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J. C. FERGUSON ET AL  
FREQUENCY MODULATION MONITOR

2,304,635

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FIG. 1

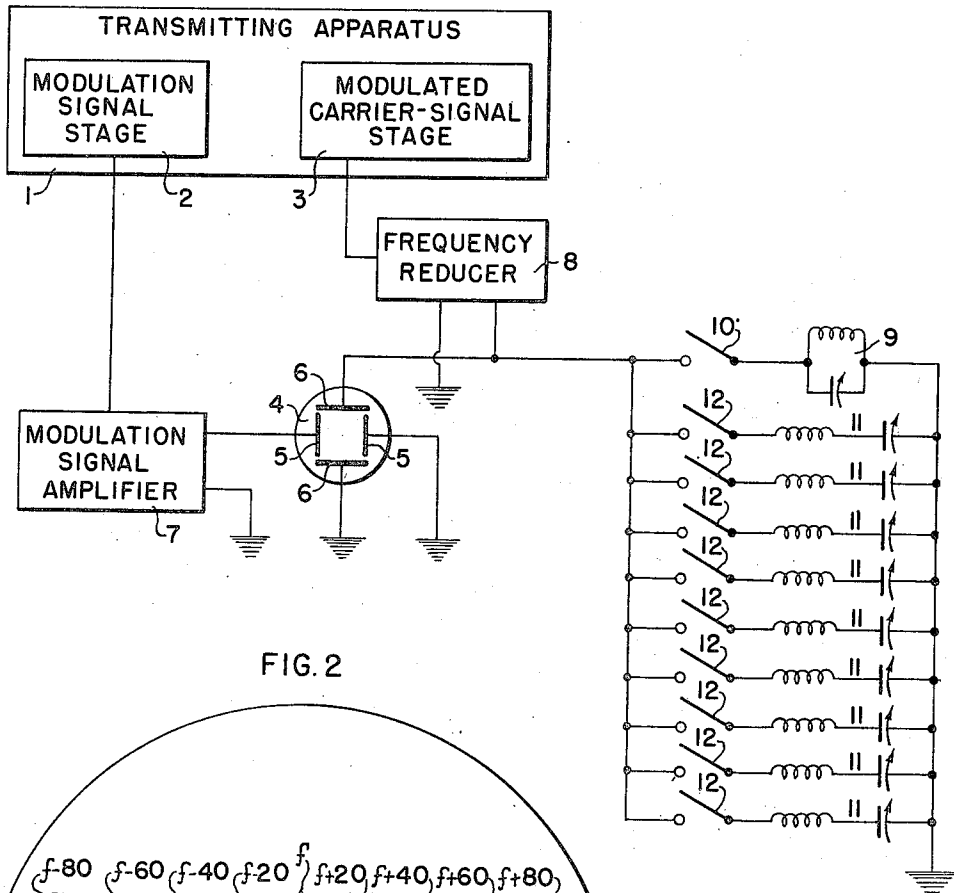
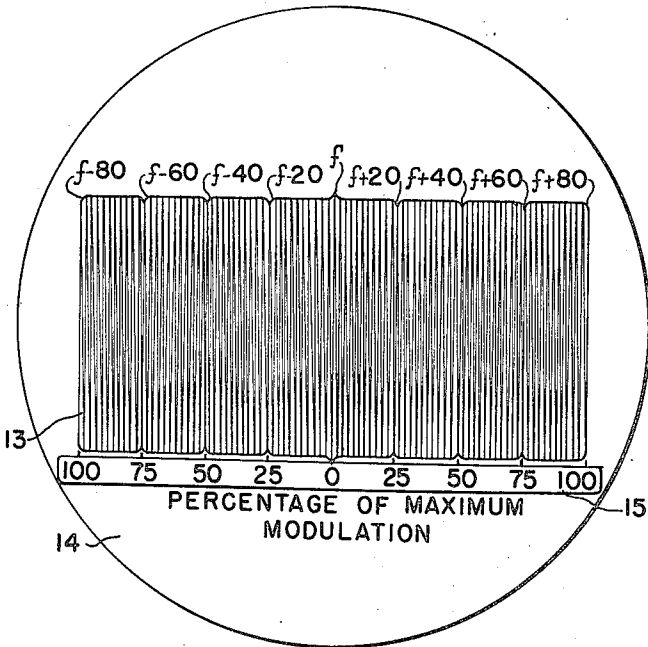


FIG. 2



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## FREQUENCY MODULATION MONITOR

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7 Claims. (Cl. 179—171.5)

This invention relates to frequency-modulated wave systems, and more particularly to means for indicating the frequency deviation due to modulation in such systems.

In frequency-modulated wave systems, the amplitude of the carrier wave is not changed, but its frequency is varied in accordance with the modulation signal. The degree of frequency variation corresponds to the amplitude of the modulation signal and may represent the loudness of a sound, while the rate at which the carrier-signal frequency is varied corresponds to the frequency of the modulation signal and may represent the pitch or tone of a sound. In the transmitter of such a system, it is desirable to have monitoring means capable of indicating the frequency deviation of the carrier signal.

