

Aug. 2, 1927.

1,637,404

R. BOWN

SIGNALING SYSTEM

Filed March 12, 1921

2 Sheets-Sheet 1.

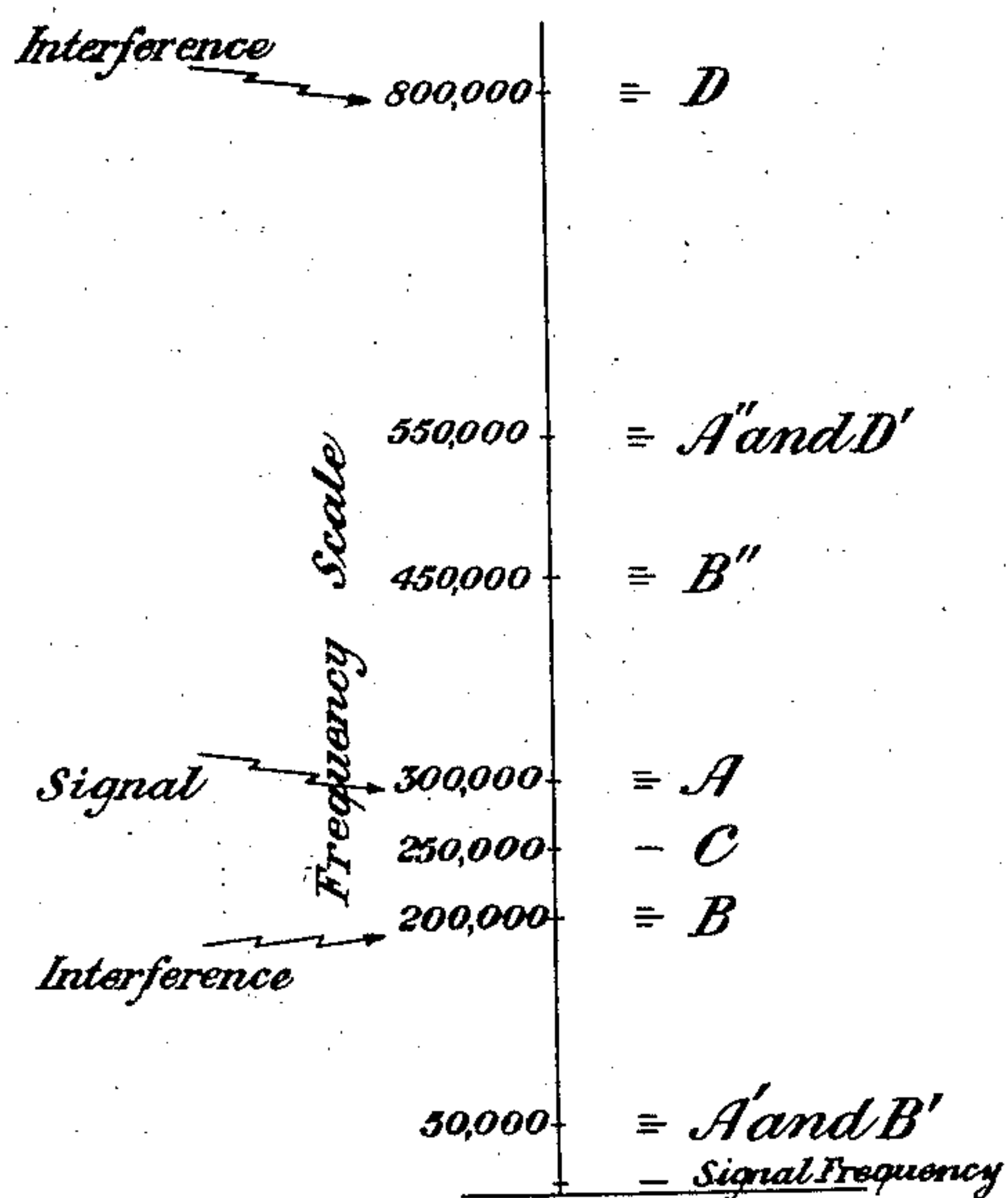


