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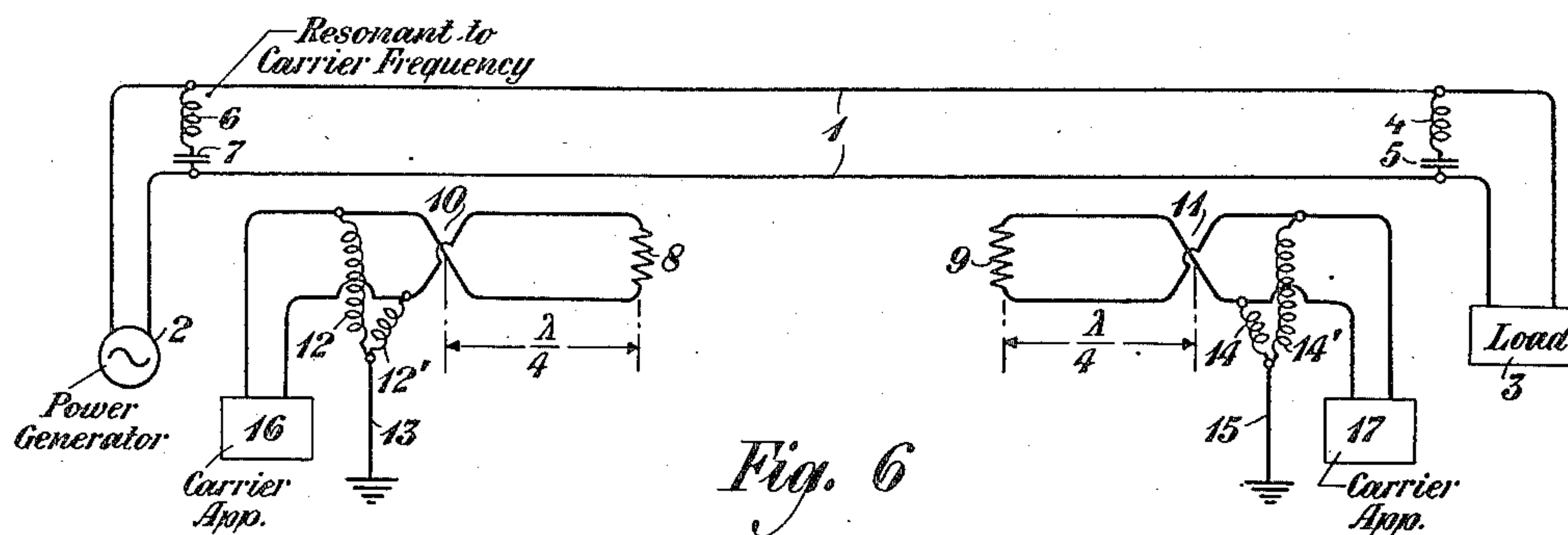
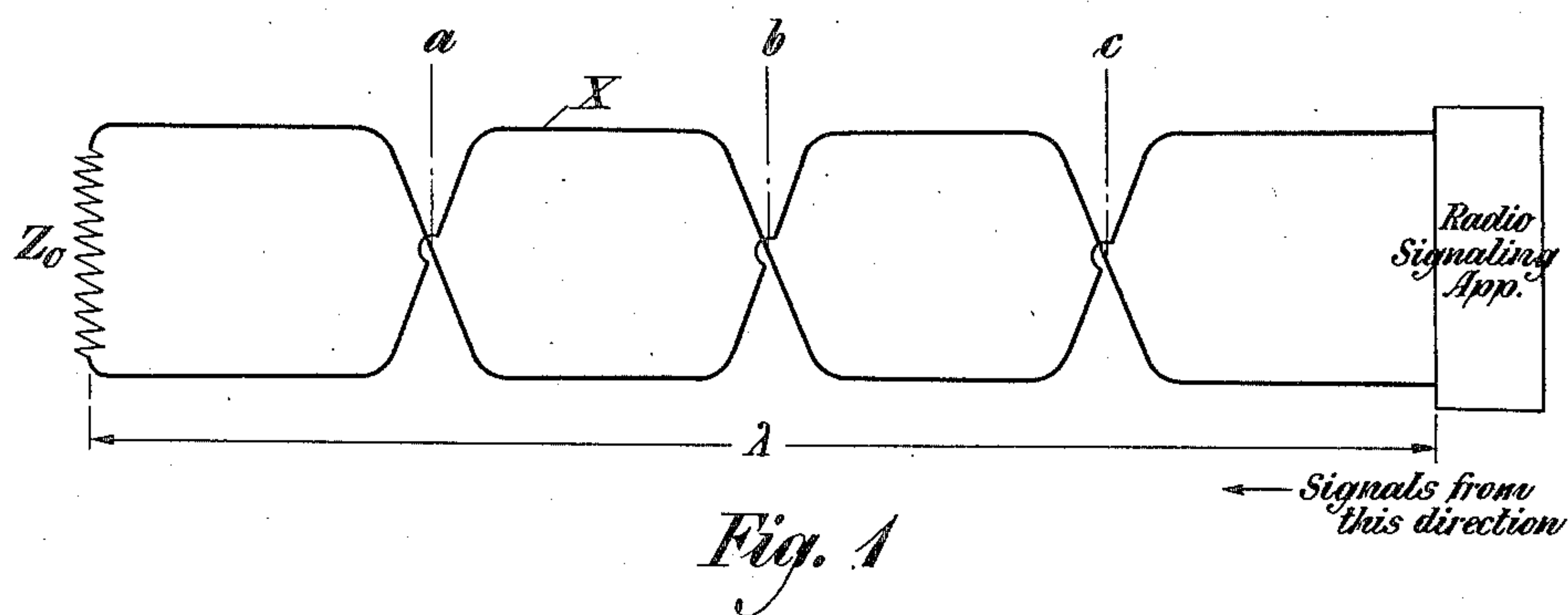
1,615,896

