

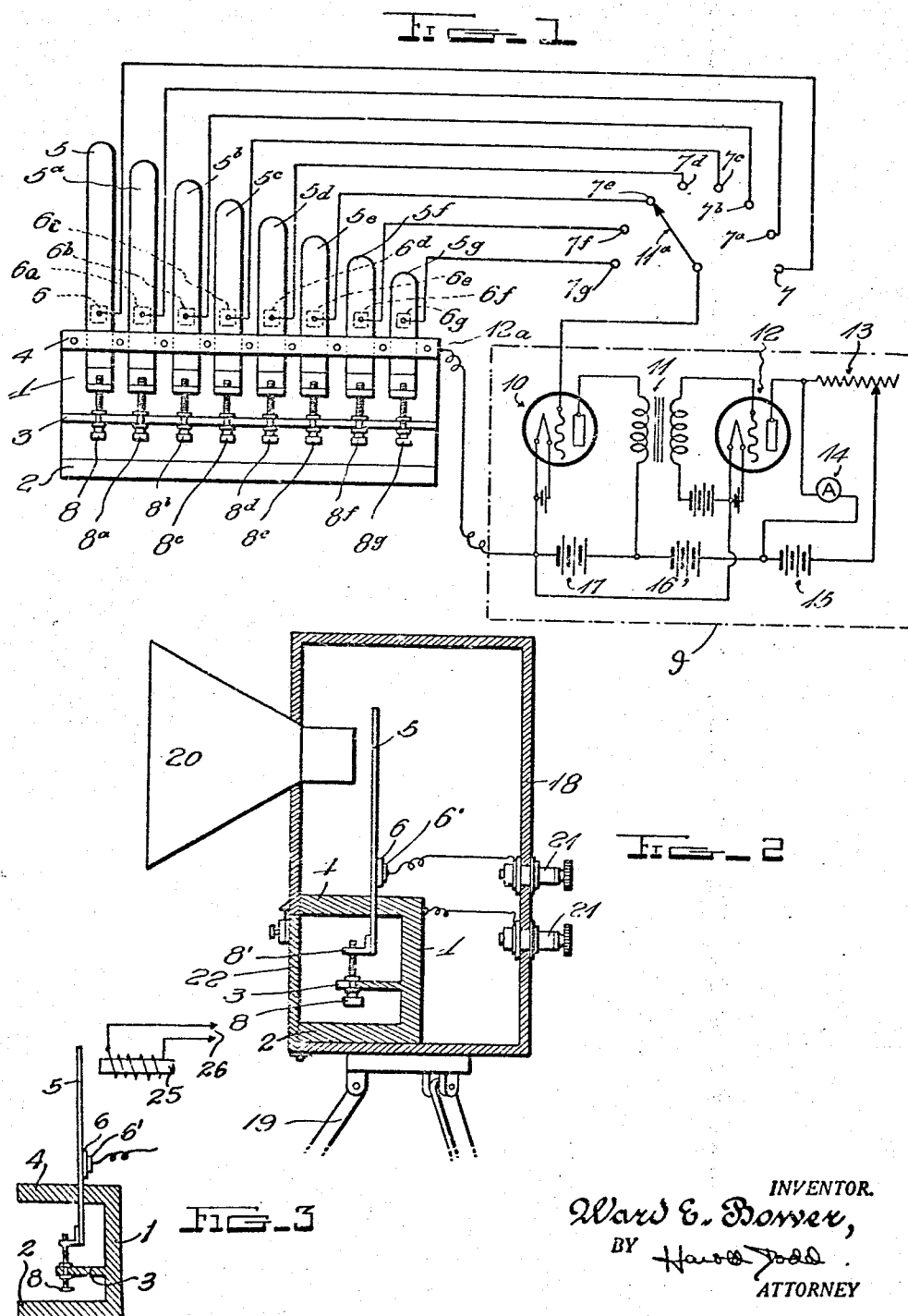
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SOUND INTENSITY MEASURING SYSTEM

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UNITED STATES PATENT OFFICE

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SOUND INTENSITY MEASURING SYSTEM

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This invention relates broadly to means and apparatus for determination of characteristics of mechanical vibrations. More particularly this invention relates to devices employed in sound analysis.

