereby cause rotation of the motor, such operation being undesirable at this stage, for reasons previously set forth.

Energization of the relay 472 closes the contacts 475 so as to maintain energization of the filament control relay 446 of the radio receiving apparatus, the maintained circuit being as follows: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 436, through the

relay 446, through the conductor 447, through the contacts 475 (now closed), through the conductor 442, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 472 also causes the contacts 476 to close to connect the microphone transmitter 477 to the microphone input circuit of the radio transmitting apparatus at station B, the circuit being as follows: from the microphone battery, through the conductor 478, contacts 476 (now closed), microphone 477, conductor 479 to the microphone input, whose other side is connected to the other terminal of the microphone battery by the conductor 480.

Energization of the relay 472 also causes the contacts 481 to close the following circuit to the transmitter control relay at station B so as to render that radio transmitting apparatus operative to transmit the carrier back to the calling station, i. e. in this instance the master station: From the positive side of the $7\frac{1}{2}$ volt battery through the conductor 436, through the conductor 482, through the transmitter control relay, through the conductor 483, through the contacts 481 (now closed), through the conductor 442 back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 472 also causes the contacts 484 to close to energize the relay 485 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 436 and 473, through the contacts 484, through the conductor 486, through the relay 485, through the conductor 487, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 485 opens the above mentioned contacts 457 and thereby disconnects the output of the radio receiving apparatus (not shown in this figure) from the grid of the tube 450 and connects the output of such radio receiving apparatus through the contacts 488 (now closed) to one side of the primary of a transformer 489 whose other terminal is connected to the plate supply or B battery. The secondary of the transformer 489 is connected directly to the head piece or receiver 470.

When the radio transmitting apparatus at station B is rendered operative as above described, it transmits a carrier (which in this instance is unmodulated) which is received at the calling station, i. e. in the case being explained, the master station (Fig. 2a).

When the carrier so transmitted from the called station B is received at the master station (Fig. 2a) the carrier causes the output of the radio receiver at station A (not shown) to so energize the grid circuit of the tube 425, through the contacts 490 as to cause the plate current of the tube 425 to be increased and thereby energize the relay 491. This relay 491 is of the slow acting type previously described with respect to Figs. 1a and 1b. Sustained energization of the relay 491 causes the contacts 492 to close thereby energizing the relay 493 in the following circuit: From the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 501, 422, through the contacts 492 (now closed), through the conductor 494, through the relay 493, through the conductors 431, 406, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 493 causes the contacts 428 to close, thereby closing the circuit to the bell 427, and causing the latter to ring. When the user at the master station Fig. 2a hears the bell 427 ring he removes his head piece or telephone receiver 497 from the hook of the hook switch 498 thereby automatically opening the contacts 429 to interrupt

the circuit of the bell 427. Removal of the head piece 497 from the hook of the hook switch 498 automatically closes contacts 499 to energize the relay 500 in the following circuit: From the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 501, 502, through the contacts 499 (now closed), through the conductor 503, through the relay 500, through the conductor 504, back to the negative side of the $7\frac{1}{2}$ volt battery.

Energization of the relay 500 causes the contacts 419 to open thereby interrupting the circuit of the motor 417. Energization of the relay 500 causes the contacts 414 to open and the contacts 505 to close. Opening of the contacts 414 interrupts the code modulating circuit to the microphone input and closure of the contacts 505 connects the microphone transmitter 506 to the microphone input in the following circuit: From the microphone battery through the contacts 505, through the conductor 507, through the microphone 506, through the conductors 508 and 408, to one side of the microphone input, the other side of the microphone input being connected, as above described, through the conductor 416 to the other side of the microphone battery.

Energization of the relay 500 causes the contacts 509 to close and thus maintain the relay 421 energized in the following circuit: From the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 501, 422, through the relay 421, through the conductor 423, through the contacts 509, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of this relay 421, as described above, insures that the radio receiving apparatus at the transmitting station will be maintained in operative condition.

Energization of the relay 500 closes the contacts 510 to cause the relay 511 to be energized in the following circuit: From the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 501, through the contacts 510, through the conductor 512, through the relay 511, through the conductor 406, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 511 disconnects the output of the radio receiving apparatus (not shown) from the grid circuit of the tube 425 and connects such output circuit to the primary 513 of the transformer 514, the connection being established through the contacts 515 of the now energized relay 511. The head piece or telephone receiver 497 is connected directly across the secondary winding of the transformer 514.

The two stations, that is, the master station and the selected slave station B are now in condition for two-way telephone speech transmission and reception.

When the conversation has ceased the users on both stations hang up their head pieces on the hooks of the hook switches and the user at the master station restores his call switch 400 to its normal or open position. These simple operations automatically restore the systems to their normal positions.

The foregoing descriptions set forth the sequence of manual and automatic operations resulting from the user at the master station calling slave station B. Except for the difference in the modulating frequency the operation in calling any one of the other slave stations from the master station is similar to that described above. Thus, if the user at the master station desires to call slave station C he would throw the call switch 516 to calling position in which

event the current interrupting device 517 would become effective to impart the particular modulation to the carrier, to which modulation the mechanically tuned relay 458 at station C would respond. If the user at the master station desired to call station D he would throw the call switch 518 to calling position to render the circuit interrupting device 519 operative and if he desired to call station E he would throw the call switch 520 to operative position in which event the circuit interrupting device 521 would be called into operation. It will be noted that each of the circuit interrupting devices 410, 517, 519, and 521 produces different modulating frequencies and the mechanically tuned relay 458 at each slave station is tuned or adjusted so as to respond to a particular one of the four modulating frequencies.

In the event that station B, i. e. one of the slave stations, desires to call the master station (Fig. 2a), the procedure and operation are as follows: The user at station B first throws his call switch 460 to calling position. This operation of the call switch automatically opens the contacts 459 thereby disconnecting the mechanically tuned relay 458 from the plate of the tube 450. Operation of the call switch 460 to calling position also causes the contacts 522 to close thereby placing the non-selective relay 523 in the plate circuit of the tube 450. The purpose of this as will later more fully appear, is to enable the calling slave station to respond to an unmodulated carrier to be transmitted back from the master station when the user at that station has responded to the call from the slave station by removing his head piece from its hook.

As explained in connection with Figs. 1a and 1b, the remainder of the operations at station B responsive to throwing the call switch 460 to calling position is to cause a carrier to be transmitted from station B and to place the receiving apparatus at station B in receptive condition for the carrier that will come back from the called station, in this instance, the master station (Fig. 2a). Turning now to the master station (Fig. 2a); it will be helpful first to describe the circuits of the motor 524 and the instrumentalities controlled thereby.

As in the case of above described forms of invention, the motor 524 is preferably of the Wallace type and it operates a cam 525 having a high spot 526 for operating two sets of contacts. The circuit of the motor 524 is from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 501, 422, thence through the winding of the motor 524, through the automatically operated switch 527 of the motor (this switch being a part of the standard Wallace motor) and then through the contacts 528, to the conductor 406 and back to the negative side of the $7\frac{1}{2}$ volt battery. The cam operated switch comprises contacts 530 and 531. When the contacts 530 are closed due to the arrival of the high spot 526 of the cam 525 at a predetermined position once during each revolution of the cam, the following circuit is established through the relay 421: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 501, 422, through the relay 421, through the conductor 423, through the contacts 530, and the conductor 406 back to the negative side of the $7\frac{1}{2}$ volt battery. As previously described, energization of the relay 421 causes the filament of the tube 425 and the filaments of the tubes of the radio receiving apparatus (not shown) at the master station to become energized

and the receiving apparatus to become operative for reception. Closure of the contacts 531 by the cam operated switch places the circuit of the bell 427 in condition to be energized when the contacts 428 are also closed by energization of the relay 493; the bell circuit being as follows: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 501, 422, through the bell 427, through the contacts 429 (now closed) of the hook switch 498, through the contacts 531, through the wire 430, through the contacts 428 and through the conductors 431, 406 back to the negative side of the $7\frac{1}{2}$ volt battery.

