Jan. 3, 1939. J. SADOWSKY 2,142,874

INTERCOMMUNICATION SYSTEM

Filed June 9, 1937 3 Sheets-Sheet 1

Fig. 1

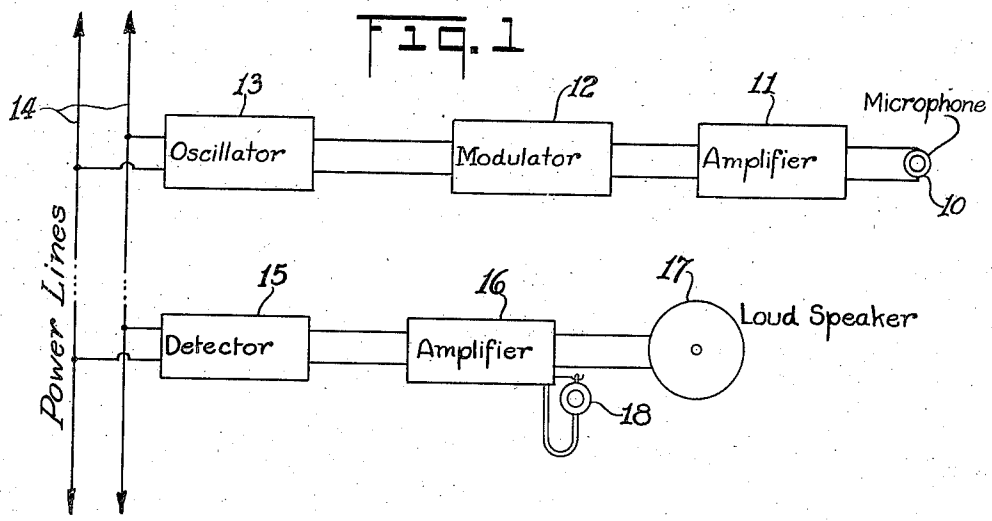
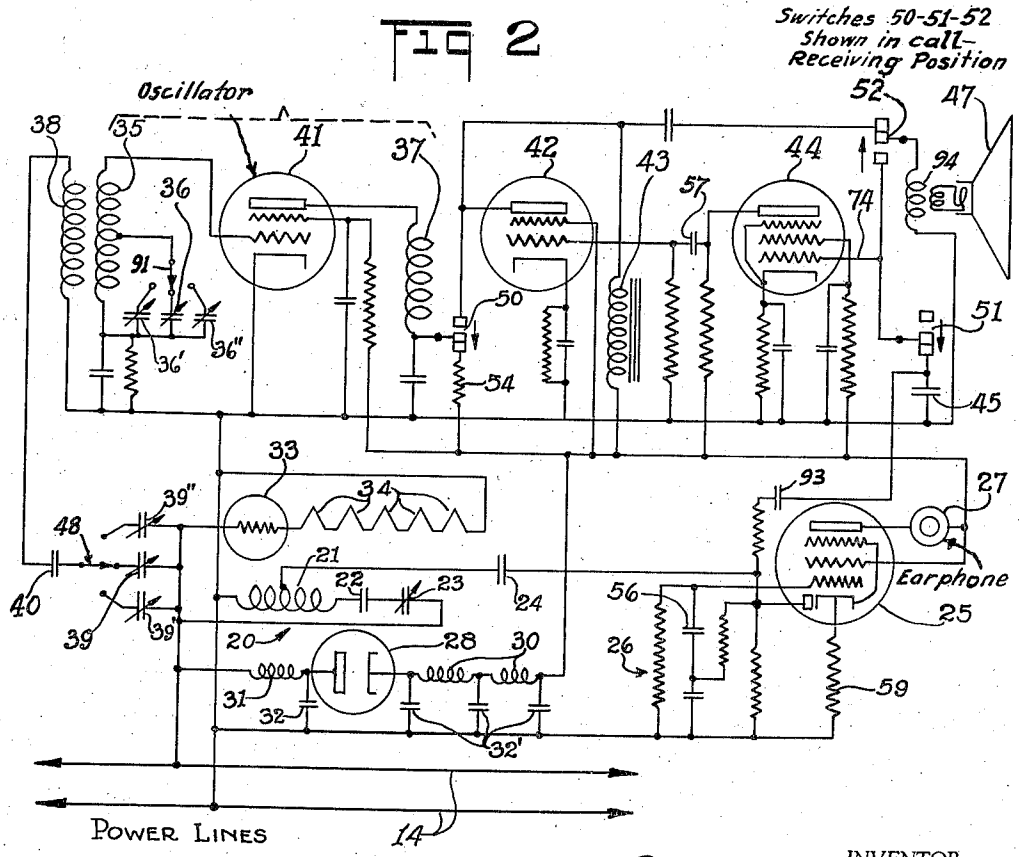