H. A. AFFEL

HIGH FREQUENCY SIGNALING SYSTEM

Filed Dec. 15, 1922

2 Sheets-Sheet 1



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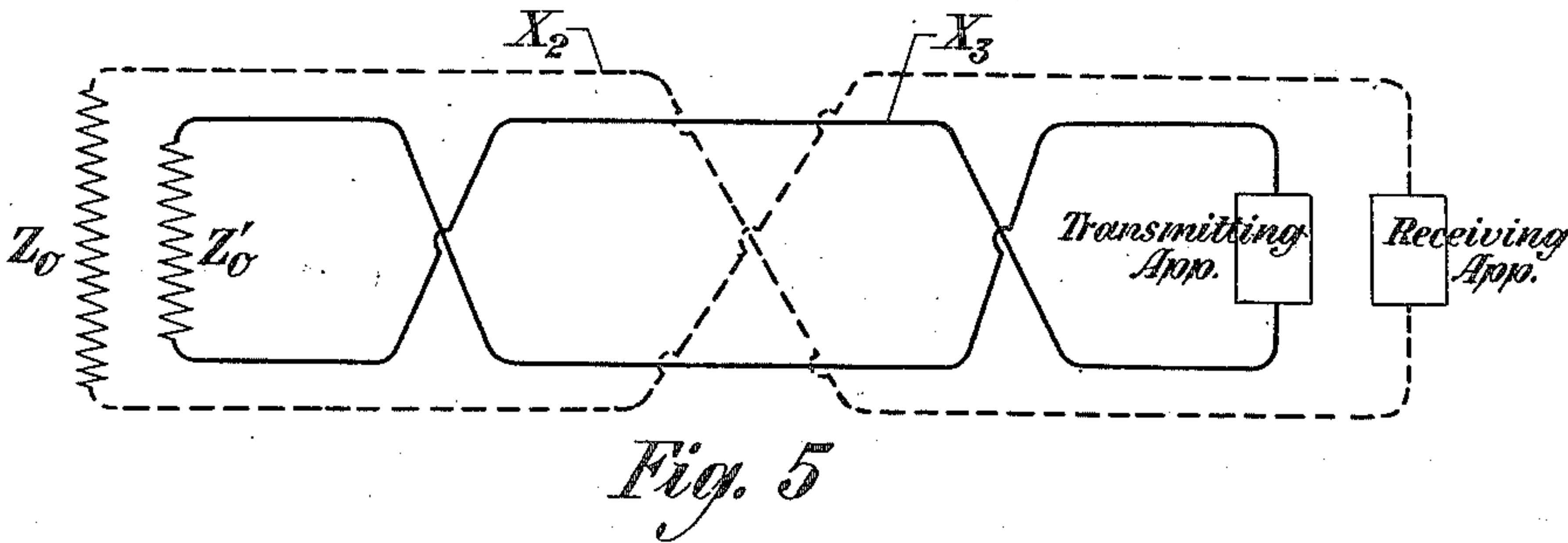
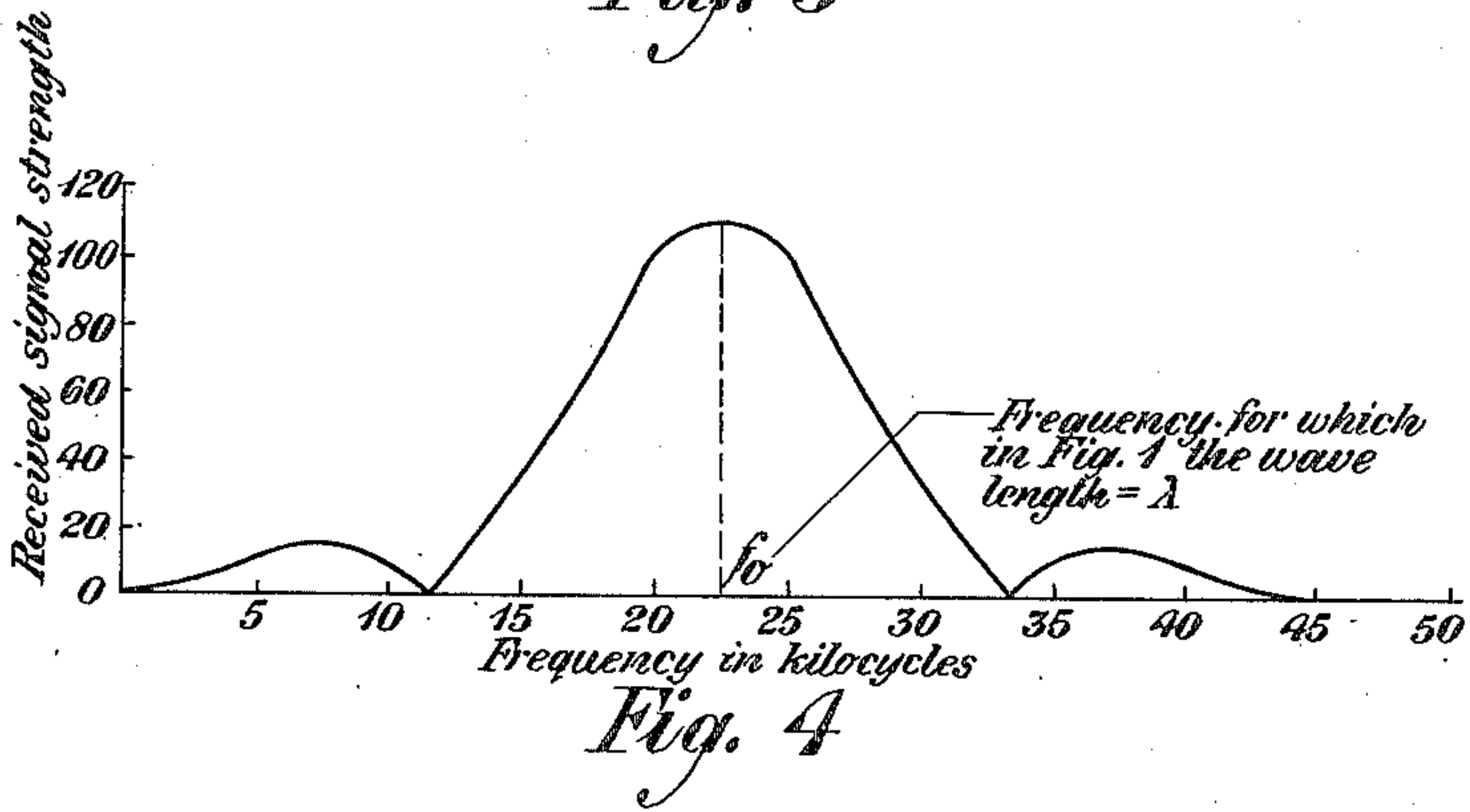
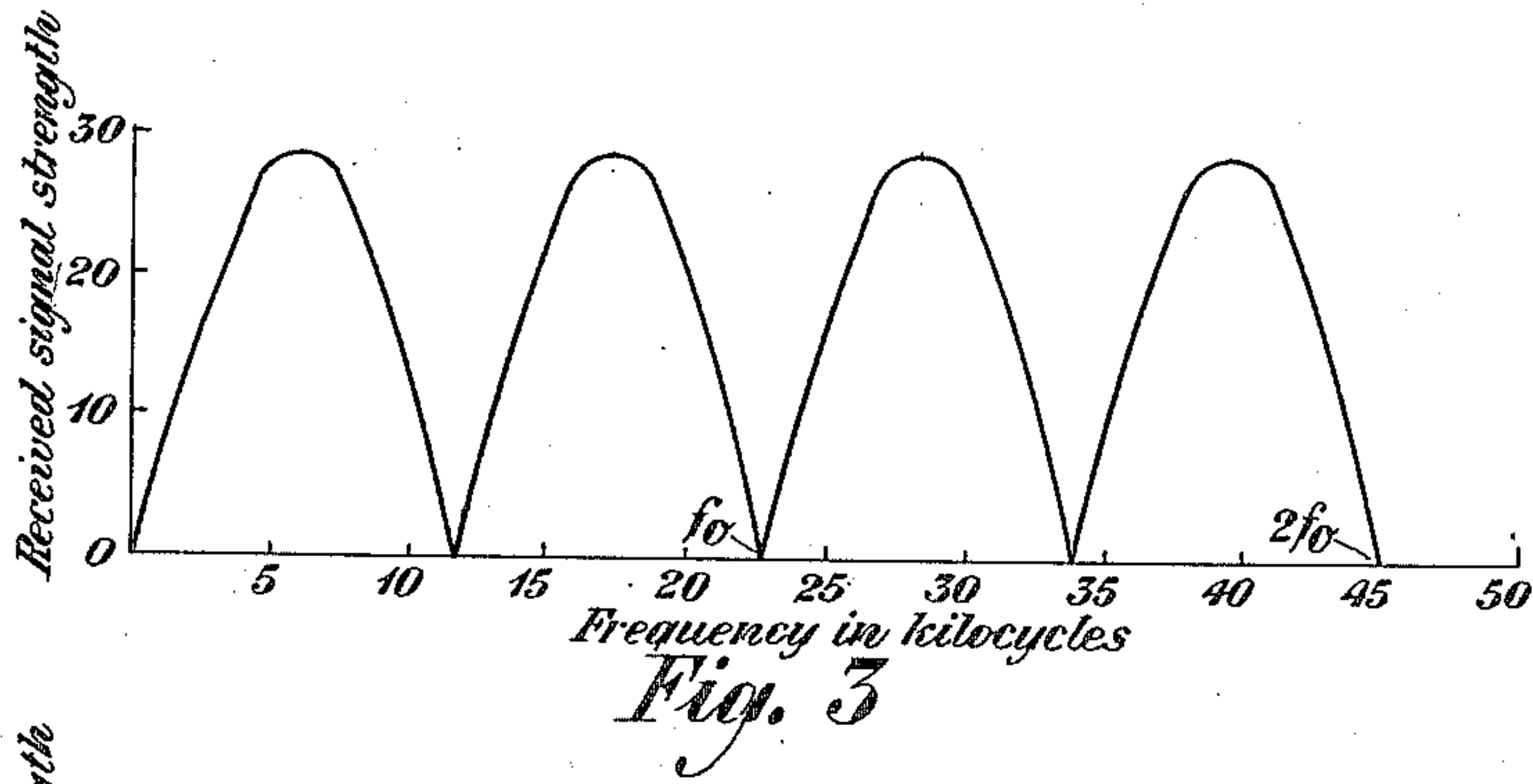