An object of this invention is to provide means whereby the frequency of mechanical vibrations may be readily and efficiently determined.

Another object of this invention is to provide an electromechanical vibrator or means having well defined frequency characteristics whereby the intensity of mechanical vibrations of a certain frequency may be detected and measured.

Still another object of this invention is to provide a periodic mechanical vibrator with means for transforming mechanical vibrations into electrical impulses.

A further object of this invention is to provide piezo electric elements upon surfaces of periodic mechanical vibrators whereby sound waves impinging upon the selected periodic mechanical vibrator are transformed into electrical impulses.

Other and further objects and features of this invention will be apparent to those skilled in the art to which this invention pertains.

According to this invention piezo electric elements are mounted upon elastic members of predetermined dimensions. A selector arrangement is connected to each of the elements for selectively connecting the elements to an amplifying system which is connected to an indicating device. In case very active piezo electric elements are employed in conjunction with a sensitive indicating device the amplifying system need not be employed. Among the uses and applications of this invention are the tuning of musical instruments, such as pianos, determination of acoustical effects in chambers, halls and churches, the determination of frequency characteristics of audio frequency amplifiers, and the determination of frequency of alternating current power transmission systems.

In the drawings Figure 1 shows a diagrammatic view of an embodiment of this invention adapted for general sound measurements; Fig. 2 is a cross-sectional view with

parts illustrated in elevation showing details of construction of the periodic mechanical vibrators; and Fig. 3 shows an arrangement of the apparatus of my invention for the determination of frequency of an alternating current power transmission system.

Referring to the drawings in detail, reference numeral 1 designates a channel member which is preferably heavily damped and free from mechanical resonating effects within the audible range of sound frequencies. Reference numerals 2 and 4 designate the walls of the channel member. A protruding member 3 is provided between the walls 2 and 4. Elastic rods 5, 5a, 5b, 5c, 5d, 5e, 5f and 5g extend through the wall member 4. These elastic rods may be of any metallic material. In certain cases, however, elastic rods of insulating material may also be used. The physical dimensions of these rods may be so chosen that their frequencies correspond to an octave of the musical scale. Thus the rods 5, 5a, 5b, 5c, 5d, 5e, 5f and 5g may be made to correspond to the notes of the musical scale designated by C, D, E, F, G, A, B and C', respectively. The piezo electric elements 6, 6a, 6b, 6c, 6d, 6e, 6f and 6g are mounted upon the vibrating reeds 5, 5a, 5b, 5c, 5d, 5e, 5f and 5g, respectively near the wall member 4. Each of these piezo electric elements may be cemented to the surface of a vibrating reed and the surface of the reed used as one of the electrodes for the piezo electric element. Cements having a metallic base, such as sodium or potassium silicate may be used to fasten the elements into position upon the reeds. When elastic reeds of insulating material are employed the surfaces of the piezo electric elements adjacent to the reeds are first coated with conducting medium such as gold leaf, finely divided platinum or various metal foils. The coatings which are adjacent to the reeds are all connected together into the input circuit of the amplifier system 9. Where vibrating reeds of conducting material are employed the reeds themselves serve as one of the electrodes for the piezo electric elements and the frame member 1 is connected to the input of the amplifier system 9 as indicated at 12a.

Coatings are provided on the outer surfaces of the piezo electric elements. Connections between the selector switch 11a contacts 7, 7a, 7b, 7c, 7d, 7e, 7f and 7g and the respective coatings of the piezo electric elements are provided. The selector switch 11 is connected to the input circuit of the amplifier system 9 and provides means whereby any one of the elements associated with the vibrating reeds may be connected into the input circuit of the amplifier. Screw members 8, 8a, 8b, 8c, 8d, 8e, 8f and 8g are mounted in the member 3 for engagement with the respective reeds. Adjustments to compensate for the variations in the effective vibrating length of each of the reeds caused by changes in temperature may be made by means of these screw members. It often may be very desirable to use the arrangement herein disclosed in tuning of musical instruments, such as a piano in which several different scales are in use, in such cases the effective vibrating lengths of the reeds may be readily adjusted by the use of the screw members so that the frequency of vibration of each of the reeds and the intervals or ratios between the frequencies of the various reeds may be changed to correspond to an octave of either the natural or the equally tempered scale. The amplifying system 9 comprises the electron discharge devices 10 and 12 coupled together by a transformer 11. Other coupling means well known in the art of amplification of electrical oscillations may be employed in place of that illustrated. Sources of anode current supply 16 and 17 are provided for the electron discharge devices 10 and 12. A source of current supply 15 is provided to furnish a balancing current for the microammeter 14 whereby the microammeter may be adjusted to its zero position when the amplifier system is functioning but no electrical oscillations are being impressed upon the input circuit.