Fig 2



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INTERCOMMUNICATION SYSTEM

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Fig 3

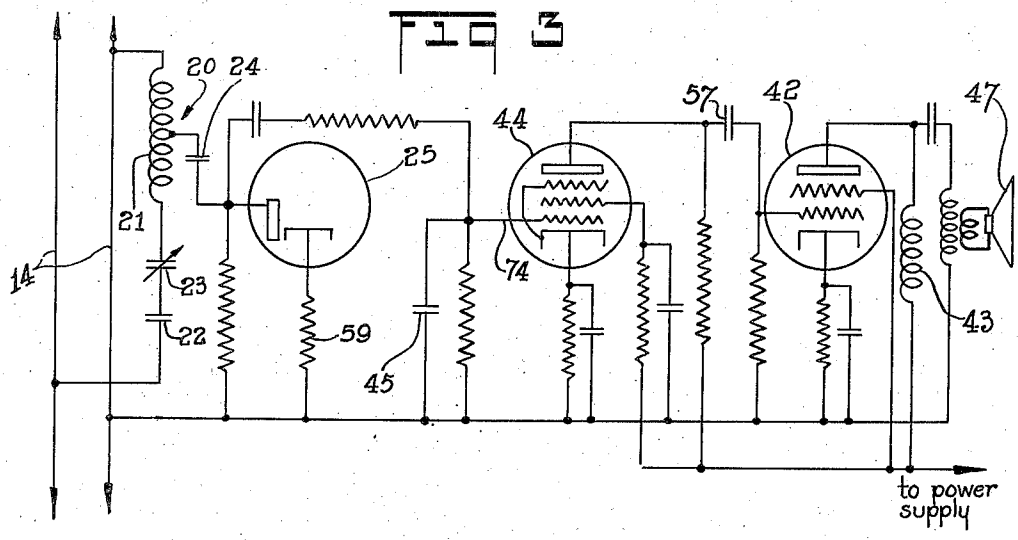
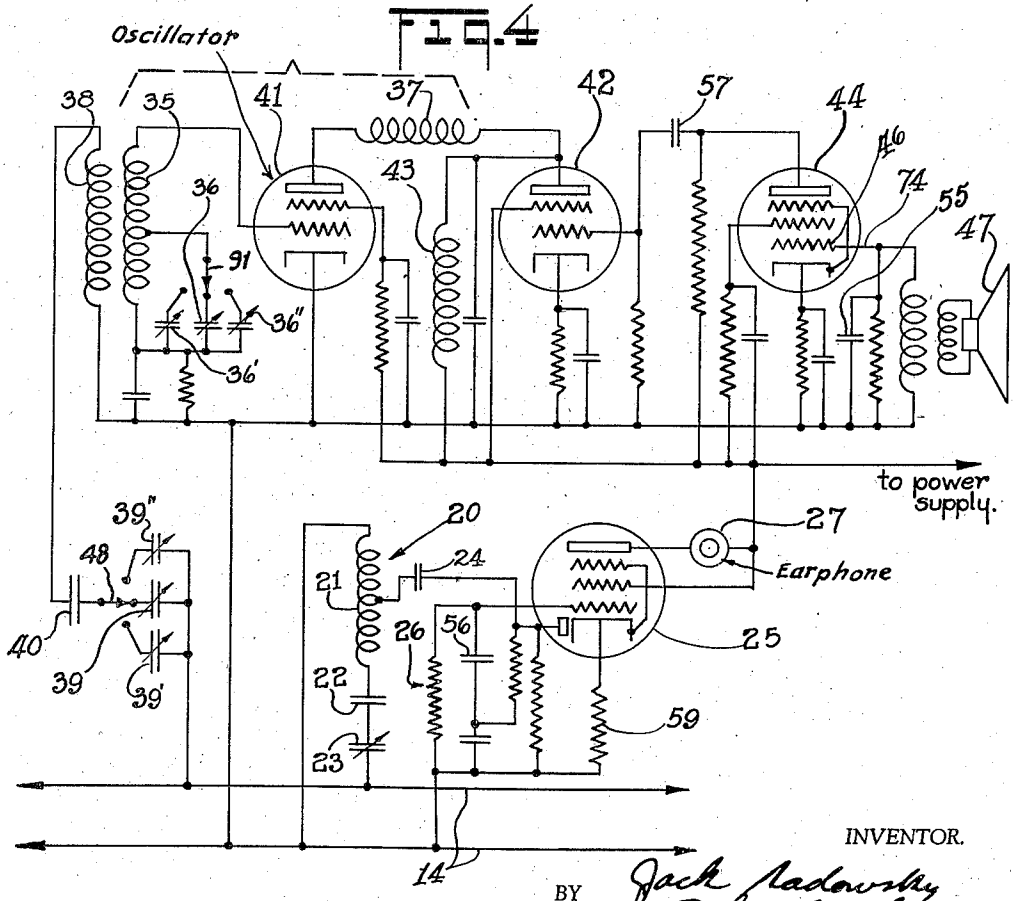