When the calling carrier transmitted from the slave station B is received at the master station (Fig. 2a) during the interval of time in which the high spot 526 of the cam 525 has operated the cam operated switch as above described, the relay 491 closes its contacts 492 to energize the relay 493. The contacts 428 and 531 now being closed, the bell 427 is energized and rings. The user at the master station now removes his head piece 497 from the hook of the hook switch 498 thereby closing the circuit of the relay 493 at the contacts 495 and interrupting the bell circuit at the contacts 429. The removal of the head piece 497 from its hook also automatically causes the contacts 499 to close to energize the relay 500 as has been previously fully described. The operations resulting from energization of the relay 500 are the same as described above, but the following additional operation should be noted. The call switches 400, 516, 518, and 520 are at this time all in open position and the relay 402 is deenergized. Therefore the transmitter control relay at the master station will not have been energized due to energization of the relay 402. When, however, the relay 500 is energized it causes the contacts 532 to close and thereby establish the following circuit including the transmitter control relay: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 433, through the transmitter control relay, through the conductor 434, through the contacts 532, through the conductor 504, back to the negative side of the $7\frac{1}{2}$ volt battery. The transmitting apparatus at the master station now sends out a carrier (in this case not modulated), to which the relay 523 at station B (Fig. 2b) responds and produces energization of the relay 466 and closure of the circuit of the bell 452 at station B. The user at station B, upon hearing his bell 452, removes his headpiece 470 from the hook of the hook switch 455 and thereupon two-way telephone conversation may take place as will now be clear in view of the foregoing descriptions. After the conversation has ceased, the parts are restored to their normal positions by restoring the head pieces 470 and 497 to their respective receiver hooks and by restoring the call switch 460 at station B to its normal, that is, non-calling position.

In Figs. 3a and 3b I have shown wiring diagrams of a master station and one of the slave stations in which a modified form of my invention is embodied. As in the case of the form of invention shown in Figs. 2a and 2b, the system is such that the user at the master station can selectively call any one of a number of slave stations and each of the slave stations may call the master station.

Since, however, the particular circuits shown in Figs. 3a and 3b differ in various respects from those previously described, I shall trace in some detail the various circuits of the modified system,

proceeding first with the master station as shown in Fig. 3a.

The apparatus at the master station comprises a motor of the Wallace type having a winding 600 and an automatically operated circuit interrupter 601. The circuit of the motor is as follows: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 602, 604, the winding 600 of the motor, conductor 605, contacts 606 (now closed), conductor 607, contacts 601, conductor 608, contacts 609, conductors 610 and 604 back to the negative side of the $7\frac{1}{2}$ volt battery. The motor 600 continuously rotates a cam disk 611 having a high spot 612 for closing once during each revolution of the cam disks the contacts 613. When contacts 613 close the relay 614 is energized in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 602, 603, through the relay 614, through the conductors 615, through the contacts 613, through the conductors 616, 610 and 604 back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 614 causes the contacts 617 to close, thereby closing the filament circuits of the tube 618 and the filament circuits of the tubes of the radio receiving apparatus, not shown.

From the description of Fig. 3a as thus far set forth, it will be apparent that the motor 600 operates the cam 611 so as periodically to close the contacts 613 and during each such closure of the contacts 613, the radio receiving apparatus at the master station is placed in operative receiving condition.

The circuits for establishing a call from station A to select one of the desired slave stations, for example station B, will now be described.

The user at the master station throws the call switch 619 (corresponding to station B) to calling position thereby closing the contacts 620 and the contacts 621. Closure of the contacts 620 establishes a circuit through the relay 622 as follows: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 602, through the contacts 620, through the conductor 623, through the relay 622, through the conductors 610 and 604 and back to the negative side of the $7\frac{1}{2}$ volt battery. Closure of the contacts 620 also energizes the motor 624 which rotates the circuit interrupting device 625, the circuit of the motor being as follows: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 602, through the contacts 620, through the motor 624, through the conductor 626, through the conductor 627, through the contacts 628 (now closed) of the hook switch 629, through the contacts 630 of the relay 622, through the conductors 610, 604, back to the negative side of the $7\frac{1}{2}$ volt battery. Closure of the contacts 630 by energization of the relay 622 also establishes the circuit through the primary of a buzzer modulating device 631, which circuit is as follows: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 602, through the primary winding of the buzzer 631, through the conductor 627, through the contacts 628 (now closed) of the hook switch 629, through the contacts 630 (now closed) of the relay 622, through the conductors 610, 604, back to the negative side of the $7\frac{1}{2}$ volt battery. The secondary circuit of the buzzer modulating device 631 is as follows: from the positive side of the microphone battery, through the conductors 632, 633, through the secondary of the buzzer 631, through the conductor 634, through the contacts 635 (now closed) of the relay 622, through the conductor 636, through the contacts

637 (now closed) of the hook switch 629, through the conductor 638, through the conductor 639, through the contacts 621, through the current interrupting device 625, through the conductor 640 to one side of the microphone input, the other side of which is connected through conductor 778 to the negative of the microphone battery. Energization of the relay 622 also causes the contacts 641 of that relay to close establishing the following circuit through the relay 642: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 602, through the relay 642, through the conductor 643, through the contacts 641 (now closed) of the relay 622, through the conductors 610 and 604 back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 642 causes its contacts 644 to close thereby energizing the transmitter control relay in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 602, through the contacts 644, through the conductor 645, through the transmitter control relay, through the conductor 646 and then back to the negative side of the $7\frac{1}{2}$ volt battery. As described in connection with other forms of the invention, the transmitter control relay, when energized, causes the radio transmitting apparatus to become operative and to transmit a carrier wave.

By the operations thus far described and in response to operation of the call switch 619 to calling position for station B, the master station is now transmitting the carrier frequency modulated by the buzzer modulating device 631 and which modulation frequency is periodically interrupted or chopped by the circuit interrupting device 625.

Energization of the relay 642 causes its contacts 647 to close and thereby energize the relay 614 through the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 602, 603, through the relay 614, through the conductor 615, through the conductor 648, through the contacts 647, through the conductor 604, back to the negative side of the $7\frac{1}{2}$ volt battery. As explained, energization of the relay 614, places the receiving apparatus at the master station in condition to receive.

Turning now to the particular slave station being called, i. e. station B shown in Fig. 3b, it will first be desirable to describe certain of the circuits at the last mentioned station. The apparatus at station B comprises a Wallace motor 650, 651, whose circuit is the same as that described in connection with the master station (Fig. 3a). This motor at station B operates a cam 652 which in turn operates contacts 653, all as described above in connection with the master station. The contacts 653 when closed energize the relay 654 through a circuit similar to that described in connection with the relay 614 of the master station (Fig. 3a). The relay at station B when energized, energizes the filament circuit for the tube 655 and also the filament circuits of the radio receiving apparatus at station B, in similar manner to that set forth in connection with the master station with respect to the relay 614. During the first occurring interval of time when the contacts 653 are closed and the radio receiving apparatus at station B has been activated, the interrupted buzzer modulated carrier transmitted from the master station is received by the receiving apparatus at station B and causes the plate current of the tube 655 to energize the selective relay 75

656 in the following circuit: from the plate of the tube 655, through the conductors 657, through the contacts 658 (now closed) of the call switch 659, through the conductor 660, through the winding of the selective relay 656, through the conductor 661, through the conductor 662, to the positive side of the B battery, or plate supply. The selective relay 656 is a mechanically tuned relay which may be of the type described above in connection with Fig. 2b with respect to the relay there indicated as 458. The relay 656 is mechanically tuned so to speak to respond to the interrupted modulated carrier transmitted from the master station and corresponding to the call of station B.

Energization of the relay 656 causes the relay 663 to be energized in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 664, through the contacts (now closed) of the selective relay 656, through the conductor 665, through the relay 663, through the conductor 666, back to the negative side of the $7\frac{1}{2}$ volt battery.

Energization of the relay 663 closes the following circuit through the bell 667: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 664, through the contacts 668 (now closed) of the relay 663, through the bell 667, through the conductor 669, through the hook switch contacts 670 (now closed), through the conductors 671, 672, back to the negative side of the $7\frac{1}{2}$ volt battery.

Energization of the relay 663 causes the relay contacts 673 to close to energize the relay 674, through the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 664, through the contacts 673, through the conductor 675, through the relay 674, through the conductor 672, back to the negative side of the $7\frac{1}{2}$ volt battery.

Energization of the relay 674 causes the relay contacts 676 to open thereby interrupting the circuit of the winding 650 of the Wallace motor and energization of the relay 674 causes the contacts 677 to close, thereby short-circuiting the winding 650 of the Wallace motor by the following path: from one side of the winding 650, through the conductors 678, 679, contacts 677 (now closed) of the relay 674, conductor 680 to the other end of the winding 650 of the Wallace motor. Opening of the contacts 676 in the motor circuit interrupts the motor circuit as described, and the short-circuiting of the winding 650 of the motor by closure of the contacts 677 produces a braking torque which rapidly brings the motor to rest with the high spot of the cam 652 in the position in which the contacts 653 are closed and maintained closed. This keeps the radio receiving apparatus at station B in receptive condition.

The bell 667 at the called station B keeps on ringing until the attendant at station B removes his head piece or telephone receiver 681 from the hook of the hook switch 682. By removal of the head piece 681 from the hook of the hook switch the contacts 670 are automatically opened thereby opening the bell circuit and causing the bell to cease to ring.

