

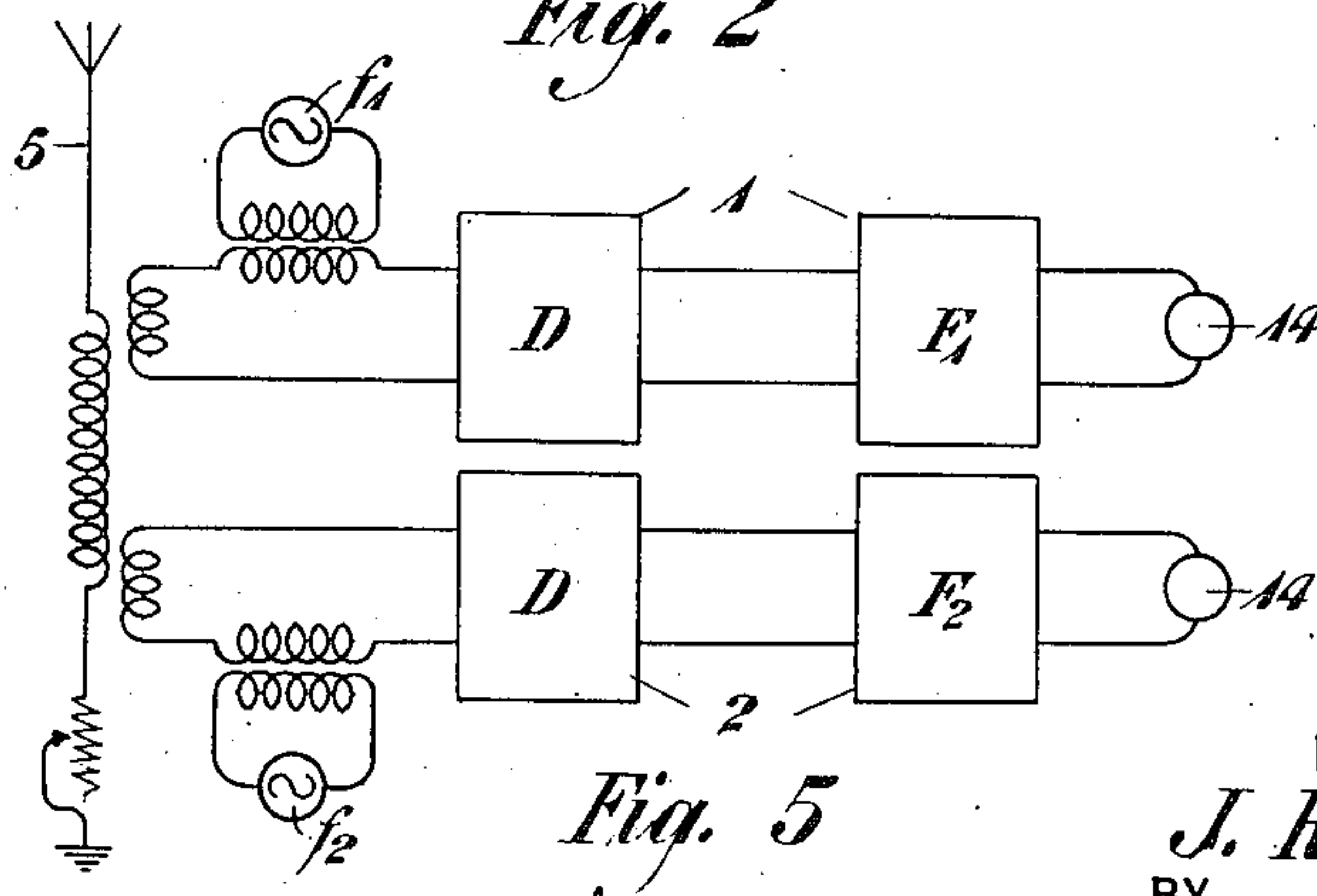
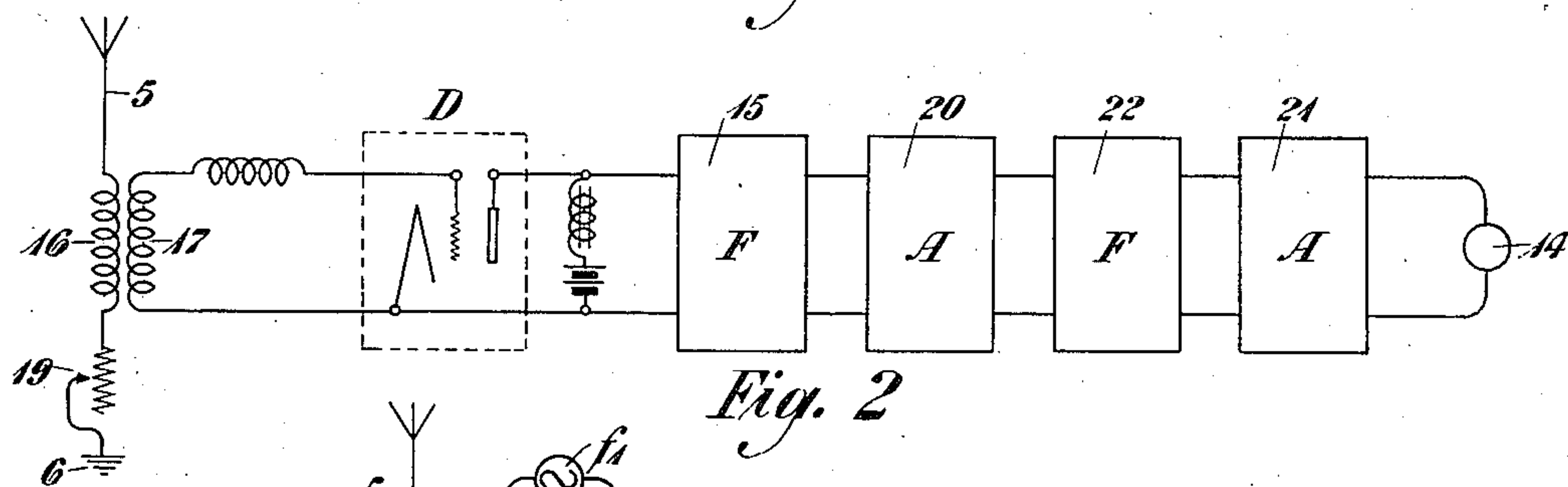
