May 12, 1931. H. P. CLAUSEN 1,804,675

SIGNALING SYSTEM

Filed March 2, 1927

FIG. 1

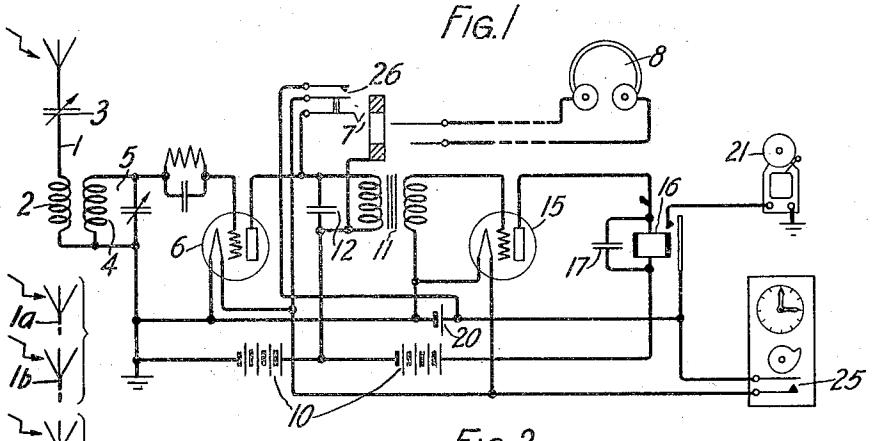



FIG. 2

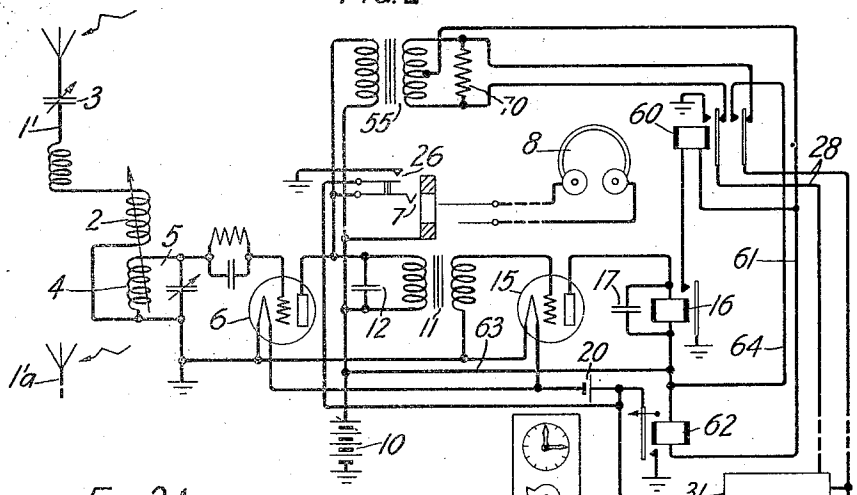
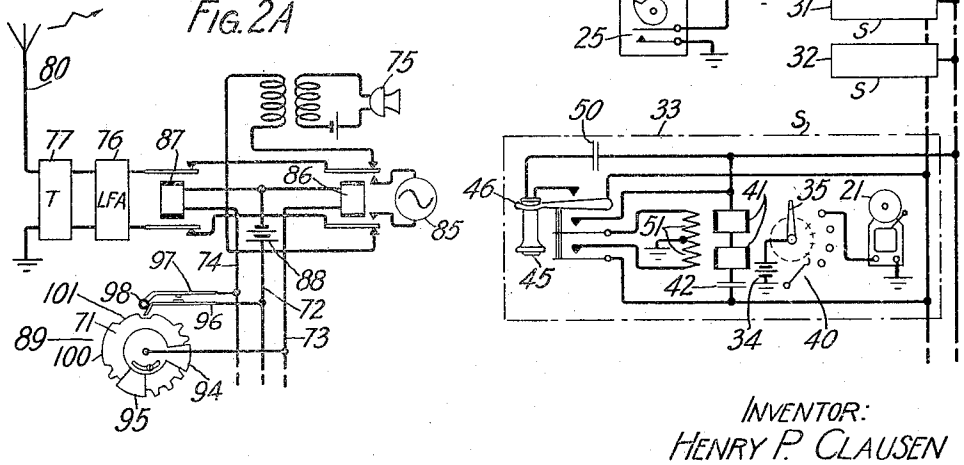



FIG. 2A




INVENTOR:
HENRY P. CLAUSEN
BY W. Griggs
ATTORNEY

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# UNITED STATES PATENT OFFICE

HENRY P. CLAUSEN, OF MAMARONECK, NEW YORK, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

## SIGNALING SYSTEM

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This invention relates to wave communication, and particularly to signal receiving systems.

