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C. S. DEMAREST ET AL

RADIO SIGNALING SYSTEM

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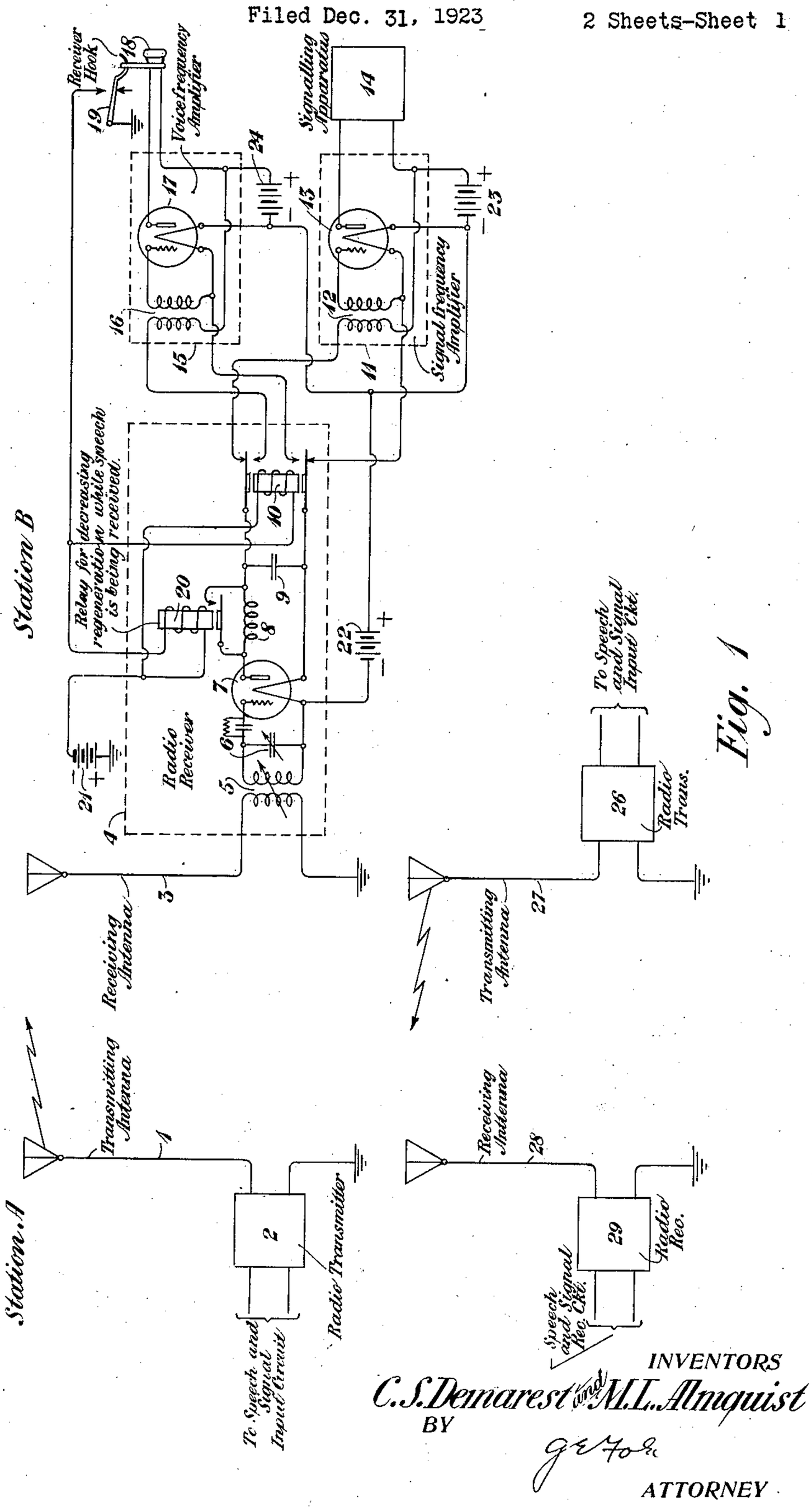

