

X 5198R

mem

May 19, 1925.

1,537,990

L. ESPENSCHIED

METHOD OF IMPROVING BROADCAST RECEPTION

Filed April 11, 1924

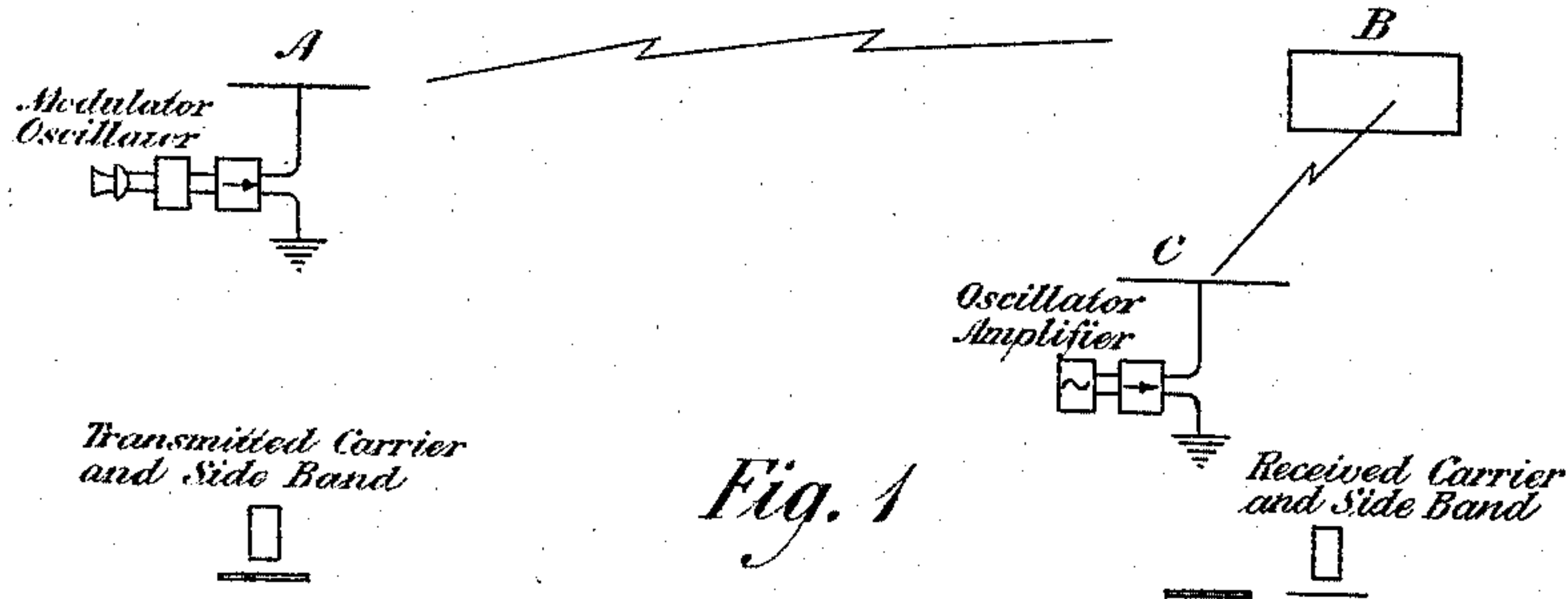


Fig. 1

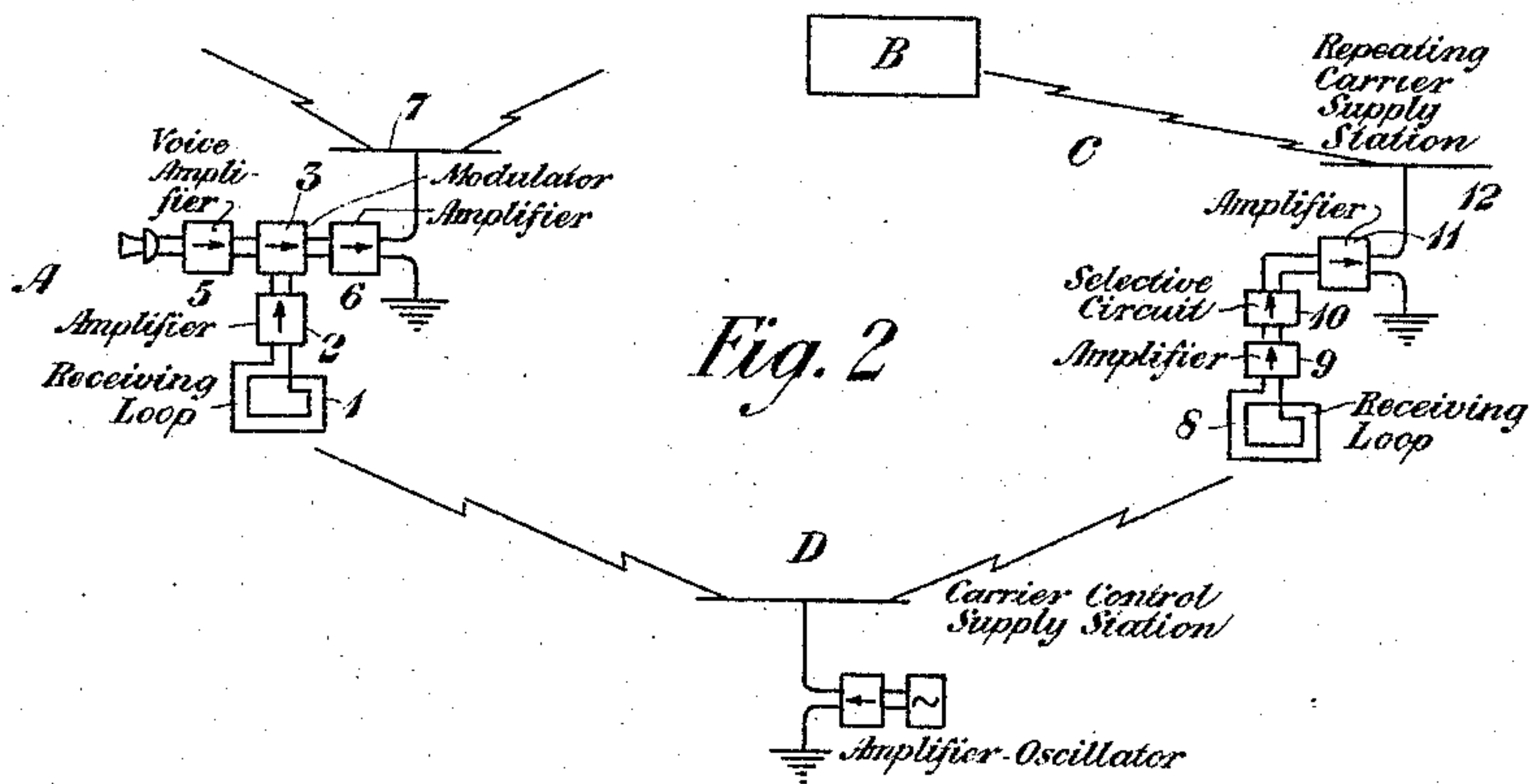


Fig. 2

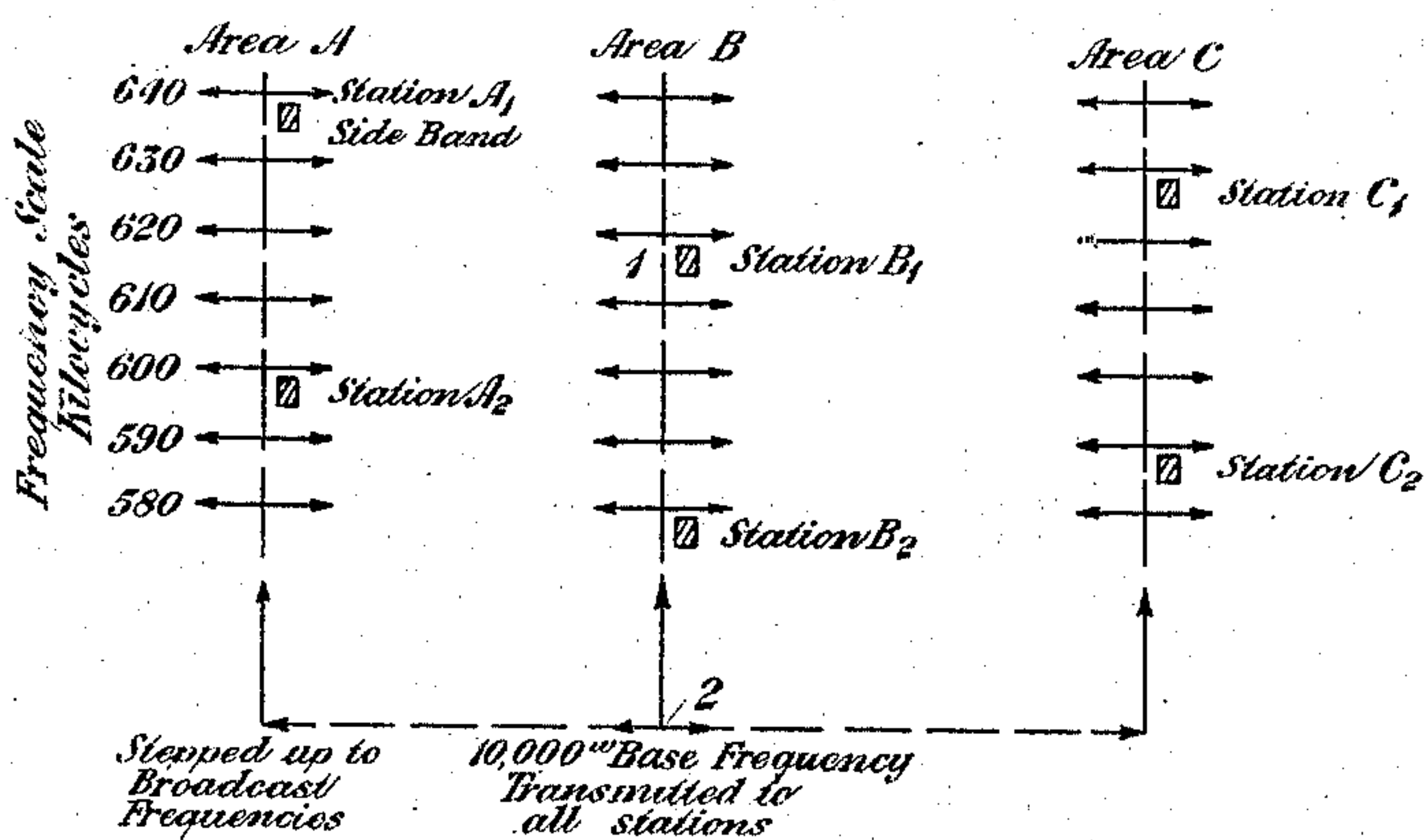


Fig. 3

INVENTOR

L. Espenschied

BY

grr

ATTORNEY

Patented May 19, 1925.

1,537,990

UNITED STATES PATENT OFFICE.

LLOYD ESPENSCHIED, OF HOLLIS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

METHOD OF IMPROVING BROADCAST RECEPTION.

Application filed April 11, 1924. Serial No. 705,950.

To all whom it may concern:

Be it known that I, LLOYD ESPENSCHIED, residing at Hollis, in the county of Queens and State of New York, have invented certain Improvements in Methods of Improving Broadcast Reception, of which the following is a specification.

This invention relates to the transmission of intelligence by radio, and more particularly to improvements in radio broadcasting.

In radio transmission received from a distant point, the reception is poor for at least two reasons, first, because the carrier as well as the side band transmitted from the distant station has been attenuated due to the distance through which they are transmitted before being received, and second, because of the so-called "fading" effect, that is, a waxing and waning in the strength of the received signal.

While the exact cause or causes which produce the so-called fading effect are at present unknown, the effect upon the transmission received at a given receiving station appears to be one of fluctuations in the attenuation of both the carrier and the side band. Since the received signal is proportional to the product of the carrier and the side band, it becomes at once apparent that the fluctuation in the received signal will not vary directly with the carrier or directly with the side band but will be, in effect, proportional to the square of the variation in the carrier and side band.

