

Sept. 15, 1925.

1,553,454

DE LOSS K. MARTIN

RADIO REPEATING SYSTEM

Filed Jan. 18, 1923

2 Sheets-Sheet 1

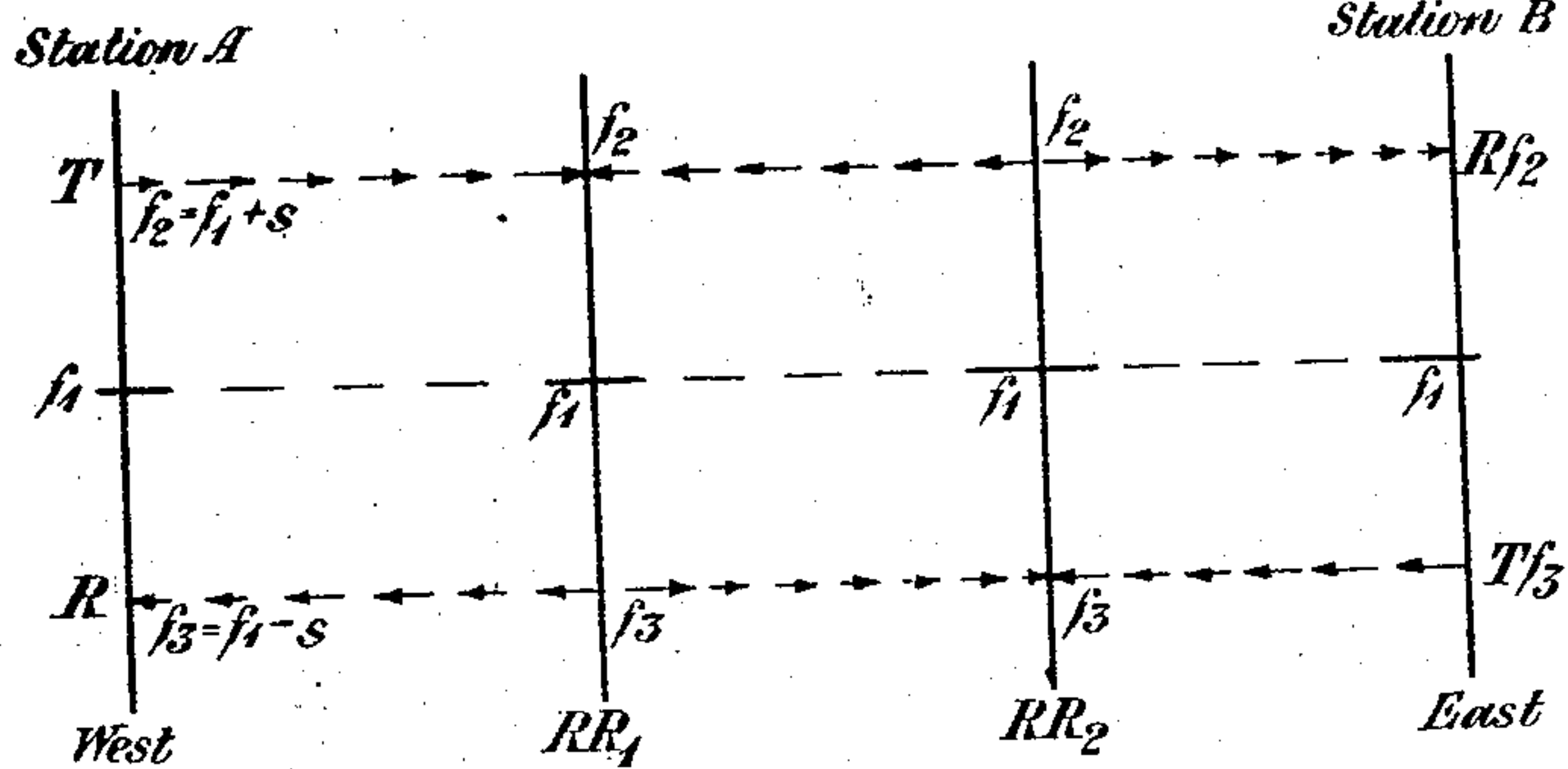


Fig. 1