Fig. 1

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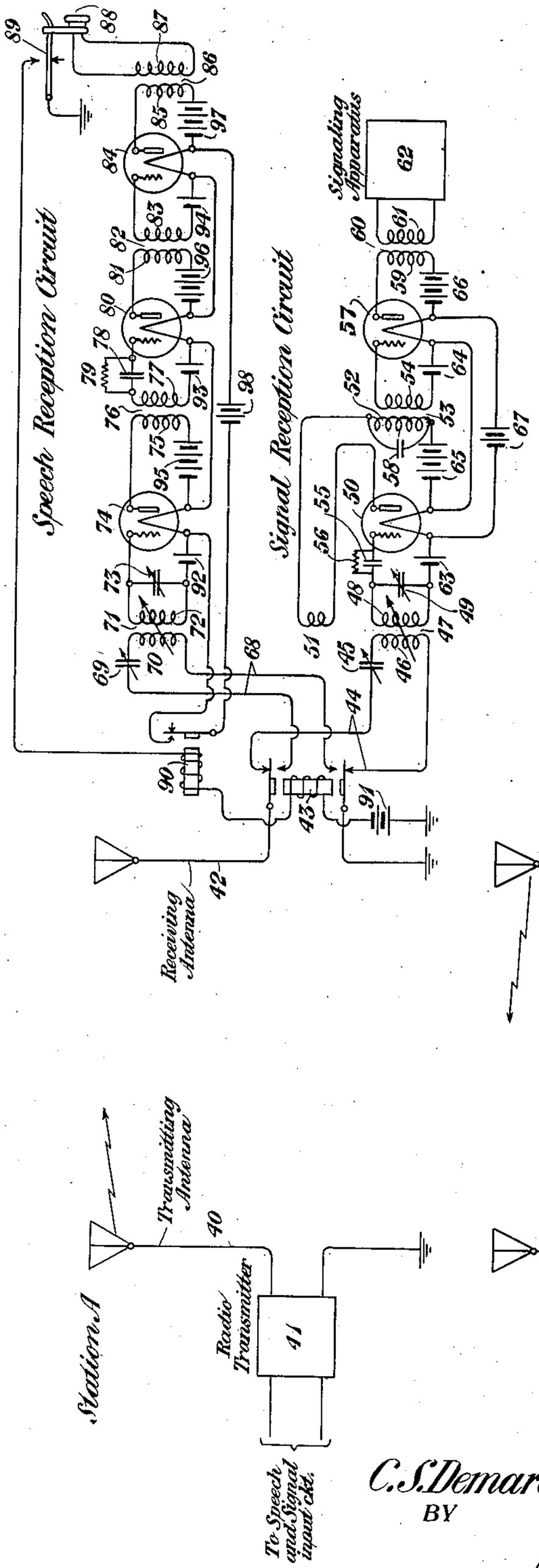

Fig. 2

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Patented Mar. 3, 1925. 1,528,011

UNITED STATES PATENT OFFICE.

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RADIO SIGNALING SYSTEM.

Application filed December 31, 1923. Serial No. 683,748.

To all whom it may concern:

Be it known that we, CHARLES S. DEMAREST and MILTON L. ALMQUIST, residing at Ridgewood and Brooklyn, in the counties of Bergen and Kings and States of New Jersey and New York, respectively, have invented certain Improvements in Radio Signaling Systems, of which the following is a specification.

This invention relates to radio signaling systems, and particularly to means for selectively signaling a particular station of such a system.

In the operation of a multi-station system, it is, of course, desirable that each station of the system shall be able not only to maintain telephone or telegraph communication with every other station of the said system, but also that each station shall be adapted to call any station of the said system with which it is desired to carry on communication to the exclusion of the other stations of the system. In such a system the signal responsive apparatus at each station should be capable of responding to frequencies slightly above or below a predetermined means value for which the apparatus is designed. This will care for slight variations of the calling frequency sent from another station. But the range of frequencies should not be too great else the apparatus will respond to frequencies not intended for the calling of the stations of the system. In the copending application of Demarest and Almquist, Serial No. 646,903, filed June 21, 1923, is described a method and means for the transmission of a calling signal from one station to another of a multi-station system in which the high frequency carrier current is modulated by impulses of current of 135 cycles in accordance with a definite code and transmitted. At the particular station called, the modulated high frequency current is demodulated, and the impulses of 135 cycle current serve to operate a relay responsive to this frequency. While, of course, the relay may be made to respond to other frequencies within a range extending, for example, from 130 to 140 cycles, it is, of course, desirable to make the range as narrow as possible in order to prevent the operation of this relay by currents other than the calling signaling currents transmitted from another station of the system. Any method, therefore, by which the sensitivity of the receiving set at 135 cycles may be increased will be of value.