Fig. 1

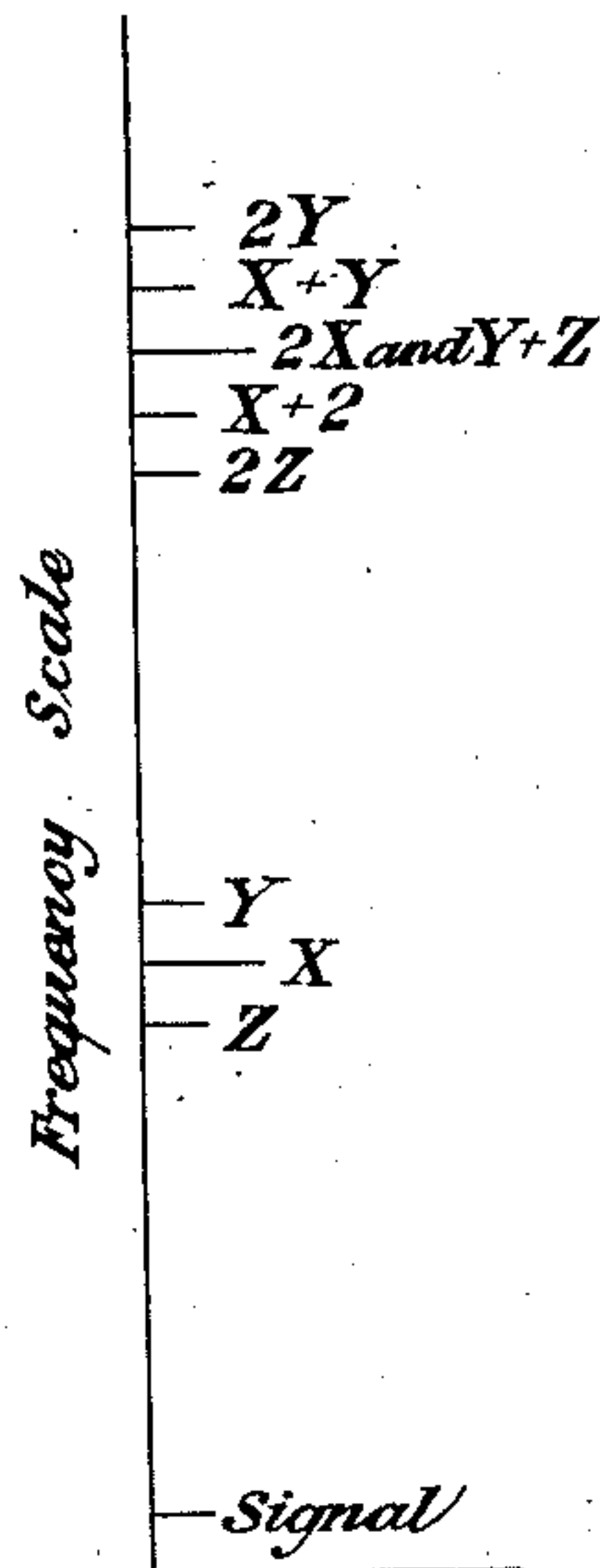


Fig. 3^a

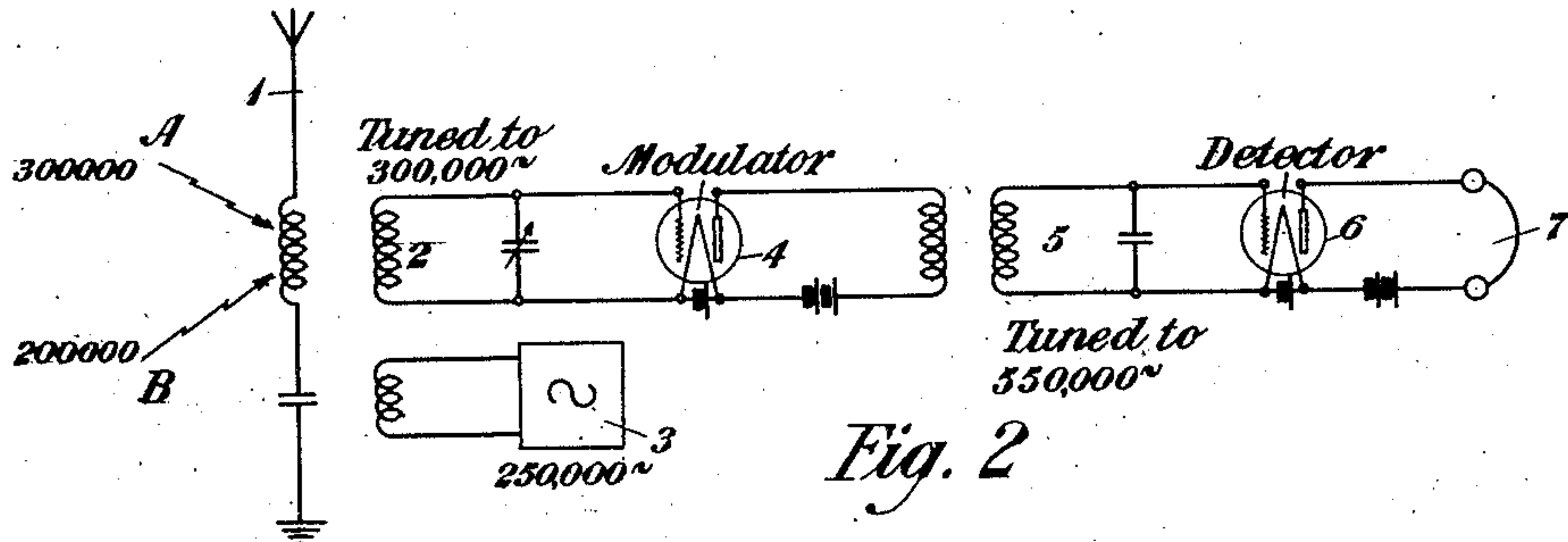