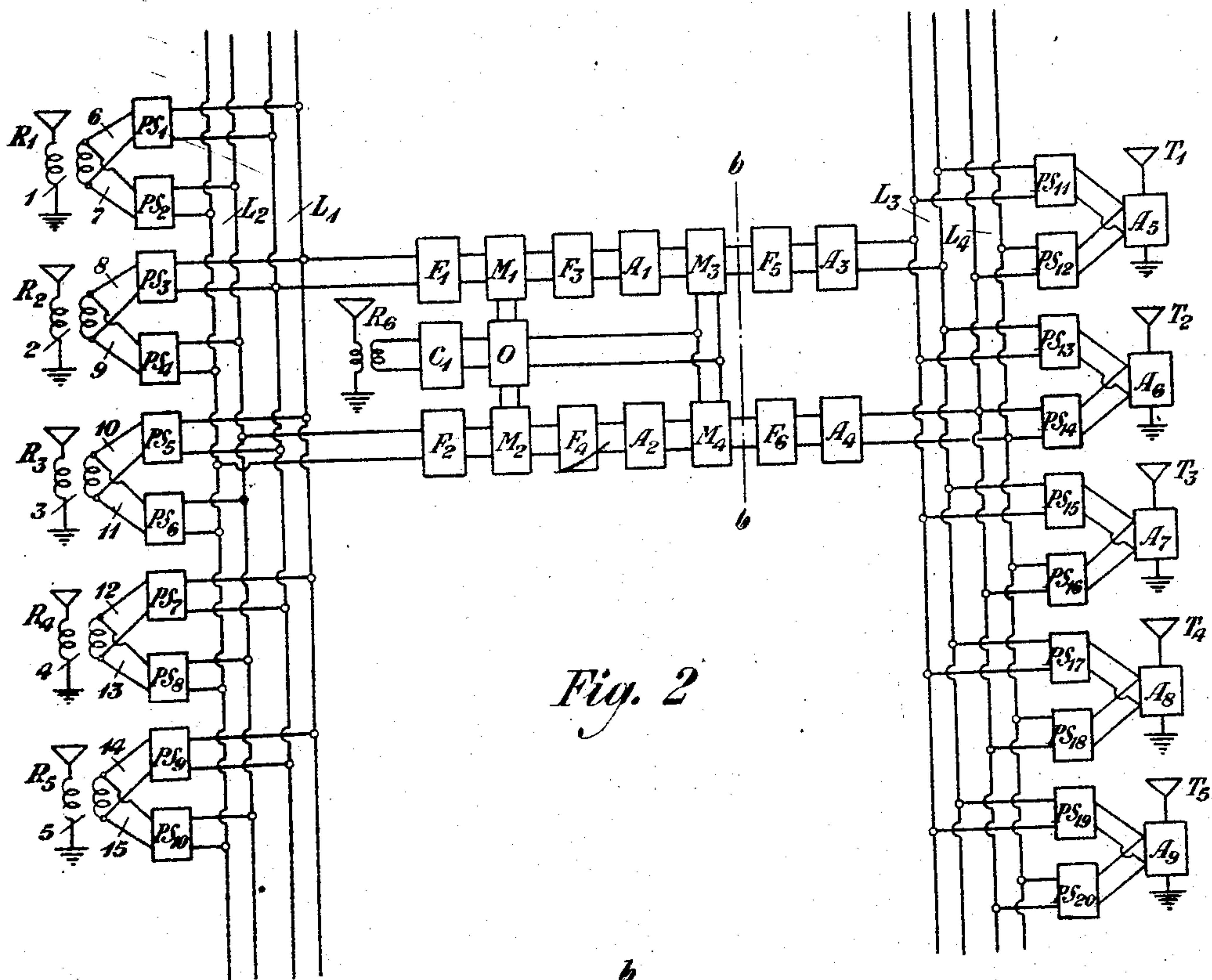


Fig. 2

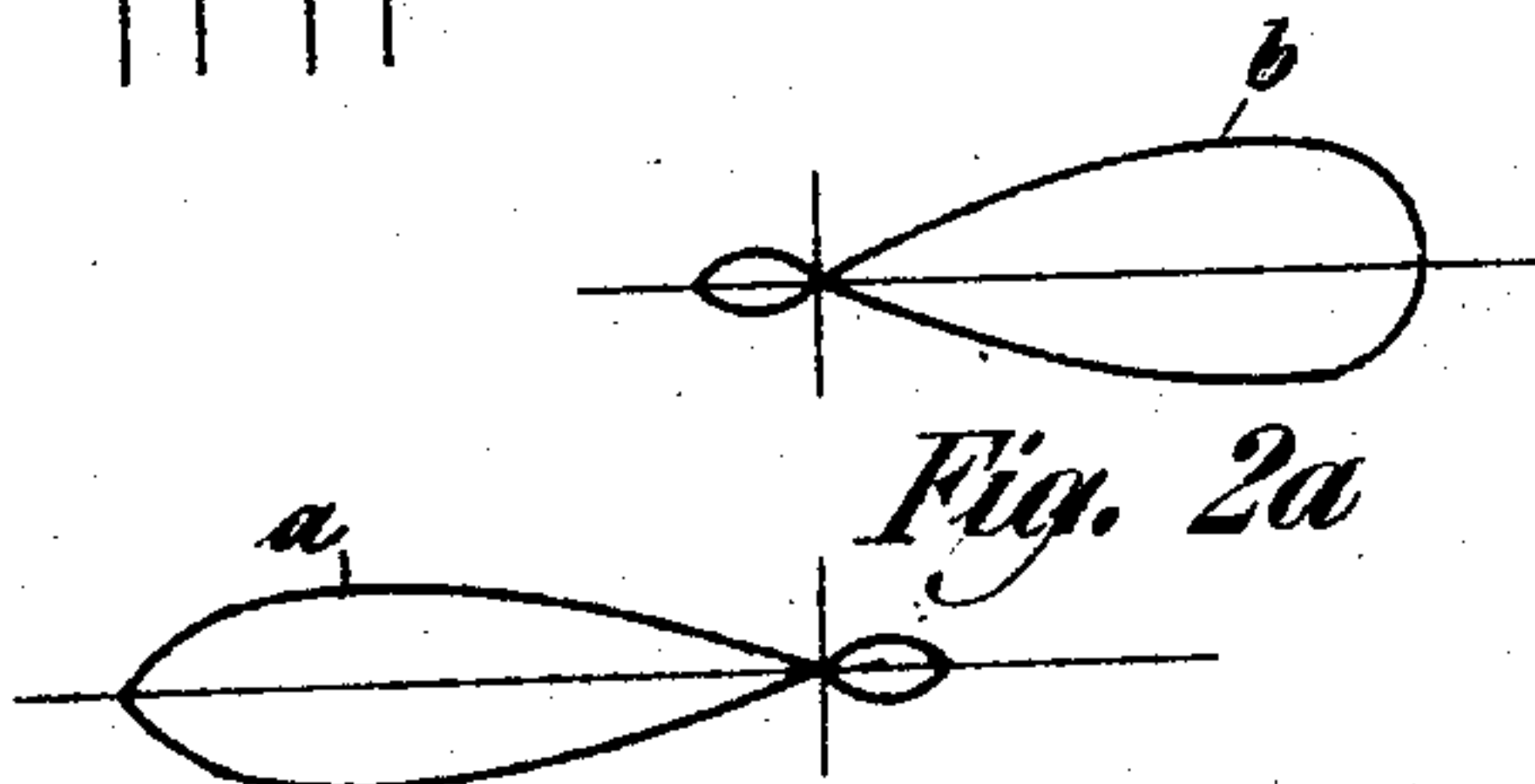


Fig. 2a

BY

INVENTOR
D. K. Martin

ATTORNEY

Sept. 15, 1925.