It is an object of the present invention, therefore, to provide a modulation indicator which is capable of providing a visual indication of the frequency deviation of a frequency-modulated carrier signal.

It is a further object of the invention to provide a modulation indicator which is capable of providing a visual indication of whether or not the frequency deviation of the carrier signal is directly proportional to the amplitude of the modulating signal.

In accordance with the present invention, there is provided a source of a modulation signal, a source of a carrier signal having its frequency modulated in accordance with the modulation signal, and means for modifying the amplitude of the carrier signal at least at one of its modulation frequencies. A visual indicator is provided, which comprises a cathode-ray tube having a luminescent screen adapted to be scanned by a beam of electrons, means for deflecting the electron beam in one direction in accordance with the modified frequency-modulated carrier signal, and means for deflecting the electron beam in another direction in accordance with the modulation signal. As a result, a pattern is produced on the luminescent screen of the cathode-ray tube which is indicative of the frequency excursions of the frequency-modulated carrier signal. In the preferred form of the invention, there is also provided an indicating means positioned adjacent the pattern on the luminescent screen and calibrated to indicate the carrier-frequency excursions as a function of the amplitude of the modulation signal.

For a better understanding of the invention, together with other and further objects thereof, reference is made to the following description

taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing:

Fig. 1 is a circuit diagram of a modulation indicator in accordance with the present invention; and

Fig. 2 is a front view of the cathode-ray tube of Fig. 1 showing a pattern such as may be produced thereon during operation.

Referring now more particularly to Fig. 1, there is shown a transmitting apparatus 1 including a modulation-signal stage or source 2 and a modulated-carrier signal stage or source 3 providing a carrier signal which is modulated by the same signal as provided by source 2. A cathode-ray tube 4 having horizontal deflecting plates 5 and vertical deflecting plates 6 is provided for the system. The modulation-signal stage 2 is connected to the deflecting plates 5 by way of an amplifier 7, as shown, and the modulated-carrier signal stage 3 is connected to the vertical deflecting plates 6 by way of a frequency reducer 8 which may comprise any suitable device for reducing the frequency of the carrier signal without otherwise affecting its frequency variation, such, for example, as a heterodyne oscillator.

A parallel resonant circuit 9, in series with a switch 10, is connected between the vertical deflecting plates 6 of the cathode-ray tube 4, as shown. Likewise, a plurality of series-resonant circuits 11, each connected in series with a switch 12, is connected between the deflecting plates 6, as shown.

The operation of the device of Fig. 1 may be understood more readily by reference to the pattern 13 on the fluorescent screen 14 shown in Fig. 2. Since the modulating signal is applied to the horizontal deflecting plates 5 of the cathode-ray tube 4, the electron beam has a horizontal deflection which varies directly in accordance with the amplitude of the modulating signal. The vertical deflection of the electron beam, when the switches 10 and 12 are open, is constant since it depends only on the fixed amplitude of the modulated-carrier signal. With the parallel resonant circuit 9 tuned to the reduced unmodified carrier frequency or the center frequency of the frequency deviation range of the output of the frequency reducer 8, and the switch 10 closed, the vertical deflection of the electron beam is accentuated at the point indicated by  $f$  in Fig. 2, corresponding to the undeviated carrier frequency. With the series-resonant circuits 11 respectively tuned to frequencies evenly spaced

above and below the resonant frequency of the circuit 9, and the switches 12 closed, the vertical deflection of the electron beam is attenuated at corresponding points indicated in Fig. 2 by  $f-80$ ,  $f-60$ ,  $f-40$ ,  $f-20$ ,  $f+20$ ,  $f+40$ ,  $f+60$  and  $f+80$ , corresponding to the attenuation of the respective frequency.

The luminescent screen 14 preferably has a medium persistence characteristic, so that the horizontal width of the pattern 13 produced by the electron beam provides a visual indication of the degree of modulation being obtained, averaged over a period of time corresponding to the persistence of the screen 14. The center frequency  $f$  is indicated by the upward extension of the pattern 13, effected by the circuit 9, and the frequency deviation in terms of kilocycles can readily be determined by reference to the notches effected by the marker circuits 11.

In the preferred embodiment of the invention, the screen 14 is provided with a scale 15 showing the percentage of the maximum modulation or frequency deviation for which the system is adapted. The gain of the modulation-signal amplifier 7, in this case, is adjusted initially so that the horizontal deflection of the electron beam for the maximum modulation corresponds with the 100% point of the scale 15. After this adjustment has been made, it is possible to observe the linearity of modulation as well as the maximum frequency deviation. This is done by noting whether a horizontal deflection of the electron beam resulting from a given deviation in kilocycles provides the corresponding percentage modulation. For example, if the system is such that 100% or maximum modulation is produced by an 80-kilocycle deviation of the frequency, a 40-kilocycle deviation will produce exactly 50% modulation provided the modulation is linear.