When the head piece is removed from the hook of the hook switch 682, the contacts 683 are automatically closed to establish the following circuit through the relay 684: from the positive side of the $7\frac{1}{2}$ volt battery, through the relay 684, through the conductor 685, through the contacts 683 (now closed), and through the conductors 671, 672 back to the negative side of the $7\frac{1}{2}$

volt battery. Energization of the relay 684 causes the contacts 686 to close thereby energizing the transmitter control relay in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the contacts 686 (now closed) through the conductor 687, through the transmitter control relay, through the conductor 688, back to the negative side of the $7\frac{1}{2}$ volt battery. Removal of the head piece 681 from the hook of the hook switch 682 causes the contacts 689 to close thereby energizing the primary of the buzzer modulating device 690 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the primary winding of the buzzer 690, through the conductors 691, through the hook switch contacts 689 (now closed), through the conductor 692, through the contacts 693 (now closed) of the relay 674, through the conductor 694, through the contacts 695 (now closed) of the call switch 659, through the conductors 671, 672, back to the negative side of the $7\frac{1}{2}$ volt battery. Since the relay 674 is now energized and the call switch at station B is in off position the following circuit exists, including the secondary of the buzzer modulating device 690: from the positive side of the microphone battery, through the conductors 696, 697, through the secondary of the buzzer modulating device 690, through the conductor 698, through the contacts 699 (now closed) of the call switch 659, through the conductor 700, through the contacts 701 (now closed) of the relay 674, through the conductors 702, 703 to one side of the microphone input, whose other side is connected through the conductor 704 to the negative side of the microphone battery.

Station B is now transmitting a carrier frequency modulated by the operation of the buzzer modulator 690 and the radio receiving apparatus at the master station has been tuned to respond to such modulated carrier frequency transmitted from station B. Return now to the master station (Fig. 3a), the modulated carrier received from station B causes the current in the plate circuit of the tube 618 to energize the relay 705 at the master station. Energization of the relay 705 causes its contacts 706 to close thereby energizing the relay 707 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 602, 603, through the contacts 706, through the relay 707, through the conductor 708, back to the negative side of the $7\frac{1}{2}$ volt battery. The relay 707 is a slow acting relay, that is, one which requires a sustained relatively prolonged current impulse to cause it to operate its contacts. Its contact operating stroke is comparatively slow while the return or restoration stroke, upon deenergization of the relay, is quite rapid. Responsive energization of the relay 707 causes the contacts 709 to close thereby establishing the following circuit through the bell 710 at the master station: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 602, 603, through the contacts 709 (now closed) through the conductor 711, through the bell 710, through the conductors 712, 608, through the hook switch contacts 609 (now closed), through the conductors 610, 604, back to the negative side of the $7\frac{1}{2}$ volt battery. The bell 710 thus is caused to ring at the master station in response to the modulated carrier transmitted back from station B and the user at the master station (Fig. 3a) removes his head piece 713 from the hook of the hook switch 629, thereby interrupting the bell circuit at the contacts 609 which automatically open when the receiver is taken from its hook.

Sustained energization of the relay 707 causes its contacts 714 to close thereby establishing the following circuit through the relay 715: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 602, 603, through the contacts 714 (now closed) through the conductor 716, through the relay 715, through the conductor 717, 604, back to the negative side of the $7\frac{1}{2}$ volt battery. Removal of the head piece 713 from the hook of the hook switch 629 at the master station causes the contacts 628 automatically to open thereby interrupting the circuit of the motor 624 and also the primary circuit of the buzzer modulating device 631. When the motor 624 is deenergized, rotation of the current interrupting device 625 ceases and the circuit of the latter is interrupted and the modulation removed from the carrier transmitted from the master station.

When the modulation is removed from the carrier transmitted from the master station, the following operations take place at station B (Fig. 3b): the selective relay 656 at station B becomes deenergized thereby causing the relay 663 to become deenergized. Deenergization of the relay 663 causes deenergization of the relay 674 by interrupting the circuit of the latter at the contacts 673 of the relay 663. Deenergization of the relay 663 causes its contacts 620 to close thereby energizing the relay 621 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 664, through the relay 621, through the conductor 722, through the contacts 620 (now closed) of the relay 663, through the conductor 723, through the conductor 724, through the contacts 725 (now closed) of the hook switch 682, through the conductors 671, 672 and back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 621 causes its contacts 726 to open and its contacts 727 to close. Opening of the contacts 726 interrupts the circuit of the primary winding of the transformer 728 and connects the primary winding of the transformer 729 to the output of the radio receiving apparatus at station B. The head piece or telephone receiver 681 is connected directly across the secondary winding of the transformer 729. Removal of the head piece 681 from the hook of the hook switch 682 also automatically opens the contacts 730 of the hook switch, thereby opening the primary circuit of the buzzer modulating device 690. Deenergization of the relay 674 as described above, causes the contacts 701 of the relay 674 to open thereby opening the secondary circuit of the buzzer modulating device 690. Deenergization of the relay 674 and removal of the head piece 681 from the hook of the hook switch 682 causes the following circuit to be established through the microphone transmitter 732: from the positive side of the microphone battery, through the conductors 696, 733, contacts 731 (now closed) of the hook switch 682, conductor 734, transmitter 732, conductor 735, contacts 736 (now closed because relay 674 is deenergized), conductors 702, 703 to one side of the microphone input whose other side is connected by the conductor 704, to the negative side of the microphone battery.

Station B is now in condition for telephone speech communication but the operations by which the master station is placed in such condition have not yet been described.

When the modulation is removed from the signal transmitted from station B back to the master station (Fig. 3a) the relay 705 at the master

station becomes deenergized thereby deenergizing relay 707. Deenergization of the relay 707 causes the contacts 714 to open thereby opening the circuit of the relay 715 and deenergizing the latter. Deenergization of the relay 707 causes its contacts 737 to close thereby energizing the relay 738 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 602, 603, through the relay 730, through the conductor 739, through the contacts 737 (now closed) of the relay 707, through the conductor 740, through the conductor 741, through the contacts 742 (now closed) of the hook switch 629, through the conductors 610, 604 back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 738 as described in connection with Fig. 3b, disconnects the radio receiver output from the primary winding of the input transformer of the tube 618 and connects the primary of the transformer 743 to the output of the radio receiving apparatus. The head piece 713 is directly connected across the secondary winding of the transformer 743.

In view of the fact that the head piece 713 is now off the receiver hook and the further fact that the relay 715 is deenergized, the following circuit exists through the microphone transmitter 744: from the positive side of the microphone battery, through the conductor 632, through the contacts 745 (now closed) of the hook switch 629, through the conductor 746, through the transmitter 744, through the conductor 747, through the contacts 748 (now closed) of the relay 715, through the contacts 749 (now closed) of the relay 715, through the conductor 750, through the contacts 751 (now closed) of the hook switch 629, through the conductors 752, 640 to one side of the microphone input whose other side is connected to the negative terminal of the microphone battery. It will be noted that this circuit of the microphone transmitter does not include the circuit interrupting device 625 so that even if the latter has been stopped on a dead spot the microphone circuit will nevertheless be complete.

Station B and the master station are now both in condition for two way telephone speech communication. When conversation is ended the parts are restored to their normal position merely by placing the head pieces at the respective stations back on to their hooks of the hook switches and by throwing the call switch 619 at the master station to its "off" position.

The operations whereby the user at the master station selects any other desired one of the stations C, D and E need not be further described. As in the case of Figs. 2a and 2b, so also in the form of invention shown in Figs. 3a and 3b, each of the slave stations responds to the particular character of modulation transmitted from the master station when the call switch corresponding to that station has been thrown to calling position.

I shall now proceed to describe the operations when one of the slave stations, say station B, shown in Fig. 3b, desires to call the master station.

The attendant at station B (Fig. 3b) throws his call switch 659 to calling position. Operation of the call switch 659 to called position causes the contacts 755 to close thereby energizing the relay 684 through the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 679, through the relay 684, through the conductors 685, 756, through the contacts 755 (now closed) of the call switch 659, through the

conductors 671, 672, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 684 causes its contacts 686 to close thereby energizing the transmitter control relay and thereby placing the radio transmitting apparatus at station B in operation to transmit its carrier frequency. Energization of the relay 684 causes its contacts 757 to close thereby energizing the relay 654 through the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 664, through the relay 654, through the conductor 758, through the conductor 759, through the contacts 757 (now closed), through the conductor 672, back to the negative side of the $7\frac{1}{2}$ volt battery. Energization of the relay 654, as above described, places the radio receiving apparatus and the tube 655 at station B in receptive condition.

Operation of the call switch 659 to calling position causes the contacts 760 to close and thereby energize the primary winding of the buzzer modulating device 690 through the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 679, through the primary winding of the buzzer 690, through the conductor 691, through the contacts 730 (now closed) of the hook switch 682, through the contacts 760 (now closed) of the call switch 659, through the conductors 671, 672, back to the negative side of the $7\frac{1}{2}$ volt battery.

