Nov. 20, 1923.

1,474,426

H. A. AFFEL

SECRET COMMUNICATION SYSTEM

Filed July 19, 1922

2 Sheets-Sheet 1

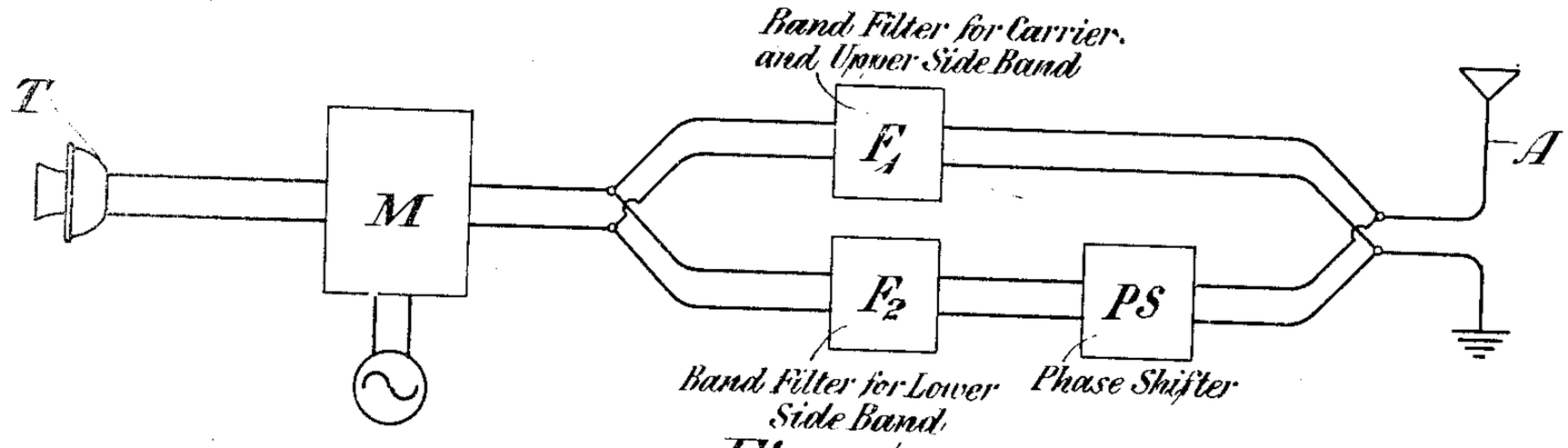

