

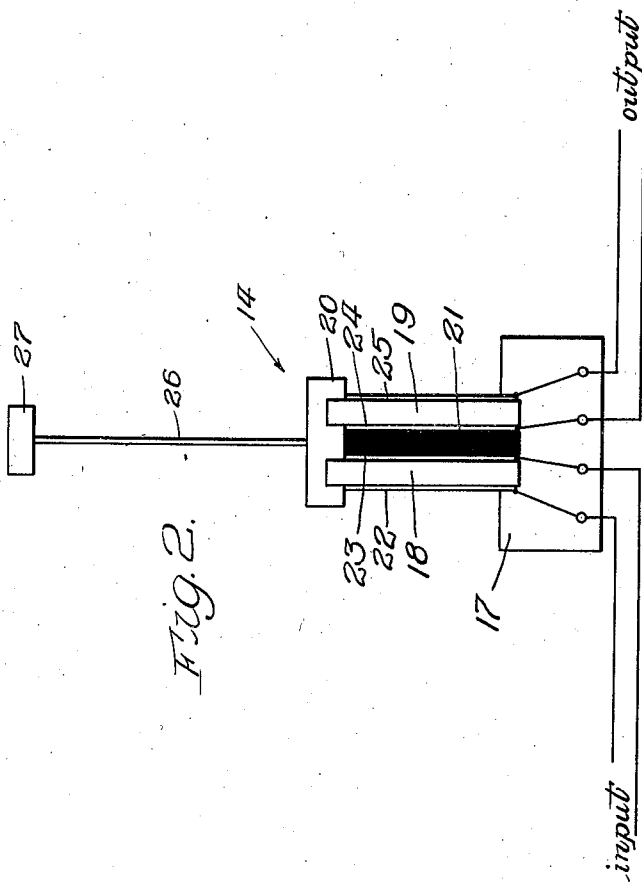
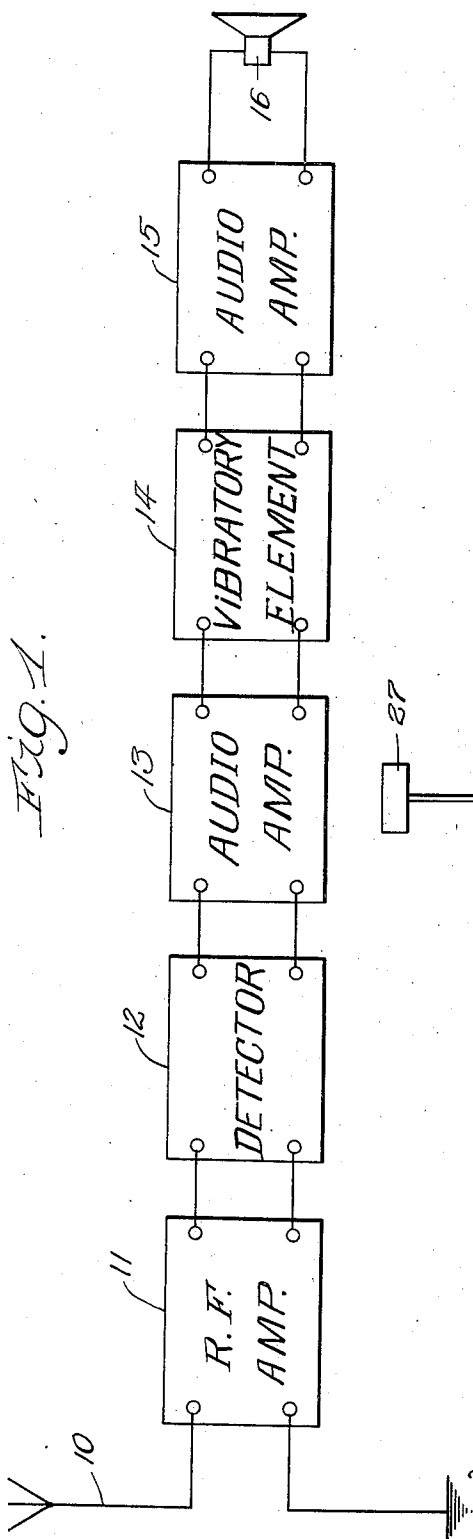
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VIBRATORY ELEMENT

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VIBRATORY ELEMENT

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4 Claims. (Cl. 178—44)

This invention relates to a vibratory element, and more particularly to means for causing said element to vibrate substantially at a desired frequency.

