

April 11, 1939.

H. CHIREIX

2,153,612

DEMODULATING MEANS

Original Filed Feb. 12, 1935 2 Sheets-Sheet 1

Fig. 1

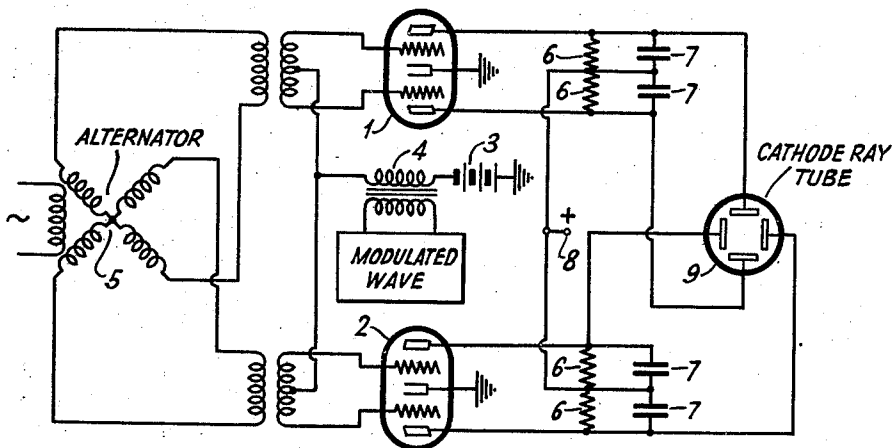


Fig. 2

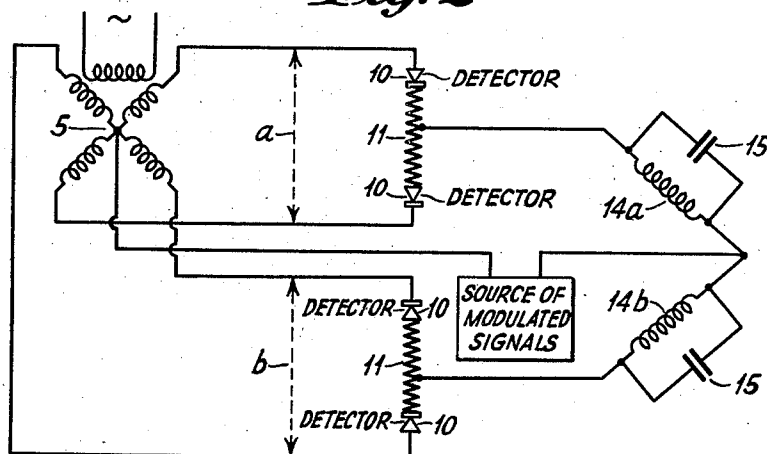
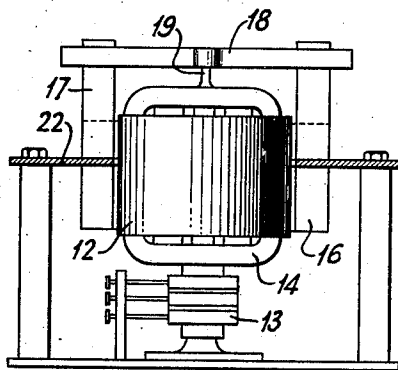