Fig. 1

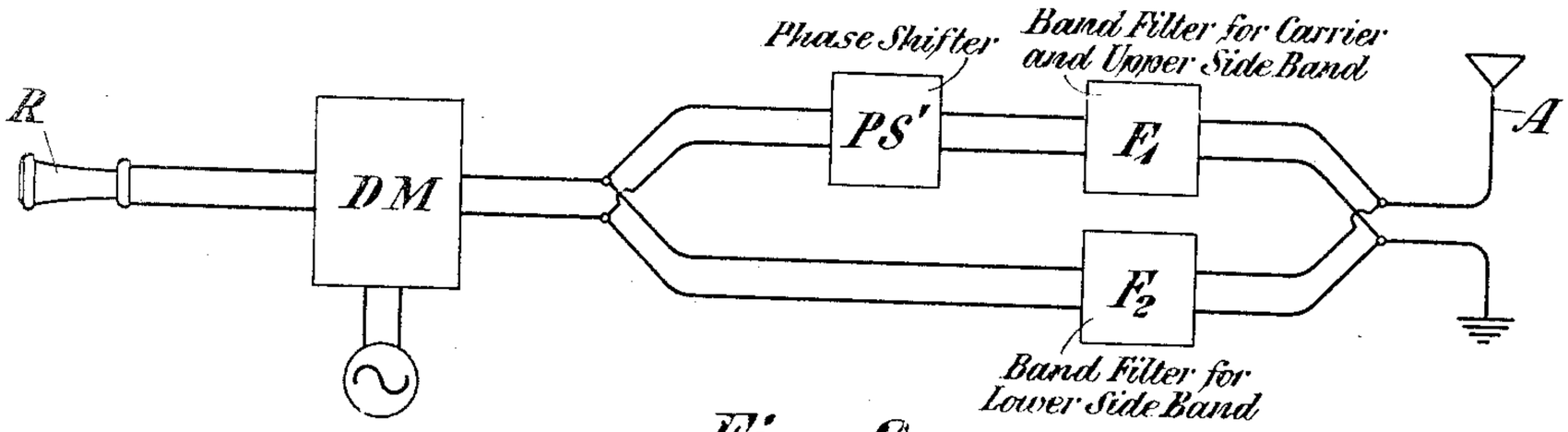

Fig. 2

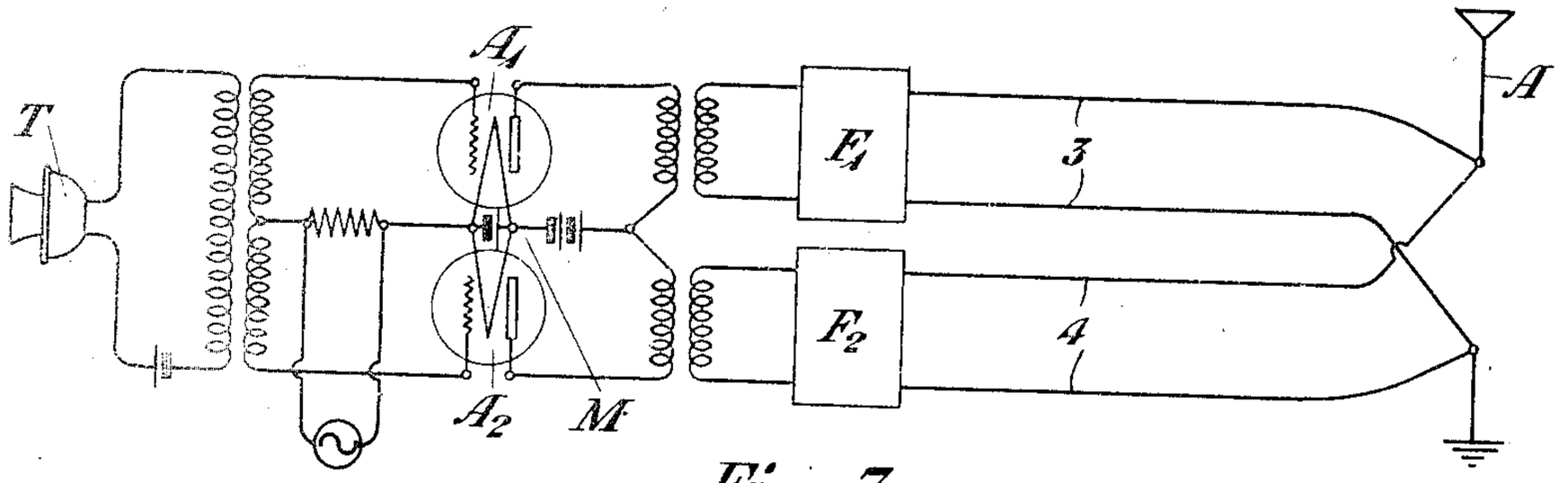

Fig. 3