Fig 4



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INTERCOMMUNICATION SYSTEM

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Fig. 5

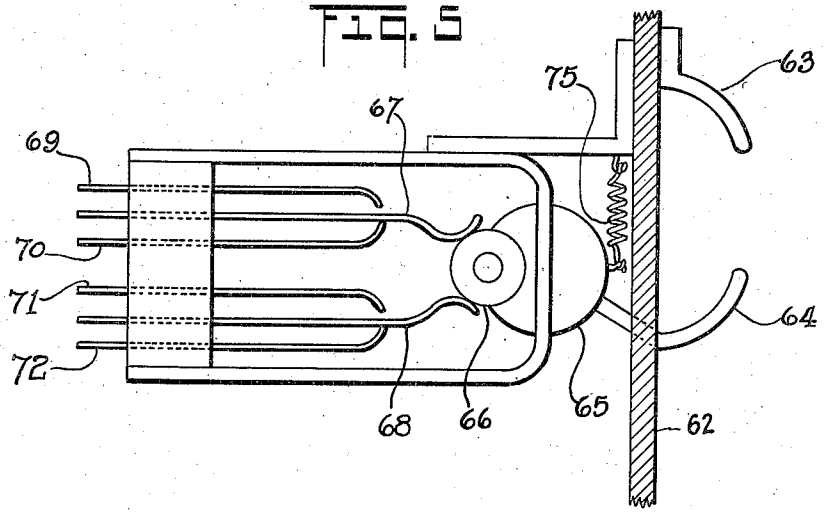


Fig. 6

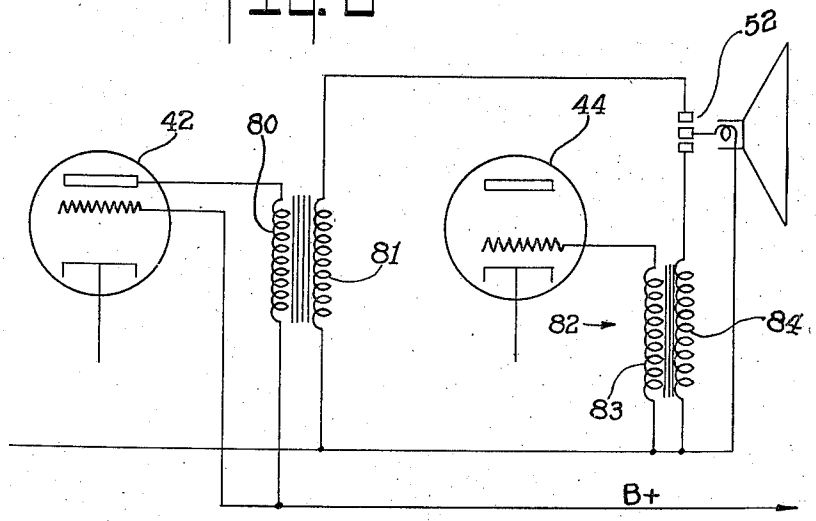
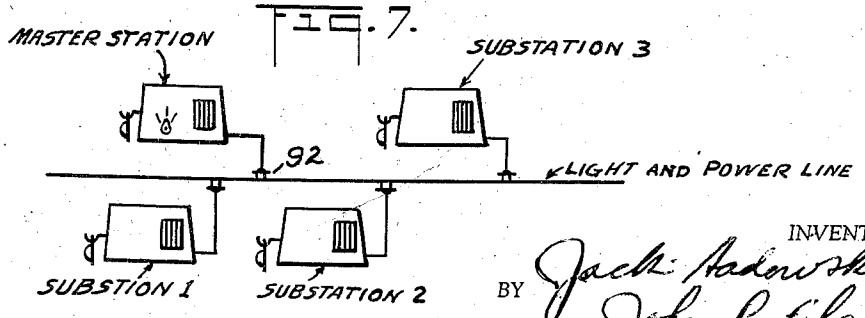


Fig. 7.



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UNITED STATES PATENT OFFICE

2,142,874

INTERCOMMUNICATION SYSTEM

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Application June 9, 1937, Serial No. 147,159

15 Claims. (Cl. 179—2.5)

This invention relates to intercommunication systems which may be employed in houses or factories.

It further relates specifically to circuits used in portable radio systems for two-way telephone communication, using as their transmitting lines the power cables installed for lighting purposes, and the primary object of my invention is to generally improve such systems.

The primary requirement of a good intercommunication set is speed in calling the person wanted, together, with portability and absence of wire lines.

The system embodied herein employs a radio frequency sending set, consisting primarily of a microphone, modulator unit and oscillator unit, connected by suitable coupling means to the wire lines. The receiving system is fundamentally a simple detector or demodulator unit, together with a speech amplifier and loud speaking unit or headphone. No invention on these units is claimed, apart from the system as claimed herein, since the individual units have been used for some time in various systems and even on wire lines. But the embodiment of this invention is comprised in the adaptability of these units, both sending and receiving, to a single compact unit which may be easily portable, and can be moved from one room to the other or from one station to the other, by simply pulling a plug from any lighting socket and plugging the station into any other lighting socket.

In addition to the portability and the compact arrangement of tubes and circuits, the calling means is also specified as part of this invention. A loud speaker unit is used to call the person wanted, and on answering, the system including some tubes and a number of circuits associated with the tubes, is transformed to a new and different circuit so that the loud speaker becomes a long distance microphone and the received sound is picked up on a small earphone.

One object of my invention is to provide a call signal which is by means of verbal speech, thus making it possible to call a specific person or to issue a specific command. For call purposes, the system is a loud speaking system, but in accordance with a further object of my invention, the conversation itself after the call is answered may be kept private through the use of an ear phone.

Still another object of my invention is to employ several parts of the apparatus for dual purposes, the loud speaker being used either as a loud speaker for calling purposes or as a microphone for transmitting purposes, and the audio amplifier being used either to amplify the incoming call before feeding the same to the loud speaker, or to amplify the microphone output of the loud speaker before using the locally transmitted speech for modulation of the carrier wave.

Still another object of my invention is to make the conversion of the station from the call receiving condition to the two-way communication condition an automatic conversion, this being done by means of a hook switch for the ear phone, the said switch being so arranged that mere removal of the ear phone from the hook makes all of the necessary changes in the apparatus.

Further objects center about the coupling of the station to the power line, and this is preferably done by means of series resonant circuits in order to present a low impedance to the line so as to at least approximately match the same, particularly when, as is frequently the case, the line is heavily loaded with low impedance apparatus. Still another object of the invention is to make possible the intercommunication of a master station and a substantial number of sub-stations, the connections therebetween being independent and mutually non-interfering. To this end, a plurality of carrier waves of differently spaced frequency is employed, and the receiving circuits must discriminate between the adjacent carrier waves. For good selectivity, the apparatus would have to be complicated by cascaded tuned circuits coupled by vacuum tube relays, but in accordance with a further object and feature of my invention, the apparatus is simplified and kept inexpensive by using a simple receiving circuit which might not be sufficiently selective if the detector were used for most efficient rectification, but instead, the detector is so biassed as to decrease the rectification efficiency, and this eliminates the broad base of the adjacent resonance curves which might otherwise overlap. This improvement also helps eliminate noises of low level.

Further objects center about the switching arrangement for the combination loud speaker and microphone, and are, first, to provide good impedance matching at the input and output of the audio frequency amplifier, and second, to eliminate audio frequency feed-back. These objects are fulfilled by connecting the low potential voice coil of the speaker to the switch contacts and using separate impedance matching transformers for the input and output of the amplifier, these transformers differing from one another and being selected to properly match the appropriate end of the amplifier on one side, while matching the low impedance voice coil on the other.

To the accomplishment of the foregoing and such other objects as will hereinafter appear, my invention consists in the communication system elements and their relation one to the other, as hereinafter are more particularly described in the specification and sought to be defined in the claims. The specification is accompanied by drawings, in which:

Fig. 1 represents a simplified unit system in

which only the fundamental units are shown in their generalized connection;

Fig. 2 is a wiring diagram of a master station for communication with three sub-stations, said diagram showing all switches and all circuit units;

Fig. 3 is a simplified diagram of the apparatus of Fig. 2, showing only those units which are in use when the station is in a call receiving position;

Fig. 4 is similarly simplified, with the station arranged for two-way communication. In this figure also all unnecessary parts have been omitted and only those in actual use are shown;

Fig. 5 is a detailed view of the switch, indicating how the contacts are changed and showing the method in which the earphone is set into its container or hook on the side of the box;

Fig. 6 is a wiring diagram for a modified and in some respects preferred method of switching the speaker in its relation to the audio amplifier; and

Fig. 7 is a schematic diagram explanatory of the manner in which the master station and sub-stations are all connected to an ordinary light and power line.