1,553,454

DE LOSS K. MARTIN
RADIO REPEATING SYSTEM

Filed Jan. 18, 1923

2 Sheets-Sheet 2
Station B

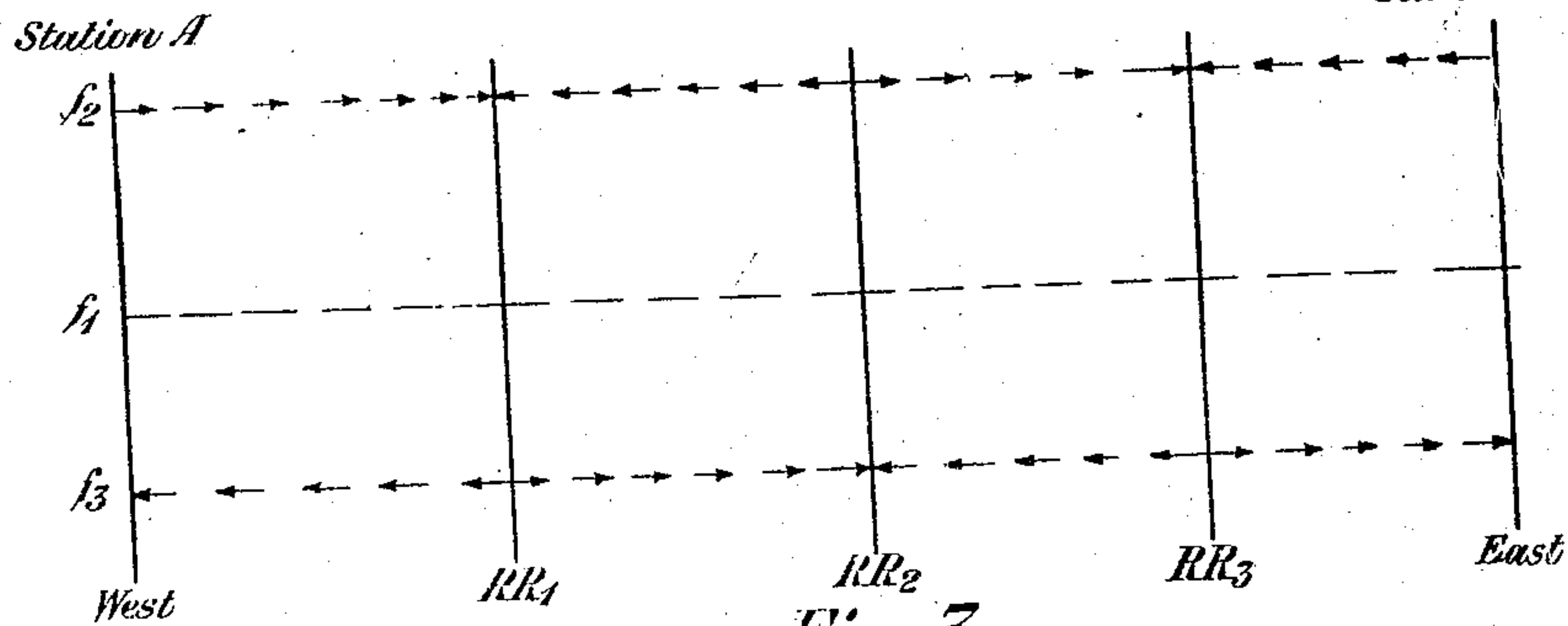


Fig. 3

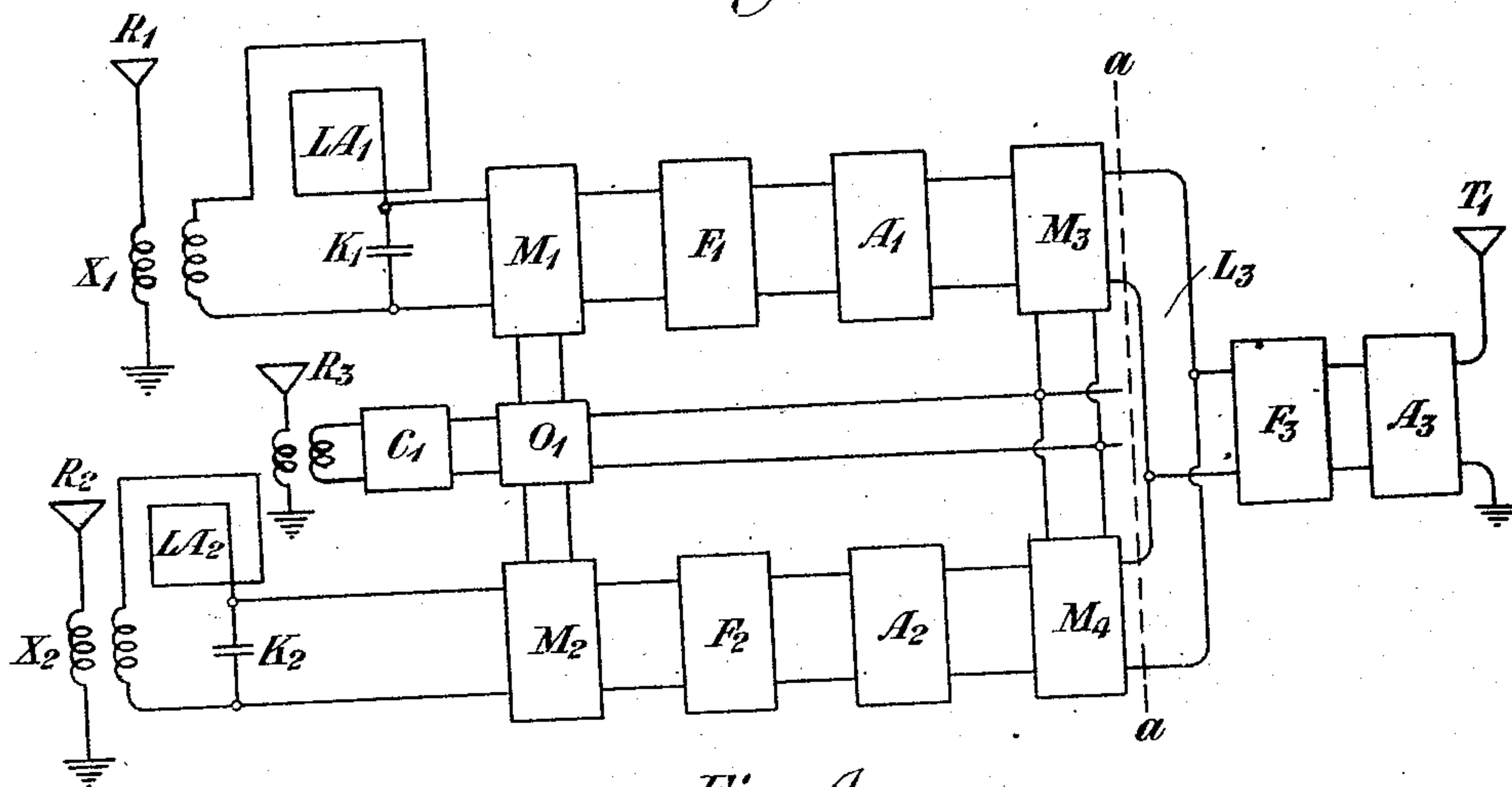