5 One feature of this invention is that it provides means for causing a crystal or other vibratory element to vibrate substantially only at a desired frequency; another feature of this invention is that it results in a very sharply peaked frequency-response characteristic curve of a vibra-
10 tory element designed to vibrate at a frequency within the audio range; still another feature of this invention is that it is particularly adapted for use in separating undesirable impulses from an
15 alternating current comprising principally a wave of a fixed audio frequency; other features and advantages of my invention will be apparent from the following specification and the drawing, in which:

20 Figure 1 is a block diagram of a system of the type in which this vibratory element is particularly useful; and Figure 2 is an elevation of an element embodying my invention.

25 In radio transmission and reception it is frequently desirable to control the frequencies delivered to the output by means of a vibratory element such as a piezo-electric crystal. Such crystals are generally designed to operate at radio or intermediate frequencies, and to pass, with
30 little diminution, a considerable band of frequencies, generally several thousand cycles wide. In a rather specialized type of radio transmission and reception, where a carrier is modulated only with an audio note of a fixed and predetermined
35 frequency, it has been found desirable and highly advantageous to filter the signal in the audio portion in such a manner as to pass substantially only the desired audio signal. This has been
40 found advantageous in radio direction finding work and radio telegraphy, for example.

45 The crystal used as a vibratory element in this specialized type of work must not only resonate at some frequency in the audio range, but must be so damped or loaded as to give a very
50 sharp frequency-response curve, preferably of such a character that the energy transmitted is from five to ten times down at five cycles either side of the desired peak. Moreover, the crystal
55 or crystals used must be so arranged that energy transmitted to the output of the receiver comprises substantially only the desired signal wave, without any coupling being present permitting transmission of undesired impulses in other ways than through the crystal.

Referring to Figure 1, a system of the kind found particularly useful in connection with reception of radio direction finding signals, for example, is illustrated. Here an antenna system
5 19 supplies energy to a radio frequency amplifier unit 11, which may be tuned in conventional manner; assuming that the receiver is not a superheterodyne, the output of the unit 11 would be rectified by a detector unit 12, and the audio
10 frequency signals would then be amplified by the first audio amplifier 13. The output of this audio amplifier would be delivered to a vibratory element indicated in general as 14, which element
15 is so arranged as to suppress or filter out substantially all undesired impulses, and its output is then used to actuate a further audio amplifier
16 which drives the speaker or other translating device 16. The vibratory element is preferably
20 both preceded and followed by audio amplifiers, since it is desirable to have a considerable amount of energy available to drive a heavily damped crystal, and yet not the full quantity that might be desired to actuate the speaker 16.

One form of vibratory element which has been found to satisfy the requirements of usage in
25 such a system is illustrated in Figure 2. A base 17 of insulating material has clamped or otherwise mounted therein two piezo-electric crystals 18 and 19, these crystals preferably being of Rochelle salt because of the ability of such salt
30 crystals to give a greater amplitude of vibration at audio frequencies when energized by an electric current. The two crystals are mechanically
35 connected or locked together by a block 20 of insulating material, which also may be clamped to each crystal. The crystals are electrically separated by a layer of insulating material 21 between them, and each face of each
40 crystal has a layer of metal foil in contact therewith, these layers being here indicated as 22, 23, 24 and 25.

