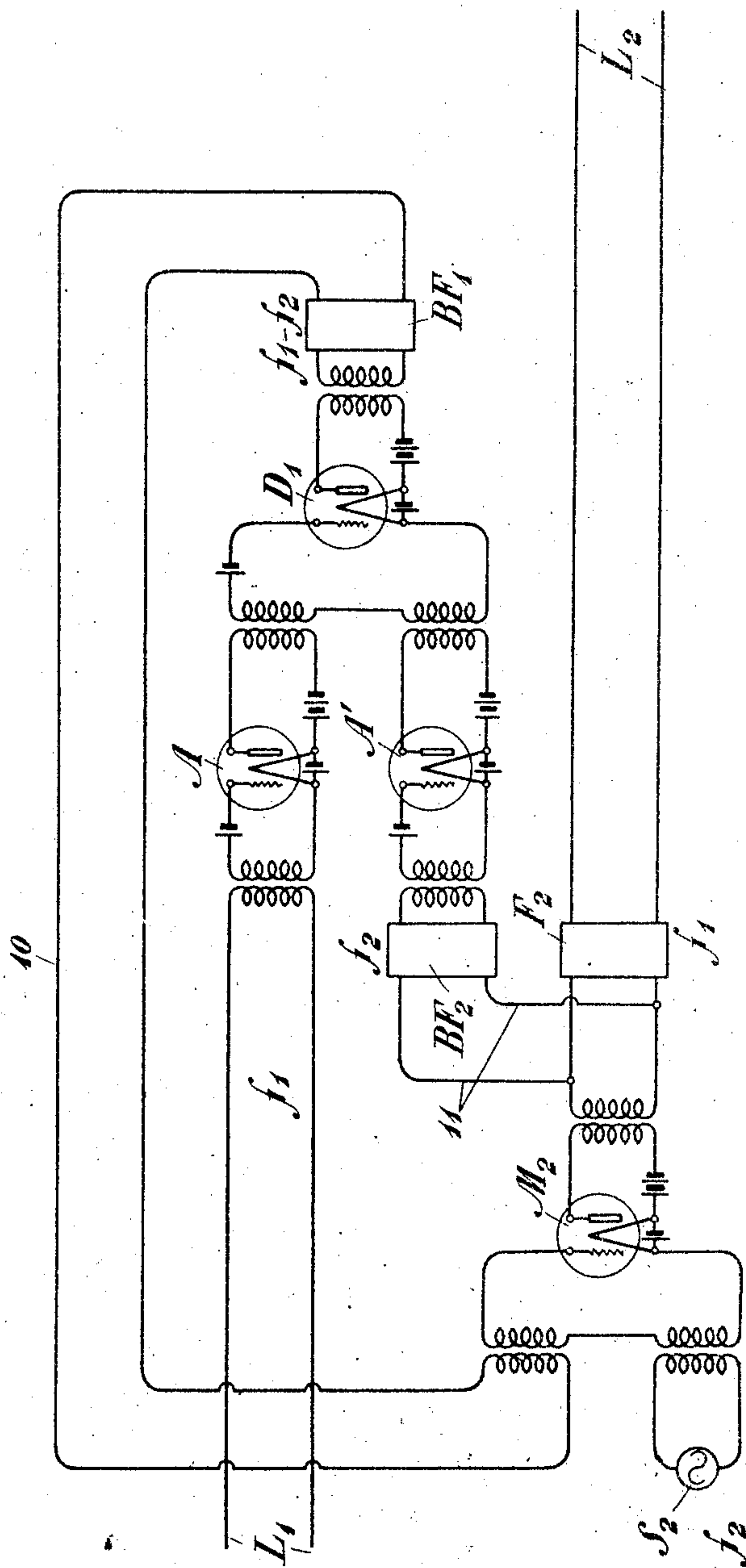


K. S. VAN DYKE.
 SYNCHRONIZING SYSTEM.
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1,412,908.

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SYNCHRONIZING SYSTEM.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, KARL S. VAN DYKE, residing at Chicago, in the county of Cook and State of Illinois, have invented certain
5 Improvements in Synchronizing Systems, of which the following is a specification.

This invention relates to signaling circuits, and more particularly to arrangements for
10 maintaining synchronism between alternating currents separately generated at different stations of a signaling system.

One of the features of the invention resides in the provision of means whereby
15 alternating currents supplied from two independent sources may be automatically maintained at the same frequency.

Another feature of the invention resides in the provision of means whereby alternating
20 currents supplied at the receiving station of a signaling system may be maintained in synchronism with carrier currents received from a distant sending station.

These features, together with other features more fully hereinafter appearing, are
25 realized in arrangements set forth in the following description and illustrated in the accompanying drawing, the figure of which constitutes a circuit diagram of one embodiment of the invention.