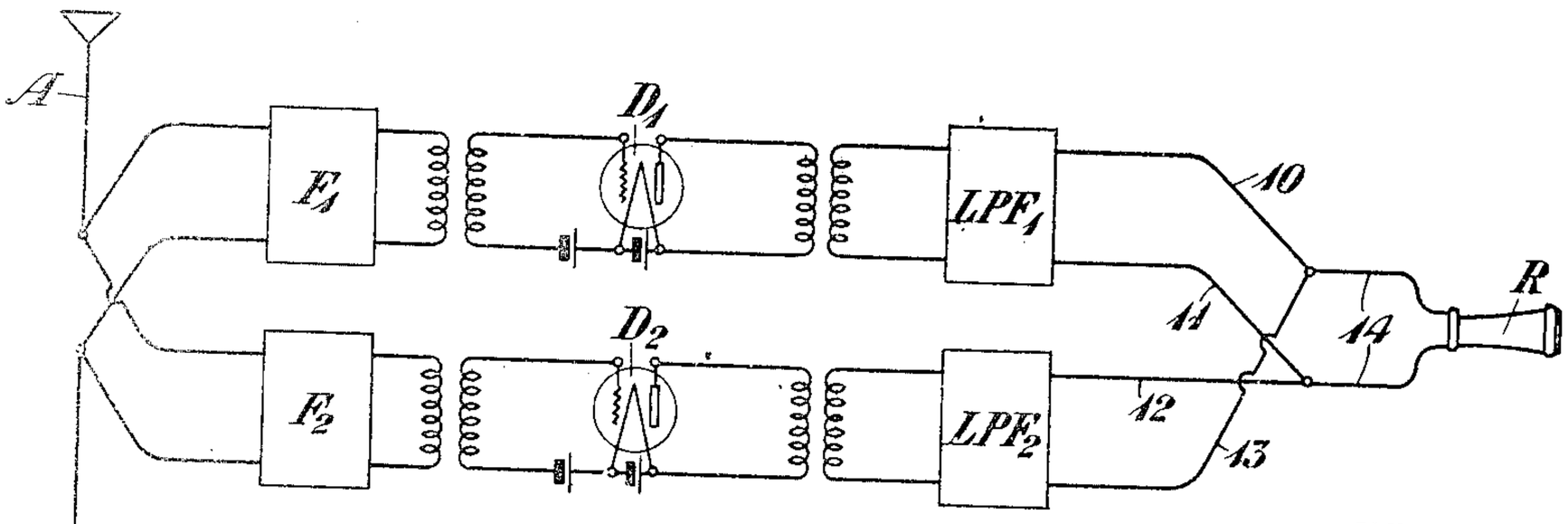

Fig. 4

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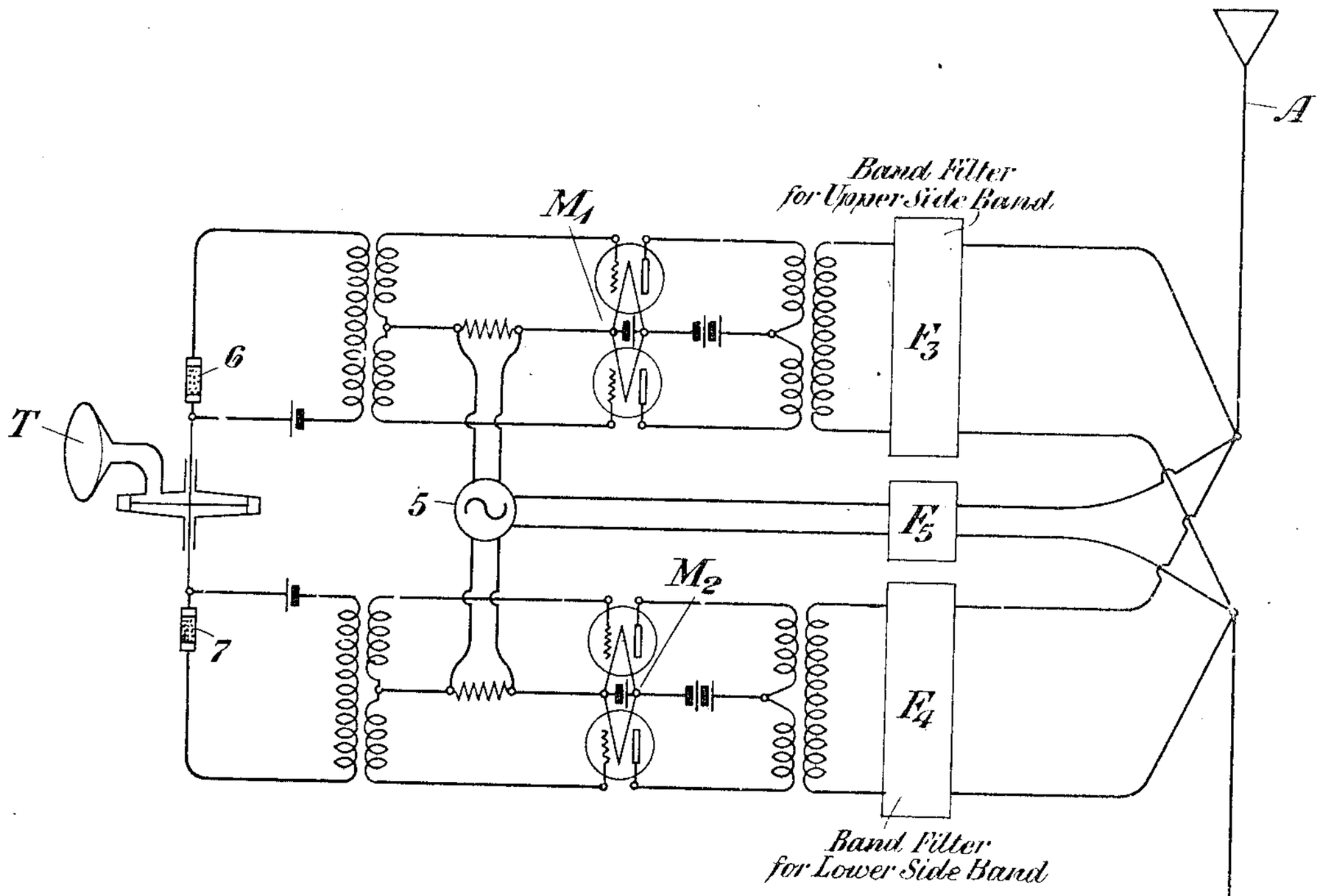