Fig. 6



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Fig. 3

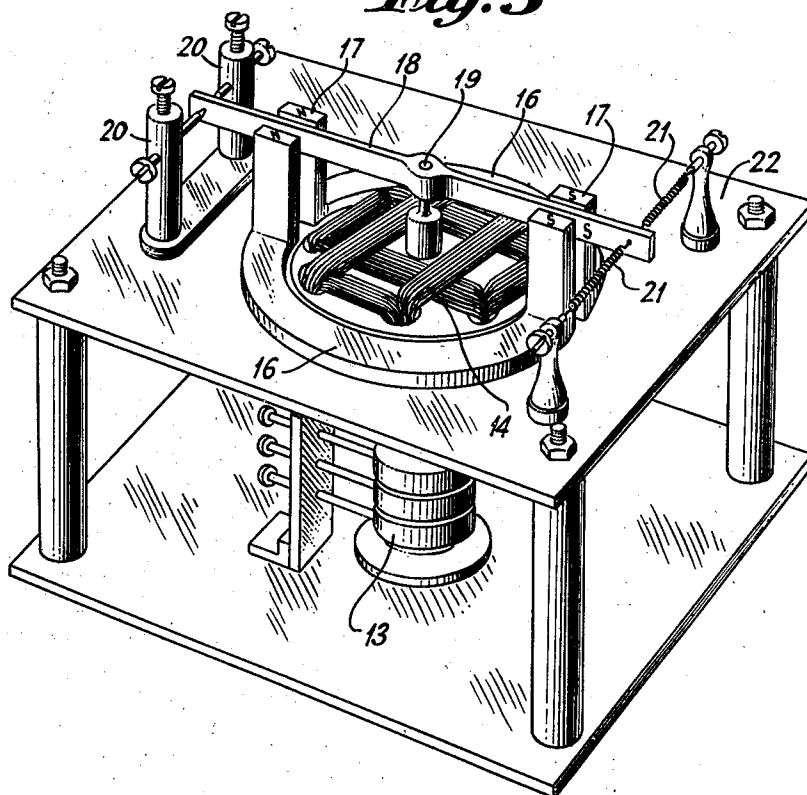


Fig. 4

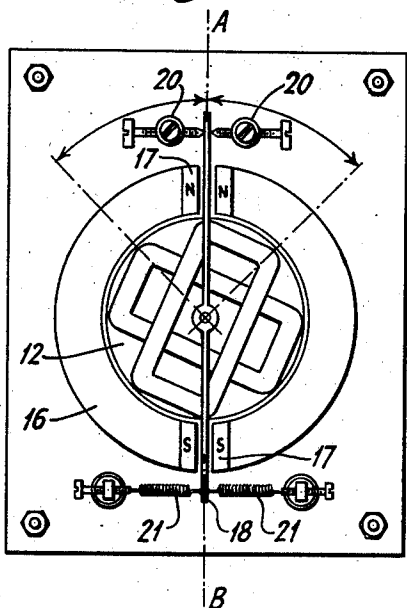
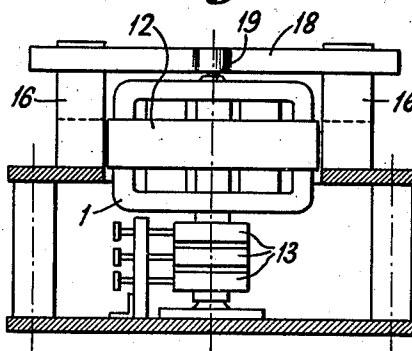


Fig. 5



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UNITED STATES PATENT OFFICE

2,153,612

DEMODULATING MEANS

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Original application February 12, 1935, Serial No. 6,137. Divided and this application June 18, 1937, Serial No. 148,834. In France February 15, 1934

2 Claims. (Cl. 178—66)

The present application which is a division of my United States application #6,137, filed February 12, 1935, now Patent #2,135,171, dated November 1, 1938, concerns novel devices adapted to be used in signal reception which in addition are suited to insure a system of secret transmission useful for communications over telephone wires or cables, telegraphy through ground, and telegraphy by Hertzian waves.

Independently of the usual means consisting in the use of a code, secrecy is assured according to the present invention by the particular method of transmission and reception.

It is known that one of the most widely used signalling methods consists in the transmission of musical or tonal, audio frequency currents, these currents being interrupted or chopped by a key in accordance with a certain code, say, the Morse code.

It is also known that it is possible to key by causing a current known as the working current to flow on a certain frequency, and another current known as the "rest" or spacing current to flow on another frequency.

It is also known that it is possible to combine in one and the same frequency the working and the spacing transmissions by causing by the key certain variations of phase in the modulator current.

The invention is concerned with this latter mode of signalling, and it discloses new means of receiving signals transmitted in this way.