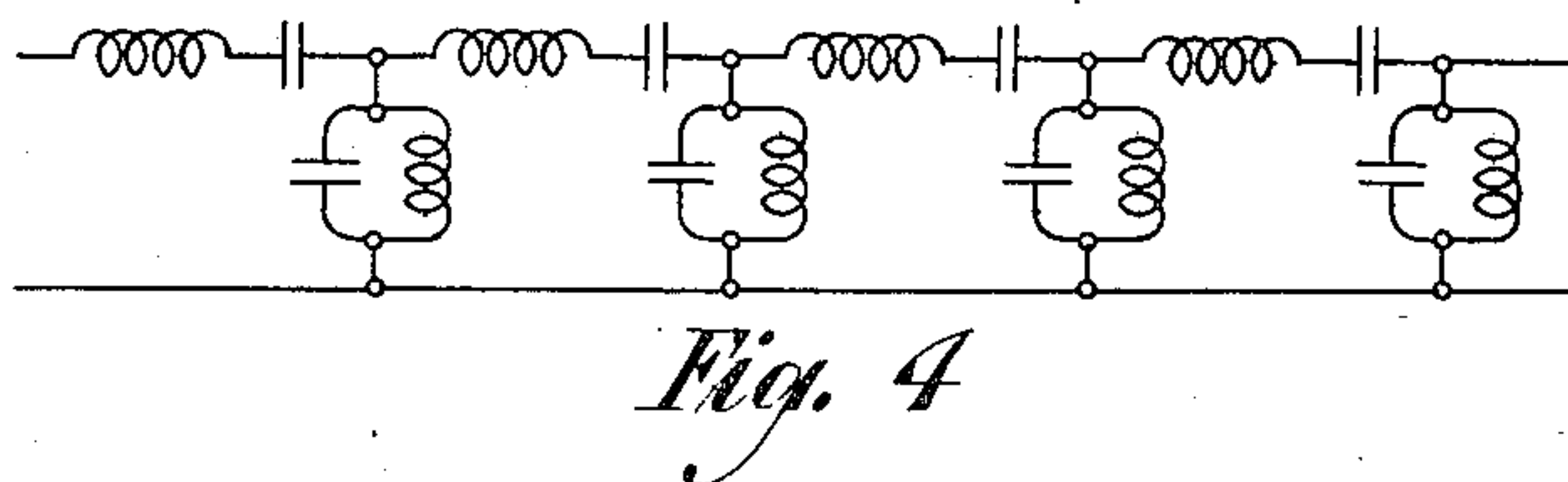
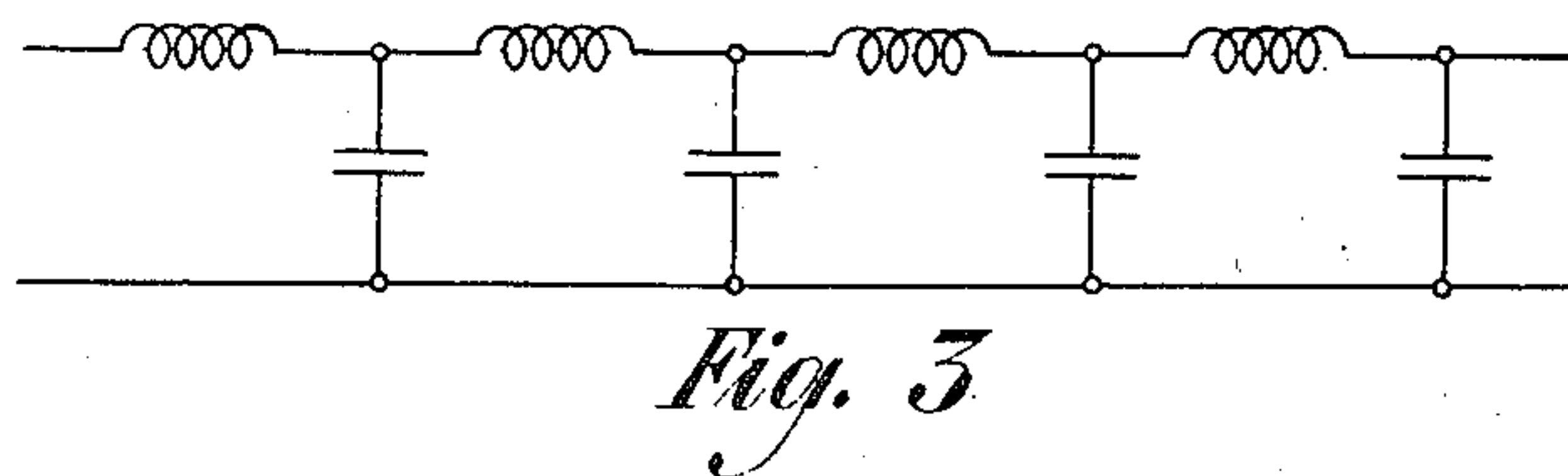