No specific limitation is intended to cover the actual operation in practice in regard to the number of stations which may operate, nor the manner in which a master or control unit may be used to talk to sub-stations. It will be quite evident to those experienced in the art that many combinations of these circuits are available and may be used for various types of intercommunication systems. For the sake of clearness, however, one specific system will be described.

This employs a single master oscillator and three sub-stations, as is schematically indicated in Fig. 7. The circuit of the master station is shown in Fig. 2. Each sub-station has a circuit generally as shown in Fig. 2, but with the oscillating unit tuned to a single definite frequency. The master oscillator shown in Fig. 2 differs by the addition of a selector (numbered **90** in Fig. 7, and moving switches **91** and **48** in Fig. 2) which selector changes the tuning in the transmitting circuit, so that it may call or talk directly to either one of the sub-stations without calling or interfering with any other sub-station. In this system, the master set may communicate with any one of the three sub-stations, but the sub-stations may communicate only with the master. Other variations, with additional selector switches, are available to enlarge such a system to any number of sub-stations, masters, or sub-masters.

Referring now to Fig. 1, this shows a schematic representation of the five fundamental divisions of such a communication system. The microphone **10** delivers its signal to the speech amplifier **11**, which is connected to the modulator **12**. An oscillator **13** of predetermined high frequency serves to generate a carrier wave and the modulator **12** allows the speech amplifier **11** to vary the power of said oscillator so that the power variations are in conformity with the speech input. This modulated power is connected to the power lines **14**, which run to the receiving system, consisting of a demodulator or detector **15** and an amplifier **16**, to which may be connected either a loud speaker **17** or an earphone **18**. The demodulator **15** is connected to the power lines and rectifies or otherwise makes available the speech signal which has been carried over the lines by the carrier current from the oscillator. This demodulated wave is passed on to the amplifier and is heard by the loud speaker or earphone.

Figs. 2, 3 and 4 indicate the type of circuit used in this device. The power lines **14** are connected to a receiving circuit **20** which consists of an inductance coil **21**, a fixed condenser **22** and a variable condenser **23**. The inductance **21** and the two condensers **22** and **23** are set so that they give series resonance to the incoming signal. The received signal is taken from this circuit by tapping the inductance **21** in the center and through a series condenser **24** connection is made to a rectifier tube **25**. This rectifier tube is of the form generally known to the trade as 6B8, although it is understood that any similar tube may be used. The tube 6B8 as shown is in reality a double tube, since it contains a diode unit for rectification and a pentode unit for amplification. Two separate tubes embodying similar characteristics may be used instead of this single tube. The signal received on the diode through the condenser **24** passes through the coupling circuit **26** and the audio frequency component is then amplified by the pentode part of tube **25**, and the amplified signal is connected to an earphone **27**.

In order to have D. C. plate voltage available for the operation of the various tubes in the set, a rectifier tube **28**, together with associated circuits, is bridged directly across the line **14** and the output of said rectifier is connected to both receiving and transmitting plate circuits. The rectifier circuit as used is of the conventional type having two audio frequency choke coils **30** and three electrolytic condensers **32'**. In order to keep the high frequency oscillator voltage from being short circuited by the low impedance rectifier circuit, a radio frequency choke coil **31** is connected in series with the rectifier supply wire and a shunting condenser **32** is connected across the rectifier supply lines. This effectively keeps the oscillator frequency on the power lines and does not allow it to be transferred to and affected by the power supply part of the system.

For the filament supply of all tubes, a ballast tube **33** is connected in series with all filaments **34** and this series unit is connected across the power lines **14**. For the sake of simplicity, the filament circuit is not indicated in the tubes themselves, but is shown at the bottom of Fig. 2 in schematic arrangement, as is shown in such wire diagrams. It has been found expedient to use heater tubes for such circuits and the two diagrams indicating cathodes in all tubes are assumed to have such heater cathodes.

The oscillator is a conventional type circuit known as an inductive feed-back circuit. The main oscillating circuit consists of an inductance **35** and a tuning condenser **36**. The plate inductance **37** is coupled to this circuit in order to provide the proper oscillation characteristics. To this oscillating circuit **35**, **36**, another inductance coil **38** is coupled in order to transfer the oscillator power to the power lines **14**. This transfer of power is made more effective by including a capacity **39** in series with the coil **38**. This makes the coupling circuit a series resonant circuit of low impedance at the frequency used. Because the master oscillator operates on three frequencies, the series capacity **39** may be changed or switched to other values **39'** or **39''** by switch **48**, and the oscillator tuning condenser **36** may be switched to **36'** or **36''** by switch **91**.

This condenser **39** is a fixed-adjustable condenser and is connected to the selector switch **48** which may substitute for condenser **39** another similar but differently tuned fixed-adjustable condenser **39'** or **39''**. The oscillator tube **41** is a conventional tube known to the trade as type

25L6. The modulator tube 42 is also a type 25L6 and is connected to the oscillator by the well known plate modulation circuit, which consists of connecting the two plates together through an inductance coil 37, and supplying plate current through an audio frequency choke coil 43. In each of these tubes as described, a screen grid is connected to the high voltage plate supply wire and sometimes such connection is made through a resistor or a resistor shunted by or by-passed with a condenser. This is common practice and is well known to those skilled in the art and need not be elaborated on here. Also, the system whereby a resistor is put in series between the cathode and the ground wire shunted by a condenser in order to obtain proper biasing voltage for the grid circuit, is common practice and need not be detailed.

A modulator tube 42 receives its input from the plate circuit of the microphone amplifier tube 44 and for the purpose of the specific circuit of this description the tube 44 is a type 6J7. This tube is a small pentode tube and receives its input from a coupling condenser 93 during the calling operation, which condenser is connected directly to the grid of the amplifier tube 44. The screen grid of this tube has a conventional connection to the plate supply and the plate element of this tube is connected by a conventional condenser-impedance circuit to the modulator. The loud speaker 47 is employed in the dual role of a loud speaker in the call receiving position and a microphone in the talking position. The switchover from call receiving to talking positions is made possible by three switches, 50, 51 and 52, said switches being operated by the earphone clip on the side of the box.