As a matter of fact, according to the prior art it has been necessary to provide at the receiving station a current being absolutely in synchronism with the outgoing current so as to bring out and make noticeable the variations in phase. Indeed, the maintenance of synchronism necessitated the transmission of synchronizing signals, and this is liable to involve serious inconvenience from the viewpoint of synchronism and of insuring secrecy of the method that is employed.

Now, the present invention dispenses with the necessity of strict synchronism and therefore of the sending of synchronizing signals or the continuation of transmission outside the actual operating periods.

It discloses more particularly two practical embodiments, these two embodiments being predicted upon the use of one and the same basic invention which is as follows:

The transmission of current being insured by means of a current generated by the aid of a tuning fork, for instance, and suitably amplified, this current, at the receiving end, is caused to beat

with poly-phase currents produced, for instance, by another tuning fork and, according to well-known methods of heterodyne reception, the said receiving tuning fork vibrates with very close approximation at the same frequency (say, within one-thousandth). What results beyond the detectors is a polyphase current having the very low frequency of the beat. With poly-phase current there is produced a rotating field by ways and means generally known in the art.

This field will turn in either sense according to the sense of the asynchronism, or else will not rotate at all during the intervals of time where isochronism is attained.

Keying is effected by means of variations of phase, that is to say, by advancing an angle θ to characterize a working transmission and retarding it a similar angle for spacing.

The rotating field just referred to will be shifted forward or caused to lag the same angle no matter what the position of its axes at the instant in question. For a "working" transmission or signalling it may turn, for instance, in the sense of the clock, while for spacing it will turn anticlockwise.

These rotations are used for decoding the transmitted text by means of one from among two arrangements hereinafter described by way of example. In describing these arrangements reference will be made to the drawings in which Figures 1 and 2 are circuit diagrams including the essential elements of my phase rotation analyzing circuits, while Figures 3, 4, 5, and 6 show details of recording or indicating devices which may be used to record or indicate the output of Figure 2.

1 and 2 represent in Figure 1 the tubes of a twin symmetric or push-pull system. Each system may comprise two triodes or tubes of a more improved type comprising, for instance, tubes having two control grids. For the sake of simplicity there is shown for each system one tube equivalent to two separate triodes. The four grids are biased at the initiation of the plate current by the source 3 and excited in parallel by the modulation to be received by means of transformer 4.

They are moreover excited by pairs in opposition by the two phases of a two-phase alternator whose frequency is very closely the same as the frequency of the currents to be received. There is thus insured detection by virtue of the lower knee in the plate characteristic.

The circuits of the plates are constituted by the resistances 6 being preferably equal and shunted by condensers 7 and inserted between the anodes

and the high voltage source connected at 8. The plates are moreover connected with the four deflector plates 9 of a cathode-ray tube. The part and purpose of the condensers 7 being to short-circuit the alternating current components of high frequencies of the plate current, there is obtained between the two deflecting plates of a system of plates an electrostatic alternating field of very low frequency due to the beats between the modulation to be received and the local generator. The cathode pencil subjected to two alternating fields of this kind will thus turn very slowly, and the spot upon the fluorescent screen will describe, for instance, very slowly a circle if the amplitudes are alike. Indeed, if isochronism is present or attained during a more or less long period the spot will be reduced to a fixed point upon this circle, and the spot will be shifted in one sense or the other as soon as isochronism ceases. If the currents received by the transformer 4 are modulated in phase as has been stated, the modulation being translated in a phase displacement of 2θ , then the spot will shift very rapidly, for instance, the clockwise sense at the instant a signal is sent and will return in the opposite sense at the instant spacing begins. Owing to the visual persistence of the retina, keying will be seen in the form of lines of like lengths, but succeeding one another at unequal intervals according to whether short dots or long dashes are involved.

It will be noted that if the transmitter is stopped the spot naturally will come to be located in the center of the screen. From the instant of start, with the key in the beginning being blocked for spacing, the spot will appear at any point at all of the circle and at the first signal it will describe in a predetermined sense a rotation 2θ . Hence, there exists no ambiguity, and the reading of the message may begin at once.