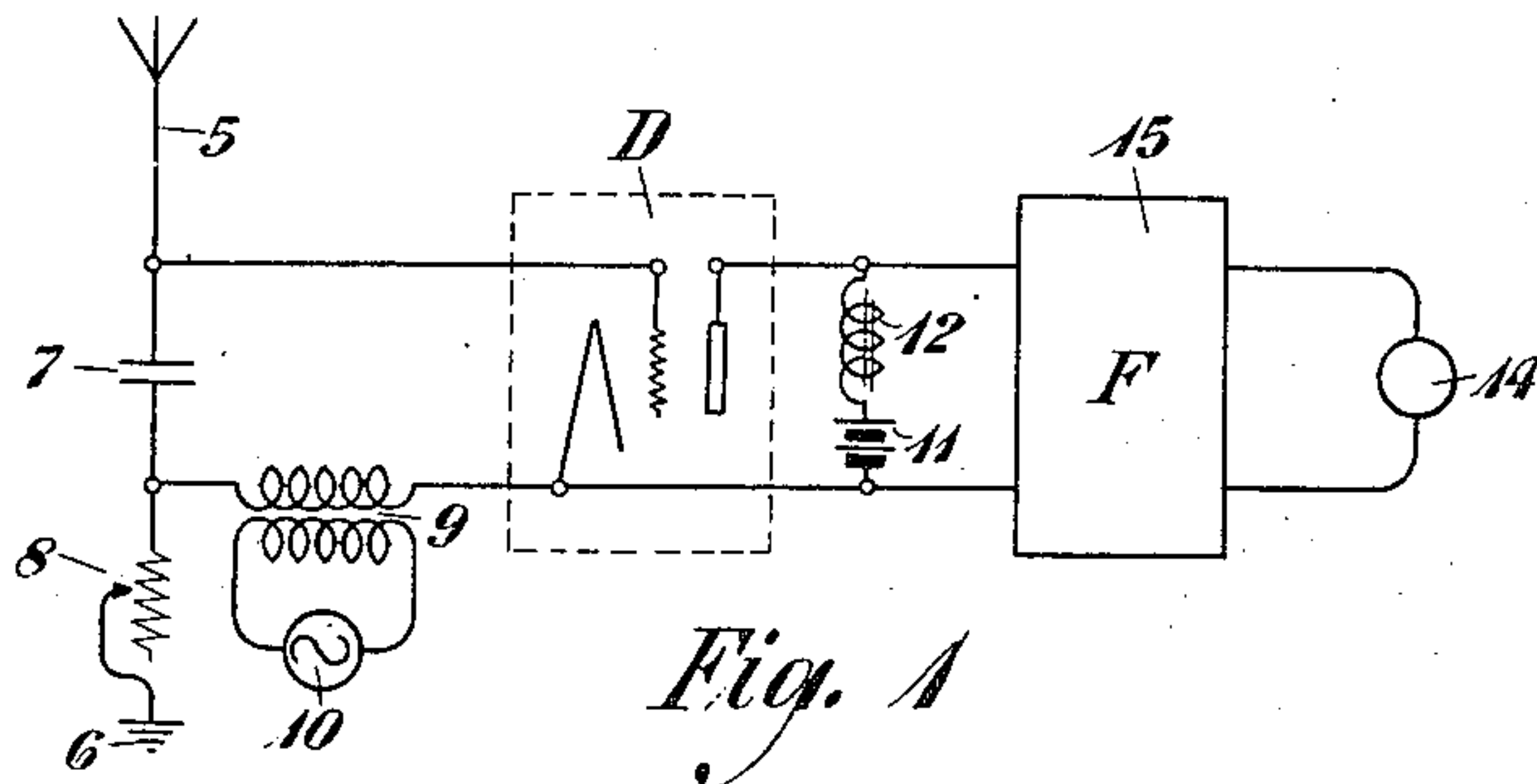
Nov. 5, 1929.