Specifically stated, an object of the invention is to conserve the energy of energy-supply means employed to energize electric space discharge devices of signal receiving systems.

A preferred embodiment of the invention comprises a vacuum tube radio receiving system having means for placing the system in operative or "stand-by" condition for short periods at given relatively widely separated times, to enable a transmitting station to signal the receiving station during any desired ones of such periods. The timed production of the stand-by condition is accomplished by a clock-controlled switch which closes the filament heating circuit of the receiver only during the periods which are to be stand-by periods. Thus, the energy of the filament current and plate current supply sources is conserved. The conservation is especially important when dry cells are employed to supply filament heating current. Upon receiving a called signal, the operator at the receiving station actuates means to maintain the filament heating circuit of the radio receiver operative during the transmission of the message about to be sent to him.

The invention also contemplates an extension of the feature just described to a plurality of receiving stations controlled from a common transmitting station. Such a radio network is especially adapted for municipal or police service.

The radio receiver may be connected by wire to a plurality of outlying receiving stations each provided with means selectively operable from the transmitting station to call the operator at the particular receiving station.

Fig. 1 is a circuit diagram of one embodiment of the invention; Fig. 2 is a circuit diagram of an embodiment of the invention involving selective calling of receiving stations; and Fig. 2A is a circuit diagram of a transmitting station for use in connection with the circuit of Fig. 2.

In the radio receiving system of Fig. 1, an antenna circuit 1 includes an inductance coil 2 and a variable tuning condenser 3. Coil 2 is coupled to an inductance coil 4 of a tuning circuit 5 in the input circuit of a three electrode electric space discharge detector tube 6. A jack 7 is connected across the plate and filament of the detector. A telephone receiver 8 is adapted to be plugged into the jack, so that the receiver 8 will be connected in the output circuit of the detector tube.

Space current from a section of a plate current battery 10 is supplied to tube 6 through the primary winding of an audio frequency transformer 11. A condenser 12 connected across the winding bypasses current of radio frequency around the winding. The secondary winding of the transformer is connected across the grid and filament of an electric space discharge amplifier tube 15.

Space current from battery 10 is supplied to tube 15 through the winding of an alternating current relay 16. Across the relay winding is connected a condenser 17, forming with the winding a circuit tuned to a frequency of, for example, 2000 cycles per second. When the relay is energized its contact closes a circuit from a battery 20 through a signal, as for example, an alarm or call bell 21.

Heating current from battery 20 is supplied to the tube filaments in parallel, through a clock controlled switch 25 which closes the filament circuit periodically. For example, the switch may close the filament circuit for one minute at intervals of one half hour.

A switch 26 is so associated with jack 7 as to be in closed condition when the receiver 8 is plugged in the jack, and to be open when the plug connected to the receiver is out of the jack. The switch 26 is connected in parallel with switch 25.

The antenna 1 and the circuit 5 are maintained tuned to the carrier frequency employed by the radio transmitting station (not shown) from which the receiving system is to receive communications. When a