The second embodiment here disclosed involves a receiver apparatus which is more practical in actual use and allows of actuating a relay so as to be able to record the transmitted text in the usual way. There is employed a special relay conceived in a way as indicated in Figure 3 and fed from an electromagnetic rotating field as soon as a state of asynchronism is established. This rotating field could be produced in accordance with the scheme shown in Figure 2 where 5 represents a local two-phase generator comprising phases a and b , 10 detectors of the copper oxide type, for instance; 11 resistances, 14a and 14b windings wound V-fashion, for instance, corresponding to the phases a and b resulting in the rotary field, 15 capacities shunting these windings, and finally, the source of modulated waves connected with the input terminals. It will be seen that a detector element such as 10 is subject to the potential resulting from a phase of the local generator 5 and the reception. One of the windings, for instance 14a, will thus be traversed by a maximum current of definite direction when the incoming energy has the phase of a while the current will be of zero value when the phases are in quadrature since the potentials are then geometrically equal at the terminals of the two detectors in the phase. The current in 14a will then again be of maximum value, but will be opposite in direction compared with the preceding one, when there is phase opposition between the incoming energy and phase a .

Hence, the current in 14a varies in accordance with a sine law, according to the phase of the

incoming energy compared with the phase a . The same situation holds true regarding the current in 14b except that the current will be of zero value in 14b when it is at its crest value in 14a because of the fact that the law of variation is here of sinuous form shifted an angle of 90 degrees because the incoming energy is combined here with the phase b being in quadrature with the phase a . The currents in 14a and 14b are therefore endowed with all of the qualities required to feed a rotating field system such as the relay which is represented in Figures 3, 4, and 5 as shall hereinafter be described. These figures are: Figure 3 a perspective view, Figure 4 a plan view, and Figure 5 a section taken on line A—B.

Referring to the drawings, 14 denotes the windings 14a and 14b connected V-fashion of the rotating field system, Figure 2. These windings are accommodated in the slots of a rotor 12, the current being fed by way of rings 13. Each of the systems, there being two, of Figures 3 to 6 contains four loops located in pairs of parallel vertical planes; the horizontal sides of one pair of loops are one-half as long as the horizontal sides of the other pair of loops. The system comprises two identical but perpendicular groups of windings of this type. The vertical sides of the adjacent loops comprising the different windings pass through common slots, there being eight slots per rotor.

The rotor turns in the interior of a stator constituted by two sets of curved magnets 16 having polarities of the same nature N and S placed opposite each other, and pole pieces such as indicated at 17 forming between themselves an air-gap.

In the air-gap of these pole-pieces is disposed a magnetized needle 18 presenting poles such as n and s . This needle is pivoted directly at 19 on the peak of the rotor 12, it constitutes the keeper of a polarized relay; its stroke is limited either way by stops on contacts such as indicated at 20. 21 denotes finally regulating springs of the keeper 18 in the air-gaps of pole-pieces 17. The assembly is mounted on the frame such as 22. The operation of the system is as follows:

As soon as a transmission takes place, a field is set up in the windings 14 and the rotor 12 will become oriented in such a way that there will be coincidence between the line of the poles of the rotor and the line of the poles of the magnets 16. When the position of equilibrium has been reached, the needle 18 is positioned on a line of symmetry of the flux. As long as the state of isochronism is maintained the rotor will not move; but as soon as the said state ceases to exist the rotor will turn slowly in either sense. If keying then takes place by virtue of the variation of the phase by an amount $\pm\theta$ compared with the mean phase the rotor will not be driven because of its high (relative) inertia, but the far lighter needle will respond to the keying.

From the instantaneous viewpoint, as a matter of fact, the rotor field will be phase-displaced by $\pm\theta$ degrees. Under these conditions the flux of the rotor will be closed by the magnets 17 by traversing the air-gaps formed between the pole-pieces 17 and the needle 18 will be shifted under the action of this flux.