Operation of the call switch 659 to calling position closes the contacts 761 to establish the following circuit through the secondary of the buzzer modulating device 690: from the positive side of the microphone battery, through the conductors 696, 697, through the secondary of the buzzer modulating device 690, through the conductor 698, through the contacts 761 (now closed) of the call switch 659, through the conductor 762, through the contacts 763 (now closed) of the hook switch 682, through the conductor 703, to one side of the microphone input whose other side is connected by means of the conductor 704, to the negative side of the microphone battery.

Operation of the call switch 659 to calling position causes the contacts 658 thereof to open and the contacts 764 thereof to close, thereby disconnecting the plate of the tube 655 from the coil of the selective relay 656 and connecting the relay 765 to the plate of the tube 655.

Operation of the call switch 659 at station B (Fig. 3b) has thus produced the following results: the radio transmitting apparatus at station B is transmitting the carrier frequency modulated by the buzzer modulating device 690, the radio receiving apparatus at station B has been put into receptive condition, and the selective relay 656 has been taken out of circuit so to speak and the relay 765 connected to the plate of the tube 655.

Turning now to the master station (Fig. 3a), the modulated carrier transmitted from station B causes the relay 705 to be energized and to close its contacts 796 thereby causing the relay 707 to be energized. It will be understood that energization of the relay 705 does not take place until the radio receiving apparatus at the master station (Fig. 3a) has been placed into receptive condition by the arrival of the high spot 612 of the cam 611 at the position where it closes the cam operated switch 613.

Energization of the relay 707 at the master station causes the contacts 709 to close thereby closing the circuit through the bell 710 and causing the latter to ring.

Energization of the relay 707 causes its con-

tacts 714 to close thereby energizing the relay 715 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 602, 603, through the contacts 714 (now closed) of the relay 707, through the conductor 716, through the relay 715, through the conductors 717, 604, to the negative side of the $7\frac{1}{2}$ volt battery.

The user at the master station now takes his head piece 713 from its hook thereby opening the circuit of the bell at the contacts 609 of the hook switch 629. Removal of the hook switch from its hook at the master station causes energization of the relay 642 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 602, through the relay 642, through the conductor 643, through the contacts 766 (now closed) of the hook switch 629, through the conductors 610, 604, to the negative side of the $7\frac{1}{2}$ volt battery.

Removal of the receiver from its hook switch at the master station also energizes the primary of the buzzer modulating device 631 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductor 602, through the primary of the buzzer modulating device 631, through the conductor 627, through the contacts 767 (now closed) of the hook switch 629, through the conductor 768, through the contacts 769 (now closed) of the relay 715, through the conductors 770, through the contacts 771 (now closed) of the relay 622, through the conductors 610, 604 to the negative side of the $7\frac{1}{2}$ volt battery.

The secondary circuit of the buzzer modulating device 631 is complete at this time and is as follows: from the positive side of the microphone battery, through the conductors 632, 633, through the secondary of the buzzer modulating device 631, through the conductors 634, through the contacts 772 (now closed) of the relay 622, through the conductors 773, through the contacts 774 (now closed) of the relay 715, through the contacts 775 (now closed) of the same relay, through the conductor 776, through the contacts 777 (now closed) of the hook switch 629, through the conductors 752, 640 to one side of the microphone input whose other side is connected through the conductor 778 to the negative side of the microphone battery.

Energization of the relay 642 places the radio transmitting apparatus in operation at the master station.

Energization of the relay 715 causes its contacts 606 to open the circuit of the Wallace motor and energization of the relay 715 causes its contacts 779 to close and thereby to short-circuit the winding 609 of the Wallace motor to bring the motor rapidly to rest with its high spot in the position in which the cam operated switch 613 is closed.

The master station is now sending a buzzer modulated carrier to station B.

Returning now to station B (Fig. 3b), the modulated carrier from the master station energizes the relay 765 at station B causing it to close its contacts 780 to energize the relay 663 in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 664, through the contacts 780 (now closed) of the relay 765, through the relay 663, through the conductor 666, back to the negative side of the $7\frac{1}{2}$ volt battery.

Energization of the relay 663 causes its contacts 668 to close to ring the bell 667 at station B.

Energization of the relay 663 causes its contacts 673 to close to energize the relay 674.

The user at station B now takes his head piece 681 off its hook, which opens the bell circuit at the hook switch contacts 670, opens the primary circuit of the buzzer modulating device 690 at the hook switch contacts 730, and opens the buzzer modulating secondary at the hook switch contacts 763.

Returning now to the master station (Fig. 3a), removal of the modulation from the carrier transmitted from station B because the relay 705 at station A to become deenergized and open contacts 706, thereby deenergizing the relay 707.

Deenergization of the relay 707 at the master station causes its contacts 714 to open and thus deenergize the relay 715.

Deenergization of the relay 707 at the master station causes its contacts 737 to close thereby energizing the relay 738.

Energization of the relay 738 disconnects the primary of the transformer 785 from the output of the radio receiving apparatus at the master station and connects the primary of the transformer 743 to the output of the radio receiving apparatus. It will be noted that the head piece 713 is connected directly across the secondary of the transformer 743.

Deenergization of the relay 715 at the master station opens the contacts 769 and thereby opens the primary of the buzzer modulating device 631 at the master station.

Deenergization of the relay 715 opens the contacts 774 and thereby opens the secondary circuit of the buzzer modulated device 631 at the master station.

Deenergization of the relay 715 causes its contacts 748 to close, putting the microphone transmitter 744 in circuit as follows: from the positive side of the microphone battery, through the conductor 632, through the contacts 745 (now closed) of the hook switch 629, through the conductor 746, through the microphone transmitter 744, through the conductor 747, through the contacts 748 (now closed) of the relay 715, through the contacts 749 (now closed) of the same relay, through the conductor 750, through the hook switch contacts 751 (now closed), through the conductors 752, 640, to one side of the microphone input whose other side is connected through the conductor 778 to the negative side of the microphone battery.

Discontinuance of modulation from the carrier of station A produces the following results at slave station B (Fig. 3b) to which we now return.

The relay 765 becomes deenergized thereby deenergizing the relay 663 thereby opening the contacts 673 and deenergizing the relay 674.

Deenergization of the relay 674 at station B places the microphone transmitter 732 at station B in circuit as follows: from the positive side of the microphone battery, through the conductors 696, 733, through the contacts 731 (now closed) of the hook switch 682, through the conductor 734, through the microphone transmitter 732, through the conductor 735, through the contacts 736 (now closed) of the relay 674, through the conductors 702, 703, to one side of the microphone input whose other side is connected by the conductor 704 to the other side of the microphone battery.

Two way telephone conversation may now proceed between the master station and the slave station B and when such conversation has ceased

the parts are restored to their normal positions by the return of the head piece 681 at both stations to their hooks and by throwing the call switch 659 to the "off" position at station B.

In Fig. 4, I have diagrammatically shown another different form of my invention. The system shown in Fig. 4 represents one of a plurality of stations, in the present case a total of five stations, although the system may be applied to a greater or less number of stations. In accordance with this system any of the stations can selectively call any desired one of the other four stations. Each station, through the operation of wave or frequency changing devices which will later be described in more detail, is capable of selectively transmitting either of two different carrier frequencies which may, for convenience, be referred to as F1 and F2, and likewise each station is capable of receiving at different stages of operation one or the other of the two frequencies F1 and F2. The selection of these frequencies is automatically effected as will hereinafter appear. The radio receiving apparatus at all five stations is normally tuned to one of the two frequencies, say the frequency F1. When any of the stations calls another station the radio receiving apparatus at the calling station is automatically shifted to the frequency F2 and when any of the stations is answering a call its radio receiving apparatus is set for reception of the frequency F1. When any station is placing a call its radio transmitting apparatus transmits at the frequency F1. When any of the stations is answering a call its radio transmitting apparatus transmits at the frequency F2. It will further be understood that regardless of the number of individual stations included in the system now being described, a total of only two frequencies of transmission and reception is employed, to wit: the two frequencies F1 and F2.

While much of the apparatus and electrical connections shown in Fig. 4 is similar to that employed in connection with the forms of invention which have been above described, it will be helpful to trace the circuits in Fig. 4 in some detail.

The Wallace motor 802 operates the cam 803 having a high spot 804 for operating the switch 805 and having a switch 806 forming a part of the motor will all be recognized in view of the preceding descriptions.

The circuit of this motor is as follows: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 800, 801, through the winding 802 of the Wallace motor, through the conductor 807, through the contacts 808, through the conductor 809, through the motor contacts 806, through the conductor 810, through the contacts 811, through the conductors 812, 813, 814, to the negative side of the $7\frac{1}{2}$ volt battery. Due to energization of the circuit just traced, the Wallace motor normally continues to rotate and periodically close the contacts 805, which, when closed, cause the relay 817 to be energized in the following circuit: from the positive side of the $7\frac{1}{2}$ volt battery, through the conductors 800, 815, through the relay 817, through the conductors 816, through the contacts 805, through the conductors 813, 814, back to the negative side of the $7\frac{1}{2}$ volt battery. The relay 817, when energized, causes the filament of the tube 818 and the filaments of the radio receiving apparatus (not shown) to be energized.