It will be understood that the vertical deflection of the electron beam may be attenuated at the mid-point and accentuated at the other marker points, if desired, without departing from the scope of the invention. It will also be understood that the marker circuits 9 and 11 need not have the form shown, but may comprise any suitable networks having, respectively, appropriate accentuation and attenuation properties. Furthermore, it readily will be appreciated that a visual or recording modulation limit indicator may be associated with any one of the circuits 11 for the purpose of warning the operator whenever the modulation momentarily exceeds a predetermined limit.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A modulation indicator comprising a source of a modulating signal, a source of a carrier signal having its frequency modulated in accordance with said modulation signal, means for modifying the amplitude of said carrier signal at one of its frequencies by accentuation, means for modifying the amplitude of said carrier signal at another of its frequencies by attenuation, a cathode-ray tube having a luminescent screen adapted to be scanned by a beam of electrons, means for deflecting said beam in one direction in accordance with said modified frequency-modulated carrier signal, and means for deflecting said beam in another direction in accordance with said modulation signal to produce a pattern on said screen indicative of the frequency excursions of said frequency-modulated carrier signal.
2. A modulation indicator comprising a source of a modulating signal, a source of a carrier signal having its frequency modulated in accordance with said modulation signal, means comprising series-resonant and parallel-resonant circuits for modifying the amplitude of said carrier signal at certain of its frequencies, a cathode-ray tube having a luminescent screen adapted to be scanned by a beam of electrons, means for deflecting said beam in one direction in accordance with said modified frequency-modulated carrier signal, and means for deflecting said beam in another direction in accordance with said modulation signal to produce a pattern on said screen indicative of the frequency excursions of said frequency-modulated carrier signal.
3. A modulation indicator comprising a source of a modulating signal, a source of a carrier signal having its frequency modulated in accordance with said modulation signal, means comprising a parallel-resonant circuit for accentuating said carrier signal at one of its frequencies, means comprising series-resonant circuits for attenuating said carrier signal at other of its frequencies, a cathode-ray tube having a luminescent screen adapted to be scanned by a beam of electrons, means for deflecting said beam in one direction in accordance with said modified frequency-modulated carrier signal, and means for deflecting said beam in another direction in accordance with said modulation signal to produce a pattern on said screen indicative of the frequency excursions of said frequency-modulated carrier signal.
4. A modulation indicator comprising a source of a modulating signal, a source of a carrier signal having its frequency modulated in accordance with said modulation signal, a cathode ray tube having a luminescent screen adapted to be scanned by a beam of electrons, a frequency selective load impedance coupled to the output of said source of frequency modulated carrier signal, the value of said impedance for a predetermined frequency within the range of excursions of said frequency modulated signal being widely different from its value at other frequencies within said range, means for deflecting said beam in one direction coupled to said impedance, and means for deflecting said beam in another direction in accordance with said modulation signal to produce a pattern on said screen indicative of the frequency excursions of said frequency modulated carrier signal.
5. A modulation indicator comprising a source of a modulating signal, a source of a carrier signal having its frequency modulated in accordance with said modulation signal, a cathode ray tube having a luminescent screen adapted to be scanned by a beam of electrons, a load impedance comprising a resonant circuit coupled to the output of said source of frequency modulated carrier signal, the value of said impedance for a predetermined frequency within the range of excursions of said frequency modulated signal being widely different from its value at other frequencies within said range, means for deflecting said beam in accordance with the energy supplied to said resonant circuit, and means for deflecting

said beam in another direction in accordance with said modulation signal to produce a pattern on said screen indicative of the frequency excursions of said frequency modulated carrier signal.

6. A modulation indicator comprising a source of a modulating signal, a source of a carrier signal having its frequency modulated in accordance with said modulation signal, a cathode ray tube having a luminescent screen adapted to be scanned by a beam of electrons, a load impedance comprising a parallel resonant circuit coupled to the output of said source of frequency modulated carrier signal, the value of said impedance for a predetermined frequency within the range of excursions of said frequency modulated signal being widely different from its value at other frequencies within said range, means for deflecting said beam in accordance with the energy supplied to said parallel resonant circuit, and means for deflecting said beam in another direction in accordance with said modulation signal to produce a pattern on said screen indicative of the frequency excursions of said frequency modulated carrier signal.

7. A modulation indicator comprising a source of a modulating signal, a source of a carrier signal having its frequency modulated in accordance with said modulation signal, a cathode ray tube having a luminescent screen adapted to be scanned by a beam of electrons, a load impedance comprising a series resonant circuit coupled to the the output of said source of frequency modulated carrier signal, the value of said impedance for a predetermined frequency within the range of excursions of said frequency modulated signal being widely different from its value at other frequencies within said range, means for deflecting said beam in accordance with the energy supplied to said series resonant circuit, and means for deflecting said beam in another direction in accordance with said modulation signal to produce a pattern on said screen indicative of the frequency excursions of said frequency modulated carrier signal.

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