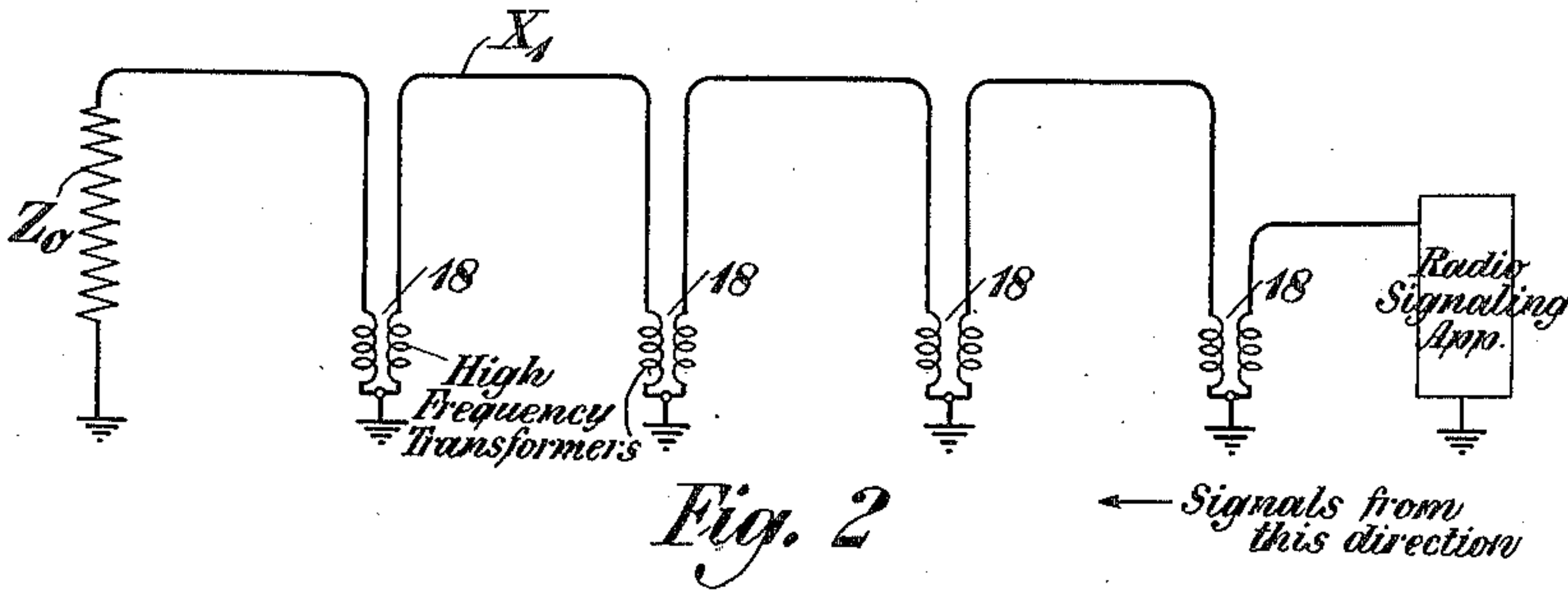
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HIGH FREQUENCY SIGNALING SYSTEM