Successive electrical impulses transmitted to the input circuit of the amplifying system may be more accurately compared when the indicating meter 14 is caused to start always at the zero point. A current limiting device 13 which may be a resistance or an impedance unit is connected into the circuit with the source 15 and the meter 14.

In Fig. 2 is shown an arrangement wherein a housing 18, supported by the tripod 19 is provided for the vibrating reed system for preventing extraneous noises from reaching the reeds. The walls of the housing are highly damped or padded to prevent sounds introduced into the confined chamber from being sustained. A sound magnifier 20 of the horn type is provided in the side of the housing for directing sound waves against the vibrating reeds indicated generally at 5 whereby deforming forces are applied to the piezo electric crystal devices represented at

6 and electrical impulses transmitted through the coating 6' and the vibrating reeds to the binding posts 21. Suitable amplifying and or or measuring apparatus is connected to the terminals 21. Resonance between the natural frequency of the piezo electric crystal devices and sound waves incident upon the several reeds is indicated by a definite deflection of meter 14. If sound energy from any source acts upon any one of the reeds and the period of the sound energy is equal to that of the reed and its associated piezo electric crystal element a definite deflection of the meter 14 will indicate resonance and its relative intensity, according to some previous calibration.

If it is desired to employ the reed arrangement herein disclosed in frequency determinations or measurements in connection with power transmission systems small solenoids 25 which are connected to the power circuit 26 may be mounted adjacent to the free ends of each of the reeds as shown in Fig. 3. A periodically varying magnetic flux will then react upon the reeds and cause that reed having a natural period equal to the frequency of the current in the power circuit to vibrate.

While I have described my invention in some of its preferred embodiments, I desire that it be understood that modifications of this invention may be made and that no limitations upon the invention are intended other than are imposed by the scope of the annexed claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A sound analyzer comprising a mechanical vibration member, a constant frequency electromechanical vibrator carried by said mechanical vibration member, an electrical impulse amplifying system including an electron discharge device, an indicating device associated with the output circuit of said amplifying system, and connections between said constant frequency electromechanical vibrator and said amplifying system for actuating said indicating device according to the operation of said electromechanical vibrator due to sound waves incident upon said mechanical vibration member.

2. In a device of the class described, the combination of a mechanical vibration member, a constant frequency electromechanical vibrator carried by said mechanical vibration member, an electrical impulse amplifying system including an electron discharge device, connections between said constant frequency electromechanical vibrator and said amplifying system, an indicating device connected with the output circuit of said amplifying system and means connected with said indicating device for causing the indicating member of said device to be main-

tained at zero when no mechanical vibrations imping upon said mechanical vibration member, said indicating device operating to measure the energy generated by said electro-mechanical vibrator when sound waves of a frequency to which said electromechanical vibrator and said vibration member are resonant imping upon said vibration member.

3. In a device of the class described the combination of a mechanical vibration member, an electromechanical vibrator carried by said mechanical vibration member, an indicating instrument for indicating the intensity of vibrations impinging upon said mechanical vibration member through the action of said electromechanical vibrator and means for directing sound vibrations against said mechanical vibration member for selectively actuating said member and imparting stresses to said electromechanical vibrator for the generation of current for controlling said indicating instrument.

4. In a device for measuring the intensity of mechanical vibrations the combination of means responsive to mechanical vibrations of a predetermined period, an electromechanical vibrator carried by said means, means for directing sound waves against said first mentioned means, and an indicating device connected to said electromechanical vibrator for indicating the intensity of vibration of said first named means when the impressed mechanical vibrations correspond in frequency to the natural frequency of said electromechanical vibrator.