In accordance with the present invention, it is proposed to reduce the effect of attenuation due to the distance of the point from which the signal is broadcasted and also to reduce the fading effect, by producing at a local station in the area in which is included a large number of receiving points, a carrier wave of exactly the same frequency as that employed by a distant broadcasting station, and then broadcasting the wave to the various receiving sets in the local area. The amplitude of this wave may be made so great that the locally produced carrier will be quite large at each receiving point as compared with the amplitude of the carrier actually received from the broadcasting station. The received signal will then be proportional to the product of the received

side band and the carrier transmitted from a point in the neighborhood of the receiving station. This will result in receiving a signal of greater strength than would be possible where the signal depended upon the transmission of both carrier and side band from the distant transmitting station. It also results in keeping one of the components entering into the received signal substantially constant and quite large with respect to the side band, so that the fading effect will be directly proportional to the fluctuations in the amplitude of the side band and will not be increased by reason of a corresponding fluctuation in the carrier.

The production of the carrier frequency in the local area may be accomplished in a number of ways, but it is preferred, where there is a national or at least regional control of the various broadcasting frequencies, to generate carriers in the different local areas of the region by producing harmonics of a base control frequency which may be transmitted to all local areas from a controlling point. Such a scheme not only maintains the various broadcasting frequencies fixed with respect to each other but enables the generation of local carrier energy of the same frequency as the carrier employed in broadcasting from a distant station with absolute accuracy.

The method of the present invention may now be understood in greater detail from the following description, when read in connection with the accompanying drawing, Figures 1, 2 and 3 of which are schematic diagrams illustrating the application of the method.

Referring to Fig. 1, an arrangement is illustrated in which the apparatus of the distant broadcasting station is represented at A, while B represents the location of the apparatus of a local broadcast listener. The apparatus schematically indicated at C represents a station in the general locality of the receiver B for supplying to local receiving stations a carrier having the frequency of that employed at the distant broadcasting station.

The transmitting apparatus at A may be of any well known type suitable for single side band broadcasting and consists essentially of a microphone or like device upon

which the broadcasted message is impressed, an oscillator or generator of high frequency waves for carrying the signal, a modulator for impressing the message upon the carrier frequency and a filter to suppress one of the side bands. The apparatus at any local receiving station such as B may be of any type now in common use. The apparatus at the local source of carrier supply C may consist of an oscillator or other source of carrier waves having the same frequency as the carrier wave employed at A, together with some suitable means for amplifying the carrier wave to the desired value, and in addition, a radiating antenna will be provided for transmitting the carrier to all of the receiving stations in the local area.

Let us suppose that the distant broadcasting station is at Chicago and that the local receiver B is somewhere in the neighborhood of New York city. The carrier supply station C will then be located at some central point in the vicinity of New York and will radiate the same frequency as that transmitted with the side band from point A to all of the local receiving stations in the vicinity.

In the diagram of Fig. 1, immediately below station A, is a schematic representation of a carrier frequency and side band as radiated from station A. At the left of the diagram and below station B, the same side band and carrier are represented but it will be understood that both the carrier and the side band will be reduced in amplitude due to the distance through which they are transmitted, and both will vary in amplitude due to the so-called fading effect. Immediately to the left of the diagram representing the received carrier and side band is a heavy horizontal line representing the reinforcing local carrier frequency transmitted from the station C. The amplitude of the carrier received at a given receiving point will be equal to the sum of the amplitudes of the unmodulated carrier component transmitted from the distant station A and the carrier frequency transmitted from the local station C. As the latter will be received with very much greater amplitude than the component received from the distant station A, the fluctuations in the amplitude of the received carrier due to fading will be substantially negligible. The only appreciable effect of the fading will be in the variation of the amplitude of the locally received side band. Since the signal will be a product of the effective received carrier and the side band, the fading effect will be limited substantially to a variation proportional to the variation in amplitude of the side band only. In any case, regardless of the amplitude of the side band, the signal will be much greater than in the case where the signal is detected by combining the re-

ceived side band with the received carrier component transmitted from the distant station, which is now the common practice.

So far as the practice of the method above outlined is concerned, it will be apparent that the carrier frequency component need not be radiated from the distant station A at all but may be suppressed by any means well known in the art. The receiving stations in the local receiving area will then depend entirely upon the carrier frequency transmitted from a local supply station for the carrier component which is to beat with the side band to produce the signal.