By the foregoing operations, the tube 818 and the radio receiving apparatus are periodically

placed in receptive condition so as to respond to the frequency F1.

In order to place a call the user throws to calling position the particular one of the call switches 819, 820, 821, 822 corresponding to the one of the other four stations which he desires to call. Let it be assumed in the present case that station A desires to call station B, in which event the call switch 819, corresponding to station B, would be thrown from the "off" to the calling position. Operation of the call switch 819 to calling position closes the contacts 823 to establish the following circuit through the relay 824: from the positive side of the 7½ volt battery, through the conductor 800, through the contacts 823 (now closed), through the conductor 825, through the relay 824, through the conductors 813, 814, back to the negative side of the 7½ volt battery. Closure of the contacts 823, by operation of the call switch 819, also closes the following circuit through the motor 826: from the positive side of the 7½ volt battery, through the conductor 800, through the contacts 823, through the motor 826, through the conductor 827, through the contacts 828 (now closed) of the hook switch 879, through the conductor 829, through the contacts 830 (now closed) of the relay 824, through the conductors 813 and 814 back to the negative side of the 7½ volt battery.

Operation of the call switch 819 to calling position closes the contacts 831 to establish the following circuit including the current interrupting device 832 and the secondary of the buzzer modulating device 833, this circuit being as follows: from the positive side of the microphone battery, through the conductors 834, 835, through the secondary of the buzzer modulating device 833, through the conductor 836, through the contacts 837 (now closed) of the relay 824, through the conductor 838, through the contacts 839, through the conductor 840, through the conductor 841, through the contacts 831 (now closed) of the call switch 819, through the circuit interrupting device 832, through the conductor 842, to one side of the microphone input whose other side is connected through a conductor 843 to the negative side of the microphone battery. It will be understood that the circuit interrupting device 832, as well as the other circuit interrupting devices 844, 845 and 846 are continuously rotated by the motor 826 when the latter is energized. In the case under discussion the circuit interrupting devices 844, 845 and 846 are being idly rotated since the corresponding call switches 820, 821 and 822 are in the off or non-calling position.

Energization of the relay 824, through the circuit above described, causes the contacts 830 to close, as stated, and the closure of these contacts establishes the following circuit through the primary of the buzzer modulating devices 833: from the positive side of the 7½ volt battery, through the conductor 800, through the primary of the buzzer modulating device 833, through the conductor 847, through the contacts 828 (now closed), through the conductor 829, through the contacts 830 (now closed) of the relay 824, through the conductors 813, 814, back to the negative side of the 7½ volt battery.

Energization of the relay 824 causes the relay contacts 848 to close to establish the following circuit through the relay 849: from the positive side of the 7½ volt battery, through the conductor 800, through the relay 849, through the conductor 850, through the contacts 848 (now closed) of the relay 824, through the conductors 813, 814,

back to the negative side of the 7½ volt battery.

Energization of the relay 849 causes its contacts 851 to close thereby establishing the following circuit through the transmitter control relay: from the positive side of the 7½ volt battery, through the conductor 800, through the contacts 851, (now closed) of the relay 849, through the conductor 852, through the transmitter control relay, through the conductor 853, back to the negative side of the 7½ volt battery. The transmitter control relay places the radio transmitting apparatus at station A in operation to transmit a carrier of frequency F1 which carrier is modulated by the buzzer 833, the buzzer modulation being interrupted by the current interrupting device 832. In other words, by the operation of the call switch 819, corresponding to station B, the user at station A has now caused his apparatus to transmit a carrier frequency F1 so modulated and coded by virtue of the operation of the current interrupting devices 832 as to select the desired station B.

Energization of the relay 849 also causes its contacts 854 to close and establish the following circuit through the relay 817: from the positive side of the 7½ volt battery, through the conductors 800, 815, through the relay 817, through the conductor 816, through the conductor 855, through the contacts 854 (now closed) of the relay 849, through the conductor 814, back to the negative side of the 7½ volt battery. This places the radio receiving apparatus and the tube 918 in receptive condition as above described.

Energization of the relay 824 causes its contacts 856 to close thereby energizing the relay 857 in the following circuit: from the positive side of the 7½ volt battery, through the conductors 800, 815, through the relay 857, through the conductor 858, through the contacts 856 (now closed) of the relay 824, through the conductors 813, 814, back to the negative side of the 7½ volt battery. The relay 857 when energized closes its contacts 859 to energize the circuit of a suitable motor driven wave changing device (not shown) whereby the radio receiving apparatus at the station under consideration is automatically tuned to receive the frequency F2. When the contacts 859 open upon subsequent deenergization of the relay 857, the motor automatically restores the wave changing device so as to restore the tuning of the radio receiver to the frequency F1.

Instead of the motor-operated wave-changing control which I have described above, other forms of wave-changing apparatus may be employed. For example, in Fig. 7 of Australian Patent No. 23,313/35, for Improvements in or relating to wave signaling systems, accepted July 1, 1936, and in Fig. 7 of British Patent No. 459,235, for Improvements in or relating to radio wave signalling systems, granted April 1, 1937 (each of said patents being issued to Wallace & Tiernan Products, Inc.), there is shown a comparatively simple form of wave-changing arrangement, controlled by a relay such as relay 857 of Fig. 4, and arranged so that the radio receiving apparatus is tuned to one frequency, such as F2, when the relay is energized, and is tuned to another frequency, such as F1, when the relay is deenergized.

Attention is now again directed to the system shown in Fig. 4.

Energization of the relay 824 at station A causes the contacts 860 to open and the contacts 861 to close whereby the selective relay 862 is disconnected from the plate of the tube 818 and the relay 863 is connected to the plate of that

tube. The circuit of the relay 862 is as follows: from the plate of the tube 818, through the conductor 864, through the contacts 860 (now open) of the relay 824, through the conductor 865, through the winding of the selective relay 862, to the positive side of the plate supply or B battery. The circuit of the relay 863 is as follows: from the plate of the tube 818, through the conductor 864, through the contacts 861 (now closed) of the relay 824, through the conductor 866, through the relay 863 and thence back to the positive side of the plate supply or B battery.

Recapitulating: by the operation of the call switch 819, to calling position at station A, the radio transmitting apparatus at that station has been automatically called into operation to transmit on frequency F1, the carrier being modulated by the buzzer 833 and coded by the current interrupting device 832, and the radio receiving apparatus at station A has been automatically placed in receptive condition and automatically tuned to receive the frequency F2. The selective relay 862 at station A has also been disconnected from the plate of the tube 818 and the relay 863 has been connected to the plate of that tube.

Assuming next that the diagram, Fig. 4, illustrates the apparatus and connections at station B (it will be understood that the apparatus at station B will differ from that at station A in that the B station will include call switches corresponding to A, C, D and E, whereas that of station A has call switches corresponding to B, C, D and E).

The Wallace motor at station B periodically energizes the relay 817 at that station so as periodically to put the receiver at that station into receptive condition; the receiver being normally tuned to the radio frequency F1. When the modulated and coded wave transmitted from station A is received at station B, during the first interval that the cam operated switch 805 closes, the radio receiving apparatus at station B causes the selective relay 862 to be energized to close the following circuit: from the positive side of the 7½ volt battery, through the conductors 800, 815, through the contacts (now closed) of the relay 862, through the conductor 867, through the relay 868, through the conductor 869, to the negative side of the 7½ volt battery. The selective relay 862 may be, as previously stated in connection with the form of the invention already described, a relay of the vibrating reed type which is, in the present case, mechanically tuned so as to respond to the coded modulation emitted from station A.

Energization of the relay 868 at station B closes the relay contacts 870 to energize the bell 871 in the following circuit: from the positive side of the 7½ volt battery, through the conductors 800, 815, through the contacts 870 (now closed) of the relay 868, through the bell 871, through the conductors 872, 810, through the contacts 811 (now closed), through the conductors 812, 813 and 814 back to the negative side of the 7½ volt battery.

Energization of the relay 868 causes its contacts 873 to close to energize the relay 874 in the following circuit: from the positive side of the 7½ volt battery, through the conductors 800, 815, through the contacts 873, through the conductor 875, through the relay 874, through the conductors 876 and 814, back to the negative side of the 7½ volt battery.

Energization of the relay 874 opens the circuit of the motor at the contacts 808 and also

establishes the following short-circuiting path across the winding 802 of the Wallace motor by virtue of closure of the contacts 877: from one side of the winding 802, through the conductors 801, 800, through the contacts 877, and through the conductor 807, back to the other side of the winding 802. This interruption of the circuit of the Wallace motor at station B and the braking torque applied by short-circuiting the field 802 quickly brings the Wallace motor to rest with the high spot 804 of the cam 803 arrested in the position in which the contacts 805 are closed.

