The present invention relates to radio telephone systems, more particularly to receiving, and is a division of my copending application, Serial No. 597,422, filed October 27, 1922, and issued March 9, 1926 as a Patent No. 1,576,308.

The main object of the invention is to provide a receiving system in which a light and compact receiving set may be used which is capable of being moved about, within limits, at the convenience of the user. A further object is to provide a set mechanically free but electrically connected so that movement of the same will be unhampered as by conductor cords or similar mechanical connections or critical orientation. Another object is to provide a combination set having both loud speaker and ear-phones attachments with automatic switch hook control.

Other objects of the invention will be apparent from a perusal of the following specification and the drawings accompanying the same.

In the drawings,

Fig. 1 is a schematic diagram showing a central office and one subscriber's line with a subscriber's station equipped with a radio telephone desk set receiver.

Fig. 2 is a similar diagram of a modified form of a radio receiving apparatus for the central office for changing the wave length transmitted to the subscriber.

Fig. 3 is a front elevation of the subscriber's desk set.

Fig. 4 is a side elevation of the same.

Fig. 5 is a modification in which the cord connection is dispensed with.

Fig. 5a is a modification of the form of Fig. 5 in which radio amplification is interposed between the line and the primary coil.

Fig. 5b is another modification of the form of Fig. 5 using inductive transmission of audio frequencies to the desk set.

Referring to the drawings, in Fig. 1, the apparatus to the left of the vertical dotted lines is situated at the central office, that to the right is at the subscriber's station while the connection indicated between the dotted lines is the line connection.

The telephone exchange system assumed herein to be used in carrying out my invention is the standard Western Electric No. 1 switchboard circuit with the usual standard Western Electric subscriber apparatus.

The part of the usual telephone exchange system here shown comprises the subscriber's station apparatus A connected by conductors 1 and 2 to the conductors 3 and 4 of the line B terminating at the central office C through the wires 5 and 6 on multiple jacks 7.

Radio broadcast from other stations is received at the telephone central station by the receiving or antenna circuit 8, from which the broadcast is relayed or amplified onto the wires 3-4 of the subscriber's line circuit B known or other suitable amplifying and coupling means such as the amplifying system indicated at 9 and the switch 10.

Other switches such as 11 are connected with the amplifier 0 in multiple with the switch 10 for the purpose of connecting to the other subscribers lines.

For broadcasting directly from the central office a radio transmitting circuit of any known or other suitable form is provided at the central office, such as the radio transmitting circuit 12 with modulating transmitter 13 coupled by means of the coupling coil 14 to multiple switching means such as the plugs 15 and 16 through which the radio transmitting circuit may be connected with any subscriber's line through local broadcast jacks such as the jack 17 multiplied onto the subscriber's line extension 5-6.

Either relayed or local broadcast is put on to the subscribers lines at radio frequency and at sufficient amplitude to enable the audio frequencies to be segregated or detected at the subscribers' stations with a simple detector set which may be of any known or other suitable form such as the crystal detector type, indicated at 18. The detector circuit 18 is arranged to be connected with either the radio telephone head set 19 or the supervisory coupling means 20, through a double pole double throw switch 21 at the will of the subscriber.

The use of the double-throw switch has the advantage of effecting an automatic disconnection of the head phones 19 upon connection of the detector circuit with
the test coupling so that all the energy will go into the latter, although, if desired, the head phones may be permanently connected and the test coupling simply connected in shunt when wanted.

To enable the reception at the subscriber's substation to be supervised from the central office, a supervisory circuit 22 is provided at the central office arranged to be connected with any subscriber's line through suitable switching means such as the plug 23 adapted to engage with plugs such as 24 connected in multiple to the subscriber's line extension 5—6. The supervisory circuit 22 may be of any suitable type, preferably that used with the Western Electric No. 1 switchboard system, the essentials being that it contain means for calling the subscriber such as the ringing key 25, and a listening and talking set 26 and listening key 27. The supervisory coupling 20 at the subscriber's substation is preferably arranged to be normally disconnected from the line and to be connected therewith at will through a suitable switch such as 28. The operator may have a special radio listening set, as indicated at 29 connected to the plug 23 through an amplifier 29 and key 27 of usual construction, so that the return currents through the line to central will be strengthened. Such amplifiers or electron tube relays are well known and need no description. I believe this combination to be new and original with me.