message is to be sent to the receiving station, a call signal is first transmitted, for causing operation of bell 21, in order to indicate at the receiving system that a message is about to be transmitted. This call signal may be sent by modulating the carrier frequency with a wave of the frequency to which condenser 17 and the winding of relay 16 are tuned. The call signal is sent at one of the times when switch 25 is in closed condition. This modulated wave is detected by tube 6 and the modulating wave is amplified by tube 15 and causes relay 16 to close the circuit of the call bell. Thereupon the attendant or operator at the receiving station inserts the plug connected to receiver 8 in jack 7, in readiness to receive the message about to be transmitted. At the expiration of the period during which switch 25 should remain closed, the transmitting station discontinues the modulation of the carrier wave by the wave for sending the call signal, and transmits the desired speech or other message by modulating the carrier wave with a wave corresponding to the message. This modulated wave is detected by tube 6 and the message is received in the receiver 8. The filament heating circuit of the tubes is maintained closed by switch 26 until, at the termination of the message, the operator at the receiving station withdraws the plug from jack 7. Even though the frequency to which condenser 17 and the winding of relay 16 are tuned be a frequency in the voice frequency range, the voice current component which has this frequency will not, upon reaching the relay, be of sufficient magnitude to operate the relay. Where the messages to be received are voice waves, the frequency to which condenser 17 and relay 16 are tuned is preferably a frequency at which the energy of the voice waves is small relative to the voice energy at other frequencies.

Since the stand-by periods or periods during which the switch 25 is closed may be small compared to the intervals between such periods, the drain on the batteries 20 and 10 over a long period of time may be made small, and yet messages may be received without undue delay. This is a matter of importance especially in cases in which the use of dry cells for heating the tube filaments is desirable.

The transmitting station (not shown) may be a broadcasting station, as for example, a station operated by a municipality, and radio receivers such as that described above may be installed at various locations, as indicated by the antennæ 1*a*, 1*b*, 1*c*, and 1*d*. These receivers may all have their switches 25 closed simultaneously; or if desired, one or more stations, such as that associated with the antenna 1, may have the switch or switches 25 closed, say for one minute each half hour, on the hour and on the half-hour, whereas another group of stations, as indicated by antennæ 1*a* and 1*b*, have their contacts such as 25 close, say for one minute each half hour, ten minutes after contacts 25 of the station with antenna 1 close, and another group of stations, as indicated by antennæ 1*c* and 1*d*, have their contacts such as 25 close, say for one minute each half hour, 20 minutes after the closing of the contacts such as 25 of the station with antenna 1. Still other groups may be employed.

The call signals for the stations represented by antennæ 1, 1*a*, 1*b*, 1*c*, and 1*d* may all be operated by the same calling frequency; or, if desired, different receiving stations or different groups of receiving stations may have their condensers 17 and relay windings 16 tuned to different frequencies, so that when at any given time a given frequency is employed as the carrier modulating calling frequency at the transmitting station, the call bells of only those receiving stations which then have their switches such as 25 closed, and which moreover respond to the given calling frequency, will be operated.

Fig. 2 shows a radio receiver including an antenna 1′ and a detector and an amplifier such as described above. However, the receiver in Fig. 2 is adapted to transfer the calling signals and messages which it receives to a line 28. The line extends to receiving stations 31, 32, 33 etc., which may be at considerable distances from each other and from the radio receiver. The stations are all alike, so only station 33 will be described. It includes an alarm or call signal, as for example call bell 21. Current for operating the bell is supplied by a battery 34 through a movable contact 35 of a selector or selectively operated circuit closer 40. The selector comprises an operating or stepping magnet 41 connected across line 28 in series with a condenser 42. The selector is of the type disclosed in U. S. patent to J. C. Field, No. 1,343,256, June 15, 1920. Current impulses flowing alternately in opposite directions through the magnet 41, or in other words, reversals of the current in magnet 41, cause the magnet to drive mechanism (not shown) which steps the movable contact 35 of the selector always in the same direction, one step for each reversal of the direction of current flow. The selector is designed for operation by an impulse code or combination of impulses which is individual to the particular selector as distinguished from the selectors at other stations. The combination of impulses may be created in a manner indicated hereinafter by way of example. In response to its individual code or combination of impulses, the selector magnet causes the movable contact to close

the circuit of bell 21 and maintains it closed for a desirable ringing period, at the expiration of which a releasing impulse is transmitted to magnet 41 over line 28. The releasing impulse may be transmitted to the magnet in a manner indicated hereinafter by way of example. In response to the releasing impulse, the magnet causes the movable contact to be returned to its normal position by a restoring spring (not shown).