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2 Sheets-Sheet 2



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Patented Feb. 1, 1927.

1,615,896

UNITED STATES PATENT OFFICE.

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HIGH-FREQUENCY SIGNALING SYSTEM.

Application filed December 15, 1922. Serial No. 607,193.

This invention relates to high frequency signaling systems, and particularly to means for rendering such systems highly selective.

In the development of the radio art, various methods and means have been disclosed, the object of which has been to increase the selectivity of signaling circuits. The best known of all methods consisted in sharply tuning the circuit so as to make it highly selective of the frequencies that it was desired to transmit or receive.

It is one of the objects of this invention to obtain greater selectivity in the antenna circuits themselves by employing long loop circuits and by transposing the conductors of the loop, which may be either a completely metallic circuit, or a partly metallic and partly grounded circuit, at intervals properly related to the wave length intended to be received.

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 a transposed metallic loop antenna embodying the basic principles of this invention.

Fig. 2 shows a transposed loop antenna of a partly metallic and partly grounded type.

Figs. 3 and 4 are curves showing the selectivity of a non-transposed antenna and a transposed antenna of the type shown in Fig. 1, respectively.

Fig. 5 shows an arrangement of antennae for transmitting and receiving at the same station, whereby interference may be prevented by the selective quality of the respective antennae.

And Fig. 6 shows the application of the invention to a system for transmitting carrier frequency signals over a power transmission line simultaneously with the transmission thereof of the power current.

In Fig. 1, the antenna X is represented as transposed at predetermined points indicated by *a*, *b* and *c*, the number and location of which depend upon the frequency to be selected. At the right-hand end, the antenna is connected with signaling apparatus, which may be of any well-known type of transmitting or receiving apparatus. At the other end of the antenna, there is connected into the circuit an impedance Z_0 , which may be pure resistance and which in magnitude equals the characteristic impedance of the antenna at the frequency or frequencies at

which it is intended to be operated. The transpositions indicated at the points *a*, *b* and *c*, are spaced at a distance apart depending upon the length of the wave upon which the terminal apparatus is intended to operate. For the particular arrangement of transpositions shown the loop circuit will be highly selective to waves whose length is four times the interval between adjacent transpositions. If the wave length varies appreciably from this, the various loop current components will be so phased as to tend to oppose and annul each other, and consequently, it will discriminate against them. Other arrangements in which the distances between transpositions are unequal will also have selective characteristics, so that selectivity does not depend upon equal spacing of the transpositions. It will be seen that by means of an antenna constructed in accordance with the principles herein disclosed, the loop circuit may be made highly selective to one frequency or, if desired, more frequencies and discriminatory to other frequencies that differ materially from the desired frequency or frequencies.

A form of loop antenna for effecting the same purpose as that shown in Fig. 1 is shown in Fig. 2. It consists of a plurality of grounded loop circuits which are inductively related by means of the transformers 18. These transformers are inserted at the common ground connections between adjacent subloops which, taken together, constitute a loop antenna similar in purpose and in general principles of operation to that shown in Fig. 1. The common ground connections between the adjacent subloops correspond to the transposition points *a*, *b*, and *c*, of Fig. 1, assuming, of course, that the loops of Figs. 1 and 2 are selective of the same frequency. The direction of the windings of the transformers 18 is such as to cause the current in one winding to flow in opposite direction from that in which the inducing current flows.

A representation of the relative frequency selectivity of nontransposed and transposed circuits is well shown in Figs. 3 and 4, wherein the ordinates represent units of current absorbed by a circuit which is exposed to another circuit over which currents of various frequencies are transmitted. It will be seen from Fig. 3 that if the particular non-transposed loop or circuit is made

miles long it will be selective of a number of different frequency bands as, for example, 5,000 to 6,000 cycles, 16,000 to 17,000 cycles, 27,000 to 28,000 cycles, and others. The curve shown in Fig. 4 represents the absorptive power of a loop or circuit of the same length as in Fig. 3 having a plurality of transpositions spaced at definite intervals apart as shown in Fig. 1. It will be seen from this curve that such a transposed loop is particularly selective of but a single frequency range extending approximately from 20,000 to 25,000 cycles. Its transmission diminishes rapidly on each side of the zone of maximum selectivity and is extremely small below 15,000 cycles and above 30,000 cycles. Other arrangements of transpositions in a loop circuit will produce selectivity curves different from that shown in Fig. 4, and the peaks may be made to occur at more than one point if desired.