Fig. 5

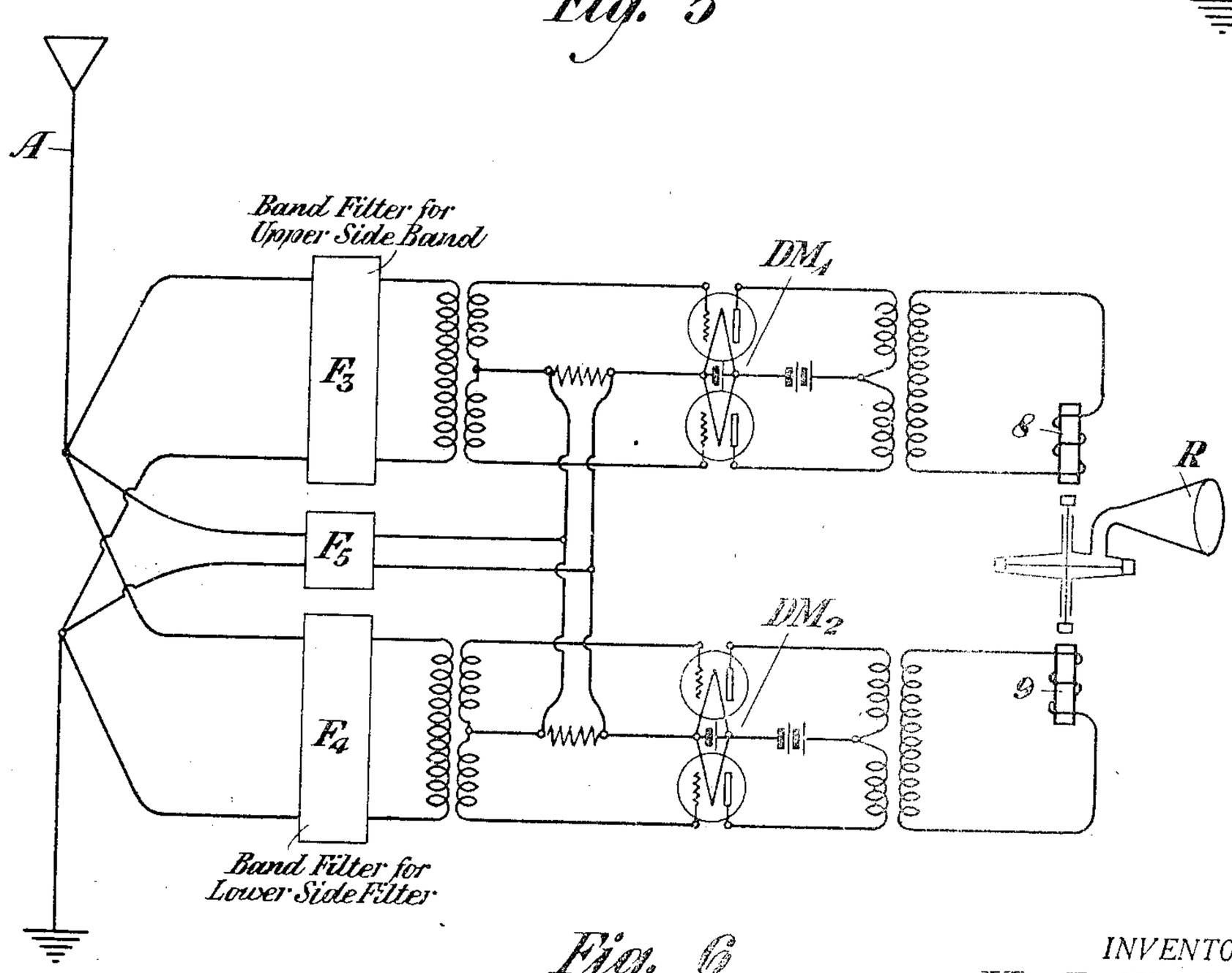

Fig. 6

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Patented Nov. 20, 1923. 1,474,426

UNITED STATES PATENT OFFICE.

HERMAN A. AFFEL, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SECRET-COMMUNICATION SYSTEM.

Application filed July 19, 1922. Serial No. 575,991.

To all whom it may concern:

Be it known that I, HERMAN A. AFFEL, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Secret-Communication Systems, of which the following is a specification.

This invention relates to communication systems and more particularly to arrangements for providing for secrecy in the transmission of messages over such systems.

The arrangements of the invention are particularly applicable to many of the well known types of radio or carrier telephone and telegraph systems and cause such systems to so operate that listening in will not be possible with many of the relatively simple types of receiving circuits now in use. The operation of the arrangements of the invention is based on a manipulation of the phase relations of the two side bands produced in the transmitting circuit by modulation and on the provision for the necessary de-phasing action by the cooperating receiving station to restore intelligibility.

In radio or carrier systems the natural action of modulation at the transmitting station is to provide at the output of the modulator circuit a carrier frequency and two side-band frequencies, in addition to other non-useful frequency components. While it may be desirable in certain types of carrier systems to suppress, by suitable circuits or filters, the carrier frequency or one of the side bands, nevertheless in the ordinary type of radio systems, as a rule, both side bands, as well as a large proportion of the carrier current, is transmitted. At the receiving station of such a system, the action of the two side-bands and the carrier, preserved from the standpoint of phase and amplitude in substantially the same relations as at the ouput of the modulator circuit, provides for the production of the restored voice or signal current. The magnitude of the restored voice or signal current at the receiving station, is a function of the phase relations between the three frequency components involved, due to the fact that the restored current is obtained from a combination of two independent actions; first, the action of the upper side band and the carrier; second, the action of the lower side band and the carrier. The resultants of both actions must, of course, be combined in the proper phase to produce the best result, and if the two components are of substantially equal amplitude and opposite