Fig. 4

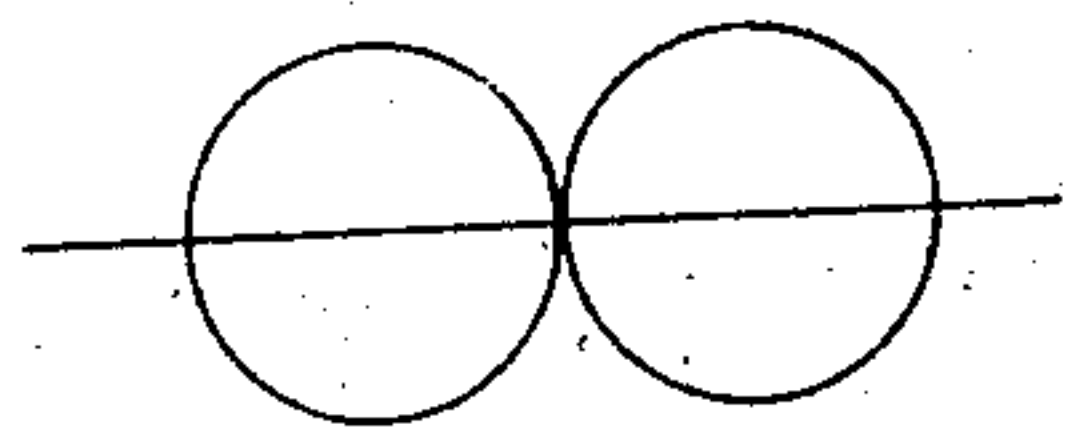


Fig. 5

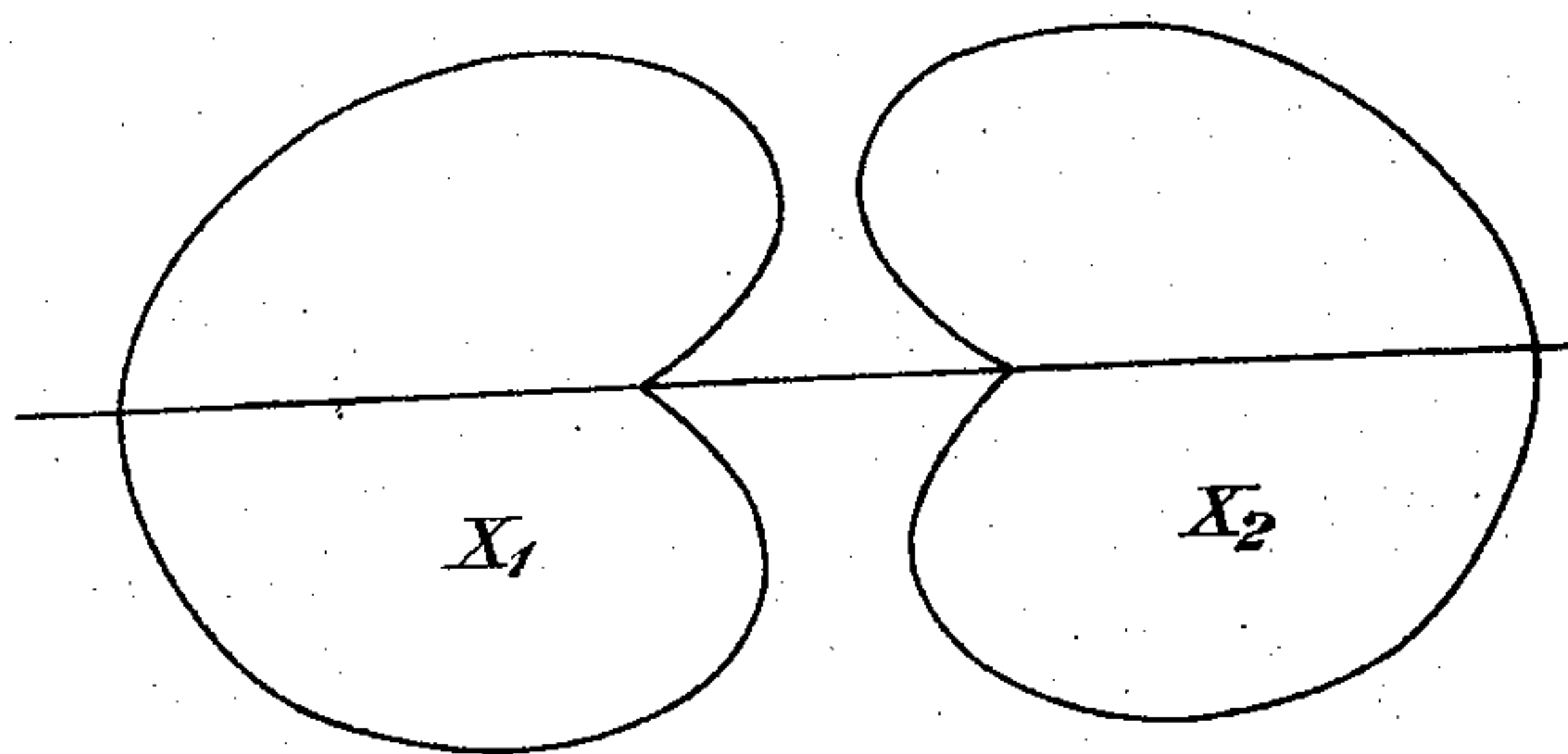


Fig. 5a

INVENTOR
D. K. Martin
BY *g v f o k*
ATTORNEY

Patented Sept. 15, 1925.