The invention as above outlined readily adapts itself to a system in which the carrier frequency employed by broadcasting stations throughout a region of considerable extent or even throughout the entire country, may be controlled from a common control station. In Fig. 2, A represents the broadcasting apparatus at a distant broadcasting station, B represents a local receiving station, C represents the station in the general locality of station B for radiating the carrier, while D represents the carrier control station for controlling the carrier frequencies employed at the various broadcasting points.

The apparatus at station D is schematically represented as comprising a suitable radio frequency source, an amplifier for amplifying the voltage of the frequency to be radiated, and an antenna for radiating the control frequency. The showing of the apparatus at station B is merely a conventional one, it being understood that where a plurality of broadcasting frequencies are to be employed, means will be provided at station D for radiating all of the broadcasting frequencies or for radiating one or more basic frequencies from which all of the broadcasting frequencies may be produced at the various broadcasting stations in accordance with methods well known in the art.

At the broadcasting station A there is represented a receiving antenna or loop 1 for receiving the control frequency transmitted from station D. The frequency thus received is impressed upon an amplifier or other translating device 2, whereby a carrier of the frequency and amplitude desired for broadcasting will be produced. This carrier will be impressed upon the modulator 3. The program to be transmitted will be impressed upon the transmitter 4, the signaling currents being amplified by an amplifier 5 and impressed upon the modulator 3 to modulate the carrier frequency. The resultant current, consisting of the side bands and carrier component, is modified by a filter suppressing one of the side bands and amplified by the amplifier 6 and impressed upon the transmitting antenna 7 to be radiated to various receiving areas. Prefer-

ably the receiving loop 1 will be so located and orientated with respect to the transmitting antenna 7 and the distant control station D that said loop will receive effectively from station D but will be substantially conjugate with respect to the antenna 7. Singing between the transmitting and receiving antennæ will thus be prevented.

The apparatus at C for locally supplying the carrier for the various receiving stations in the local area is schematically represented as consisting of a receiving loop 8 for receiving the carrier control frequency transmitted from station D, an amplifier 9 for amplifying the control frequency, and a selective circuit such as the filter or tuned circuit 10 for purifying the wave and eliminating any components corresponding to the side band from station A or components corresponding to other broadcasting frequencies employed. The purified wave will then be amplified by another amplifier 11 and impressed upon a transmitting antenna 12 for radiation to the various receiving stations in the locality. The loop 8 may be located and orientated with respect to the antenna 12 and the points A and D so that it will receive effectively waves transmitted from D but will ineffectively receive waves transmitted from station A. It is also desirable that the loop 8 should be substantially conjugate with respect to the transmitting antenna 12 to avoid singing between said antenna and the loop.

By the arrangement above described, the carrier frequency radiated from the local station C to the various receiving points in the local area may be made quite large as compared with the carrier frequency component radiated from the distant broadcasting station A, and by means of the control exercised from D may be held to exactly the same frequency as the carrier component radiated from A. Also, the amplitude of the carrier transmitted from C may be kept independent of the fading effect upon the carrier frequency component transmitted from A to D.

A more general application of the method is illustrated in Fig. 3. Here A, B and C represent three broadcasting areas which may be supposed to correspond to areas such as those into which the United States has recently been divided by the Department of Commerce, or where such large areas are impractical, the three areas illustrated may be considered as corresponding to subdivisions of such areas. Z represents a central carrier supply station for the entire system. From this point a base carrier frequency may be radiated or transmitted over wire circuits to the various local areas and from this base frequency all the broadcasting carrier frequencies are derived as multiples. For example, the base frequency may be

10,000 cycles, in which case the interval between the various characters would be 10,000 cycles. By means well known in the art, there are produced at some suitable point in area A not only the carrier frequencies by which broadcasting is to take place in that area, as for example, 600 kilocycles or 640 kilocycles, but also all the frequencies which are to be used at all of the other broadcasting areas, such as B, C, etc. Thus there will be supplied for detection at all receiving stations in area A carriers which are used for transmission and from stations B₁ and B₂ in area B and from stations C₁ and C₂ in area C, etc.