phase, the net resultant will be nil. Accordingly, the arrangements of this invention provide means whereby a definite de-phasing action, or change in the normal phase relation, may be introduced at the transmitting end of a radio or carrier system to so disturb the normal relations between the carrier and side band, that unless means are also provided at the receiving station for restoring the proper phase the volume will be greatly reduced and the message rendered unintelligible. Such an arrangement would prevent listening in and reception of the signals by the relatively simple types of receiving sets now in use as such sets would ordinarily not be provided with the phase restoring apparatus, nor would they ordinarily provide means of sufficient selectivity for eliminating one of the side bands and thus restoring intelligibility of the signal. The arrangements of this invention also provide means at the receiving station for restoring the original phase relation between the frequency components to provide an intelligible signal.

It is also within the intention of this invention to shift the phase of one side band to such an extent that the currents transmitted in it will represent substantially different elements of the original voice or signal impulses than are transmitted simultaneously by the other side band, so that the quality will be distorted and rendered unintelligible if both side bands are demodulated together in an ordinary receiving station.

The invention may be more fully understood from the following description together with the accompanying drawing in the Figures 1, 2, 3, 4, 5, and 6 of which are shown radio transmitting and receiving arrangements embodying the principles of this invention. Fig. 1 shows schematically a radio transmitting station including means for shifting the phase of one of the transmitted side bands so that the transmitted current will be unintelligible. Fig. 2 shows schematically a radio receiving system cooperating with Fig. 1 including means for shifting the phase of one of the received side bands so that an intelligible signal may be received. Figs. 3 and 4 show transmitting

and receiving stations respectively which accomplish the above results electrically, while Figs. 5 and 6 show transmitting and receiving stations accomplishing these results mechanically. Like reference characters have been utilized to denote like parts in all of the figures. While the figures of the drawing illustrate transmitting and receiving stations operating on the principle of radiating energy through the ether it is understood that these types of stations might equally well be connected to wire lines of a carrier system.