Fig. 2

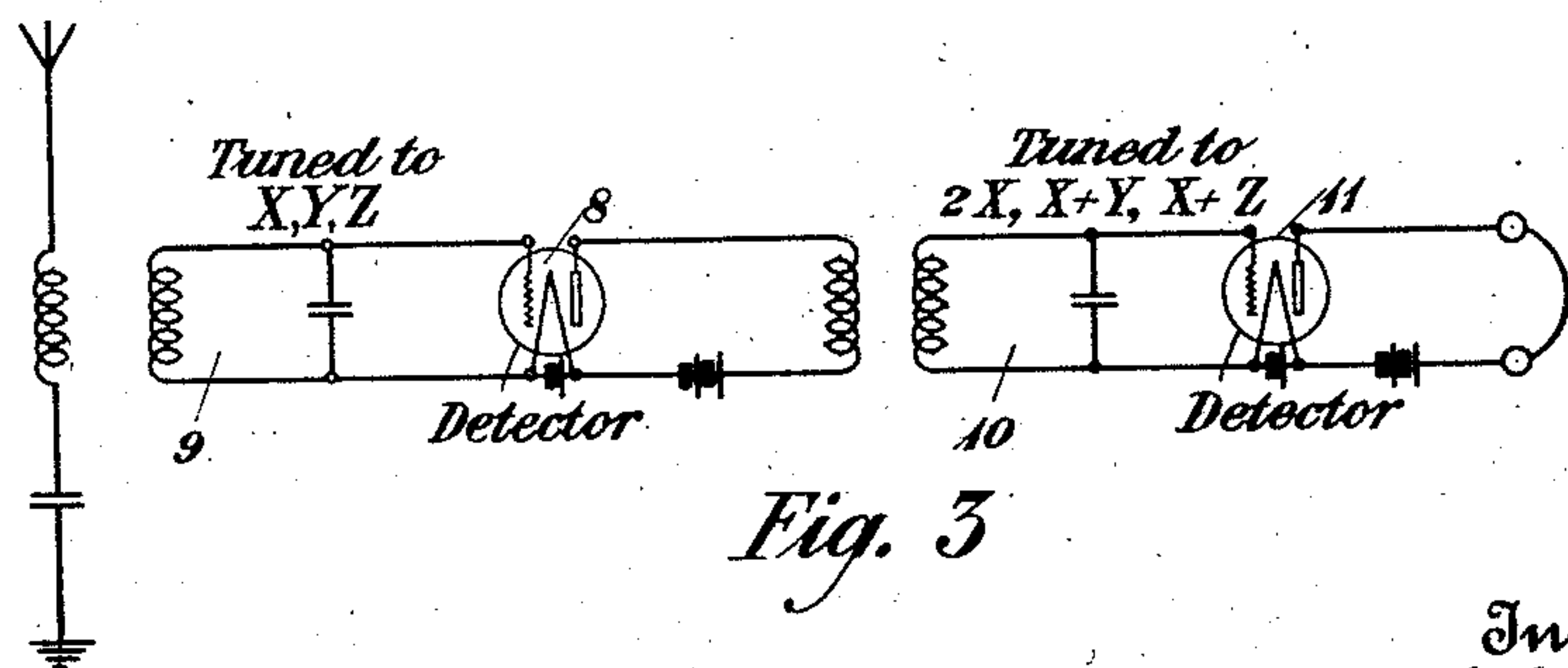


Fig. 3

Inventor
Ralph Bown

By his Attorney

gr 40

Aug. 2, 1927.