Station 33 includes a telephone receiver 45 for receiving speech messages, for example, transmitted to the station over line 28. The receiver normally rests on a receiver hook 46, thereby maintaining three receiver hook switches open. The upper switch, when closed, connects the receiver across line 28, in series with a condenser 50. The two lower switches when closed, connect the two sides of line 28 to ground through the two equal resistances 51, respectively.

At the radio receiver a voice frequency transformer 55 has its primary winding connected in the output circuit of tube 6, in parallel with the primary winding of transformer 11. The two back contacts of a pulsing relay 60 normally connect the two sides of line 28 to the two ends respectively, of the secondary winding of transformer 55.

Whenever receiver 45 is off its hook, a relay 62 is energized to maintain the filament heating circuit of the tubes 6 and 15 closed. The circuit for thus energizing relay 62 is a simplex circuit extending from ground, through battery 10, conductor 63, winding of relay 62, conductor 61, the two halves of the secondary winding of transformer 55, the two sides of line 28, the two lower switches of receiver hook 46, and the two resistances 51 to earth. The contacts of the relay 62 are connected in parallel with the contacts of switch 25 and in parallel with the contacts of switch 26, so the filament heating circuit will be closed whenever the relay or either of these switches is closed.

The primary call signal relay 16 is operated by trains or groups of call signaling waves, which may be produced and transmitted to the relay winding as described hereinafter by way of example. The wave trains or groups so transmitted to relay 16 are sent to the relay in given combinations or codes. The combinations correspond, respectively, to the above mentioned combinations of impulses of which each combination is individual to one of the selectors.

Whenever the pulsing relay 60 is energized, due to closure of the contact of the primary call signal relay 16, the relay 60 closes a circuit for sending a current pulse over line 28 to each of the receiving stations such as 31, 32 and 33. This pulse passes through the magnets such as 41 and charges the condensers, such as 42. The circuit for this pulse extends from ground through battery 10, conductor 63, conductor 64, outer front contact of relay 60, right hand conductor of line 28, in parallel through the circuits comprising magnets 41 in series with condensers 42 at the various receiving stations, through the left hand side of line 28, and inner front contact of relay 60, to ground.

As indicated above, the selectors are designed to step their movable contacts in response to reversals of current through the selector magnet windings. By means of condenser 42 these reversals are obtained, in magnet 41, from the unidirectional current pulses sent over line 28 by closures of relay 60. Each closure causes a pulse of current which traverses the magnet in a given direction and charges the condenser. When the relay opens its front contacts and closes its back contacts, the condenser discharges, sending current in the reverse direction through the magnet 41, over a circuit extending from the condenser through the magnet, right hand conductor of line 28, outer back contact of relay 60, secondary winding of transformer 55 in parallel with any impedance such as impedance 70 with which it may be desired to shunt the transformer winding in order to reduce the impedance thereacross, inner back contact of relay 60, and left hand conductor of line 28, to condenser 42. The impedance 70, if employed, may be, for example, a resistance of such magnitude that the condenser, in discharging the charge accumulated from battery 10, produces sufficient operating current for magnet 41.

Fig. 2A shows, by way of example, a radio transmitting station for sending call signaling waves and message waves to be received by the radio receiver connected to the antenna 1′ in Fig. 2. In Fig. 2A, the contacts of a relay 87 and the back contacts of a relay 86 normally connect a telephone transmitter 75 to the input circuit of a voice frequency amplifier 76. The amplifier may be of any suitable type, as for example, an electric space discharge tube amplifier of usual type. The output side of the amplifier is connected to a radio transmitter 77. The output side of this radio transmitter is connected with a transmitting antenna 80. The radio transmitter may be of usual type, with a source of radio frequency carrier current and means for modulating this carrier current by voice currents from transmitter 75 and amplifier 76 when messages are to be sent, or by call signaling waves which are delivered to amplifier 76 from a source of electro-motive force 85 when the front contacts of relay 86 and the contacts of relay 87 are closed. The frequency of source 85

may be, for example 2000 cycles per second, or the frequency to which condenser 17 and the winding of relay 16 in Fig. 2 are tuned. The carrier frequency is the frequency to which the antenna 1' and the circuit 5 of Fig. 2 are tuned.