The user at station B, upon hearing his bell 871, removes the head piece or telephone receiver 878 from the hook of the hook switch 879 and the latter automatically opens those of its contacts which are normally closed and closes those of its contacts which are normally open. The circuit of the bell 871 is thus opened at the hook switch contacts 811 and the bell stops ringing at station B. Closure of the contacts 880 of the hook switch 879 energizes the relay 849 in the following circuit: from the positive side of the 7½ volt battery, through the conductor 800, through the relay 849, through the conductor 850, through the contacts 880 (now closed) of the hook switch 879, through the conductors 812, 813, 814 back to the negative side of the 7½ volt battery.

Energization of the relay 849 causes energization of the transmitter control relay at station B so as to render radio transmitting apparatus at that station operative. At this time the primary circuit of the buzzer modulating device 833 at station B is energized in the following circuit: from the positive side of the 7½ volt battery, through the conductor 800, through the primary of the buzzer modulating device 833, through the conductor 847, through the contacts 881 (now closed) of the hook switch 879, through the conductor 882, through the contacts 883 (now closed) of the relay 874, through the conductor 884, through the contacts 885 (now closed) through the conductors 813, 814, back to the negative side of the 7½ volt battery.

Also at this time the following circuit exists including the secondary of the buzzer modulating device 833 at station B: from the positive side of the microphone battery, through the conductors 834, 835, through the secondary of the buzzer modulating devices 833, through the conductor 836, through the contacts 886 (now closed), through the conductor 887, through the contacts 888 (now closed) of the relay 874, through the contacts 889 (also now closed) of the relay 874, through the conductor 890, through the contacts 891 (now closed) of the hook switch 879, through the conductors 892, 842, to one side of the microphone input whose other side is connected through the conductor 843 with the negative side of the microphone battery.

Closure of the contacts 893 of the hook switch 879 energizes the transmitter wave change relay 894 at station B in the following circuit: from the positive side of the 7½ volt battery, through the conductor 800, through the relay 894, through the conductor 895, through the contacts 893 (now closed) of the hook switch 879, through the contacts 896 (now closed) of the relay 824, through the conductors 813, 814, back to the negative side of the 7½ volt battery. The relay 894 controls the circuit of the motor of a wave-changing switch so as to cause the transmitting apparatus at station B to transmit at frequency F2; it being

understood that when the relay 894 is subsequently deenergized the motor will automatically restore the wave changing switch so as to adjust the radio transmitting apparatus at station B to the frequency F1.

Instead of using a motor-operated wave-changing apparatus, as just described, other forms of wave-changing apparatus may be employed under the control of the relay 894 of Fig. 4. For example, in Fig. 8 of Australian Patent No. 23,313/35 mentioned hereinabove, and in Fig. 8 of British Patent No. 459,235 mentioned hereinabove, there is shown one of such other forms of apparatus, controlled by a relay such as relay 894 of Fig. 4, and arranged so that when the relay is energized, the radio transmitting apparatus will transmit at one frequency, such as F2, and when the relay is deenergized, the transmitting apparatus will transmit at another frequency, such as F1.

Attention is now again directed to the system shown in Fig. 4.

The called station B is now transmitting at frequency F2 which is modulated by the buzzer modulating device 833 (but not coded since all of the call switches at station B are now in their "off" position).

Let it now again be assumed that the apparatus shown in Fig. 4 is that at station A, i. e. the calling station, and at which the modulated wave transmitted from the called station B is being received. The relay 863 at station A now immediately responds and closes its contacts 897 to energize the relay 868 at station A. Energization of the relay 868 at station A causes the bell 871 at station A to ring and also causes the relay 874 at station A to be energized. The user at the calling station, that is station A, hearing his bell 871, now removes his head piece or telephone receiver 878 from the hook of his hook switch 879. Resultant opening of the hook switch contacts 811 interrupts the bell circuit and the bell at station A now ceases to ring. The resultant opening of the contacts 828 of the hook switch 879 at station A breaks the circuit of the primary of the buzzer modulating device 833 at that station. Resultant opening of the contacts 839 of the hook switch 879 breaks the circuit of the secondary of the buzzer modulating device 833 which circuit, as above described, also includes the circuit interrupting device 832. Resultant opening of the contacts 828 of the hook switch 879 also breaks the circuit of the motor 826 at the calling station A.

Closing of the contacts 900 of the hook switch 879 at station A energizes the relay 901 in the following circuit: from the positive side of the 7½ volt battery, through the conductor 800, through the relay 901, through the conductor 902, through the conductor 903, through the contacts 904 (now closed) of the relay 824, through the conductor 905, through the contacts 900 (now closed) of the hook switch 879, through the conductors 813, 814, back to the negative side of the 7½ volt battery.

Energization of the relay 901 disconnects the primary of the input transformer 906 of the tube 818 through the output of the radio receiving apparatus at station A and connects the output of the latter to the primary of the transformer 907 whose secondary connects directly to the head piece or telephone receiver 878.

Returning now to station B, i. e. assuming that the drawing, Fig. 4 now represents the apparatus at station B, the selective relay 862 at station B now becomes deenergized because the modulation

has been removed from the carrier transmitted from station A and, deenergization of the relay 862 causes deenergization of the relay 868 at station B. Energization of the relay 868 at station B causes the contacts 873 of that relay to open thereby opening the circuit of the relay 874 and deenergizing the latter. Deenergization of the relay 874 causes its contact 883 to open thereby opening the circuit of the primary of the buzzer modulating device 833 at station B. Deenergization of the relay 874 at station B also causes the relay contacts 888 to open thereby opening the circuit including the secondary of the buzzer modulating devices 833. Deenergization of the relay 874 at station B also causes the contacts 908 and 909 of that relay to close thereby establishing the following circuit including the microphone transmitter 910 at station B: from the positive side of the microphone battery, through the conductor 834, through the contacts 911 (now closed) of the hook switch 879, through the conductor 912, through the microphone transmitter 910, through the conductor 913, through the contacts 909 (now closed), through the contacts 908 (now closed), through the conductor 914, through the hook switch contacts 915 (now closed), through the conductors 892, 842 to one side of the microphone input whose other side is connected to the negative side of the microphone battery.

Deenergization of the relay 868 at station B causes the contacts 916 thereof to close and to energize the relay 901 at station B in the following circuit: from the positive side of the 7½ volt battery, through the conductor 800, through the relay 901, through the conductor 902, through the contacts 916 (now closed) of the relay 868, through the conductor 917, through the contacts 900 (now closed) of the hook switch 879, through the conductors 813, 814, back to the negative side of the 7½ volt battery. Energization of the relay 901 disconnects the primary of the input transformer 906 of the tube 818 and connects the primary of the transformer 907 to the output of the radio receiving apparatus at station B. The telephone receiver or head piece 878 at station B is connected directly across the secondary of the transformer 907.

The apparatus at station B is now in condition to talk and to receive speech but the apparatus at station A is not yet in condition to be used for the transmission of speech.

Returning now to station A, i. e. assuming that Fig. 4 now again represents station A, it will be recalled that the modulation has been removed from the carrier transmitted from the called station B. The non-selective relay 863 at station A now becomes deenergized and breaks the circuit of the relay 868 at station A. Deenergization of the relay 868 causes its contacts 873 to open thereby breaking the circuit of the relay 874 at station A and thereby establishing the following circuit including the microphone transmitter 910 at that station: from the positive side of the microphone battery, through the conductor 834, through the contacts 911 (now closed) of the hook switch 879, through the conductor 912, through the microphone transmitter 910, through the conductor 913, through the contacts 909 (now closed) of the relay 874, through the contacts 908 (now closed) of the relay 874, through the conductor 914, through the contacts 915 (now closed) of the hook switch 879, through the conductors 892, 842, to one side of the microphone input whose other side is connected to the negative side of the microphone battery.

Two way telephone speech communication can now take place between stations A and B. When the conversation has ceased the users at stations A and B restore their head pieces 878 to the hooks of their hook switches 879 and the user at station A throws his call switch 819 to the off position. The apparatus at both stations A and B is then restored automatically to its normal condition.

The operation when station A desires to call any of the other stations that is for D or E, or when any of the five stations desires to call any of the other four stations, it is believed will be understood in view of the foregoing description.

While the foregoing descriptions and explanations will enable those of average skill in the art to understand the construction and operation of my various forms of invention, I shall in addition now set forth further description of the construction and operation of some of the details thereof.