1,637,404

R. BOWN

SIGNALING SYSTEM

Filed March 12, 1921

2 Sheets-Sheet 2

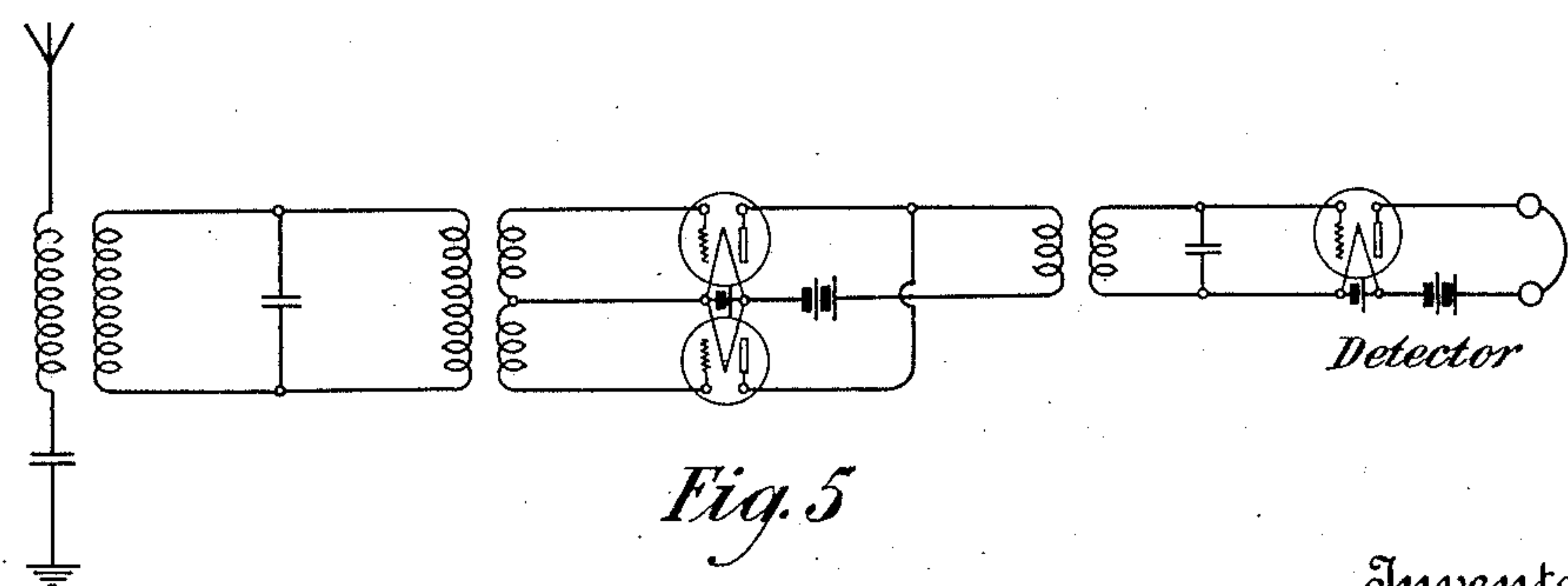
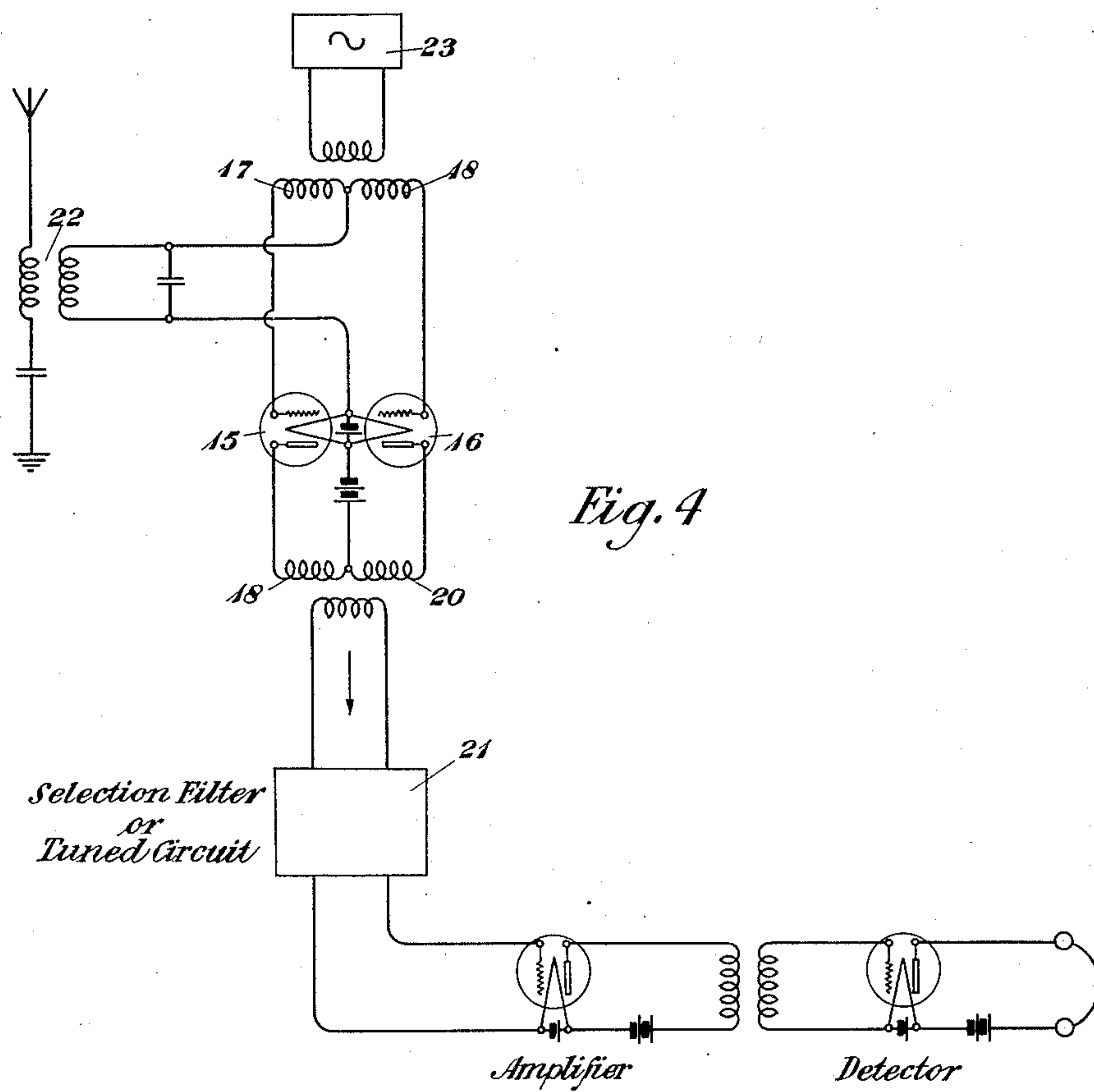