1,553,454

UNITED STATES PATENT OFFICE.

DE LOSS K. MARTIN, OF ORANGE, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

RADIO REPEATING SYSTEM.

Application filed January 18, 1923. Serial No. 613,460.

To all whom it may concern:

Be it known that I, DE LOSS K. MARTIN, residing at Orange, in the county of Essex and State of New Jersey, have invented certain Improvements in Radio Repeating Systems, of which the following is a specification.

This invention relates to radio signaling systems and particularly to a system employing one or more repeater stations between the terminal stations of such a system, which repeater stations are characterized by a change of frequency between the input and output sides thereof and so arranged as to require the minimum number of frequencies consistent with the avoidance of interference at the repeater itself or between adjacent repeaters.

In the operation of a long distance radio system having one or more repeaters between the terminal stations thereof, it has been necessary to change the received frequencies of each transmission channel at each repeater in order to prevent currents transmitted from the said repeater from entering the receiving circuits of the same repeater, or the receiving circuits for other channels at a distant repeater, thereby preventing singing or cross-modulation between such channels. For a system without repeaters, two frequencies are normally required for each channel, one for transmitting in one direction and another for transmitting in the other direction. If, for the purpose of illustration we consider a system having two terminals and a single repeater therebetween and if we transmit from one terminal a frequency f_1 and from the other terminal a frequency f_2 , we can avoid interference at the repeater by changing the frequency f_1 to f_3 before radiating it therefrom to the distant terminal to which the signal is intended to go and, similarly, we can change the frequency f_2 at the repeater station to the frequency f_4 before radiating it therefrom. While interference would thereby be avoided, both at the repeater station and also at the terminal stations, it is obvious that such a system requires four frequencies in order to effect two-way transmission between terminal stations. It is obvious that the frequency range required for such a radio repeater system will increase directly with the number of channels and repeaters in the system.

If two or three repeaters are included in such a system, the number of frequencies required for the system will, in general, be increased two per channel per repeater. The large demand made upon the available frequencies by such a system greatly reduces the utility of radio repeaters. However, by the use of directive means of transmission and reception, and means for spacing and controlling the frequencies, it is possible to operate a repeater system with only two frequencies per channel.

It is the object of this invention to effect transmission by a radio system employing one or more repeaters, in which system the number of frequencies per channel of transmission is, in general, limited to two per channel of transmission, regardless of the number of repeaters employed.

Other objects of this invention will be apparent from the following description when read in connection with the attached drawing, of which Figure 1 shows graphically the frequency distribution in a repeater system in which for each two-way transmission channel the terminal stations transmit on different frequencies; Fig. 2 shows a circuit arrangement at a repeater station in which the principle of operation of the system shown in Fig. 1 may be carried out; Fig. 2^a shows the directional characteristics of the antenna systems shown in Fig. 2; Fig. 3 shows graphically the frequency distribution in a system in which transmission at both stations is at the same frequency and similarly reception at both stations is upon the same frequency; Fig. 4 shows the circuit arrangement at a repeater station for carrying out the principle of operation of the system shown in Fig. 3; and Figures 5 and 5^a are directional characteristics explanatory of the system.

It is desired to clearly set forth at this point that while reference may be made throughout the description of these various embodiments of my invention of the use of a single frequency as, for example, f_2 or f_3 , as representing the transmitted or received frequencies constituting a transmission channel, it is to be understood that the designation of these channels by single frequency waves is for the purpose of rendering the description simple and therefore clear, but it is not to be construed as limiting the invention in any way to transmis-

sion or reception upon a single frequency. The transmitted and the received waves of each channel may, of course, be a side band of frequencies produced by the modulation
 5 of a carrier frequency by the frequencies within the voice range, such as is done in radio telephony, or by the modulation of a carrier frequency by telegraph frequencies, such as is employed in radio telegraphy.

10 In a system, such as is represented graphically by Fig. 1, a frequency f_2 , produced by the modulation of a carrier frequency f_1 , by some definite frequency or frequencies that may be designated s is transmitted from
 15 station A in the direction of station B in order to transmit a signal therebetween. In like manner, transmission from station B to station A is effected by a frequency f_3 , which may be produced by the modulation of a carrier frequency f_1 by a signaling frequency which may be designated s , that is to say, the frequency f_2 may be considered
 20 as made up of $f_1 + s$ and the frequency f_3 as being made up of $f_1 - s$. From Fig. 1 it will be seen that the frequency f_2 , transmitted from station A, will, upon its receipt at the radio repeater station RR_1 , be translated to frequency f_3 and transmitted therefrom to the repeater RR_2 , wherein it will
 25 again be translated to the frequency f_2 and transmitted to the receiving station B. In similar manner, frequency f_3 will be transmitted from the station B and upon its receipt at the repeater RR_2 , will be translated to the frequency f_2 and transmitted to repeater RR_1 , where in it will again be translated to frequency f_3 and transmitted to station A.

30 The manner in which this is carried out will be clearly understood from a consideration of the circuit arrangement shown in Fig. 2, which is illustrative of a desired form of arrangement for effecting this result. In Fig. 2, R_1, R_2, R_3, R_4 and R_5 represent a plurality of receiving antennae which
 45 are coupled by means of the transformers 1, 2, 3, 4 and 5 to a plurality of parallel circuits. Thus, for example, the antenna R_1 is coupled by means of a transformer 1 with the parallel circuits 6 and 7, each of which has connected thereto a phase shifting device designated PS_1 and PS_2 respectively. The receiving antenna R_2 is coupled by means of the transformer 2 with the parallel
 50 circuits 8 and 9, with which are connected the phase shifting devices PS_3 and PS_4 respectively and similarly the receiving antennae R_3, R_4 and R_5 are connected by the transformer 3, 4 and 5 respectively with
 55 pairs of parallel circuits 10 and 11, 12 and 13, 14 and 15, with which circuits the phase shifting devices PS_5 and PS_6, PS_7 and PS_8, PS_9 and PS_{10} are respectively connected. What may be termed the output side of each
 60 odd numbered phase shifting device, $PS_1,$