In operation, broadcast is put onto the subscribers' lines such as 3—4 at the central station C, either directly by means of the local set 12 or indirectly by means of the relay set 8—9 and a subscriber at substation A wishing to receive the broadcast listens in by means of the detector circuit 18 and radiophone 19. During the broadcasting if the supervisory operator desires to test the quality of reception at other points on the line, he plugs 24 and depresses the ringing key 25 whereupon the subscriber at A is signalled in the usual manner. The subscriber at A responding is instructed to reverse switch 21 and close switch 28, which thereupon disconnects the audio circuit of the detector from the receivers 9 and connects it with the line extension 1—2 by way of conductors 29—30, coupler 20 and switch 28, from whence the circuit is extended over the line conductors 3—4, line extension 5—6, jack and plug connection 24—23 and listening key 27 to the supervisory operator's listening set 26. The operator now listening in on the reception at the subscriber's substation can ascertain the quality thereof and finding it defective can judge of the cause of such defect. For example he can discern the effects of static, induction from power lines, cross talk from telephone lines, loose connections etc.

In Fig. 2 I have shown a radio receiving circuit 8, connected to usual radio amplifier and detector apparatus 9, which in turn is connected to an audio amplifying set 9, connected to a modulator and transmitting set 9, having its output side terminating on switching means such as plugs for connection to line circuits. The principle involved herein is that of receiving at one wave length and relaying onto the subscribers' lines at a different wave length. The transmitter 9a and the receiver 8—9a are capable of being separately tuned, in a manner well understood in the art, which is important as an element in this invention, because all my subscribers' instruments are standardized and flat tuned, that is, all are permanently tuned on the same wave length, which is the normal transmitting wave length of the central office to which they are connected for service. The range of tuning is immaterial.

In Figs. 3 and 4 I have shown a form of subscriber's desk instrument embodying the elements 18, 19, 20, 21, and 25 of Fig. 1. The base 34 is hollow, and the detector set 18 with coupler 20, is arranged therein with suitable circuit connections through cords 42—43 or through ordinary wiring. If cords are employed, the mutual capacity of the conductors must be neutralized or minimized so as not to interfere with reception of the high frequency waves by the detector set. On base 34 is erected a column 32 carrying a switchhook 31, controlling contacts within the column and shown in the diagram Fig. 1 at 31. This hook when down disconnects the entire set from line, and when up connects the set through wires 42—43 to line. Two manual switches 21 and 28 are mounted on the base with contacts preferably within the same, to control the listening set connection to 19 and the cut-back to central at 29—30. A horn 35 is mounted on the upper end of the column, with coupling nipples 33 arranged on opposite side of its neck for receiving the two head phones 19 when the subscriber prefers to listen in that way. Tuning handles of any desired form may be also arranged on this outside of the base as shown at 18.