It could also be said that the instantaneous displacement of the field creates in the opposite pole-pieces 17 supplementary poles n and s , or s and n which destroy the symmetry of the lines of force. It is evident that if the keying is ir-

regular the line of the poles n and s will not be positioned exactly in the center of the arc amounting to 2θ ; but this is immaterial, in fact, one could even stay on a continuous dash or a space provided that the angle θ is not chosen too large ($\theta < 90$ degrees). If, for instance, there is chosen $2\theta = 90$ degrees and staying on space, the instantaneous torque will be of maximum value at the instant work is started, because the polar line will then be caused to turn suddenly an angle of 90 degrees, and since the entire flux of the rotor will become closed in the air-gaps of the pole pieces 17. If one keys thereafter in a regular manner, the rotor will be displaced 45 degrees approximately and present a position as indicated in Figure 4. If the state of isochronism is not exact, the rotor will be shifted more according to the ship frequency which, however, is always very small. It will be understood that it is desirable to make the rotor relatively heavy in order that it may not be driven along. The springs 21, 21 moreover should be so regulated in order that in the absence of transmission the needle may be in equilibrium (unstable) in the air-gaps of the pole-pieces 17.

It will evidently be possible to have recourse to the contacts of the relays to operate a recorder with tape or simply for closing the circuit of a telephone fed from the local oscillator. In this latter instance there is thus preserved the advantage of reception by ear.

It will be noticed that the circuit arrangements hereinbefore disclosed are directly useful with high frequency and may be employed under particularly favorable conditions in telegraphic communication on long waves. It is very likely, indeed, that by the aid of tuning forks frequencies that are stable to within $\frac{1}{100,000}$ may be obtained, in other words, that on waves greater than 3000 meters it is possible to insure an asynchronism whose frequency will not be over two beats each second. By using circuit arrangements as hereinbefore disclosed together with apparatus of a kind as described, it will be feasible to handle traffic under conditions far better than under present day conditions. As a matter of fact, it is well known that from the view point of disturbances, atmospherics and jamming, keying and signalling predicated upon phase shifting insures a maximum degree of immunity.

Although in the exemplified embodiments hereinbefore illustrated recourse is had to two-phase fields, it is evident that the invention is equally applicable to any other multi-phase fields.

It will be evident, on the other hand, that other dispositions predicated upon the same basic idea

could be considered. More particularly speaking, in the second solution it could be conceived that the light needle designed to respond to and follow the keying is subjected to a turning field independent of the former, though connected with it mechanically.

For instance, the rotor could be made heavier and the stator could be divided into two parts, one constituted by magnets such as 16 whose purpose, as above pointed out, is to orientate the rotor flux, and another consisting of non-magnetized magnetic pieces supporting the poles 17 and designed to collect the flux of the rotor when the lines of the poles are displaced under the action of keying. This arrangement has the advantage over the preceding one of shifting the mobile needle 18 in an air-gap not permanently magnetized. This modification is illustrated in Figure 6. The rotor 12 of the relay comprises slots or grooves in which are placed windings 14 of the rotary-field system, the current being fed by way of the rings 13.

Upon the casing 22 of the stator are mounted, on the one hand, the magnetic pieces 17, and these are of the same form as the pieces 16—17 in Figures 3 to 5. They enclose between themselves an interferric space in which is mounted a needle or pointer 18 pivotal on the end 19 of the rotor. The latter is sufficiently heavy so that its flux will embrace the pieces 16 and 17. The mechanism of the contacts between which the needle moves is the same as in Figures 3 to 5.

I claim:

1. A device for producing indications of the rotation of an electrical field produced by phase modulations on a carrier wave comprising, a support member, a slotted rotor mounted for rotation in said support, field producing windings in the slots of said rotor, a permanent magnet enclosing said rotor, said permanent magnet having a plurality of adjacent pole pieces of like polarity, and an additional magnet mounted for rotation between said pole pieces.

2. In a device for producing indications of the rotation of an electrical field produced by phase modulations on a carrier wave, a support member, a rotor mounted for rotation in said support member, field producing windings supported by said rotor, a permanent magnet adjacent said rotor, said permanent magnet comprising a plurality of adjacent pole pieces of like polarity, an indicating magnet mounted for movement between said pole pieces, and resilient means tending to hold said additional magnet in a predetermined position.

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