30 Referring to the drawing, L_1 designates a circuit whereby a frequency generated at the distant station may be applied to the apparatus shown at the station of the figure. For this purpose the circuit L_1 may be associated
35 with a transmission line leading to the distant station, or may be associated with the receiving antenna in the case of a radio system. L_2 designates a circuit for transmitting the locally generated frequency to
40 any apparatus to which it is to be applied. For instance, in the case of a homodyne receiving system the circuit would be arranged so that the received frequency from the circuit L_1 , and the locally generated frequency
45 transmitted from the circuit L_2 would both be applied to a detecting apparatus. In such a case it is desirable that the locally generated frequency be the same as that received from the distant station. The locally generated
50 frequency may be supplied by any suitable source, such as S_2 . In practice it is not convenient to maintain this source at the same frequency as that received, as the

erated at the local frequency may both vary, 55 from time to time.

In order to insure that the frequencies supplied to the circuit L_2 as the result of the action of the generator S_2 shall be the same as the frequency incoming from the
60 circuit L_1 , an apparatus is provided for normally detecting the difference between the two frequencies and then adding or subtracting the detected difference frequency to the frequency generated by the source S_2 ,
65 so as to produce the resultant frequency which will be the same as that incoming from the circuit L_1 . This apparatus comprises a demodulator or detector D_1 , modulator M_2 , amplifiers A and A' and filters
70 BF_1 and BF_2 and F_2 . The demodulator or detector D_1 may be of any well known type and for purposes of illustration is disclosed as being a vacuum tube detector. The input
75 circuit of this detector is associated with the incoming circuit L_1 through the amplifier A which serves to amplify the received frequency. This amplifier may be of any well known type, such, for instance, as the
80 vacuum tube amplifier. The frequency generated at the source S_2 is also applied to the input circuit of the detector D_1 through a similar amplifier A' in a manner more fully hereinafter described.

In accordance with a well known principle 85 the detector D_1 will produce in its output circuit frequencies corresponding to the sum and the difference of the frequencies applied to its input circuit, and if the frequency incoming to the circuit L_1 be taken
90 as f_1 and the frequency generated by the source S_2 be taken as f_2 the demodulator D_1 will impress upon its output circuit a frequency $f_1 - f_2$, assuming, of course, that the frequency f_2 is lower than the frequency f_1 .
95 A filter BF_1 may be arranged in the output circuit of the demodulator D_1 for selecting this difference frequency from the other frequencies appearing in the output circuit. The filter BF_1 may be of any well known
100 type such as a band filter of the general character disclosed in U. S. patents issued to George A. Campbell Nos. 1,227,113 and 1,227,114, dated May 22, 1917.

The modulator M_2 is provided for the
105 purpose of adding the selected difference frequency to the frequency supplied by the source S_2 . Consequently a circuit

10 is provided which leads from the filter BF_1 to the input circuit of the modulator M_2 . The source S_2 is also associated with the input circuit of the modulator M_2 .
 5 The modulator M_2 will then supply to its output circuit a frequency corresponding to the frequency f_2 , a frequency corresponding to the sum of the frequency f_2 and the difference frequency transmitted from the filter BF_1 , and a frequency corresponding to the difference of these two frequencies. The frequency corresponding to the sum, it will be noted, will be identical with the frequency f_1 and this frequency may be selected
 10 by means of a sharply tuned circuit F_2 and impressed upon the outgoing circuit L_2 .

In order that the frequency f_2 appearing in the output circuit of the modulator M_2 may be transmitted to the detector D_1 , a branch circuit 11 leads from the output of the modulator M_2 and in this branch circuit a filter BF_2 is inserted, this filter being arranged to select only frequencies in the neighborhood of the frequency supplied by
 15 the source S_2 while suppressing the side frequency resulting from the modulation of said frequency by the difference frequency transmitted over circuit 10.

The operation is as follows:

10 For the best working of the circuit the frequency of the source S_2 should differ considerably from the frequency received in the circuit L_1 . For example, assuming that the frequency incoming to the circuit L_1 is 10,000
 15 cycles per second, and that the source S_2 is set to generate a frequency somewhere in the neighborhood of 9,000 cycles. The frequency of 9,000 cycles from source S_2 will be impressed upon the modulator M_2 and
 20 appearing in its output circuit will be selected by the filter BF_2 and amplified by the amplifier A' . At the same time the frequency of 10,000 cycles from the circuit L_1 will be impressed upon the amplifier A . These
 25 two frequencies upon being amplified are impressed upon the input circuit of the detector D_1 , in the output of which will appear frequencies of 10,000 and 9,000 respectively, as well as their sum 19,000 and their difference 1,000. The filter BF_1 will be so
 30 constructed as to transmit only frequencies in the neighborhood of 1,000 so that the difference frequency will be transmitted to the circuit 10 while the other frequencies will
 35 be suppressed.

The difference frequency of 1,000 cycles is now impressed upon the input circuit of the modulator M_2 simultaneously with the frequency of 9,000 cycles from the source S_2 .
 40 In the output circuit of the modulator, therefore, frequencies of 1,000 and 9,000 cycles appear, as well as the difference, 8,000 cycles and the sum, 10,000 cycles. The sum frequency of 10,000 cycles it will be noted
 45 is identical with the frequency incoming to

the circuit L_1 , and the filter F_2 may be so designed as to select this frequency to the exclusion of the others while, as above stated, the filter BF_2 will select the frequency of 9,000 cycles. In this manner the
 50 frequency supplied to the circuit L_2 will be the same as that supplied to L_1 .