The same thing will be done for the other areas so that each area will have reproduced at some point therein all of the frequencies used in the various other areas in which reception is desired to be obtained. By this scheme all of the broadcasting frequencies will not only be reproduced locally with greater volume than if they were transmitted from distant points, but each of the frequencies produced in each of the areas will be identical so far as frequency is concerned, and will bear the same frequency relation to each other.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. The method of reducing the effect of "fading" upon radio receiving sets in a local area when signals are radiated from a distant point, which consists in producing at some point in the local area a carrier wave of the same frequency as the carrier wave employed at the distant signaling station, and radiating said wave to the receiving sets in the local area.

2. The method of reducing the effect of "fading" upon radio receiving sets in a local area when signals are radiated from a distant point, which consists in producing at some point in the local area a carrier wave of the same frequency as the carrier wave employed at the distant signaling station, and radiating said wave with an amplitude sufficiently great so that it will arrive at the various receiving stations in the local area with an amplitude greater than that of the carrier wave component transmitted from the distant station.

3. The method of reducing the effect of "fading" upon radio receiving sets in a local area when receiving signals from a distant point, which consists in producing at a controlling station a controlling wave, transmitting said controlling wave to the distant transmitting station and to a point in the local receiving area, producing at the

distant signaling point a carrier wave for signaling having a frequency determined by the controlling wave, producing at a point in the local receiving area under the control of the controlling wave a wave of the same frequency as the carrier used for transmitting at a distant transmitting station, and radiating the wave thus produced to the various receiving sets in the local receiving area.

4. The method of reducing the effect of "fading" upon radio receiving sets in a local area when receiving signals from a distant point, which consists in producing at a controlling station a controlling wave, transmitting said controlling wave to the distant transmitting station and to a point in the local receiving area, producing at the distant signaling point a carrier wave for signaling having a frequency determined by the controlling wave, producing at a point in the local receiving area under the control of the controlling wave a wave of the same frequency as the carrier used for transmitting at a distant transmitting station, and radiating the wave thus produced to the various receiving sets in the local receiving area with an amplitude sufficiently great so that it will arrive at any of the receiving sets with an amplitude greater than the carrier wave component transmitted from the distant signaling station.

5. The method of reducing the effect of "fading" upon radio receiving sets in a local area when signals are radiated from a distant point, which consists in producing at some point in the local area a carrier wave of the same frequency as the carrier wave employed at the distant signaling station and having substantially constant amplitude, and radiating said wave to the receiving sets in the local area.

6. The method of reducing the effect of "fading" upon radio receiving sets in a local area when signals are radiated from a distant point, which consists in producing at some point in the local area a carrier wave of the same frequency as the carrier wave employed at the distant signaling station and having substantially constant amplitude, and radiating said wave with an amplitude sufficiently great so that it will arrive at the various receiving stations in the

local area with an amplitude greater than that of the carrier wave component transmitted from the distant station.

7. The method of reducing the effect of "fading" upon radio receiving sets in a local receiving area when receiving signals from distant transmitting stations, which consists in producing at a point in the local area a plurality of carrier waves having frequencies corresponding to the various carrier frequencies employed by the distant signaling stations from which it is desired to receive signals in the local areas, and transmitting the waves thus produced to the various receiving sets in the local area.

8. The method of reducing the effect of "fading" upon radio receiving sets in a local receiving area when receiving signals from distant transmitting stations, which consists in producing at a point in the local area a plurality of carrier waves having frequencies corresponding to the various carrier frequencies employed by the distant signaling stations from which it is desired to receive signals in the local areas, and transmitting the waves thus produced to the various receiving sets in the local area with an amplitude greater than that of the corresponding carrier component received from a distant signaling station.

9. In a radio signaling system in which receiving sets are grouped in local areas and in which transmitting sets are located in the various local areas, the method of reducing the effect of "fading" upon the receiving sets in a given local area when receiving from transmitting stations located in distant areas, which consists in producing at a controlling station a controlling frequency, transmitting the controlling frequency to a point in each local area, producing under the control of said controlling wave at each of said points carrier waves having frequencies corresponding to each of the transmitting stations in all of the areas, and radiating in each local area all of said carrier frequencies to the receiving sets in the local areas.

In testimony whereof, I have signed my name to this specification this 5th day of April, 1924.

LLOYD ESPENSCHIED.