An impulse transmitter 89 is employed for disconnecting the transmitter 75 from amplifier 76 and causing the carrier wave transmitted from the radio transmitter to be modulated by a given combination (or code) of trains (or groups) of 2000 cycle alternations, this combination corresponding to the above mentioned impulse combination or code individual to selector 40 of station 33. The impulse transmitter may be of any suitable type, as for example that disclosed in detail in J. C. Field Patent 1,354,814, October 5, 1920. However, the impulse transmitter 89 is shown as in the above mentioned Field Patent 1,343,256. Conductors 72, 73 and 74 associate the impulse transmitter with a battery 88 and the relays 86 and 87, and, as indicated by the dotted extensions of these lines, also associate other impulse transmitters with this battery and these relays in the same manner as in the case of the impulse transmitter 89. These other impulse transmitters are like the impulse transmitter 89, but are respectively adjusted to cause trains (or groups) of the 2000 cycle alternations from source 85 to be impressed on amplifier 76 in codes (or combinations) corresponding respectively to the impulse combinations or codes individual to the selectors at the respective receiving stations (31, 32, etc.) other than station 33. Thus, there is at the transmitting station of Fig. 2A an impulse transmitter individual to each of the receiving stations of Fig. 2, operable for causing operation of the call signal bell at the particular receiving station.

Normally the telephone transmitter 75 is connected to the amplifier 76 and the source 85 is disconnected from the amplifier. When relay 86 is energized by operation of an impulse transmitter as described hereinafter, it disconnects the telephone transmitter from the amplifier, and connects the source 85 to the amplifier provided relay 87 is not energized. Energizations of relay 87 while relay 86 is energized are caused by operation of the impulse transmitter as described hereinafter, to create properly timed interruptions of the application of the 2000 cycle wave to the amplifier, the timing of the interruptions being such that the resulting combination of 2000 cycle wave trains transmitted to the amplifier, corresponds to the impulse combination or code individual to the receiving station for selection of which the impulse transmitter is designed.

Impulse transmitter 89 comprises a rotatable disc 71 provided with teeth, certain ones of which may be blocked out by adjustable cams 94 and 95 to obtain the particular number and combination of effective teeth desired for calling a particular station. The disc is adapted to rotate in a counter-clockwise direction, for causing its teeth to control contact springs 96 and 97 in circuit with the relay 87. The free end of the contact spring 97 is bent downward, and carries an insulating roller 98 which, as the disc rotates, is adapted to ride on top of the cam 95 and separate contacts 96 and 97 during the time of the passage of cam 95.

The contact spring 96 is normally out of engagement with the rotatable disc. During the revolution of the disc, spring 96 is in engagement with the disc, maintaining the circuit of the relay 86 closed to disconnect the telephone transmitter from the amplifier 76, and to connect the source 85 to the amplifier during such times as the relay 87 is not energized.

Assuming that while the clock controlled contact 25 is closed, the disc of transmitter 89 is caused to rotate for sending a call signal to step selector 40 to its circuit closing or bell ringing position. As the disc starts to rotate it causes springs to complete the circuit of relay 86. The relay disconnects the telephone transmitter from amplifier 76 and connects source 85 to the amplifier through the closed contacts of relay 87. Therefore the carrier wave from the radio transmitter is modulated by a 2000 cycle wave. The radio receiver detects this modulated wave, to operate relay 16 by the resulting 2000 cycle wave. Relay 16 operates relays 60 and 62, over a circuit extending from battery 10 through conductor 63, winding of relay 62, conductor 61, winding of relay 60, and contact of relay 16, to ground. Relay 62 closes its contact, to shunt switch 25. Relay 62 is preferably made a slow release relay, for the purpose of avoiding opening of the filament circuit of tubes 6 and 15, should the switch 25 open before transmission of the selective code signal has been completed. Relay 60 applies potential from battery 10 to line 28, charging condenser 42. The charging pulse energizes magnet 41, but the magnet releases its armature (not shown), and a restoring spring (not shown) restores contact 35 to the normal position of the contact, before the first tooth of the disc operates spring 96. As explained in the above mentioned Patent 1,343,256, the construction of the selector is such that, when the armature of magnet 41 returns to its normal (neutral) position, a holding pawl (not shown) is withdrawn from a position in which it prevents the restoring spring for the movable contact 35 from rotating the contact backward toward the normal position of the contact; and if the holding pawl remains withdrawn from its holding posi-

tion for a sufficient interval, the restoring spring for the movable contact returns the contact to the normal position of the contact.