With the plug (92 in Fig. 7) inserted into the wall outlet, the tubes are energized. When the master unit is calling a sub-station, the switches at the called station are in a position as shown by the arrows in Fig. 2. In this position the switches cause certain parts of the circuit to be inoperative, as shown by a simplified drawing, Fig. 3. Here only the receiving circuit is shown, the oscillator circuit being not in operation and the pentode part of tube 25 cannot be employed because the earphone 27 is not used. Switch 52 is connected in such a manner that the loud speaker 47 is used as a loud speaker and receives power directly from the plate of tube 42. The control grid of this tube 42 is connected through a suitable coupling circuit so that it receives the speech wave from the plate of tube 44. The control grid circuit of tube 44 is connected through switch 51 so that it receives speech energy from the diode portion of tube 25.

As the master unit sends out a signal, it is received on the receiving circuit 20, Fig. 3, and is demodulated by the diode part of tube 25 and amplified by the two tubes 44 and 42, and then transformed into audible power by the loud speaker 47, resulting in a considerable signal which will be sufficient to call anyone from quite a distance. When the person called answers, he lifts the earphone 27 from the hook, thus throwing all three switches 50, 51 and 52, and transforming the scheme of connections into that shown in Fig. 4. In both Figs. 3 and 4, filament circuits and the plate supply rectifier circuits have been omitted for the sake of simplicity. The received signal (Fig. 4) now arrives through the receiving circuit 20 and is transferred as usual through the coupling condenser 24 to the diode part of tube 25, and the rectified signal is amplified in to the pentode part of tube 25 and the plate circuit of said tube is connected directly to the ear phone 27, which is now the only means of receiving the audible signal.

It may be seen from Fig. 2 that throwing of switch 52 converts loud speaker 47 into a microphone, and the throwing of switch 50 connects the modulator tube 42 directly with the oscillator tube 41, and allows sufficient plate current to flow through the coil 37 to the plate of the oscillator tube 41 in order that it may function as an oscillaor and send out power through the oscillator coupling coil 38. The loud speaker 47, because of the amplification provided and because of the area included in its diaphragm, may pick up conversation at quite a distance and the user at the sub-station may stand several feet from this microphone while talking to the master control unit. The output of this microphone is connected to the tube 44, which now becomes a simple amplifier tube and thence to the tube 42 which acts not only as an amplifier, but as a modulator for the oscillating circuit controlled by tube 41. When switch member 50 is in a receiving position, the plate supply is connected to the plate of the oscillator tube 41 through the radio frequency inductance 37 and a series resistance 54. This series resistance is made of such a value that it will keep the oscillator tube from oscillating even though a small amount of plate current may flow through the tube and the filament is still lighted. As soon as the switch 50 is thrown to the transmitting position, by lifting the receiver 27 from its hook, the full plate voltage is supplied to the tube 41 through the low resistance inductance 37 and the oscillator immediately sends out a carrier wave over the power lines 14.

Power lines in residences have been found to be very good for the transmission of high frequency carrier waves, particularly those of frequencies between 30,000 cycles per second and 200,000 cycles per second. Furthermore, experiment has shown that such frequencies will not go through the various coils in the meter, which is generally installed at the power line entrance to the house, so that any communication on the user's side of the meter will be confined to that particular circuit and will not leak out and travel to the next house to cause interference there.

Transmission is exceptionally good when there is no overload on the line. Experiment has shown that ordinary lights and even small motors when put on the line cause little or no interference and an imperceptible drop in the efficiency for such transmission as has been outlined. However, the operation of heating devices, such as electric stoves, large flat irons and very large motors, when connected to the power lines very close to the plug in which the intercommunication set is attached, will seriously drop the efficiency of the communication when ordinary tuned circuits are used. In order to offset some of this low impedance interference, the receiving circuit 20 has been arranged to operate on a very low impedance basis and for this purpose the inductance 21 and the condensers 22 and 23 are connected in series so that at resonance their impedance is of the order of a few ohms. This permits the receiving of signals even though other low resistances may be on the line in close proximity. The coil 21 is tapped in the middle for the connection to the diode rectifier 25 through the condenser 24. This is done in order to greatly increase selectivity with only a slight

loss of power, due to the fact that the diode is a low resistance unit and would spoil selectivity because it would shunt half of tuned circuit **20** if the connection were made at the end of the coil **21** between the coil **21** and the condensers **22** and **23**.

The operation of two or more receiving units on the same power lines presents no difficulty, since the ordinary rules of receiving circuits apply here in the same manner as they do to radio circuits and tuning to one frequency from the master oscillator eliminates other frequencies, as is done in exactly the same way in a radio set. Suitable condensers such as **24**, **57** and **93** are placed in the circuit in order to cut out as much 60 cycle hum as possible.

Additional hum elimination is obtained by the use of a loud speaker unit which is tuned to a free period of about 300 cycles per second. This characteristic permits the transfer of audible voice signals without detracting from their quality but cuts down to a very low ratio the 60 cycle hum if any should leak through the system.

Another noise eliminator is built into the detector circuit in the method of biasing. The biasing resistance **59** is made higher than is necessary so that small voltages which are due to interference picked up from motor commutators or sparking contacts will not get past the diode detector circuit. Only the voice signal which has considerable power will override the detector bias and pass into the amplifier. The diode portion of tube **25** is biased at such a potential as to eliminate all signals of voltages below the bias voltage. Such signals would include low volume noise, and adjacent carrier signals. Because of the selectivity of the series resonant tuned receiving circuit, the adjacent carrier is of necessity brought to a much lower volume than the desired signals. It is found in actual practice that the bias can be substantial, without appreciably affecting the quality of the desired signal. If, for example, the bias is twenty per cent of the peak voltage of the carrier, an undesired signal of less than twenty per cent of the desired signal is automatically eliminated thereby increasing the apparent selectivity. This bias may be either positive or negative.

Fig. 5 gives a detailed view of a switch which is operated when the earphone is set into clips. The switch assembly is fastened to the side of the box **62** and the upper earphone clip **63** is firmly attached to the box structure. The lower clip **64** is moveable by virtue of its attachment to the switch cam **65**, and when the earphone is not in place the lower clip **64** is pulled upward by the spring **75**. When the earphone is attached, both upper and lower clips **63** and **64** engage the circular cap on the earphone unit, holding it securely and at the same time keeping the moveable arm in an extended position.