Fig. 5 shows the application of this invention to a system adapted for the simultaneous transmission and reception of signals without producing interference therebetween. In this system the loop X_2 is connected with the receiving apparatus of the system, and loop X_3 is connected with the transmitting apparatus. Both X_2 and X_3 have connected therewith resistance elements Z_0 and Z_0' equal to the characteristic impedance of their respective antennæ, but a different transposition arrangement is applied to the antenna X_2 than to the antenna X_3 , so that the former is balanced against the latter, while individually they permit the reception and transmission respectively of the proper frequencies in coordination with the distant stations.

In Fig. 6, the power transmission line 1 has connected therewith a power generator 2 which would normally be of the low frequency type and at the distant end a load 3. Bridged across the line 1 near the right-hand end is an inductance 4 and a condenser 5, and similarly, near the left-hand end an inductance 6 and a condenser 7, the purpose of the said inductances and condensers being to provide, in effect, a low impedance short circuit of the line for the signaling carrier frequencies. Associated with this tuned section of the line near the left-hand end is a loop 8 having inserted therein a transposition 10 which in combination with the tuned circuit, if the loop is of the proper length and the transposition is properly located, will render the transmission between the said loop circuit and the line highly selective to the carrier frequency and discriminatory to the power frequency. Bridged across the sides of the loop are the drainage coils 12 and 12' connected to ground by conductor 13, the object of which is to prevent currents set up by potentials induced between the loop cir-

cuit and ground from affecting the carrier apparatus connected with the loop circuit. This carrier apparatus which is designated 16 may be of any well-known type having means for detecting the signal superimposed on the carrier wave, and need not be particularly described here. A similar loop 9 having inserted therein a transposition 11 is inductively related with the transmission line 1 at the other end of the tuned section of the said line. This loop circuit has bridged across its sides the coils 14 and 14' which are connected to ground by conductor 15. Carrier apparatus 17, preferably similar to 16, is connected with the said loop circuit for transmitting and receiving purposes.

It will be apparent from the foregoing description of the arrangement shown in Fig. 6 that the loop circuits with which the carrier frequency receiving and transmitting apparatus is associated and inductively related with the power line, permit the modulated signals to be transmitted from the loop circuits to the tuned section of the power line by virtue of the inductive relationship existing between them. These loop circuits, or short inducing lines, should be transposed in such manner that the potentials induced by the power energy will tend to balance out by virtue of the relatively low frequencies and relatively small phase change involved, but the carrier frequencies will be efficiently transferred in both directions between the power lines and the short inducing lines 8 and 9, due to their considerably greater phase change.

Although 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:

1. A transposed antenna in which the distance between transpositions is a function of the wave length to be transmitted or received. 110
2. A transposed loop antenna in which the distance between transpositions is a function of the wave length to be transmitted or received. 115
3. A loop antenna having transpositions therein, the distance between which is a function of the wave length to be transmitted or received, and having a terminating impedance equal to the surge impedance of the said antenna. 120
4. In a high frequency signaling system, the combination with a loop antenna having transpositions therein, the distance between which is a function of the wave length to be transmitted or received and terminated in an impedance equal to the surge resistance of the said antenna of a terminal signaling 125 130

apparatus connected with the said antenna.

5. In a high frequency signaling system the combination with a loop antenna having transpositions therein, the distance between
5 which is a function of the wave length to be transmitted, of a second loop antenna likewise having transpositions therein, the distance between which is a function of the wave length to be received, the frequency
10 of reception differing from the frequency of transmission.

6. In a high frequency signaling system the combination with a transposed loop an-

tenna of transmitting apparatus for applying signals thereto, a second transposed loop
15 antenna having receiving apparatus connected therewith, the spacing of the transpositions in the transmitting antenna being different from that in the receiving antenna, the difference being determined by the dif-
20 ference between the transmitting and the receiving frequencies.

In testimony whereof, I have signed my name to this specification this 13th day of December, 1922.

HERMAN A. AFFEL.