As the teeth of the first group on disc 71 pass under the spring 96 they cause closures of the circuit of the winding of relay 87 at springs 96 and 97, with consequent interruptions of the application of the 2000 cycle modulating wave to the amplifier 76. Each group or train of modulating waves applied to the radio transmitter causes the relay 16 to operate relay 60 with consequent application of the voltage of battery 10 to line 28. The voltage thus applied to the line causes a charging current for condenser 42 to flow in one direction through the winding 41; and when the wave train ceases and relays 16 and 60 become deenergized, the condenser 42 discharges, sending current in the opposite direction through the winding 41. The reversals of current thus produced in winding 41 by the passage of the first group of teeth under spring 96, cause the selector 40 to step its movable contact 35 around, and an additional reversal and consequent additional step of rotation of contact 35 occurs as the spring 96 rises from the space between two teeth to the cam surface of cam 94. The contact 35 is thus stepped around a distance corresponding to the total number of reversals in this group of reversals thus produced by the first group of teeth and the cam 94. The duration of the period in which spring 96 rests on cam 94 is sufficient to allow the restoring springs of the selectors to return the movable contacts of the selectors to their normal positions; but, as explained in the above mentioned Patent 1,343,256, those selectors, including the one at station 33, which are arranged to respond to codes of reversals, the first group of which is made up of the number of reversals in the group of reversals produced by the first group of teeth on disc 71 and the cam 94, will, in releasing their armatures, cause a holding spring (not shown) to engage the movable contact and hold it in advanced position.

As cam 94 passes from under spring 96 and the second group of teeth pass under the spring, a second set of trains (or groups) of modulating waves is applied to amplifier 76. Consequently a second set of energizations of relays 16 and 60 ensues. Contact 35 is therefore stepped to a position in which it is held while cam 95 passes under roller 98.

As the third group of teeth and the initial portion of a smooth surface 100 of disc 71 pass under spring 96, a third set of trains or groups of modulating waves is applied to amplifier 76, and cause energizations of relays 16 and 60. Contact 35 is therefore stepped to its circuit closing position, where it is held during the period in which surface 100 is in mechanical and electrical contact with spring 96. This period is a ringing period for the call bell 21. The 2000 cycle modulating wave is not transmitted to amplifier 76 during this period.

After the ringing period, a smooth surface 101 of disc 71 passes under spring 96, causing the 2000 cycle modulating wave to be transmitted to the amplifier, so that relays 16 and 60 operate and contact 35 is released, and is returned to its normal position by its restoring spring (not shown).

When disc 71 reaches its normal position, relay 86 is deenergized, and disconnects source 85 from the amplifier and connects the telephone transmitter 75 to the amplifier.

During the ringing period or as soon thereafter as possible, the operator at station 33 removes receiver 45 from its hook, to connect the receiver to line 28 for listening to the message which is about to be transmitted from transmitter 75.

As explained above, while the receiver is off of its hook the slow release relay 62 is energized over the above traced simplex circuit, to maintain the filament heating circuit for tubes 6 and 15 closed. When the receiver is replaced, after transmission of the message has been completed, these circuits are opened.

The condenser 50, if employed, prevents any tendency for direct current to flow to receiver 45.

As indicated by the antenna 1′*a* in Fig. 2, a plurality of systems such as that shown in the remainder of the figure may be employed to receive from the transmitting station of Fig. 2A. These receiving systems may be located in various parts of the country, and the selective apparatus associated with each receiving station such as the stations 31, 32 and 33 may be arranged to respond to a system of code signals individual to the receiving station.