On the switch cam **65** is attached a fibre roller **66** which engages the spring contact arms **67** and **68** and these in turn make contact with the spring members **69** and **71** when the earphone is in the clips and **70** and **72** when the earphone is removed. This structure is equivalent to two single pole double throw switches. Actually the unit contains four of these, the other two being directly behind the two shown in the drawings and all four acted upon by the roller **66**. Three of these switches are connected in the circuit as switches **50**, **51**, and **52**. The fourth may be used to disconnect the wire **74** from the grid of the tube **44** when the higher frequencies are used.

Fig. 6 shows an alternate switching means for the loud speaker. The circuit is similar to the one incorporated in Fig. 2, but differs from it in that the voice coil of the speaker is connected to the switch instead of a high impedance transformer. This switching of low impedance circuits is used when high frequencies are employed and this results in the set being more stable and less noisy. The primary winding **80** is left in the plate circuit of tube **42** and the secondary **81** is connected to one contact of switch **52**. In the grid of tube **44**, another transformer **82** is used in which the high voltage winding **83** is always connected to the grid circuit. The low voltage winding **84** is connected to switch **52**. The operating circuit is the same except that transformer **80**, **81** replaces the choke and the associated blocking condenser.

To explain the advantages of the alternative circuit shown in Fig. 6, I may mention that two difficulties tend to arise with the circuit of Fig. 2. The first difficulty is that the transformer **94** is selected as a compromise between conflicting requirements, for it should be a high impedance transformer when the speaker acts as a microphone and the transformer feeds into the amplifier input, and should be a low impedance transformer when the speaker acts as a reproducer and transfers energy from the amplifier output to the speaker. The second difficulty is that the physical necessities of the multiple contact switch construction cause the contacts connected to both the input and output ends of the amplifier to be in close proximity, and if the voltages on the contacts are high, as when using a transformer of substantial impedance, there is a tendency for self-oscillation or squealing. In Fig. 6, both of these difficulties are overcome. The first difficulty is overcome because two separate transformers are employed, one, the transformer **82**, acting as an input transformer for the amplifier; and the other, the transformer **80**, **81**, acting as the output transformer for the amplifier, and these are selected to have impedance best suited for their respective functions. The secondary **83** of transformer **82** is of high impedance, and primary **80** of the output transformer is of low impedance. The second difficulty is overcome by connecting the switch contacts directly to the voice coil and the low impedance sides of the transformers, for the voice coil is of low impedance, and the low impedance sides of the transformers (specifically, primary **84** and secondary **81**) are similarly of low impedance, in an effort to match the impedance of the voice coil. In this way the potentials at the switch contacts are very low, and there is no appreciable tendency toward audio frequency feed-back or squealing.

It is believed that the construction and operation, as well as the many advantages of my improved intercommunication system, will be apparent from the foregoing detailed description thereof. The operation may be summarized as follows:—Assuming that A at the master station wishes to call B at sub-station **1**, he picks up the ear phone from the hook, thus making the transmitting oscillator effective. He turns the selector switch to sub-station **1**, thereby tuning the parallel resonant circuit of the oscillator, and the series resonant circuit coupling the same to the power line, to a carrier or transmission frequency corresponding to the reception frequency of sub-station **1**, that is, corresponding to the tuned frequency of the series resonant circuit which couples the power line to the receiving detector at

substation 1. A thereupon calls B by name, or transmits any suitable verbal instructions which will lead to calling B at sub-station 1. This verbal call is reproduced by the loud speaker at sub-station 1, for at this time the ear phone is not in use and consequently the hook switch is down, thus connecting the detector to the audio amplifier and connecting the latter to the loud speaker. When B answers at sub-station 1, he merely picks up the ear phone from the hook and answers A. In picking up the ear phone, the hook switch converts the loud speaker from its function as a loud speaker to instead operate as a microphone, and it is connected to the audio amplifier which in turn is connected to modulate the local oscillator at sub-station 1. This local oscillator is fixedly tuned to the reception frequency of the master station, and any answer spoken by B is heard by A in the ear phone at the master station. The conversation thus proceeds privately until concluded, at which time the parties may hang up the ear phones on the respective hooks.

Similar description applies to a call put in by A from the master station to sub-station 2, or to sub-station 3, etc.

If B at sub-station 1 wishes to call A at the master station, he merely picks up the ear phone and calls A verbally. His call is transmitted through the local loud speaker, acting as a microphone, and after amplification in the local audio amplifier, the call modulates the radio frequency being generated by the local oscillator at substation 1. This energy is fed to the power line, and is reproduced through the detector, the audio amplifier and the loud speaker at the master station. When A hears the call and picks up the ear phone, the loud speaker is instantly quieted and thereafter acts as a microphone for A's answer to B.

Similar description applies to a call put in at station 2 or station 3, etc. Any of these calls from any sub-station is heard at the master station regardless of the position of the selector switch. This is so because the sub-stations all transmit on a common frequency and the selector switch at the master station affects only the transmission frequency and not the reception frequency at the master station.

It will be understood that with only two stations it is unnecessary to use a selector switch, and in such case, only two carrier frequencies will be employed, one for transmission from one of the stations, and the other for transmission from the other station.

The advantages of my improved system may be briefly reviewed as follows. One outstanding advantage is that the call signal is by means of verbal speech instead of merely a bell, signal lamp, or the like, thus making it possible to issue a peremptory command or to call a specific person from among many. Yet the conversation itself may be kept private, through the use of an ear phone. Another advantage is the dual use of important parts of the apparatus. The loud speaker is used either as a loud speaker for calling purposes, or as a microphone for transmitting purposes. The audio amplifier is used to amplify the incoming call before feeding the same to the loud speaker, and is also used to amplify the microphone output of the loud speaker before using the locally transmitted speech for modulation of the carrier energy generated by the local oscillator. From another viewpoint, it may be said that the microphone and audio frequency amplifier which would anyway be needed for transmission, are additionally employed for paging or loud speaking reception when the station is being called.