J. R. CARSON

1,734,112

RADIO RECEIVING SYSTEM

Filed Sept. 6, 1921



INVENTOR
J. R. Carson
BY *J. R. Carson*
ATTORNEY

UNITED STATES PATENT OFFICE

JOHN R. CARSON, OF HARMON-ON-HUDSON, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

RADIO RECEIVING SYSTEM

Application filed September 6, 1921. Serial No. 498,730.

This invention relates to radio signaling, and has for its object that of providing methods and means for increasing the discrimination between messages and disturbances due to strays and static effects. A further object is to avoid the distortion which is present in the case of a tuned antenna due to the narrow band of frequencies to which a tuned antenna is receptive. Still a further object is to provide a simple and convenient arrangement for receiving on a single antenna a plurality of messages of different radio frequencies with equal facility. These objects are attained by the use of an aperiodic antenna which is substantially equally receptive to all frequencies, and in obtaining the desired selectivity at low frequencies subsequent to detection.

In radio signaling, in general, serious trouble is encountered due to the excessive amount of static disturbances. On the usual tuned antenna, the effect of static, coming, as it does, in the form of relatively sudden and sharp electric blows, sets up oscillations in the antenna of the same frequency as that to which the antenna is tuned, which is also the frequency of the signal message. The more sharply the antenna is tuned, the better does it absorb the message waves of its own frequency, but the better does it also absorb static energy of the same frequency. As a result, the advantages to be gained by the tuning of antennae are not so great as is commonly supposed, and much difficulty still is present with them in the matter of discriminating between oscillations set up by incoming messages and by static disturbances. On the other hand, advantages accrue with the use of an untuned or aperiodic antenna when used in combination with other means for obtaining selectivity, as set forth hereinafter.