Fig. 5

Inventor
Ralph Bown

By his Attorney

John

Patented Aug. 2, 1927.

1,637,404

UNITED STATES PATENT OFFICE.

RALPH BOWN, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SIGNALING SYSTEM.

Application filed March 12, 1921. Serial No. 451,700.

This invention relates to signaling systems in which the signals are transmitted by means of carrier current impulses, usually of a frequency considerably higher than the frequency of the signals; and more particularly to the receiving end of such systems.

It is old in systems of the kind mentioned to derive the signal frequency from the received high frequency impulses in two steps or stages, either by the double detection or double demodulation, sometimes called beating down; so that if the received frequency were for example, 300,000, the first step might be to reduce this to 50,000 by combining the received frequency with another of 250,000 generated locally, or derived from any convenient source. The signal is derived from the 50,000 frequency by detection or demodulation by the heterodyne or homodyne method. By then using tuned circuits or filter circuits in the intermediate stage as well as in the initial and final stages selectivity of the system may be greatly improved. Amplification in the intermediate stage has also advantages in some cases.

The object of the present invention is to further improve the selectivity of a receiving system of this kind.

In the accompanying drawings Figure 1 is a frequency diagram illustrating the principle of the invention. Fig. 2 is a diagrammatic representation of a system for practicing the invention. Fig. 3 is a modification of the invention. Fig. 3^A is a diagram illustrating the operation of the system of Fig. 3, and Fig. 4 is an embodiment of the invention using a balanced demodulator and Fig. 5 is a modification of the arrangement of Fig. 4.