Any appropriate means for connecting the various layers of metal foil to the audio amplifiers may be provided, as binding posts. In the
45 embodiment here illustrated the layers 22 and 23 of foil are adapted to furnish the energy input to the vibratory element, and particularly to the crystal 18 thereof, being connected to the audio amplifier 13. Since the two crystals are
50 mechanically locked together, vibration of crystal 18 as a result of current applied to the faces thereof will also result in vibration of crystal 19, and distortion of this crystal as a result of such
55 vibration will set up in the foil layers 24 and 25 currents which may be connected to the audio

amplifier 15 to be further amplified and translated into sound waves by the speaker 16. Inasmuch as the two crystals are electrically separate, induction and capacity effects between the two faces of the crystal 18, for example, may be disregarded; and the only frequency existing in the output from the vibratory element is the frequency of mechanical vibration. In practice this is not absolutely the only current present in the output, since static impulses having a very steep wave front, as a result of shock excitation, sometimes get through to the speaker; the percentage of noise reaching the speaker in a system of this kind, however, is relatively insignificant with respect to a similar receiver not using such a vibratory element, the signal to noise level ratio being generally improved from ten to twenty times.

Although a piezo-electric crystal has one natural frequency to which it responds better than others, it will, in its natural state, pass a fairly wide band of frequencies. If the crystal is relatively heavily loaded or damped, however, as by a mechanical mass, its response to frequencies other than the desired resonant frequency is practically negligible. By providing mass loading by a mechanical element having a natural frequency of vibration the same as the resonant frequency of the crystals and the same as the desired signal frequency the preferred combination is attained, and substantially all response to other frequencies is eliminated. It will be understood, however, that all of the elements do not have to have the same natural frequency, it being sufficient if the best transfer of energy through the system is achieved at some point in the audio range.

Such mass loading is here shown as accomplished by a thin vibratile reed 26 loaded at its outer end with a heavier mass 27. The frequency of the crystals 18 and 19, of course, may be the same and be identical with that of the signal which it is desired to receive, and the natural mechanical period of vibration of the loaded reed 26 should also be this same signal frequency. As a result of this loading, impulses or wave differing from the desired signal are unable to develop any appreciable vibration in the system; whereas the desired signal wave, being at the resonant frequency of one or all of the elements, achieves good transfer of energy. This arrangement, because of the use of electrically independent but mechanically connected crystals, results in transfer of energy substantially only as a result of vibration of the entire system; and the loading is such that there is no vibratory response of the system except to the exact signal frequency desired, or to frequencies or impulses only a very few cycles on either side thereof.

While the best theoretical results are attained when both crystals and the reed have each substantially the same natural period of vibration as the signal, this is not necessary, as a practical matter, for good results. Even though the natural frequency of both crystals, for example, is considerably different from the signal frequency,

the loading imposed by the mechanical vibrating element (the reed) will, if its natural frequency is that of the signal, permit transfer of energy to it substantially only at signal frequency; and this mechanical element must vibrate, of course, in order that there may be any appreciable output from the system.

While I have described and claimed certain embodiments of my invention it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims in which it is my intention to claim all novelty inherent in my invention as broadly as permissible in view of the prior art.

I claim:

1. Apparatus of the character described for separating undesired current impulses from an alternating current wave of a fixed frequency in the audio range, including: two vibratory elements, at least one of said elements being loaded with a mass of sufficient weight to damp out substantially all vibrations except those to which it is resonant, the resonant frequency being the same as the frequency of the wave; mechanical means interconnecting said element; means whereby said current vibrates one of said elements to effect vibration of the other; and means whereby the vibration of said other element generates a current substantially free from said undesired impulses.

2. Apparatus of the character described for separating undesired current impulses from an alternating current wave of a fixed frequency in the audio range, including: two electrically separate but mechanically connected piezo-electric crystals; means loading said crystals to damp out substantially all vibrations except those with the frequency of said wave; means whereby said current is applied to one of said crystals to effect vibration of both crystals and the loading means; and means whereby vibration of the other of said crystals generates a current substantially free from said undesired impulses.

3. Apparatus of the character claimed in claim 2, wherein said loading means is a vibratory element having a frequency of natural vibration equal to that of said wave.

4. Apparatus of the character described for separating undesired current impulses from an alternating current wave of a fixed frequency in the audio range, including: two piezo-electric crystal elements, at least one of said elements being loaded to damp out substantially all vibrations except those to which it is resonant, the resonant frequency being the same as the frequency of the wave; mechanical means interconnecting said elements; means whereby said current vibrates one of said elements to effect vibration of the other; and means whereby the vibration of said other element generates a current substantially free from said undesired impulses.

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