$PS_3,$ etc., is connected with a common trunk circuit L_1 and similarly the output side of each even numbered phase shifting device is connected with a common trunk circuit L_2 . The circuit L_1 is connected through a
 70 translating circuit with another common trunk circuit L_3 , from which a plurality of branch circuits lead to the transmitting antennae T_1, T_2, T_3, T_4 and T_5 . Each branch circuit of the trunk circuit L_3 contains a
 75 phase shifting device designated $PS_{11}, PS_{13}, PS_{15}, PS_{17}$, and PS_{19} . Furthermore, there is associated with each transmitting antenna a power amplifier designated $A_5, A_6 \dots A_n$. The translating circuit connecting the
 80 common trunk circuit L_1 with the common trunk circuit L_3 contains a band filter F_1 , a demodulator M_1 , a low pass filter F_3 , an amplifier A_1 , a modulator M_3 , a band filter F_5 and an amplifier A_3 . The filters are preferably of the type shown in the patent to Campbell, No. 1,227,113, dated May 22, 1917. The modulating and demodulating devices
 85 are preferably of the well known vacuum tube type and desirably of a form in which the fundamental carrier frequency is suppressed therein and not transmitted through the output side of such device. The amplifiers are also preferably of the vacuum tube type and may be of any number of stages
 90 necessary for desirable operation.

The common trunk circuit L_2 is likewise connected through a translating circuit to a common trunk L_4 , which has a plurality of
 100 branch circuits extending to the transmitting antennae T_1, T_2 , etc., the said branches containing a plurality of phase shifting devices PS_{12}, PS_{14} , etc. The latter translating circuit is similar to the first mentioned translating circuit and contains a band filter
 105 F_2 , a demodulator M_2 , a low pass filter F_4 , an amplifier A_2 , a modulator M_4 , a band filter F_6 and an amplifier A_4 . A source of high frequency oscillations O is arranged symmetrically with respect to the translating
 110 circuits and is connected with the demodulators M_1 and M_2 and the modulators M_3 and M_4 . This oscillator has connected therewith an antenna R_6 , adapted to receive oscillations from the terminal stations thereby controlling the frequency of the oscillations set up in O which in turn controls the demodulating and modulating processes. A control device C_1 is inserted between the
 115 antenna R_6 and the oscillator O for control purposes.

The receiving antennae and the transmitting antennae constitute two arrays, the purpose of which is to control the directivity of
 120 the system, and while only five antennae have been shown in connection with each array, it is to be understood that the number may vary without departing from the limits of the invention. In the system shown
 125 graphically in Fig. 1, the repeaters RR_1 and
 130

RR₂ would preferably be of the type shown in Fig. 2. The stations A and B might be of any well known type embodying either a single antenna structure or a multiple antenna structure in the form of an antenna array.

Let it be assumed that a wave of the frequency f_2 is transmitted from station A, which may be called the west station, and impinges upon the receiving antennae R₁ to R₅ inclusive so as to set up oscillations therein. By the proper adjustment of the phase shifting devices PS₁, PS₃, PS₅, PS₇ and PS₉, the system, which includes the common trunk L₁, may be made efficient for reception from the west. In other words, the receiving structure which includes the branch circuits 6, 8, and 10, etc., and the odd numbered phase shifting devices connected by branches to the common trunk circuit L₁, can be made highly selective from the west, that is to say, its directional characteristic would be as represented by *a* of Fig. 2^a. It is true that some of the energy received from the west would also pass into the branch circuits 7, 9, 11, etc., but since, as will later be shown, the phase shifting devices PS₂, PS₄, etc., are arranged to insure the proper phasing of the currents in the line L₂ only for waves impinging upon the antennae R₁, R₂, etc., from the east, substantially none of the oscillations from the west will pass into the line L₂ because the direction from which they approach the antenna array is not that for which the even numbered phase shifters are adjusted. The high frequency current, set up in the common trunk circuit L₁, by the wave from the west, will pass through the filter F₁, which is adapted to pass the frequency f_2 , and will be impressed upon the demodulator M₁. Simultaneous with the impression of the frequency f_2 on the demodulator, there will also be impressed thereon the frequency f_1 , set up by the oscillator O, and the product of demodulation will be impressed upon the filter F₃. Since, as has been stated, the frequency f_2 may be considered as equal to $f_1 + s$, the result of homodyning the frequency f_2 with f_1 is the signal frequency s . The signal frequency transmitted by the filter F₃ and amplified by the amplifier A₁, will be impressed upon the modulator M₃ simultaneous with the impression thereon of oscillations of the frequency f_1 . The results of modulation, namely, the side bands $f_1 + s$ and $f_1 - s$, will be impressed upon the filter F₅, which is designed to pass only one of the side bands, viz, $f_1 - s$, which, as heretofore stated, equals f_3 . This frequency, f_3 , when amplified by A₃, is impressed upon the common trunk circuit L₃, which in turn impresses it upon the branch circuits containing the odd numbered phase shifting devices. These devices are so adjust-

ed that the oscillations will be applied to the power amplifiers and thereby to the transmitting antennae T₁, T₂, etc., in such phase relation that the direction of radiation from the transmitting antennae will be toward the east, as shown by *b* of Fig. 2^a. It should be noted that by the proper adjustment of the odd numbered phase shifting devices connected between the receiving antennae and the line L₁, the repeater system was made selective to oscillations transmitting from west to east, and, furthermore, by the proper adjustment of the odd numbered phase shifting devices connected with the transmitting antennae, the repeater system is made highly directive of transmission from west to east. So to revert to Fig. 1, the oscillations of frequency f_2 , which constitute one side band of frequency f_1 , transmitted from station A to repeater RR₁, are translated to a frequency f_3 , which is the opposite side band of the carrier frequency f_1 and is transmitted mainly in the direction of the repeater RR₂.