The conversion of the station from call-receiving condition to duplex communication condition is preferably obtained automatically by means of a hook switch for the ear phone, so that mere lifting of the ear phone from the hook will make the necessary changes in the apparatus. The coupling of the transmitting and receiving parts of the station to the power line is made by means of series resonant circuits, this having the advantage of presenting a low impedance to the line so as to at least approximately match the same. In respect to the transmitter, there is the advantage that there will be no loss of efficiency even when the line is heavily loaded with low impedance power consuming apparatus. In general, for efficient coupling of the transmitter, one should feed into a matched impedance or if that cannot be done, into a higher impedance. The line impedance is variable and varies over wide limits from time to time, as when apparatus having low impedance to the signal energy is connected to the line. In the present invention, the impedance of the transmission system is kept low by the use of a series resonant coupling circuit.

Selective calling of a number of stations is made possible by using a number of different carrier frequencies. These may be spaced reasonably widely apart, but cannot be spaced too far apart without going outside the range of best frequency for the present purposes. Reasonably good selectivity is therefore desirable, but that in turn would require the use of cascaded tuned circuits coupled by vacuum tubes. In the present apparatus this additional complexity of equipment is eliminated by using a simple receptive circuit which might not be sufficiently selective were the detector used in unbiassed condition for most efficient rectification. Instead, the detector is biassed to decrease the detection or rectification efficiency by a small amount, and this eliminates the base or broadest part of the resonance curve, thus insuring against overlapping of the resonance curves of adjacent carrier waves employed in the system.

It will be apparent that while I have shown and described my invention in preferred forms, many changes and modifications may be made in the structures disclosed, without departing from the spirit of the invention defined in the following claims.

What I claim is:

1. A duplex station for a telephone communication system for wired radio communication on lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator tuned to a transmission carrier frequency, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a combination loud speaker and microphone, means connecting said station to a line including means for coupling both the oscillator and the detector circuit simultaneously to the line, a switch movable between paging and duplex-telephony positions, means for energizing the loud-speaker from the detector for paging or call-receiving purposes when the switch is in the paging position, and means to connect the loud speaker to modulate the oscillator for transmission purposes when the switch is in the duplex-

telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker.

2. A duplex station for a telephone communication system for wired radio communication on lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator tuned to a transmission carrier frequency, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a combination loud speaker and microphone, a hook switch for supporting the earphone and being thereby held in paging position when the earphone is not in use, said switch being biased to move to duplex-telephony position when the earphone is removed from the hook, and means connecting said station to a line and including radio frequency couplings for coupling the oscillator and the detector circuit to the line, means for energizing the loud speaker from the detector for paging or call-receiving purposes when the switch is in paging position, and means to connect the loud speaker to modulate the oscillator for transmission purposes when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker.

3. A duplex station for a telephone communication system for wired radio communication on lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator tuned to a transmission carrier frequency, an audio frequency amplifier, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a combination loud speaker and microphone, means connecting said station to a line and including radio frequency couplings for coupling both the oscillator and the detector circuit simultaneously to the line, a switch movable between paging and duplex-telephony positions, means to connect the detector to the input of the amplifier and means to connect the loud speaker to the output of the amplifier for paging or call-receiving purposes when the switch is in the paging position, and means to connect the speaker to the input of the amplifier and means to connect the output of the amplifier to modulate the oscillator for transmission purposes when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker.

4. A duplex station for a telephone communication system for wired radio communication on power lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator tuned to a transmission carrier frequency, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector cicuit, a combination loud speaker and microphone, means connecting said station to a power line by means of an ordinary plug and socket connection, said means at the station including means for coupling both the oscillator and the detector circuit simultaneously to the line, and connections to power supply apparatus for energizing the tubes of the aforesaid oscillator and detector circuits, a switch movable between paging and duplex-telephony positions, means for energizing the loudspeaker from the detector for paging or call-receiving purposes when the switch is in the paging position, and means to connect the loud speaker to modulate the oscillator for transmission purposes when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker.

5. A duplex station for a telephone communication system for wired radio communication on lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator tuned to a transmission carrier frequency, a receiving circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator and including a detector, means biassing said detector to decrease its rectification efficiency and thereby eliminate low level signals-and-noises, an earphone to be operatively coupled to and responsive to the output of said detector, a combination loud speaker and microphone, means connecting said station to a line including means for coupling both the oscillator and the receiving circuit simultaneously to the line, a switch movable between paging and duplex-telephony positions, means for energizing the loudspeaker from the detector for paging or call-receiving purposes when the switch is in the paging position, and means to connect the loud speaker to modulate the oscillator for transmission purposes when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker.

6. A duplex station for a telephone communication system for wired radio communication on lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator tuned to a transmission carrier frequency, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a combination loud speaker and microphone, means connecting said station to a power line including a series resonant radio frequency coupling circuit for the oscillator and a series resonant radio frequency coupling circuit for the detector, affording low impedance coupling to the line, a switch movable between paging and duplex-telephony positions, means for energizing the loud speaker from the detector for paging or call-receiving purposes when the switch is in the paging position, and means to connect the loud speaker to modulate the oscillator for transmission purposes when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker.

7. A duplex station for a telephone communication system for wired radio communication on lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator

tuned to a transmission carrier frequency, a detector circuit tuned to a reception carrier frequency different fom the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, an audio frequency amplifier, a combination loud speaker and microphone, said speaker having a voice coil, a plurality of impedance matching transformers, means connecting said station to a line including means for coupling both the oscillator and the detector circuit simultaneously to the line, a switch movable between paging and duplex-telephony positions, means to connect the detector to the input of the amplifier, and means to connect the voice coil of the loud speaker to the output of the amplifier through one of said impedance matching transformers, when the switch is in the paging position, and means to connect the voice coil of the speaker to the input of the amplifier through a different impedance matching transformer, and means to connect the output of the amplifier through the first transformer to modulate the oscillator for transmission purposes, when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker.

8. A duplex station for a telephone communication system for wired radio communication on power lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator tuned to a transmission carrier frequency, an audio frequency amplifier, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a combination loud speaker and microphone, a hook switch for supporting the earphone and being thereby held in paging position when the earphone is not in use, said switch being biased to move to duplex-telephony position when the earphone is removed from the hook, means connecting said station to a power line and including radio frequency couplings for coupling the oscillator and the detector circuit to the line and power connections to power supply apparatus for energizing the tubes of the aforesaid oscillator, amplifier and detector circuits, means to connect the detector to the input of the amplifier, and means to connect the loud speaker to the output of the amplifier, and means to deenergize the oscillator, when the switch is in paging position, and means to connect the speaker to the input of the amplifier, and means to connect the output of the amplifier to modulate the oscillator, and means to energize the oscillator, when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker.