The buzzer modulating device shown at 631 in Fig. 3a, at 690 in Fig. 3b, and at 883 in Fig. 4, may be of the type comprising a transformer, in the primary circuit of which, a microphone transmitter button is connected in series to act as an interrupter; the microphone transmitter button being mounted on a reed so as to impart a mechanical resonance characteristic to it, the reed being mechanically operated as an armature by the core of the transformer. Such a device is generally similar to the well-known induction coil having an interrupter in its primary circuit actuated by the core upon which the primary and secondary windings are wound. The secondary winding of the transformer constitutes the output of the device. Such devices are readily available and are known as "microphone hummers". It will be understood, of course, that other forms of devices may be substituted for this particular type of tone generator, as for example, audio frequency oscillators, etc.

The mechanically tuned relay shown at 458 in Fig. 2b, at 655 in Fig. 3b, and at 862 in Fig. 4, may be of the type shown in Figs. 10 and 11 of the above-mentioned Australian Patent No. 23,313/35, and in Figs. 10 and 11 of the above-mentioned British Patent No. 459,235. It will be understood that the entire apparatus shown in Fig. 10 of each of the patents just cited, is such as may be included within the casing or box shown at 458, for example, in Fig. 2b.

Other forms of mechanically or electrically tuned or selective devices may be used in lieu of the particular mechanically tuned device shown in Figs. 10 and 11 of the cited Australian and British patents.

One of the features of my invention is that the radio receiving apparatus and the radio transmitting apparatus at each station may be spaced at any desired reasonable distance from the control apparatus, thereby facilitating advantageous location of the component parts of the system. For example, the radio receiving apparatus proper, which except insofar as it is taken to include tubes 26, 425, 450, 618, 655 or 818 and the directly associated relays and transformers, is not shown in Figs. 1a, 1b, 2a, 2b, 3a, 3b, or 4, may be enclosed in a suitable box and located near the top of a light house. Similarly, the radio transmitting apparatus proper, which is likewise not shown in any of the figures mentioned, may be enclosed in a box and located on a tower or mast at the top of the light house where its antennas would

be in the clear, and the control unit, which comprises, for example, at least the major part of the apparatus shown in any one of the cited figures, may be located (together with the modulator for the transmitter, if desired) in the light keeper's house so as to be readily accessible at all times.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiments thereof, but I desire to have it understood that the apparatus disclosed is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combinations and relations described, some of these may be altered and others omitted and some of the features of each modification may be embodied in the others without interfering with the more general results outlined, and the invention extends to such use within the scope of the appended claims.

What I claim is:

1. A wave signalling system comprising in combination, a transmitting apparatus, a remotely located receiving apparatus, control means for intermittently supplying local energy to said receiving apparatus to render it operative and by such intermittent supply to prolong the useful life of the receiving apparatus and to conserve energy, a signalling device associated with said receiving apparatus, and means responsive to wave energy transmitted from said transmitting apparatus to said receiving apparatus during an operative interval of said receiving apparatus for bringing said signalling device into operation to indicate that such transmitted waves are being received by the receiving apparatus, said last-mentioned means being adapted to effect continued operation of the signalling device, and including means responsive to cessation of waves from the transmitter for interrupting continued operation of the signalling device.

2. In a wave signalling system, in combination, wave receiving apparatus, remotely located wave transmitting apparatus, means for intermittently supplying local energy to said receiving apparatus to render the same operative during the intervals of energy supply, a signalling device, means controlled by the receiving apparatus for bringing said device into continued operation upon reception of calling waves from the remote transmitter during an operative interval of the receiving apparatus and for thereafter maintaining the continued operation for an unlimited period of time, or discontinuing the operation of said device at will under control of the remote transmitter, when there is no operator at the receiving station.

3. A two-way radio telephone system comprising in combination, radio transmitting apparatus, means for controlling said transmitting apparatus to call a remotely located station, radio receiving apparatus at said remotely located station including a signalling device and means for operating said signalling device in response to the call emanating from said transmitting apparatus, radio transmitting apparatus at the called station, a telephone receiver and support therefor at the called station, means called into operation by removal of said telephone receiver from its support for causing the transmitting apparatus at the called station to become operative, radio receiving apparatus at the calling station including a telephone receiver and a signalling device and

means for operating said last mentioned signalling device in response to the operation of the transmitting apparatus at the called station, and means including said telephone receivers whereby conversation may be carried on between the calling and called stations by radio telephony.

4. A wave signalling system comprising a plurality of remotely separated stations each including wave transmitting means and wave receiving means having signalling devices for indicating reception of waves from another of the stations; means at one of the stations for intermittently connecting the receiving means with a source of current to render the signalling device susceptible of operation to indicate wave reception constituting a call from a second of the stations; means for controlling operation of the transmitting means at the first station to transmit waves for sending a call back to the second station; means at the second station controlled by operation of its transmitting means for connecting the receiving means at the second station with a source of current to render its signalling device susceptible of operation to indicate wave reception of a call back from the first station; and means including transmitting and receiving instruments at each station whereby, following reception of the call back at the second station, two-way communication may be carried on between the first and second stations.

5. In combination, radio receiving apparatus including means for locally supplying electrical energy thereto to cause said apparatus to become receptive, means intermittently interrupting said supply of energy to said apparatus, an electric motor for actuating said last-mentioned means, a signalling device, and means controlled by said receiving apparatus in response to a call from a remote wave transmitter during a receptive interval of said receiving apparatus, for operating the signalling device and arresting the motor.

6. In a radio wave communicating system, a station having transmitting and receiving apparatus and a signalling device to produce a distantly sensible signal under control of the receiving apparatus, and a remotely located station adapted to receive calls from the first station and including means for receiving and translating radiant energy, intermittently operating means for supplying local energy to said receiving means, a signalling device, means controlled by said first and second mentioned means for operating said signalling device to indicate a call, a telephone receiver and support therefor, means responsive to removal of said telephone receiver from its support for discontinuing operation of said signalling device, and means responsive to removal of said telephone receiver from its support for initiating a call back to the first station for operating the signalling device thereat and thereby announcing that the call has been received.

7. A radio telephone system comprising in combination, a radio transmitting apparatus, manually initiated means for causing said apparatus to transmit a call, a remotely located radio receiving apparatus including a call bell for indicating reception of the call, means for intermittently supplying local energy to said receiving apparatus to render the same operative during the intervals of energy supply, and radio transmitting apparatus, radio receiving apparatus, and a call bell, whereby response to the call may be indicated at the calling station.

8. A radio telephone system comprising, in combination, a call switch, a signalling device,

a transmitting instrument, and a receiving instrument, at one station, a signalling device, a transmitting instrument, and a receiving instrument, at another station, supporting means for each of said receiving instruments, means responsive to operation of said call switch for causing radiant energy to be transmitted from said first mentioned station to call said second mentioned station, means at said second mentioned station for receiving the radiant energy transmitted from the first station and for operating the signalling device at the second station to indicate the call, means operable in response to removal of the receiving instrument from its support at the second mentioned station for transmitting radiant energy between said stations to cause the signalling device at the first mentioned station to indicate response to the call, and means whereby conversation may be carried on between said stations by radio telephony after the receiving instrument at the first mentioned station is removed from its support.

9. A radio telephone station comprising, in combination, normally inoperative radio transmitting apparatus, normally intermittently receptive radio receiving apparatus, a signalling device adapted to produce a distantly sensible signal, and a single manually operable device, means controlled thereby for causing the transmitting apparatus to transmit and the receiving apparatus to be receptive for effecting operation of the signalling device upon reception of a call back in response to the transmission, and means including transmitting and receiving instruments whereby following announcement by the signalling device of a call back by a remote station, communication can be carried on therewith.

10. In a station of a wave signalling system, in combination, wave receiving means, wave transmitting means having control devices therefor, a signalling device having an energizing circuit settable for control by the receiving means to give an indication of receipt of waves from a remote transmitter, calling switch means for actuating the transmitter control devices and for setting the energizing circuit of the signalling device to be controlled by the receiving means, and call-receiving means comprising means operable independently of said calling switch means for setting the energizing circuit of the signalling device to be controlled by the receiving means and call-returning switch means for opening the energizing circuit of the signalling device set by the said independent setting means and for actuating the transmitter control devices.

11. The combination of claim 10 in which means are provided for periodically actuating the means for independently setting the energizing circuit of the signalling device.

12. A radio wave communicating system having a plurality of separated stations, and having communicating means including wave transmitting and receiving apparatus and transmitting and receiving instruments at each station, a signalling device at each station for announcing reception of waves, a call switch at one station for initiating wave transmission to operate the signalling device at a second station, a reply switch at the called station for initiating wave transmission to transmit a call back for operation of the signalling device at the first station, and means including a reply switch at the first station, whereby two-way communication may be carried on between the stations and with the transmitting and receiving instruments, in re-

sponse to operation of said last-mentioned reply switch.