At RR₂, this frequency f_3 would be retranslated to the frequency f_2 and transmitted to station B in the same manner in which reception, translation and transmission has been described in connection with repeater RR₁. The frequency f_3 , transmitted from station B, will be translated at repeater RR₂ to the frequency f_2 and will be impressed upon the receiving antenna of repeater RR₁. Since we have described the method of translating the oscillations transmitted from west to east, through this repeater, it is desirable in order to complete the description to describe the translation of the east to west signals. The oscillations impressed upon the receiving antenna array from the east will be impressed upon both the even numbered as well as the odd numbered branch circuits connected with the individual antennae constituting the array. Since the odd numbered phase shifting devices are not adjusted to properly phase the resulting currents when the wave arrives from the east, substantially no current will result in the line L₁. On the other hand, since the even numbered phase shifting devices are adjusted to properly phase the resultant currents, due to oscillations arriving from the east, the resultant current will be set up in the common trunk L₂ and will be impressed upon the filter F₂, which is adapted to pass the frequency f_2 . This frequency will be homodyned with the frequency f_1 from the oscillator O and current of the resultant frequency s will pass through the filter F₄ and be amplified at A₂ and in turn be impressed upon the modulator M₄, together with the carrier frequency f_1 . The results of modulation will be impressed upon the filter F₆, which is adapted to pass current of the lower

side band, that is to say, F_3 , and this current, when amplified by A_4 , will be impressed upon the common trunk L_4 , which in turn impresses it upon the various branch circuits containing even numbered phase shifting devices. These devices are so adjusted that the wave resulting from the oscillations set up in the individual antennae will be transmitted toward the west, as represented by a of Fig. 2^a.

It will be seen from the foregoing description that only two frequencies are required in this radio repeating system, even though two repeater points exist between the terminals thereof. The avoidance of interference is partly effected by the use of directive antenna arrays or equivalent means for reception and transmission. Interference is furthermore prevented by receiving from both directions at substantially the same frequency and transmitting in both directions at the same frequency the latter frequency being different and widely separated from the first mentioned frequency. This separation of the transmitted and the received frequencies tends to prevent singing between the transmitting and the receiving antennae of the repeater station, which might occur if a transmitted frequency were substantially the same as a receiving frequency, even though the transmitted frequency were mainly directed in an opposite direction to that from which the receiving antennae were intended to receive.

Figure 3 shows a system in which transmission from station A and station B occurs at a frequency f_2 and reception at both stations occurs at the frequency f_3 , both of which frequencies may be presumed to be side bands of a carrier frequency f_1 . The arrangement for effecting reception, translation and transmission at each of the repeater points RR_1 , RR_2 and RR_3 is shown in Fig. 4. This arrangement comprises two loop antennae LA_1 and LA_2 , with each of which is associated vertical antennae, R_1 and R_2 respectively. While the characteristic of a loop antenna, as shown in Fig. 5, is such as to receive equally well in opposite directions, such loop antenna may be made fairly uni-directive by associating therewith a vertical antenna. Thus, for example, the receiving structure X_1 would be adapted to receive efficiently from the west whereas the structure X_2 would be adapted to receive efficiently from the east by the proper phasing of the currents set up in the vertical and the loop antennae. The output side of the loop antenna LA_1 is connected with a demodulator M_1 , with which is also connected an oscillator O_1 , adapted preferably to generate oscillations of the carrier frequency f_1 . The output side of the modulator M_1 is connected with a low pass filter F_1 , which in turn is connected with an am-

plifier A_1 , and the output side of the latter is connected to the modulator M_3 , with which the oscillator O_1 is also connected. In similar manner, the output side of the loop antenna LA_2 is connected with a translating circuit, including the demodulator M_2 , low pass filter F_2 , amplifier A_2 and modulator M_4 . The oscillator O_1 is connected with the demodulator M_2 and the demodulator M_4 . The output side of each of the modulators is connected with a common output circuit L_3 , which in turn is connected to the antenna T_1 through a circuit containing a band filter F_3 and an amplifier A_3 .

The mode of operation of the circuit shown in Fig. 4 is, in general, similar to that shown in Fig. 2. Oscillations arriving at the repeater RR_1 from the west, that is, from station A, would, of course, be impressed upon both antennae X_1 and X_2 , but since the reception characteristic of X_1 shows that this antenna is more selective to oscillations arriving from the west than is the antenna X_2 , substantially all of the energy would be, therefore, absorbed by the antenna structure X_1 . The resultant current would be impressed upon the demodulator M_1 , together with the carrier frequency current f_1 . The result of demodulation, that is, the signal current s , will pass through the filter F_1 and, when amplified by A_1 , will be impressed upon the modulator M_3 , together with oscillations of the carrier frequency f_1 . The resultant bands $f_1 + s$ and $f_1 - s$ will pass to the common output circuit L_3 , but since the filter F_3 is adapted to transmit only the lower side band, that is, $f_1 - s$, current at that frequency will pass there-through and when amplified by A_3 will be radiated by the antenna T_1 . This antenna has no directive qualities so that energy therefrom would be radiated in substantially all directions. However, since the frequency of the radiated oscillations is different from that for which the loop antenna circuits are tuned (by virtue of their inductance and the capacity of the condensers K_1 and K_2) substantially none of this energy will be absorbed by these antennae and accordingly local singing at a repeater point is avoided.

In like manner, oscillations of the frequency f_2 arriving at repeater RR_1 from the east will be mainly absorbed by the antenna X_2 , since this antenna is selective of oscillations from the east, and the resultant current will be translated in frequency by the translating circuit consisting of the demodulator M_2 , the filter F_2 , the amplifier A_2 and the modulator M_4 , together with the local source of carrier frequency O_1 . The resultant bands of frequencies will be impressed upon the filter F_3 , which, as heretofore stated, will transmit only the lower side band, viz, f_3 . Oscillations of this frequency

would therefore be radiated by the antenna T_1 in substantially all directions but interference would be prevented in a manner similar to that herein set forth.