In Fig. 1 is shown a transmitter T connected to a modulator M. Any well known type of modulator may be employed and hence the modulator is illustrated schematically. The voice or signal currents will be superimposed on a carrier wave at the modulator M. The output of the modulator is connected to a divided circuit, each branch of which includes a filter or selective device, such as F_1 and F_2. These selective devices may be the types of band filters described in the U. S. patent to G. A. Campbell, #1,227,113. The filter F_1 is designed to readily pass the carrier frequency and the upper side band resulting from modulation, while the filter F_2 is designed to pass the lower side band. Connected in one of these branch circuits is a phase shifting device PS which will operate to disturb the normal phase relation of one of the side bands, such as the lower side band. The phase shifting device might consist of a filter type network or the filter elements in the band separating filters F_1 and F_2 might be extended in number for one or the other to cause the necessary phase disturbance. The upper and lower side bands and carrier are then recombined and transmitted either by radiation from the antenna A or over line wires, if desired. It is pointed out that when these components are thus recombined and radiated that the normal phase relations between them are so shifted or disturbed that the message, if received by ordinary apparatus would be unintelligible.

The receiving circuit of Fig. 2 cooperates with the sending station of Fig. 1 and includes the receiving antenna A which is connected to a divided circuit, the branches of which include the band filters F_1 and F_2. Band filter F_1 is designed to select and transmit the carrier and upper side band frequencies and band filter F_2 is designed to select and transmit the lower side band frequency. Associated in one of these branched selective circuits is a phase shifting device PS′, which may be of a type similar to the previously mentioned phase shifting device PS. This phase shifting device will operate to restore the normal phase relation existing between the component frequencies at the output of modulator M so that when these component frequencies are recombined and transmitted to the demodulator DM an intelligible signal will be received at the receiver R.

In Fig. 3 is shown one modification of the invention in which secrecy is obtained by shifting one of the side bands through 180°, or, in other words, reversing it in phase from its normal relation to the carrier and the other side band. In this arrangement the voice or signal current from the transmitter T is transmitted over a transmitter circuit which is coupled through a transformer to the circuit of a duplex vacuum bulb modulator M which includes the vacuum bulbs A_1 and A_2. This type of duplex modulator is more fully illustrated in the U. S. patent to J. R. Carson, #1,343,306. In a balanced modulator circuit of this type the voice or signal potential applied as shown will render the grid of one of the tubes positive and the grid of the other tube negative at the same time. The two output circuits of the modulator are connected to the separate selective circuits 3 and 4 which include the band filters F_1 and F_2. Filter F_1 will select and transmit the upper side band from tube A_1 and filter F_2 will select and transmit the lower side band from tube A_2. It is pointed out that these side band frequency components will not be in phase with each other but one of them will be reversed in phase with respect to the other, due to the manner in which the voice potential affects the grids of the tubes previously pointed out. Accordingly, when these components are recombined and transmitted from antenna A they will be unintelligible to ordinary receiving apparatus.

A receiving station adapted to receive the signals transmitted from an arrangement, such as shown in Fig. 3, is illustrated in Fig. 4. In this arrangement the receiving antenna is associated with the selective circuits including the band filters F_1 and F_2 to those of Fig. 3, and associated with each of these circuits is a detector circuit, shown as including a vacuum bulb detector, as D_1 and D_2 for the purpose of eliminating the carrier wave. The output of the detector circuits are connected to separate circuits which include the low-pass filters LPF_1 and LPF_2 which serve to eliminate any components of the carrier wave and thus give the voice current. The upper and lower conductors 10 and 11 respectively of one of these circuits are connected to the upper and lower conductors of a receiver circuit, while in the other of these circuits the upper conductor 12 is connected to the lower conductor of circuit 14 and the lower conductor 13 is connected to the upper conductor of circuit 14. By connecting these circuits to circuit 14 in this manner one of the voice or signal currents may again be shifted in phase 180°, or reinverted, so that

the original phase relation will be restored and when the voice or signal currents are recombined they will give an intelligible signal.