In an aperiodic antenna, the effect of static is again to set up high frequency oscillations in the antenna, but since this latter is not tuned to any particular frequency, the static disturbances produce effects distributed over a wide range of frequencies, this being determined by the wave shape of the static, and even though the static has a more or less definite frequency, it will not, in general, be

that of the message high frequency. If such oscillations be combined at the receiving station with the locally generated high frequency oscillations of a definite frequency, the difference frequencies which result after detection will differ from each other by a much greater percentage than did the high frequency oscillations (message and static) which came in on the antenna, and, therefore, it will be easier to discriminate between them at this lower frequency by tuned circuits such as wave filters.

Again, in the case of tuned antennae, the range of frequencies for which they are especially receptive is quite small, and the sharper the tuning, the narrower does this range become. In the case of high frequency waves which have been modulated with respect to a low frequency signal, the frequencies which are sent out by the transmitter and which must be received are spread over a comparatively wide band. If the high frequency is indicated by p and the message low frequency with which it is modulated is represented by q , the actual frequencies included in the wave are $(p+q)$, p , and $(p-q)$. In radio telephony, for example, in which modulating frequencies up to 2,000 are of importance and substantially all of which are present, the high frequency waves received contain all frequencies from $(p+q)$ to $(p-q)$, representing a total frequency range, therefore, of about 4,000 cycles. If the receiving antenna is tuned for the frequency p , its receptivity for the frequencies $(p+q)$ or $(p-q)$ is substantially smaller, the reduction being the greater as the antenna is more sharply tuned, and substantial distortion, therefore, results. In the case of an aperiodic antenna which is equally receptive over the whole range of frequencies from $(p+q)$ to $(p-q)$, such distortion does not appear. If these received waves are now combined with locally generated oscillations of frequency p , there results, among other things, the difference frequency q , which, in the case of telephony, will include substantially all frequencies up to about 2,000, and if in the circuit there is now placed suitable means to eliminate all frequencies outside of this range, such as a

wave filter, a system of high selectivity is provided.

It is sometimes desirable to receive at one station a plurality of messages coming from one or more transmitting stations, which messages may be carried on different high frequency oscillations. With an aperiodic antenna, all of these high frequency messages will be received with equal readiness, but by providing a plurality of local circuits with suitable low frequency tuning, it is possible to separate these messages, as will be seen hereinafter.

The invention will be better understood by reference to the accompanying drawing, which shows circuits embodying my invention. In said drawing, Figure 1 shows one type of circuit and Fig. 2 shows a modification thereof; Figs. 3 and 4 show two forms of wave filters which may be used for the purposes hereinafter described, and Fig. 5 shows a circuit adapted for multiplex reception.

For the sake of uniformity, the term "carrier frequency" will be used in this specification to represent the high frequency which is modulated with the signal to be transmitted. The term will be used whether the oscillations of this frequency are obtained from the incoming message, from static or from a local source. The term "signaling frequency" will be used to represent the oscillation frequency of a message which is to be transmitted, and this, in general, will be within the range of audibility.

In Fig. 1, the reference numeral 5 represents an aperiodic antenna connected to earth at 6 in the usual manner. This antenna is shown as having included in its circuit a condenser 7 and a resistance 8, by which latter the aperiodicity of the antenna may be controlled. Connected across the terminals of the condenser 7 are the input terminals of a detecting device. This may be of any form desired, but I have shown as a suitable one an audion D consisting of the usual filament, grid and plate electrodes. Included in the input circuit of this detector is the secondary winding of the transformer 9, in the primary of which is connected a source of high frequency oscillations 10. While this has been shown schematically, I would in general prefer to use a vacuum tube oscillator of the type which is now well understood in the art.

The output circuit of the detector may be connected in any suitable manner, and, as an illustration, there is shown the plate battery 11 and choke coil 12. In ordinary practice, the indicating device 14, such as a telephone receiver, would be connected around the elements 11 and 12, but, for the purpose of carrying out my invention, I have introduced between the indicator 14 and the detector D a wave filter 15.

This filter 15 may be of the form which is

now well understood in the art and is described in patent to Campbell, No. 1, 227,114, dated May 22, 1917. One form of such filter is shown in Fig. 3 and consists of a recurrent structure in which each element consists of an inductance and a capacity, the various elements being connected together in such a way that the inductance elements are in series and the capacity elements are in shunt to the circuit. This particular wave filter, as described in the above noted patent to Campbell, has the property of suppressing all oscillations above a certain frequency and permitting all others to pass, and is, therefore, commonly called a "low pass filter." A second form of wave filter is shown in Fig. 4 in which each series element consists of an inductance and capacity in series and in which each shunt element consists of an inductance and a capacity in parallel. When suitably designed, this wave filter has the property of suppressing all oscillations below a frequency f_1 and above a frequency f_2 , transmitting, therefore, a band of frequencies extending from f_1 to f_2 . Since these wave filters do not constitute in themselves a part of my invention, it is unnecessary to describe them in further detail.