5. In a device for measuring the intensity of mechanical vibrations the combination of a plurality of mechanical vibration members of different frequency characteristics, electromechanical vibrators individual to each of said members, an amplifier connectible with each of said electromechanical vibrators, and indicating means connected with the output circuit of said amplifier and operative under control of the electromechanical vibrator resonant to a particular impressed frequency.

6. In a device for measuring the intensity of mechanical vibrations the combination of a plurality of mechanical vibration members, of different frequency characteristics, electromechanical vibrators individual to each of said members and corresponding to the frequency thereof, an amplifier system having an input and an output circuit, circuit selecting means connected to the input circuit of said amplifier system, each of said electromechanical vibrators being individually connected to said circuit selecting means whereby a selected one of said electromechanical vibrators may be connected to said amplifier system and indicating means associated with the output circuit of said amplifier system and operative under control of the elec-

tro-mechanical vibrator which is resonant to the particular impressed frequency.

7. In a system for measuring the intensity of sound the combination of a plurality of vibrating reeds of different frequency characteristics, means for supporting said reeds, means for adjusting the length of the vibrating portion of said reeds, piezo electric elements of a frequency corresponding to the frequency of said reeds mounted upon each of said vibrating reeds, an amplifying system, connections between said piezo electric elements and said amplifying system, and indicating means connected with the output circuit of said amplifying system for indicating the relative intensities of the sound waves impinging upon said vibrating reeds under control of the piezo electric elements resonant to the frequency of the impressed sound waves.

8. In a system for measuring the intensity of sound the combination of a plurality of vibrating reeds of different frequency characteristics, means for supporting said reeds, means for adjusting the length of the vibrating portion of said reeds, a piezo electric element having a frequency corresponding to the frequency of said reeds individual to each of said vibrating reeds, an amplifying system, means for selectively connecting each of said piezo electric elements to said amplifying system, an indicating device connected with said amplifying system for indicating the intensity of the sound waves impinging upon said reeds, and means connected with said indicating device for maintaining said device at its zero point except when sound waves impinge upon said reeds for the selective operation of a particular reed and the piezo electric element associated therewith.

9. In an apparatus for measuring the intensity of sound waves the combination of a plurality of elastic reeds each resonant to a selected frequency, means for supporting said reeds, members associated with said supporting means and with said reeds for moving said reeds with respect to said supporting means whereby the natural period of vibration of said reeds may be varied, piezo electric elements mounted upon each of said reeds, said elements having a natural frequency corresponding to each of said reeds and means for detecting oscillations generated by any one of said piezo electric elements under control of sound waves incident upon said reeds.

10. In an apparatus for measuring the intensity of sound waves the combination of a plurality of elastic reeds of different frequency characteristics, means for supporting said reeds, members associated with said supporting means and with said reeds for moving said reeds with respect to said supporting means whereby the natural period of vibration of said reeds may be varied, piezo

electric elements having frequencies corresponding to the frequencies of said reeds and mounted upon each of said reeds, an indicating meter for measuring the energy generated by the individual piezo electric elements, a cabinet for housing said reeds for excluding extraneous sounds from said reeds, and means for directing sound waves against said reeds for selectively actuating a reed corresponding in frequency to the frequency of the impressed sound waves and controlling said meter by the oscillations generated by the corresponding piezo electric element.

11. In a system for measuring the intensity of sound waves the combination of a plurality of elastic reeds each having different frequency characteristics, means for supporting said reeds, means for moving said reeds with respect to said supporting means whereby the natural period of said reeds may be varied, piezo electric elements corresponding in frequency to the frequency of said reeds carried by each of said elastic reeds, a housing for said reeds for excluding extraneous sounds from said reeds, means mounted upon said housing for directing sound waves against said reeds, an amplifier system, connections between said amplifier system and selected ones of said piezo electric elements, and indicating means connected with said amplifying system and actuated by the energy generated by the selected piezo electric element for determining the intensity of the sound waves impinging upon said elastic reeds.

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