Referring to Fig. 1, let it be supposed that the desired signal is arriving as a modulation of a carrier-current of a frequency of 300,000 as indicated at A, the representation being of the carrier frequency with the upper and lower side bands. According to the usual method this frequency will be combined with a locally generated frequency C of say 250,000. The difference between these frequencies, i. e., 50,000, indicated at A', is derived by the combination or interaction of these two frequencies in a modulating device and by tuning the output of the tube to the frequency of 50,000. The

signal frequency may be then derived from the frequency of 50,000 by detection or demodulation. It will be observed however, that if there chances to be a frequency B of 200,000 arriving at the receiving station simultaneously with the signal frequency of 300,000, the combination of the beating frequency C with the frequency of 200,000 will also give a frequency B' of 50,000, which will be superimposed upon A' and therefore inseparable from it by any system of tuning at the intermediate stage. The only separation between the signal frequency of 300,000 and the interfering frequency of 200,000 must therefore be obtained by the tuning at the initial stage, that is, before any demodulation.

The interaction of 300,000 and 250,000 gives, however, not only a difference frequency of 50,000 but a sum frequency A'' of 550,000, so that by properly designing the selecting circuits at the intermediate stage this sum frequency may be used instead of the difference frequency. It will be seen that if this is done the interfering frequency of 200,000 cannot give a frequency in the intermediate stage coinciding with that of the signal frequency. The sum of 200,000 and 250,000 will give a frequency B'' of 450,000. These frequencies A'' and B'' are therefore separated by as wide a gap as the arriving frequencies of 300,000 and 200,000 and the interfering frequency can therefore be discriminated against not only at the initial stage but also at the intermediate stage, thus increasing the selectivity. It will be observed that by using the sum frequencies in place of the difference frequencies, there is no frequency in the neighborhood of a given signal frequency which can combine with a given beating frequency to produce the same frequency as that produced by the signal. There is, of course, the possibility in the case represented by Fig. 1, that there would be an arriving frequency D of 800,000, which combined with the frequency C would give a difference frequency of 550,000, so that in this case A'' and D' would be superimposed and inseparable in the intermediate stage. In such a case, however, the wide difference between the frequency D and the frequency A makes it possible to satisfactorily discriminate against the former by the tuning at the initial stage.

Fig. 2 illustrates an apparatus for carrying out the invention. The receiving antenna 1 is associated with the tuned circuit 2, here represented as tuned to a frequency of 300,000. A local source 3 of high frequency currents here indicated as 250,000, is associated with the tuned circuit 2, both feeding the input circuit of the modulating device 4. To the output circuit of this tube is connected the selective circuit 5, tuned in this case to a frequency of 550,000. A detector 6 of any desired type is connected to the tuned circuit 5 and with it is associated the signal receiving instrument 7 represented as a pair of telephone receivers. It will be observed that this system involves nothing new in the way of apparatus and differs from known systems only in having the tuning at the intermediate stage designed to utilize the sum rather than the difference frequencies.

The same principle may be employed in what may be designated detecting up, as distinguished from modulating or beating up. This is represented in Figs. 3 and 3^A. The system shown in Fig. 3 is the same as shown in Fig. 2, except that the local source of high frequency current is absent. It is obvious that the high frequency may in general be derived not only from a local source but from some nearby transmitting station, or it may arrive with the signal frequency. In Fig. 3, the incoming signal, which may be a radio telephone signal, consists of a carrier X, and two side bands Y and Z, (see Fig. 3^A). The result of the interaction of these in the detector 8 is to produce in addition to the signal which results from the detecting down action, the double frequencies and sum frequencies, indicated in Fig. 3^A at the points marked 2Y, X + Y, 2X and Y + Z, X + Z and 2Z. Of these, 2Y, 2Z and Y + Z will be weak, since their components are relatively weak, while 2X, X + Y and X + Z will be strong due to the strength of the carrier X over the side bands Y and Z. The selective circuit 9 is tuned to the frequencies X, Y and Z. The selective circuit 10 of the intermediate stage is tuned to the frequencies 2X, X + Y and X + Z. The selection and detection of this upper range of frequencies will thus result in the production of a good signal quality due to the interaction of the strong components 2X, X + Y and X + Z in the second detector 11.