The operation of the system of Fig. 1 is as follows: If the incoming message consists of trains of waves of carrier frequency p_1 , in which the trains are emitted from the sending station in accordance with some code, it will be desirable to use the heterodyne method of reception. In this case the local generator 9 would be of a frequency p_2 , differing slightly from the carrier frequency. In the output of the detector there would then appear, among other things, a frequency $p_1 - p_2$. The wave filter 15 would be designed to suppress all frequencies substantially higher than $p_1 - p_2$ and if this latter is quite low, it will be sufficient to have a wave filter of the form shown in Fig. 3. Under certain conditions, however, it might be desirable to suppress the frequencies substantially lower as well as those substantially higher, and, in such case, the filter of Fig. 4 would be used. Static disturbances falling on this aperiodic antenna would set up oscillations extending over a wide range of frequencies, and the amount of energy at or near the carrier frequency would be relatively small. Those oscillations which differ by even a small percentage from the carrier frequency would then give a difference frequency as a result of the combination with the locally generated oscillations which would be outside the range of transmission of the filter 15. This can be well illustrated by a concrete case. For example, let the carrier frequency of the incoming message be 100,000 and let the locally generated frequency be 99,500. The heterodyne detection would then give a note in the indicator 14 of

frequency 500, and the wave filter 15 would then be adjusted to cut off at 500 cycles or slightly above. If static disturbances set up oscillations which differ by more than 1/2% from the locally generated frequency, the resulting difference frequency therefrom would be more than 500 and would be substantially suppressed by the filter. If the resultant frequency is substantially less than 500, the ear will detect the difference in pitch and will largely ignore such disturbances. The proportion of static energy which will lie within this range of 1/2% above and below the locally generated frequency will be very small, and, therefore, high selectivity is obtained against static disturbances.

In case the incoming message consists of a carrier frequency p_1 which is varied in amplitude in accordance with the signal frequency q , it will then be necessary to have the generator 9 give oscillations of carrier frequency. Upon detection the signal frequency q will be produced and will pass through the filter 15, whereas static disturbances, setting up mainly disturbances of other than carrier frequency, will yield frequencies too high to pass through the filter.

It is to be understood that the signal frequency q may be variable, which would, in general, correspond to the transmission of a telephone message. In that case, q would have substantially all values up to 2,000 and the filter F would be designed to pass all frequencies up to that value. The importance is apparent in this case of having a circuit which has the property of passing a band of frequencies of a definite range rather than the usual tune circuit which is more or less sharply selective for a single frequency. Under such circumstances, as explained above, there will be no distortion in connection with the antenna reception for the reason that an aperiodic antenna is equally receptive for all frequencies. At the same time, a large proportion of the static energy will be at frequencies which differ so much from the locally generated frequency p_1 that the resulting difference frequency will lie outside the range of the filter.

Fig. 2 shows a slight modification of Fig. 1. In this case, instead of using the condenser 7, the antenna may include the inductance 16 to which is inductively connected, by the coil 17, the input of a detector of the same type as shown in Fig. 1. The aperiodicity of this antenna may also be controlled by an adjustable resistance 19 and in certain cases it may be desirable to reduce this resistance to zero.

In general, an aperiodic antenna is not so efficient in receiving the waves of a particular frequency as a tuned antenna, and consequently, it will be desirable to amplify the signal. Suitable amplifiers may, therefore, be inserted at any desired point in the circuit.

Fig. 2 shows schematically two such ampli-

fiers 20 and 21 for amplifying the low frequency message, and obviously, additional amplifiers could be used, if desired. A second filter 22 has also been inserted, in this case between the two amplifiers, and obviously, additional filters may be inserted if it is advantageous to more completely suppress undesired frequencies.

