Aug. 25, 1931. W. HAHNEMANN 1,820,223

HIGH FREQUENCY MACHINE TRANSMITTER

Filed Oct. 27, 1927

Fig. 1

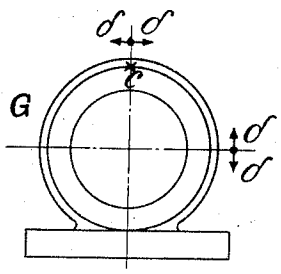


Fig. 2

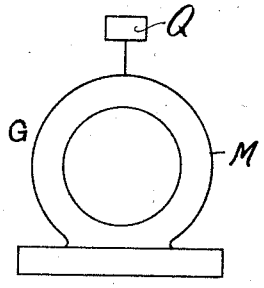


Fig. 3

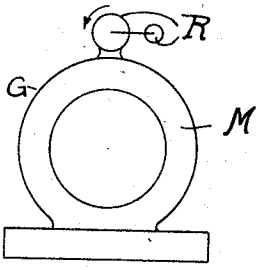
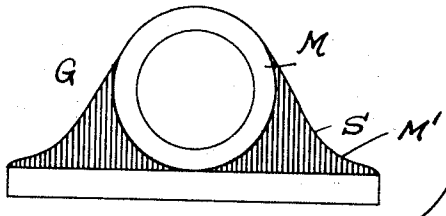


Fig. 4



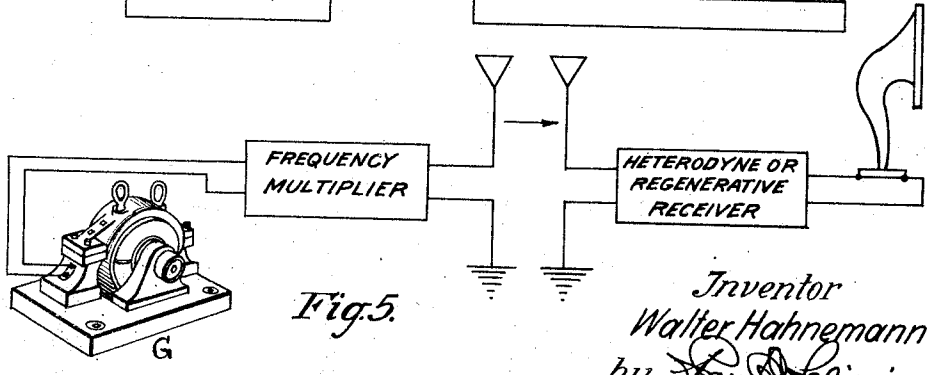


Fig. 5.

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UNITED STATES PATENT OFFICE

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HIGH-FREQUENCY MACHINE TRANSMITTER

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When using high-frequency machines in connection with frequency transformers, particularly transformers of the iron-cored type, for the production of electric oscillating currents of high-frequency for wireless telegraphic or telephonic purposes, one of the most essential requirements consists in that the frequency of the currents produced by the machine in accordance with its number of revolutions should be held constant to a very high degree, as otherwise very minute variations of the speed of rotation, especially in the case of a very high multiplication of the machine frequency being carried out, will cause in a heterodyne receiving apparatus cooperating with the transmitting system, corresponding variations of the pitch of the receiving beat note so as to render practicable operation absolutely impossible. The recent development of speed regulators, however, especially a design of speed regulating devices operating according to the well-known Tirrill principle, has made it possible to produce wireless waves by means of electric generators in connection with frequency raisers down to a length of 300 meters with sufficient constancy of frequency, which hitherto has only been accomplished by means of vacuum tubes.

Moreover, there exists a further drawback inherent to such machine transmitters, especially when carrying out extremely high multiplications, which practically presents itself as a trilling phenomenon of the beat note in the receiver. Such a trilling beat note which is characteristic of machine transmitters of the type in question, involves great disadvantages especially when a receiver of the audion reaction type is employed, in that with a degree of reaction comparatively much below that possible when receiving waves free of this trilling disturbance such as of vacuum tube transmitters, the signals are distorted to a large degree, the advantages of reaction in audion receivers thus being decreased considerably.