There is a limitation which the system of beating up shares with the beating down system, namely, that an interfering frequency equal to the sum frequency, may be arriving simultaneously with the signals and it may to some extent get through the initial stage of tuning and appear in the intermediate stage, which is tuned to that frequency and where further discrimination between

the two would be impossible. To avoid this, a balanced modulator such as shown in Fig. 4 may be used. This balanced modulator is of the type disclosed in Patent No. 1,343,306 issued to J. R. Carson. It consists of two demodulating tubes 15 and 16, having a portion of their input and output circuits in common and with balanced coils 17 and 18 arranged respectively in the parts of the input circuits individual to the tubes and normally affecting the grids of the tubes equally and oppositely. The output circuits similarly have balanced coils 19 and 20 in their individual branches, coupled equally to the output circuit 21, containing the filter or selecting circuit. The signal impulses are applied to a coil 22 in the portion of the input circuits common to the two tubes. A source of beating frequency 23 is shown as supplying equally to the balanced coils 17 and 18. The signal impulses, unmodulated by the beating frequency, will affect the two grids equally and in the same sense, and will therefore, produce no corresponding impulses in the output circuit 21. However that portion of the signal frequency which is modulated by interaction with the beating frequency in the tubes 15 and 16 will appear in the output circuit as the sum or difference frequency resulting from modulation. Under the assumed case, this frequency is the sum frequency represented in Fig. 1 as 550,000. An incoming interfering signal of a frequency of 550,000 will therefore, be unable to get through to the output circuit, which is tuned to that frequency because it can be evidenced in that circuit only as modulated by the local beating frequency, which would so alter it in frequency that the tuned output circuit would discriminate against it.

Fig. 5 represents the balanced modulator applied to the detecting-up scheme illustrated in Figs. 3 and 3^A. The elements of the circuit are the same as those just described in Fig. 4, with the exception that the signal frequency and the beating frequency are both applied to the balanced input coils, this being necessary because they are both received on the antenna, and with the further exception that the tuned circuit in the output is connected to the common portion of the output circuits of the two tubes instead of to balanced coils in the individual portions of the output circuits. The input frequencies X, Y and Z (see Fig. 3^A) can have no direct effect upon the output circuit and it is only the results of their intermodulation which can appear in the output circuit. For the assumed case of detecting up the predominating frequencies in the output will be 2X, X + Y, and X + Z, as in the simple case of Fig. 3. An interfering signal in this frequency range is thus precluded from passing directly to the output. In so

far as it gets there it will be altered in frequency and can therefore be selectively discriminated against. It will be obvious that the arrangement utilized in Fig. 5 may be
5 utilized also in the arrangement shown in Fig. 4, for the same purpose by applying the beating frequency at the same point as the signal frequency.

It will be obvious that certain phases of
10 this invention are applicable equally to both wire and wireless communication and that amplifiers may, if desired, be used at the initial, intermediate or final stages, or at all of them. Various changes in the details of
15 the circuit arrangements may be made without departing from the spirit and scope of the invention.

What I claim is:

1. The method of increasing the selectiv-
20 ity of signal receiving apparatus, which consists in selecting to favor oscillations of the frequency of the desired signal carrier, thereby to reduce interference on other frequencies and substantially eliminate that on
25 remote frequencies, combining the selected oscillations with another set of oscillations to produce a third set of oscillations of a frequency equal to the sum of the combined frequencies, selecting to favor the said sum

frequency, thereby further reducing interfer- 30
ence from incoming frequencies not remote from the desired signal carrier frequency, and then detecting to produce the signal from said selected sum frequency oscillations before they are again subjected to interfer- 35
ence sources.

2. The method of increasing the selectiv-
ity of signal receiving apparatus, which consists in selecting to favor oscillations of the frequency of the desired signal carrier, 40
whereby interference on other frequencies is reduced and that on remote frequencies is substantially eliminated, combining the selected oscillations with another set of os-
cillations of a frequency such as to give a 45
sum frequency different from the beat frequency with any interference except that of a frequency remote from the signal carrier, selecting to favor said sum frequency to get
a further discrimination against interfer- 50
ence on frequencies not remote from the signal carrier, and then producing the signal impulses from the said sum frequency before it is again subjected to interference sources.

In testimony whereof, I have signed my 55
name to this specification this ninth day of March, 1921.

RALPH BOWN.