What is claimed is:

1. A radio telephone receiving apparatus comprising a space discharge device, a local source of power therefor, timing means for normally disassociating and for periodically associating for short periods said device and said source of power, a circuit controlling device controlled by said space discharge device and controllable through said device from a distant radio transmitting station, whereby said transmitting station may operate said circuit controlling device during said periods and means operable by a local operator for associating said device and source of power independently of said timing means whereby said receiving apparatus may be maintained energized for longer periods when desired.

2. A radio signaling network comprising a central station, a plurality of outlying stations, receiving apparatus at each of said

outlying stations comprising a power operated device and a local source of power therefor, timing means for normally disassociating and for periodically associating said device and said source of power for short periods independently of said central station, a calling device for each of said outlying stations controllable from said central station only when said source of power is associated with said power operated device, whereby said central station may call each of said outlying stations during said periods, and means at each of said outlying stations operable by a local operator during any of said periods for associating said source with said power operated device independently of said timing means to enable said central station to communicate with said operator for a longer period.

3. A system comprising receiving circuits for receiving signals from a common source, timing means for periodically rendering certain of said circuits operative to receive signals from said source for given time intervals, and timing means for periodically rendering certain of said circuits operative to receive signals from said source at times exclusive of said intervals.

4. In combination, a plurality of separated signal stations, call signal devices at said stations, respectively, station selectors at said stations, respectively, responsive to selecting impulses to select said stations in accordance with an impulse code and operate the call device at the selected station, common radio receiving means for said stations, for receiving radio waves representing signals and station selecting impulses, connecting means connecting said radio receiving means to said stations, and timing means for periodically rendering said radio receiving means operative.

5. In combination, a plurality of separated signal stations, call signal devices at said stations, respectively, station selectors at said stations, respectively, responsive to selecting impulses to select said stations in accordance with an impulse code and operate the call device at the selected station, a radio receiver common to certain of said stations for receiving radio waves representing signals and station selecting impulses, another radio receiver common to certain others of said stations, for receiving radio waves representing signals and station selecting impulses, timing means for periodically rendering one of said radio receiving circuits operative for given time intervals, and timing means for periodically rendering said other radio receiver operative at times exclusive of said intervals.

6. A wave receiving system comprising selectors, means responsive to energy pulses for operating said selectors, timing means for periodically rendering said first means operative, and means responsive to the operation of said first means by said pulses for maintaining said first means operative between said pulses.

7. In combination, a plurality of separated signal stations, message receiving means at said stations respectively, call signals at said stations, station selectors at said stations respectively, responsive to selecting impulses to select said stations in accordance with an impulse code and operate the call signal at the selected station, common radio receiving means for said stations, for receiving radio waves representing messages and station selecting impulses, connecting means connecting said radio receiving means to said stations, means at each of said signal stations for connecting the message receiving means at the station to said connecting means, timing means for periodically rendering said radio receiving means operative, and means responsive to connection of any one of said message receiving means to said connecting means for maintaining said radio receiving means operative while said message receiving means is so connected.

8. In combination, a signaling line, a plurality of signal stations connected to said line at separated points along the line, message receiving means at said stations respectively, calling signals at said stations respectively, station selectors at said stations respectively, responsive to selecting impulses to select said stations in accordance with an impulse code and operate the call signal at the selected station, radio receiving means connected to said line for receiving radio waves representing signals and station selecting impulses, means at each of said stations for connecting the message receiving means at the station to said line, timing means for periodically rendering said radio receiving means operative, maintaining means for maintaining said radio receiving means operative while said message receiving means is connected to said line, a simplex operating circuit for said maintaining means, said simplex circuit including said line, and means operable in response to connection of said message receiving means to said line to close said simplex operating circuit.

9. A radio telephone system comprising a transmitting station and one or more receiving stations, receiving apparatus at each of said receiving stations comprising, a power operated device, a source of power therefor, timing means for normally dissociating and for periodically associating said device and said source of power, a calling device at each of said receiving stations controllable from said transmitting station only when said source of power is associated with said power operated device whereby said transmitting station my call any one of said re-

ceiving stations during such periods, and means operable at each receiving station for receiving messages from said transmitting station, said means maintaining said power operated device and said source of power associated independently of said timing means.

In witness whereof, I hereunto subscribe my name this 26th day of February A. D. 1927.

HENRY P. CLAUSEN.