Theoretical analysis, as well as practical considerations and oscillographic investigations, have shown that the trilling phenomenon referred to has its origin in minute frequency variations occurring in the speed of rotation of the machine and having values of about 1/10.000th of the normal speed value. At first it seemed as if the minute frequency variations per one revolution were caused by variations of the rotation speed of the revolving part of the machine, and very tedious and long tests had to be carried out to give the degree of uniformity of the revolving element a value larger than 1/10.000th. This, however, has been found to be without result. It has been found, however, that the phenomenon of trilling of the beat note is based not in absolute variations of the speed of rotation—for, even with variations of the speed of 1/10.000 the forces of inertia are so large as not to produce practical disturbances—but in frequency variations occurring between rotor and stator as the result of the mechanical vibrations of the casing. These vibrations of the stator casing and of its foundation possess a component in the direction around the rotation axis presenting torsional oscillations around the same. They are caused to a great extent by the unequal forces which are transferred by the rotation of the rotor, whose crankshaft is never absolutely free of oscillating movements, to the casing across the bearings and impinging upon the latter to set it into oscillation. The casing, therefore, is impinged upon once each revolution, thus performing an oscillating movement about its normal position. The phenomenon of the trilling pitch of the beat note will now, after these preliminary statements, be explained by the following consideration in connection with Figure 1 of the accompanying drawings, in which drawings:

Figure 1 is a schematic view of a high frequency generator exponentially illustrating certain phenomenon pertaining to the production of beat note trills.

Figures 2, 3 and 4 are similar views showing different ways of carrying the principle of the invention into practical effect.

Figure 5 is a diagram of a complete transmitting and receiving system as adapted for carrying out the invention.

Supposing the circumference of the rotor of the high frequency generator to be $c=2000$

mm. (Figure 1), and amplitude of the component of rotation of the oscillations of the casing around the axis to be $\delta=1/10$ mm. along this circumference, i. e., $2\delta=2/10$ mm. to both sides from the normal position, and supposing one torsional oscillation to occur once per revolution of the rotor, a rise or decrease of frequency

$$\frac{1/10}{2000}=1/20000$$

each will result, the total alteration of frequency being of 1/10.000th. If this fundamental machine frequency is multiplied, say about to its one hundredth fold value, this multiplied frequency will vary, too, by this same degree of 1/10.000th. Supposing for instance the multiplied frequency to be of 1,000,000 oscillations per second, corresponding to a wave length of 300 meters its variations about this value will be of 100 oscillations per second. These frequency variations influence the beat note of a heterodyne receiver in that the beat note varies as many times in one second by 100 oscillations, as corresponds to the number of revolutions of oscillations, of the machine per second. This phenomenon gives the impression of trilling of the beat note and will be designated as the "trilling note" of such a high-frequency machine transmitter.

It is the object of the present invention to overcome the drawbacks occurring in connection with the "trilling note", for which the above mentioned difficult and laborious experimental work has furnished the necessary analytical data and practical means. According to my invention, means are provided for the machine which are adapted to decrease the vibrations of the stator casing around the rotation axis to such a minimum value as to reduce the frequency variations of the multiplied utilization frequency to a value practically insufficient to give rise to the phenomenon in question. The generic object to this end consists in mechanically balancing the machine very accurately to a degree far above that hitherto known and required for ordinary purposes (for instance with respect to strains and stresses of material caused by percussions of the machine structure), so that neither very minute percussions giving rise to the trilling tone may occur or are damped to a practically unimportant value.

However there may occur cases, in which a trilling tone may not be eliminated even with a practically highest possible mechanical balance of the machine, for instance when generating extra high frequencies, i. e., employing extremely high multiplication ratios, or there may be cases where the costs of the plant play an essential part. In all such cases the elimination or damping out of torsional oscillations around the axis giving rise to the trilling note may be obtained to a less or greater extent by additional means, as will be described hereinafter. It will be understood that the vibrations of the casing are not wholly or at all times caused by the vibrations of the rotor axis transferred to the casing across the bearings, though this is by most the normal case, but any periodic percussions reaching the machine structure from outside, for instance, from a neighbouring machine, across a common foundation plate, may give rise to disturbances of the sort in question.