5 If it were desired to control the direction of the transmitted oscillations from the repeater shown in Fig. 4, the output side of the modulators M_3 and M_4 (along the line a, a) may be connected with the common trunk circuits L_3 and L_4 of Fig. 2, by connecting that part of the circuit to the left of the line a, a of Fig. 4, with that part of the circuit of Fig. 2 to the right of the line b, b . In such a modification of Fig. 4, the results of modulation of M_3 would be impressed upon the filter F_3 of Fig. 2, and the current of the frequency passed by this filter would be amplified by A_3 and impressed upon the common trunk L_3 . The resultant oscillations would be radiated by the antennae T_1, T_2 , etc., in a given direction, depending upon the phase adjustment of the odd numbered phase shifters, PS_{11}, PS_{13} , etc., and in like manner, the products of modulation of M_4 of Fig. 4 would be selected and amplified and radiated in a definite direction, depending upon the adjustment of the even numbered phase shifting devices connected between the transmitting antennae and the common trunk L_4 . It will be seen that the arrangement shown in Fig. 4 reduces the frequencies required for transmission between the stations A and B of Fig. 3 to two, irrespective of the number of intervening repeater stations. Furthermore, in the arrangement shown in Fig. 4, reception from both directions is effected at the same frequency and transmission in both directions is also effected at the same frequency, which frequency is widely different from the reception frequency to prevent local singing at the repeater station.

While this invention has been described as embodied in a particular form and arrangement of parts, it is to be understood that it is capable of embodiment in other and different forms within the spirit and scope of the appended claims.

What is claimed is:

50 1. In a radio repeating system having terminal stations and a plurality of repeater stations located there between in which simultaneous two-way signaling is effected by using for each transmission channel a transmitting wave of different frequency from the received wave, the method for limiting throughout the system the number of frequencies necessary for the transmission of each signaling channel to those transmitted and received by any terminal station, which consists in selecting the frequencies of the waves simultaneously transmitted from both terminal stations so that at any repeater station the oppositely traveling waves received thereby will be of the

same frequency, changing at each repeater station the frequency of both of the said waves by the same amount and radiating both of said waves at the same frequency without producing interference between the 70 said waves.

2. In a radio repeating system having terminal stations and a plurality of repeater stations located therebetween in which simultaneous two-way signaling is effected by using for each transmission channel a transmitting wave of different frequency from the received wave, the method for limiting throughout the system the frequencies necessary for the transmission of each signaling channel to those transmitted and received by any terminal station, which consists in selecting the frequencies of the waves simultaneously transmitted from both terminal stations so that at any repeater station the oppositely traveling waves received thereby will embrace the same band of frequencies, changing at each repeater station the frequencies of each of said bands by substantially the same amount and radiating bands embracing substantially the same frequencies without producing interference between the said bands.

3. In a radio repeating system having terminal stations and a plurality of repeater stations located therebetween in which two-way signaling is effected by using at each terminal station a transmitting wave of different frequency from the receiving wave, the method for limiting throughout the system the frequencies to those transmitted and received by any terminal station, which consists in selectively receiving at each of said repeater stations east and west waves of substantially the same frequency, changing the frequency of the said waves by the same amount, radiating both of said waves at substantially the same frequency and controlling the direction of radiation of each of said waves. 110

4. In a radio repeating system having terminal stations and a plurality of repeater stations located therebetween in which two-way signaling is effected by using at each terminal station a transmitting wave of different frequency from the receiving wave, the method for limiting throughout the system the frequencies to those transmitted and received by any terminal station, which consists in selectively receiving at each of said repeater stations east and west waves embracing substantially the same band of frequencies, changing the frequencies of both waves by the same amount, radiating both of said waves and controlling the direction of radiation of each of said waves. 125

5. In a radio repeating system having terminal stations and an even number of repeater stations located therebetween, the method of relaying a two-way signaling 130

channel between said terminals without producing interference between the input and output sides of any repeater station or between the stations themselves, which consists in modulating at each station a carrier frequency " f " by a signaling frequency " s ", selecting and transmitting from one terminal station the " $f+s$ " component of modulation, selecting and transmitting from the other station the " $f-s$ " component, whereby both waves received at any repeater station will be of the same frequency, changing the frequency of both waves at each repeater station by the frequency " $2s$ " and radiating both of said waves from each repeater station at the same frequency.

6. In a radio repeating system having terminal stations and an even number of repeater stations located therebetween, the method of relaying a two-way signaling channel between said terminals without producing interference between the input and output sides of any repeater station or between the stations themselves, which consists in modulating at each station a carrier frequency " f " by a band of signaling frequency " s ", selecting and transmitting from one terminal that band representing the " $f+s$ " component of modulation, selecting and transmitting from the other station that band representing the " $f-s$ " component, whereby both waves received at any repeater station will embrace the same band of frequencies, changing the frequencies of both waves at each repeater station by the frequency " $2s$ ", thereby producing the side band opposite to that received at the said repeater station and radiating from the said repeater station both waves embracing the same band of frequencies.

7. In a radio repeating system having terminal stations and an even number of repeater stations located therebetween, the method of relaying a two-way signaling channel between said terminals without producing interference between the input and output sides of any repeater station or between the stations themselves, which consists in directly receiving at each repeater station oppositely traveling waves embrac-

ing substantially the same band of frequencies, changing at each repeater station the frequency of both of said waves by an amount adapted to produce the side band opposite to that of the received waves and directly controlling the radiation from the repeater station of each of said waves.

8. In a radio repeating system, the combination with a plurality of receiving antennae adapted to receive waves of a definite frequency, of means for controlling the directivity of reception of the said antennae, a translating circuit having means associated therewith to change the frequency of all received waves by substantially the same amount, a plurality of transmitting antennae adapted to transmit the said waves at the frequency to which they have been changed, and means for controlling the direction of radiation of the said waves from the said transmitting antennae.

9. In a radio repeating system, the combination with a directionally controlled receiving antenna system arranged to receive waves from different directions of the same frequency or the same band of frequencies, a frequency translating circuit arranged to change the frequency of all received waves by the same amount, and a directionally controlled transmitting antenna system arranged to transmit each of the said waves of changed frequency in a predetermined direction.

10. In a radio repeating system, the combination with a directionally controlled receiving antenna system arranged to receive from different directions waves having the same frequency or band of frequencies, a frequency translating circuit having means to change the frequency of each of the received waves by the same amount, and a directionally controlled transmitting antenna system having means to transmit the said waves of changed frequency in different predetermined directions.

In testimony whereof, I have signed my name to this specification this 15th day of January 1923.

DE LOSS K. MARTIN.