One of the objects of this invention is to increase the sensitivity of the receiving sets for calling signals, which object is obtained either by using a separate receiving set for the calling signals from that used in the reception of speech signals (each set being of maximum efficiency for the respective range of frequencies) or by using different connections in a receiving set designed for the joint reception of the calling and speech signals, the said receiving sets being designed to take advantage of certain conditions inherent in the reception of a particular low frequency signal.

A low frequency signaling system, such as the 135 cycle system referred to above, has the advantage that the frequency of the side band is very close to that of the carrier and therefore higher regeneration may be employed than is possible for speech reception (where the side band is fairly broad), the regeneration being carried to a point very close to the oscillating condition. This makes is possible to obtain maximum amplification through the use of the minimum number of vacuum tubes. The regeneration may be obtained by plate and grid tuning or by a magnetic feed-back as in the ordinary regenerative circuit. Since the increase in regeneration increases the sharpness of tuning and since the signaling apparatus, that is, the call responsive apparatus, must be able to function at all times, it becomes necessary to keep the wave length of the transmitting station within narrow limits. A device for controlling the transmitted carrier frequency is shown in the copending application of Demarest and Almquist, Serial No. 646,903, filed June 21, 1923. The present invention is concerned mainly with the provision of receiving means highly responsive to a low frequency calling signal.

The invention will be clearly understood from the following description read in connection with the attached drawing, of which

Figure 1 shows an embodiment of the invention in which a single radio receiver functions for the detection of both the speech and the calling signal, and Fig. 2 is a form in which separate receiving circuits have been provided for the speech and the calling signals, each of which is highly efficient for the particular frequencies employed.

In Fig. 1, which represents two stations A and B of a multi-station system, the transmitting antenna 1 at station A has connected therewith a radio transmitter 2, which may be of any well-known type, by means of which a carrier current may be modulated by speech currents and also by calling signal currents, and the resultant modulated waves may be transmitted to the other stations of the system. At station B the receiving antenna 3 is connected with the radio receiver 4 by means of the coupling transformer 5. The secondary winding of this transformer is connected with the grid and filament of the vacuum tube detector 7, the input circuit including the condenser 6 whereby the input circuit may be tuned broadly to cover the range of frequencies to be received at station B and also including preferably a grid condenser and leak. The output side of the detector 7, viz., the plate-filament circuit, includes an inductance 8 which is arranged to be shunted by the operation of the relay 20. This output circuit is connected with the armatures of relay 10, the outer contacts of which extend to the calling-signal amplifier 11 and the inner contacts of which extend to the speech-signal amplifier 15. The vacuum tube 13 of the amplifier 11 is connected with the output of the detector 7 by means of the transformer 12. The condenser 9 is of such value relative to the primary winding of transformer 12 as to tune the circuit for 135 cycles so that the maximum gain will be at this frequency. The output side of the tube 13 is connected with the calling-signal apparatus 14, which may be either of the type disclosed in the copending application of Demarest and Almquist, Serial No. 646,903, cited heretofore, or of any well-known type. The output side of the detector 7 is connected with the vacuum tube 17 of the speech-signal amplifier by means of the transformer 16, and the output side of the tube 17 is connected with the telephone receiver or equivalent device 18. Relays 10 and 20 are connected with the source of current 21 and also with the receiver switchhook 19 in such manner that when the receiver 18 is upon the hook the circuit of the relays is open and remains deenergized until the receiver 18 is removed from the hook of the switch 19. Battery 22 serves to provide the filament heating current for all the vacuum tubes, and battery 23 provides the plate current for tubes 7 and 13, and battery 24 the plate current for tube 17.

For the transmission of speech and calling signals from station B to other stations, such as A, of the radio system, a transmitting antenna 27 is provided having connected therewith a radio transmitter 26, which may be of the type represented by 2 of station A. Similarly at station A a receiving antenna 28 having a radio receiver 29 connected therewith is provided, which radio receiver should preferably be similar to that represented by 4 of station B.