9. A master station for a telephone communication system for wired radio communication on lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a combination loud speaker and microphone, means connecting said station to a line, a station selector for calling any one of a plurality of stations each responsive to a different carrier frequency, and tuning means for said oscillator shifted by said selector to a transmitting frequency appropriate to the selected sub-station, a switch movable between paging and duplex-telephony positions, means for energizing the loud speaker from the detector for paging or call-receiving purposes when the switch is in the paging position, and means to connect the loud speaker to modulate the oscillator for transmission purposes when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker.

10. A master station for a telephone communication system for wired radio communication on lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator, an audio frequency amplifier, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a combination loud speaker and microphone, a hook switch for supporting the earphone and being thereby held in paging position when the earphone is not in use, said switch being biased to move to duplex-telephony position when the earphone is removed from the hook, means connecting said station to a line including a series resonant coupling circuit for coupling the transmitting oscillator to the line, a station selector for calling any one of a plurality of stations each responsive to a different carrier frequency, and tuning means in said oscillator and oscillator coupling circuit shifted by said selector to a transmitting frequency appropriate to the selected sub-station, means to connect the detector to the input of the amplifier and means to connect the loud speaker to the output of the amplifier when the switch is in paging position, and means to connect the speaker to the input of the amplifier and means to connect the output of the amplifier to modulate the oscillator, when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker.

11. A communication system for wired radio communication on a line, said system providing duplex telephony without necessitating a talk-listen switch, said system comprising one master station and a plurality of sub-stations, said stations each comprising a radio frequency oscillator, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a combination loud speaker and microphone, means connecting said station to the line, a switch movable between paging and duplex-telephony positions, means for energizing the loud speaker from the detector for paging or call-receiving purposes when the switch is in the paging position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker, and means to connect the loud speaker to modulate the oscillator for transmission purposes when the switch is in the duplex-telephony position, said master station being additionally provided with a selector for selecting any one of the sub-stations for communication, and tun-

ing means in the master oscillator shifted by said selector to a transmitting frequency appropriate to the selected sub-station.

12. A communication system for wired radio communication on a line, said system providing duplex telephony without necessitating a talk-listen switch, said system comprising a master station and a plurality of sub-stations, said stations each comprising a radio frequency oscillator, a detector circuit tuned to a receptive carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to the detector circuit, a combination loud speaker and microphone, means connecting said station to the line, a switch movable between first and second positions, means to connect the detector to energize the loud speaker for paging or call-receiving purposes, and means to make the oscillator inoperative, when the switch is in the paging position, and means to connect the speaker to modulate the oscillator, and means to make the oscillator operative, when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker, said master station being additionally provided with a selector for selecting any one of the sub-stations for communication, and tuning means in the master oscillator shifted by said selector to a transmitting frequency appropriate to the selected sub-station.

13. A communication system for wired radio communication on a power line, said system providing duplex telephony without necessitating a talk-listen switch, said system comprising one master station and a plurality of sub-stations, said stations each comprising a radio frequency oscillator, an audio frequency amplifier, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a combination loud speaker and microphone, a hook switch for supporting the earphone and being thereby held in paging position when the earphone is not in use, said switch being biased to move to duplex-telephony position when the earphone is removed from the hook, means connecting said station to the power line including a series resonant coupling circuit for coupling the transmitting oscillator to the line, and connections to power supply apparatus for energizing the station apparatus, means to connect the detector to the input of the amplifier and means to connect the loud speaker to the output of the amplifier, for paging or call-receiving purposes, when the switch is in paging position, and means to connect the speaker to the input of the amplifier, and means to connect the output of the amplifier to modulate the oscillator, when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the loudspeaker, said master station being additionally provided with a selector for selecting any one of the sub-stations for communication, and tuning means in said oscillator and series resonant coupling circuit shifted by said selector to a transmitting frequency appropriate to the selected sub-station, the oscillators of said sub-stations all being tuned to a single transmission frequency corresponding to the reception frequency of the master station.

14. A duplex station for a telephone communication system for wired radio communication on power lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator tuned to a transmission carrier frequency, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a switch for supporting the earphone and being thereby held in paging position when the earphone is not in use, said switch being biased to move to duplex-telephony position when the earphone is removed from the hook, means connecting said station to a power line and including radio frequency couplings for coupling both the oscillator and the detector circuit simultaneously to the line and power connections to power supply apparatus for energizing the tubes of the aforesaid oscillator and detector circuits, means to connect the detector to a device functioning as a loud speaker for paging or call-receiving purposes when the switch is in paging position, and means to connect a device functioning as a microphone to the oscillator to modulate the oscillator for transmission purposes when the switch is in the duplex-telephony position, and means for connecting said earphone to the detector for simultaneous reception during transmission through the device functioning as a microphone.

15. A duplex station for a communication system for wired radio communication on power lines, said system providing duplex telephony without necessitating a talk-listen switch, said station comprising a radio frequency oscillator tuned to a transmission carrier frequency, an audio frequency amplifier, a detector circuit tuned to a reception carrier frequency different from the transmission carrier frequency of the oscillator, an earphone to be operatively coupled to said detector circuit, a hook switch for supporting the earphone and being thereby held in paging position when the earphone is not in use, said switch being biased to move to duplex-telephony position when the earphone is removed from the hook, means connecting said station to a power line and including radio frequency couplings for coupling both the oscillator and the detector circuit simultaneously to the line and power connections to power supply apparatus for energizing the tubes of the aforesaid oscillator, amplifier and detector circuits, means to connect the detector to the input of the amplifier and means to connect the output of the amplifier to a device functioning as a loud speaker, for paging or call-receiving purposes, when the switch is in paging position, and means to connect a device functioning as a microphone to the input of the amplifier, and means to connect the output of the amplifier to modulate the oscillator for transmission, when the switch is in the duplex-telephony position, and means connecting said earphone to the detector for simultaneous reception during transmission through the device functioning as a microphone.

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