In Fig. 5 is illustrated an arrangement whereby secrecy is attained by shifting one of the side bands through 180°, or reversing it in phase with respect to the other side band. In this arrangement and in the receiving arrangement of Fig. 6 the phase inverting and reinverting is accomplished by mechanical means. In the transmitting circuit of Fig. 5 two separate modulator circuits are employed having the modulators M_1 and M_2, which have been shown as of the duplex vacuum bulb type. Separate filter circuits are associated with the output of each modulator. The filter F_3 may be designed to transmit the upper side band while the filter F_4 may transmit the lower side band. The modulators may be supplied from a common carrier source S which may also be transmitted through the filter F_5 to the antenna A. The separate modulator circuits are excited by the voice from the same source, as the transmitter T, which, however, is a double microphone transmitter using a single diaphragm so connected that while the resistance of one microphone button, such as 6, is increasing, the resistance of the other microphone button, such as 7, is decreasing. The resultant voice currents applied to the separate modulator circuits will accordingly be in complete opposition and two side band currents will result with phases oppositely related to the carrier. The secrecy possibilities of such an arrangement reside in the fact that for reception by ordinary listening in receiving systems, both side bands and carrier would fall into one demodulator and no effective voice current would result.

The receiving arrangements of such a system, shown in Fig. 6, would comprise an antenna A to which would be connected three selective circuits, one for the upper side band including filter F_3, one for the lower side band including filter F_4, and one for the carrier including filter F_5. Separate demodulating circuits having the demodulators DM_1 and DM_2 would be employed and the carrier selective circuit would be connected in common to each of these. The output of each demodulator would be connected to circuits including the magnets 8 and 9 arranged to operate in a "push and pull" manner on a single diaphragm of receiver R. The voice currents resulting from the side bands would accordingly aid and not oppose each other and intelligible signals would result.

In the above arrangements, phase shifters are shown connected in the high frequency circuits and affecting the phase of the side band directly. It will, of course, be understood that the desired phase shift may also be produced by manipulating the phase of the voice or signal currents before modulation and after demodulation.

While the arrangements of the invention have been disclosed in certain specific arrangements which are deemed desirable, it is understood that they are capable of embodiment in many and widely, varied forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a transmission system in which the frequency components to be transmitted comprise an upper and lower side band resulting from the modulation of a voice or signal current and a carrier current, the method of maintaining secrecy in the transmission of messages in such a system which consists in altering the normal phase relation existing between said components.

2. In a transmission system in which the frequency components to be transmitted comprise an upper and lower side band resulting from the modulation of a voice or signal current and a carrier current, the method providing secrecy in the transmission of messages in such a system which consists in altering at the sending station the normal phase relation existing between said components and in restoring at the receiving station the normal phase relation between said components.

3. In a transmission system in which the frequency components to be transmitted comprise an upper and lower side band resulting from the modulation of a voice or signal current and a carrier current, the method of maintaining secrecy in the transmission of messages in such a system which consists in altering the normal phase relation existing between said components by shifting one of said components in phase through 180°.

4. In a transmission system in which the frequency components to be transmitted comprise an upper and lower side band resulting from the modulation of a voice or signal current and a carrier current, the method of maintaining secrecy in the transmission of messages in such a system which consists in altering the normal phase relation existing between said components by inverting one of said components in phase.

5. In a transmission system in which the frequency components to be transmitted comprise an upper and lower side band resulting from the modulation of a voice or signal current and a carrier current, the method of providing secrecy in the transmission of messages in such a system which consists in altering at the sending station the normal phase relation existing between said components by inverting one of said components in phase and in restoring at the receiving station the normal phase relation existing

between said components by reinverting said component in phase.

6. In a secret transmission system a sending station comprising a talking or signaling circuit, a modulator circuit associated therewith, selective circuits associated with said modulator circuit for separating the side band frequencies, and means in one of said selective circuits for altering the normal phase relation existing between said side band frequencies.

In testimony whereof, I have signed my name to this specification this 17th day of July, 1922.

HERMAN A. AFFEL.