Having in mind the foregoing description of the parts of the apparatus in which this invention is embodied, it will be clearly understood from the following description of the method of transmitting calling and speech signals, for example, from station A to station B. Let it be assumed that a wave be transmitted from antenna 1 comprising a carrier and its side bands representing the carrier as modulated by 135 cycle current. This modulated wave might be transmitted in accordance with a code in the manner described in the copending application of Demarest and Almquist, Serial No. 646,903, or might be an uncoded signal. In any case the carrier and the side band would be received by antenna 3 and impressed by the transformer 5 upon the input circuit of the detector 7. The 135 cycle current resulting from detection would be impressed by the output circuit of the detector 7 upon the signal frequency amplifier 11. The 135 cycle current as amplified by 11 would be impressed upon the calling signal apparatus 14, and the operation of this device would apprise the subscriber at station B that another station of the system desired to get in communication with him. As pointed out heretofore, the inductance 8 in the output side of the receiver 4 is adjusted to tune the plate circuit to the point where it will almost oscillate at the radio frequency for which the set is tuned. By such adjustment, the radio receiver is made highly regenerative, thereby giving high amplification to frequencies close to the carrier, such for example, as the frequencies obtained when the carrier is modulated by 135 cycles. In this manner, and also by the use of an amplifier 11, which gives maximum amplification at 135 cycles, the receiving efficiency of station B at the frequency of 135 cycles is materially improved. Upon the receipt of the calling signal at B, the subscriber removes his receiver 18 from the hook switch 19 which completes the circuit from battery 21 through relays 20 and 10 and thereby operates these relays. By the operation of relay 20, the inductance 8 is shunted and thereby effectively disconnected from the output circuit of the detector 7. This act detunes the output circuit of the detector

and decreases the regeneration to a point where uniform amplification for speech frequencies is obtained. By the operation of relay 10, the output side of the detector 7 is connected with the speech amplifier 15, which amplifier is specially designed and adjusted for the frequencies present in the voice range, that is, 200 to 2,000 cycles.

The arrangement shown in Fig. 2 represents a system in which separate radio receivers are provided for the speech reception circuit and for the signal reception circuit. In this figure, transmitting antenna 40 and radio transmitter 41 correspond to the elements designated 1 and 2 of Fig. 1. At station B receiving antenna 42 is connected with the armatures of relays 43. This antenna is normally connected with the signal reception circuit through the outer contacts of the said relay. The inner contacts of this relay serve to connect the antenna with the speech reception circuit. A tuning condenser 45 and a primary winding 46 of transformer 47 are connected by means of conductors 44 and the outer contacts of relay 43 with the antenna 42 in order to tune the antenna for the frequencies of the calling signal. The secondary 48 of transformer 47 is connected with the input side of the vacuum tube detector 50, and the condenser 49 is connected across the winding 48 in order to tune this circuit to the incoming frequency. The output side of the tube 40 contains a feed-back winding 51 in order to provide for regeneration, and the circuit also contains the primary winding 52 of transformer 53 whereby the detected component, that is, the 135 cycle current, will be impressed upon the input of the vacuum tube amplifier 57 by the transformer winding 54. The primary winding 52 of transformer 53 is tuned to 135 cycles by the condenser 58. The output circuit of this tube contains the primary winding 59 of transformer 60, of which the secondary winding 61 is connected with the signaling apparatus 62 responsive to the amplified 135 cycle current.

The speech reception circuit includes at its input end the tuning condenser 69 and the primary winding 70 of transformer 71 whereby the antenna 42 may be tuned for the particular range of currents represented by the carrier frequency as modulated by the speech frequencies. The speech reception circuit comprises a radio frequency amplifier represented by the tube 74 and its connecting circuit, a detector represented by the tube 80 and its connecting circuit, and an audiofrequency amplifier represented by the tube 84 and its connecting circuit. The tuned antenna circuit is connected with the input side of tube 74 by means of the transformer 71, the connection including the secondary winding 72 and the tuning condenser 73. The output side of the detector is connected by means of the windings 81 and 83 of transformer 82 with the input side of tube 84 the output side of which is connected by means of windings 85 and 87 of transformer 86 with the telephone receiver 88 shown upon the switchhook 89. A plurality of batteries designated 63, 64, 65, 66, 67, and 92, 93, 94, 95, 96, 97 and 98 have been shown for various obvious purposes, but it is to be understood that common sources of current supply might be used in place of the separate sources shown on the drawing. Relays 43 and 90, having connected therewith battery 91, are designed to operate when the receiver 88 is removed from the switchhook 89. Upon the operation of relay 43 the antenna 42 will be connected by conductor 68 with the input side of the speech reception circuit. The operation of relay 90 serves to connect the source of current 98 with the filaments of the various vacuum tubes in order to energize the tubes.