In order to suppress the oscillating percussions of the casing of the alternating current generator G giving rise to the trilling note, I may, as shown in Fig. 2, connect with it a mechanical member or members coupled to it in such a way as to introduce a large damping and which are preferably tuned to the frequency of the percussions. In Fig. 2, for example, a damping mass Q is schematically represented, the same consisting of a receptacle containing mercury and mechanically connected with the casing M of the machine. The use of mercury as damping material presents the advantage in that mechanical vibrations of small amplitude and large power may be damped by it in a most efficient way. This mass of mercury may vary according to conditions but should be about 10% of the vibrating mass of the high frequency machine, in order to dampen the machine sufficiently to exclude trilling notes. In the calculation of the swinging mass obviously only the upper portion of the machine, that is the housing which surrounds the rotor, need be taken into consideration, since the bed plate, which may be integral with the upper portion, is prevented from vibrating by its attachment to the usual foundation. This case is similar to Frahm's anti-rolling tanks for the prevention of the rolling motion of ships.

According to a further object of my invention I connect with the casing in question a periodically moving, for instance, rotating member adapted by virtue of the distribution of its masses and the periodicity of its movement, to act against the percussions of the casing by compensation. For instance I may employ a balancing mass eccentrically rotating and driven synchronously with the rotor of the high-frequency machine by means of a suitable arrangement. Figure 3 represents schematically the embodiment of this feature of my invention, showing an eccentrically rotating mass R mechanically connected to the casing of the machine. Thus while in Figure 2 an artificial decrease of amplitude is effected by damping means, in Figure 3 the oscillations of the casing are suppressed by compensation.

The vibrations in question giving rise to the trilling note may be furthermore sup-

pressed or minimized by suitably stiffening the machine. For instance the machine frame or casing M′ may be connected to its foundation plate by special stiffening rods S, as shown in Fig. 4, or the base portion or portion M′ of the machine frame or casing below its horizontal center may be elongated to a certain degree with reference to its top portion or portion above its horizontal center to increase the mass of the casing to the desired degree.

In the illustration of the transmitting and receiving system shown in Fig. 5 the alternator G is shown as used to supply current to a frequency multiplier radiating energy to a heterodyne or regenerative receiver. The signal frequency transmitted from the frequency multiplier and received by the receiver is imposed upon a carrier wave on which is also ordinarily impressed those frequency variations caused by mechanical vibration percussions produced by the action of the alternator and which in turn produce the beat note trills in the receiver. By modifying the alternator as set forth such vibrations have been wholly or for all practical purposes eliminated, with the result that the frequencies causing beat note trills in the receiver are eliminated or suppressed.

What I claim to be secured by Letters Patent of the United States is:

1. The method of transmitting messages between a wireless transmission apparatus supplied with current by a high frequency alternator and a heterodyne or regenerative receiver so as to prevent trilling of the beat note in the receiver, which consists in transmitting and receiving the messages while during transmission suppressing the mechanical torsional vibrations of the stator relative to the rotor of the alternator which give rise to frequency variations producing such beat note trills.

2. The method of transmitting messages between a wireless transmission apparatus supplied with current by a high frequency alternator and a heterodyne or regenerative receiver so as to prevent trilling of the beat note in the receiver, which consists in transmitting and receiving the messages while during transmission opposing a resistance to the mechanical torsional vibrations of the stator relative to the rotor of said alternator so as to suppress those vibrations which give rise to frequency variations producing such beat note trills.

3. The method of transmitting messages between a wireless transmitting apparatus supplied with current by a high frequency alternator and a heterodyne or regenerative receiver so as to prevent trilling of the beat notes in the receiver, which consists in transmitting and receiving the messages while suppressing those vibrations resulting from the action of the alternator which give rise to frequency variations in the carrier wave producing such beat note trills.

4. The method of transmitting messages between a wireless transmitting apparatus supplied with current by a high frequency alternator and a heterodyne or regenerative receiver so as to prevent trilling of the beat notes in the receiver, which consists in transmitting and receiving the messages while suppressing those frequency variations mechanically produced and imposed by the action of the alternator upon the carrier wave and which cause in the receiver such beat note trills.

In testimony whereof I have affixed my signature.

WALTER HAHNEMANN.