The foregoing arrangement is flexible and will lend itself to various detailed forms of subscribers' instruments. For example, the cord connections of the radiophone set 18—19 may be dispensed with, as indicated in Figure 5. The line connections 42—43 here terminate in the primary coil 18a, of which the secondary 18b is carried on the instrument, conveniently in the base thereof, which coil, because of its being arranged in the base parallel to the flat bottom thereof, will always lie substantially parallel to the primary coil, as indicated in Figs. 5, 9a and 9b. In addition to making the set self-orientating, this horizontal arrangement of the primary and secondary loops or coils renders
the receiving set unresponsive to ordinary radio waves with horizontal magnetic component and prevents the waves radiated by the primary loop 18° from harmfully affecting outside receivers having vertical aerials or loops, because the waves from the said primary loop are polarized with their magnetic and electrostatic components at substantially right angles to those of the ordinary waves to which their aerials and antennas are adjusted. Coil 18° may be enclosed in a casing as indicated in dotted lines, and the instrument adjusted with reference thereto either over it, or to one side. It is to be understood that the circuit of the coil 18° may be tuned in any desired way, as by a series variable condenser or by a fixed condenser, with taps off of the coil in accordance with well understood practice. The coil 18° constitutes a bridge across the telephone line which for best results must be tuned, as is well understood in the art. Several instruments and several secondaries may be used if desired with a single primary. In this case I have shown a tube detector 18° with A and B batteries and tuning condenser all enclosed within the instrument body. Tubes suitable for this purpose are commercially available, and small batteries are also on the market, either storage cells or dry batteries. Where more ample battery capacity is desired, separate batteries may be connected to the desk set through a cord of usual type as indicated at 50 in Fig. 5. In any case the receiver 19 is connected to the instrument circuits through a cord, which for simplicity of illustration is omitted in Figs. 3 and 4, but is indicated in Fig. 5. The mechanical parts are numbered the same in Fig. 5 as in Figs. 3 and 4, the outline only of the desk stand or casing being shown in dotted lines.

It is to be understood that radio or audio amplifying means, or both, may be added to the receiving set without departing from the scope of my invention. Where the detached or loose coupled form of instrument is employed the arrangement of Fig. 9° may be used, where the radio amplification may be between the line connections 42—43 and the primary winding 18°, and audio amplification means may be mounted on or in the instrument unit. A further modification is that indicated in Fig. 5°, which is accomplished by connecting to the line wires 42—43 a complete detector set including radio and audio amplifying tubes, detector coils and tuning devices, with the primary winding of an audio transformer or inductorium of any suitable form arranged the same as coil 18°. The instrument would then carry the secondary 18° of said inductorium, the receiver, and a wire connection to the receiver, only. Various other modifications will suggest themselves to those skilled in the art, and it is to be understood that I con-template all such non-essential changes or modifications as fall fairly within the scope of the appended claims.

Having thus described my invention, which I claim is:

1. A radio telephone receiving system comprising means for relaying modulated carrier waves, to a receiving station, a primary loop or coil connected to receive said relayed waves and to radiate the same, said loop being fixed in a horizontal position and a receiving set related to said primary loop but mechanically detached therefrom, and movable with respect thereto, said set carrying a secondary or collecting loop so arranged in the set as to be normally held in horizontal position when the receiving set is in a normal operating position.

2. The method of receiving radio telephone signals through inductive action or loose coupling which comprises receiving ordinary waves having a horizontal magnetic component, at a local point and reradiating the same locally polarized to bring the magnetic component into a vertical plane, collecting the same on a mechanically detached local receiver carrying a horizontal coupling loop or secondary coil, whereby the plane of the secondary coil or coupler will render it non-responsive to waves having a horizontal magnetic component.

3. The method of receiving radio broadcast matter on a local set within a given zone without interference from outside broadcast sources or interference with receivers outside the zone, which comprises polarizing the desired broadcasted waves within the zone at substantially right angles to ordinary radio waves, and causing the local set to receive only the polarized waves.

4. The method of relaying radio broadcast matter to selected directional receiving sets within a given zone which comprises receiving the desired broadcasted waves, amplifying, conducting said waves to and reradiating or inductively transmitting the same within the zone polarized at substantially right angles to the original, and coupling the receiving sets to respond to the polarized waves, only.

5. The method of relaying radio broadcast matter to receiving sets within a given zone which comprises causing the radio waves of the desired broadcasted matter to be amplified and retransmitted to said given zone and there polarized and reradiated at substantially right angles to ordinary radio waves in the given zone and causing said receiving sets to receive only the polarized waves.

In testimony whereof I hereunto affix my signature.

EDWARD E. CLEMENT.