In practice, either or both of the frequencies f_1 and f_2 may vary. If the frequency f_1 varies it will be necessary to construct
 55 the filter F_2 so that it will transmit a band of frequencies in the neighborhood of the frequency f_1 , in which case it might be a band filter similar to the filter BF_1 . The filter BF_2 will, of course, be so designed as to
 60 transmit a band in the neighborhood of the frequency f_2 , thereby accommodating any slight variation in the frequency of the source S_2 . Likewise, since the difference frequency detected by the demodulator D_1
 65 will be in the neighborhood of 1,000 the filter BF_1 should be so designed as to transmit a band in the neighborhood of 1,000 cycles. The width of the band transmitted by the filter BF_1 should be about twice the
 70 width of the bands transmitted by the filters BF_2 and F_2 since if both frequencies f_1 and f_2 vary, and vary simultaneously in opposite directions there is a possibility that the difference frequency will have twice as great a range
 75 of variation as either the frequencies f_1 or f_2 . In any case it is readily apparent that since the demodulator, together with the filter BF_1 , determines the difference between the
 80 frequencies f_1 and f_2 at any given instant regardless of how these frequencies may vary, and since the modulator M_2 together with the filter F_2 then adds this difference to the frequency f_2 , the frequency transmitted to the circuit L_2 will also be identical with
 85 that incoming to the circuit L_1 regardless of any small variation from time to time in the frequencies f_1 and f_2 .

It will be obvious that the general principle herein disclosed may be embodied in
 90 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 producing from a separate source energy of a frequency corresponding to that transmitted from a distant source, which consists in generating energy of a frequency as near as practicable to
 95 the frequency transmitted from a distant source, producing a frequency equal to the difference, if any, between the generated frequency and the frequency transmitted from the distant source, and combining the
 100 generated frequency and the difference frequency to produce the desired frequency.
2. The method of producing from a separate source energy of a frequency corresponding to that transmitted from a distant
 105

source, which consists in generating energy of a frequency as near as practicable to the frequency of the distant source, detecting a frequency equal to the difference, if any, between the generated frequency and the frequency of the distant source, and then modulating the generated frequency in accordance with the difference frequency to produce the desired frequency.

3. The method of producing from one source energy of a frequency corresponding to that of another source, which consists in generating, by said first mentioned source, energy of a frequency approximating that of said second mentioned source, combining the frequencies from the two sources to produce a frequency equal to the difference, if any, between the frequencies of the two sources, and then combining the difference frequency with the frequency generated by said first source to produce a frequency corresponding to said second mentioned source.

4. A method of producing from one source energy of a frequency corresponding to that of another source, which consists in generating, by said first mentioned source, energy of a frequency approximating that of said second mentioned source, detecting a frequency equal to the difference, if any, between the frequencies of the two sources, and then modulating the frequency generated by said first mentioned source in accordance with said difference frequency to produce a frequency corresponding to that of said second mentioned source.

5. In a synchronizing system, two independent sources of oscillations generating approximately the same frequency, means to detect the difference, if any, between the frequencies generated by the two sources, and means to modulate the frequency generated by one of said sources in accordance with said difference frequency, thereby producing a frequency corresponding to that of the other source.

6. In a synchronizing system, two independent sources generating approximately the same frequency, means to combine the frequencies produced by the two generators so as to produce a frequency corresponding to their difference, if any, and means for combining the difference frequency thus obtained with the frequency generated by one of the sources to produce a frequency corresponding to that of the other source.

7. In a synchronizing system, means at

one station for generating oscillations to be transmitted to a distant station, means at the distant station for generating by a separate source oscillations of a frequency as near as practicable to the frequency transmitted from the first station, means for detecting the difference, if any, between said frequencies, and means for modulating the oscillations generated at the distant station in accordance with said difference frequency to produce a frequency corresponding to that transmitted from said first mentioned station.

8. In a synchronizing system, means at one station for generating oscillations to be transmitted to a distant station, means at the distant station for generating by a separate source oscillations of a frequency as near as practicable to the frequency transmitted from the first station, means for combining the frequency generated at the distant station with the frequency transmitted from said first station so as to produce a frequency corresponding to their difference, if any, and means for combining the difference frequency thus obtained with the frequency generated at the distant station to produce a frequency corresponding to the frequency transmitted from said first mentioned station.

9. In a synchronizing system including two separate sources of oscillations, the method which consists in generating by said sources energies whose frequencies approximate each other as near as practicable, detecting the difference, if any, between said frequencies, and then modulating the frequency of one of said sources in accordance with said difference frequency to produce a frequency corresponding to that of the other source.

10. In a synchronizing system including two separate sources of oscillations, the method which consists in generating by said sources energies whose frequencies approximate each other as near as practicable, combining the two frequencies so as to produce a frequency corresponding to their difference, if any, and then combining the difference frequency thus obtained with the frequency generated by one of said sources to produce a frequency corresponding to that of the other source.

In testimony whereof, I have signed my name to this specification this 1st day of June, 1920.

KARL S. VAN DYKE.