13. In a radio wave communicating system, in combination, a plurality of stations each having signalling means to announce that a call is being received from another station, one of the stations having a call switch for initiating a call by radio waves to effect operation of the signalling means at a second station, means controlled at the second station for effecting a call back by radio waves to effect operation of the signalling means at the first station, thereby indicating that the original call has been received, means including a reply switch and communication transmitting and receiving instruments at the first station, for establishing radio wave communication with the second station in response to operation of said reply switch after the call switch has been operated and the said call back received, and control means at the first station, responsive to operation of the reply switch when the call switch has not been operated, for effecting a call back by radio waves to effect operation of the signalling means at the second station, in reply to an original call initiated by said second station.

14. In a station of a wave signalling system, wave receiving and transmitting apparatus, control means for rendering said apparatus operative, said control means including a call switch for initiating transmission of a call to another station and for supplying energy to said receiving apparatus to render it continuously operative for reception of a call back and means operable independently of the call switch for intermittently supplying energy to the receiving apparatus to render it operative during the intervals of energy supply, and signalling means controlled by the receiving apparatus for announcing reception of a call from another station during intervals of energy supply by the means operating independently of the call switch, and for announcing reception of a call back from another station after initiation of a call to that station by operation of the call switch.

15. In a station of a wave signalling system, in combination, wave transmitting means, wave receiving means, a signalling device adapted to be controlled by said receiving means to indicate reception of waves from a remote transmitter, automatic contact means for periodically conditioning said signalling device to be controlled by the receiving means, switch means for continuously conditioning said signalling device to be controlled by the receiving means, switch means for initiating wave transmission by the transmitting means, and common manually operated control means for both said switch means.

16. In a station of a wave signalling system, wave receiving means, a signalling device controllable thereby to indicate reception of waves from a remote station, contact means for periodically supplying local energy to said receiving means and conditioning said signalling device to respond to received waves, a motor for actuating said last-mentioned means, and braking means controlled by the wave receiving means for bringing the motor to rest during an energy-supplying period of the contact means, on receipt of waves.

17. In a wave signalling system, in combination, a master station and a plurality of slave stations, said master station including wave transmitting means, and means for selectively effecting modulation of wave transmission thereby at any of a plurality of predetermined frequencies respec-

tively corresponding to the slave stations, and each of said slave stations having wave receiving means, a signalling device and a control circuit therefor, means controlled by the receiving means for closing the control circuit of the signalling device to indicate a call from the master station, said last mentioned means including a relay responsive to the corresponding predetermined frequency of the slave station exclusive of the other predetermined frequencies, means for normally intermittently supplying local energy to the receiving apparatus at each slave station, and a single radio receiver at said master station for receiving messages from any of said slave stations.

18. In a wave signalling system, in combination, a master station and a plurality of slave stations, said master station including wave transmitting means, means for selectively effecting modulation of wave transmission thereby at any of a plurality of predetermined frequencies respectively corresponding to the slave stations, control devices for both said means to effect a call to a slave station, and means for suppressing operation of the aforesaid modulation-effecting means in replying to a call from a slave station, and each of the slave stations including wave receiving means, a signalling device for indicating reception of waves, means controllable by the receiving means and responsive to the corresponding predetermined frequency of the slave station exclusive of the other predetermined frequencies for controlling the signalling device, and control means for suppressing said last mentioned controlling means and for effecting control of the signalling device by the receiving means irrespective of the aforesaid predetermined frequencies.

19. In a station of a wave signalling system comprising a plurality of stations, in combination, wave transmitting means, wave receiving means, a signalling device, relay means controllable by the receiving means and responsive to reception by the latter of a carrier having a predetermined characteristic modulation only, relay means controllable by the receiving means and responsive to reception by the latter of a carrier not having the said predetermined characteristic modulation, and circuit-controlling means for placing the signalling device under control of either of the said relay means respectively according to conditioning of the station to receive a call from another station or to receive a reply call from another station in response to a call made with the aforesaid wave transmitting means.

20. The combination of claim 19 in which the circuit-controlling means include devices for normally placing the signalling device periodically under control of the first mentioned relay means and manually operated devices for placing the signalling device continuously under control of the second mentioned relay means.

21. In a wave signalling system, a station having wave transmitting means, means for modulating a carrier transmitted by the transmitting means at any selected one of a plurality of different characteristic modulations, calling means for controlling said transmitting and modulating means to initiate transmission of a carrier having the selected characteristic modulation, and replying means for controlling the transmitting means to initiate transmission of a carrier independent of any of the aforesaid plurality of different characteristic modulations, and at a remote station, wave receiving apparatus

and call bell means controlled thereby for announcing reception of transmission initiated by either the calling or replying means at the first station.

22. In a station of a wave signalling system comprising a plurality of stations, in combination, wave transmitting means having circuits normally adapted to transmit a carrier of a predetermined frequency, means for altering the said circuits to transmit a carrier of a second predetermined frequency, wave receiving means having circuits normally responsive to a carrier of the first predetermined frequency, means for altering the said circuits to respond to a carrier of the second predetermined frequency, call switch means for initiating normal operation of the transmitting means and for bringing the receiving circuit altering means into controlling relation with the receiving means and call-replying circuit-controlling devices including transmitter-operation-initiating devices, for bringing the transmitting circuit altering means into controlling relation with the transmitting means.

23. In a station of a wave signalling system, in combination, wave transmitting means, a wave receiving circuit normally responsive to a carrier of a predetermined frequency, means for altering the said circuit to render the same responsive to a second predetermined frequency, control means for initiating wave transmission by the wave transmitting means, common manually operable call switch means for bringing the circuit-altering means into controlling relation with the receiving circuit and for bringing the transmitter control means into controlling relation with the transmitting means, a call bell, and means controlled by the receiving apparatus for effecting operation of said bell in response to reception of a call back signal on the aforesaid second predetermined frequency.

24. The combination of claim 23 in which the transmitter control means includes a plurality of selectable circuit interrupting devices for effecting different characteristic modulations of the carrier transmitted by the transmitting means respectively corresponding to a plurality of remote stations which may be called.

25. In a station of a wave signalling system, in combination, wave receiving means, a signalling device having an energizing circuit controlled by the receiving means for indicating reception of waves, a wave transmitting circuit normally adapted to transmit a carrier of a predetermined frequency, means for altering the transmitting circuit to transmit a carrier of a second predetermined frequency, common control means, including transmitter-operation-initiating devices, for bringing the transmitter circuit altering means into controlling relation with the transmitting means and for opening the energizing circuit of the signalling device, and means for causing said signalling device to indicate a call back from a called station.

26. In a station of a wave signalling system, wave transmitting means, wave receiving means, signalling means having control apparatus for operating the same under control of the receiving means to indicate reception of either an original call or a reply call, said control apparatus being selectively conditionable to respond to an original call having a predetermined characteristic modulation only, or to a reply call not having the said predetermined characteristic modulation, and control means for placing said control

apparatus in the first or second mentioned conditions of response respectively in accordance with the conditioning of the station to receive an original call from another station or to receive a reply call from another station in response to a call made with the aforesaid wave transmitting means.

27. In a station of a wave signalling system, wave transmitting means, wave receiving means, signalling means, relay means controllable by the receiving means for operating the signalling means upon receipt of a modulated carrier and selectably in response to either one of two different modulations of said carrier, and means for selecting that one of the said two modulations to which the relay means shall respond, respectively in accordance with the conditioning of the station to receive a call from another station or to receive a reply call from another station in response to a call made with the aforesaid wave transmitting means.

28. In a station of a wave signalling system, wave receiving means, wave transmitting means, modulating means for selectably impressing on the carrier transmitted by said last-mentioned means one of two different calling modulations, means for selecting which of the said two modulations is to be impressed on the carrier, in accordance respectively with the conditioning of the station to initiate a call to another station or to effect a reply call to another station in response to a call received by the wave receiving means, and means for impressing voice modulations on a transmitted carrier, for effecting speech transmission to another station after a call has been received.

29. In a station of a wave signalling system having a plurality of stations, wave transmitting means, receiving means including wave receiving apparatus, for indicating reception of a modulated carrier, control means selectably operable to condition the station either for receiving a call and transmitting a reply call or for transmitting a call and receiving a reply call, means operable in response to said control means and including modulating apparatus, for causing the transmitting means to transmit a calling carrier having a selected one of a plurality of characteristic modulations or a replying carrier having a predetermined characteristic reply modulation, and means also operable in response to said control means and including relay devices controllable by the receiving apparatus, for rendering the receiving means responsive to a calling carrier having a special characteristic modulation or to a reply carrier having a characteristic reply modulation.

30. In a wave signalling system, wave receiving apparatus, means for intermittently supplying energy to said apparatus to render it receptive during the intervals of energy supply, a signalling device, manually operable switch means for interrupting operation of the signalling device, means responsive to reception of a call by the receiving apparatus during a receptive interval thereof, for indicating said call by operating the signalling device continuously thereafter, means for interrupting continued operation of said signalling device when the call is discontinued, and means for interrupting continued operation of said signalling device by manual operation of said switch means.