In Fig. 5 there is shown a circuit for multiplex reception. The aperiodic antenna 5 is again shown, with which are associated two local circuits I and II each of substantially the same form as shown in Figs. 1 and 2. If the one message received has a carrier frequency p_1 , its corresponding local receiving circuit would have a local generator of frequency p_1 , and the output of the detector would contain a filter F_1 , which has a range corresponding to the low frequency of its message. Similarly, if the second message has a carrier of frequency p_2 , its local circuit would have a generator of frequency p_2 , and the corresponding filter F_2 would have a corresponding low frequency range. It may well be that the low frequency of the two messages will be the same, in which case F_1 and F_2 would have the same range, and this could certainly be true if both are telephone messages. In this case, the messages are separated by virtue of the fact that the message of carrier frequency p_1 coming into the circuit II and combining with local oscillations of frequency p_2 would yield a difference frequency substantially outside the range of the filter F_2 , and so also, for the carrier frequency p_2 coming into the circuit I. While I have shown but two local circuits, it is obvious that a larger number than this may be provided, one for each message to be received.

From the above it will be apparent that with the wide frequency distribution of static energy and the consequent relatively small amount of such energy at or near the carrier frequency, the amount of the static effects in the audio range will be small and the portion of this latter which is of approximately signal frequency will be still smaller.

One of the important features of the system described consists in the elimination of high frequency tuning, and necessary selectivity is obtained by using low pass filters which will eliminate or suppress all frequencies differing substantially from the signal frequency, and there results, therefore, a high degree of freedom from transient disturbances.

What is claimed is:

1. In a high frequency signaling system, an aperiodic receiving antenna adapted to receive high frequency oscillations modulated in accordance with signal frequencies, a local source of high frequency oscillations, a detector on which the two oscillations are impressed, the input circuit of the detector being aperiodic, and means in the output of

the detector for suppressing all frequencies substantially above the signal frequencies.

2. In a radio signaling system, an aperiodic receiving antenna adapted to receive oscillations of a carrier frequency modulated in accordance with signal frequencies, a local source of oscillations of carrier frequency, a detector on which the two oscillations are impressed the input circuit of the detector being aperiodic, and a wave filter connected directly to the output of said detector for suppressing all frequencies substantially different from the signal frequencies.

3. The method of receiving signals on an aperiodic antenna which consists in receiving an incoming high frequency message modulated in accordance with a signal frequency, generating high frequency oscillations locally, combining said oscillations with said locally generated high frequency oscillations, impressing these on a detecting device with an aperiodic input circuit and suppressing all frequencies above the signal frequency.

4. The method of receiving signals on an aperiodic antenna which consists in receiving an incoming high frequency message of carrier frequency modulated in accordance with signal frequencies, generating high frequency oscillations of carrier frequency locally, combining with said high frequency message said locally generated high frequency oscillations of carrier frequency and impressing these on a detecting device with an aperiodic input circuit and suppressing all frequencies above the signal frequencies.

5. In radio signaling by means of sustained alternating currents of a certain signal frequency, the method of diminishing the effects of static, which consists in receiving the high frequency current on an aperiodic antenna, locally generating oscillations of carrier frequency, impressing the received and locally generated oscillations on a detecting device with an aperiodic input circuit and suppressing all oscillations of frequencies differing substantially from the signal frequency.

6. In radio telephone signaling, the method of preventing distortion due to antenna tuning, which consists in receiving a modulated high frequency wave on an aperiodic antenna, generating high frequency oscillations locally, combining said modulated high frequency wave with said locally generated high frequency oscillations, impressing these on a detector with an aperiodic input circuit, and selectively suppressing all frequencies differing substantially from the signal frequencies.

7. In a multiplex radio signaling system, an aperiodic antenna adapted to receive a plurality of messages of different carrier frequency, a plurality of local receiving circuits associated with said antenna, a local generator of high frequency oscillations associated with each local circuit, each generator having

a frequency equal to the carrier frequency of the message to be received therein, a detector for each local circuit, and a wave filter in the output of each detector to suppress all frequencies differing substantially from the signal frequency.

8. In a high frequency signaling system, an aperiodic receiving antenna adapted to receive high frequency oscillations modulated in accordance with signal frequencies, a local source of high frequency oscillations, a detector with a direct aperiodic connection to the antenna for receiving the two sets of oscillations, and a wave filter in the output of the detector for suppressing all frequencies substantially above the signaling frequencies.

In testimony whereof, I have signed my name to this specification this 30th day of August, 1921.

JOHN R. CARSON.