Since the signal reception circuit is normally connected by means of conductors 44 with the receiving antenna 42, the calling signal transmitted from antenna 40 at station A will be impressed by the transformer 47 upon the detector 50 which is designed to be regenerative. The detected currents will be impressed by transformer 53 upon the 135 cycle amplifier circuit, which is also designed to give high amplification at this particular frequency. The low frequency component will be impressed by transformer 60 upon the signaling apparatus 62. Upon the receipt of a calling signal, the subscriber at station B removes his receiver 88 from the hook of switch 89 which operates relays 43 and 90 thereby connecting the antenna 42 with the speech reception circuit and also energizing the vacuum tubes of the circuit. The incoming high frequency currents as modulated by the speech currents will be amplified by the high frequency amplifier 74 and will be impressed by the transformer 76 upon the detector 80. The speech current resulting from detection will be impressed by the transformer 82 upon the audiofrequency amplifier 84 and the resultant amplified speech current will pass to the receiver 88.

As in Fig. 1, station B has a transmitting antenna and associated circuit preferably similar to that shown at station A. And, furthermore, station A has a receiving antenna and circuit preferably similar to that shown at station B.

It should also be understood that while we have shown only two stations, there are representative of any number of stations constituting a system embodying the applicant's invention.

While this invention has been disclosed as embodied in a particular form, it is to be understood that it is capable of embodiment

in other and different forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a radio communication system, the combination with an antenna adjusted for the reception of a plurality of bands of frequencies, of a radio receiver connected with the said antenna and comprising a vacuum tube detector having its output circuit so tuned that it will almost oscillate when the frequencies of one of the said bands are applied to the said detector, an amplifier connected with the said receiver adjusted to give maximum amplification to one of the frequencies resulting from detection, and an indicating device responsive to the low frequency.

2. In a radio communication system, the combination with an antenna adjusted for the reception of a plurality of bands of frequencies of a radio receiver containing a vacuum tube detector having its input circuit connected with the said antenna and having its output circuit normally connected with an amplifier designed to give maximum amplification of one of the said bands, a second amplifier designed to produce maximum amplification of another band of frequencies and switching means to connect the said radio receiver with either of said amplifiers.

3. In a radio communication system, the combination with a broadly tuned antenna of a radio receiver connected with the said antenna and containing a vacuum tube detector whose input circuit is tuned to cover the same range as the said antenna and whose output circuit is normally connected with an amplifier designed for maximum amplification of certain of the received frequencies, the said output circuit being normally tuned to almost oscillate at the received carrier frequency, and switching means to detune the said output circuit and to disconnect it from the said amplifier.

4. In a radio communication system, the combination with a broadly tuned antenna of a radio receiver connected with the said antenna and containing a vacuum tube detector whose input circuit is tuned to cover the same range as the said antenna and whose output circuit is normally connected with an amplifier designed for maximum amplification of certain of the received frequencies, the said output circuit being normally tuned to almost oscillate at the received carrier frequency, a second amplifier designed for the maximum amplification of other frequencies received by said antenna, and switching means to disconnect the said output circuit from the said first amplifier and to connect it with the said second amplifier and also to detune the said output circuit.

5. In a radio communication system, the combination with a transmitting station arranged to transmit speech modulated carrier waves and also signal-modulated carrier waves, of a receiving station having an antenna tuned for the reception of both of said waves, a detector connected with the said antenna, a plurality of receiving circuits each designed for maximum efficiency throughout the range of frequencies which each is intended to receive, and switching means to control the connection of the detector with each of the said receiving circuits.

6. In a radio receiving system, the combination with an antenna of a vacuum tube detecting circuit connected therewith having its plate and grid circuits tuned almost to the oscillating state for the received carrier frequency, a signal amplifying circuit, a speech amplifying circuit, and switching means to connect either of said amplifying circuits to the said detector.

In testimony whereof, we have signed our names to this specification this 29th day of December, 1923.

CHARLES S. DEMAREST.
MILTON L. ALMQUIST.