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Sinker et al.

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[54] ELECTRIC POWER SOURCE

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Related U.S. Application Data

[63] Continuation of Ser. No. 725,726, May 1, 1968, abandoned.

[52] **U.S. Cl.**.....**310/8.3**, 310/8.2, 310/8.5, 310/8.7, 310/9.1, 73/194 B, 73/194 E, 181/.5 AG, 137/81.5, 322/2

[51] **Int. Cl.**.....**H04r 17/00**

[58] **Field of Search**.....310/8, 8.2, 8.3, 8.5, 8.6, 310/8.7, 9.1, 9.4; 73/194 R, 194 B, 194 E; 322/2; 181/.5 AG; 340/116, 117, 10, 15, 17; 102/70.2 A; 137/81.5

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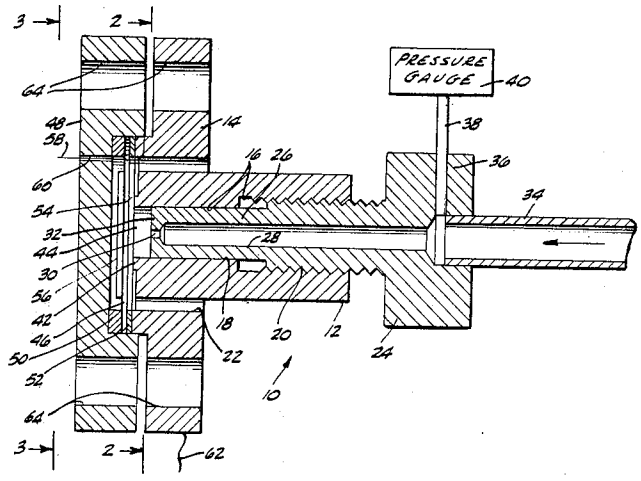
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[57] **ABSTRACT**

An electric generator operated by means of flow of fluid against a diaphragm to which a piezo-electric material is secured. The fluid flows into a cavity through an orifice and the fluid exhausts from the cavity between the diaphragm and a closely spaced annular shoulder. Pressure variations within the cavity caused by flexure of the diaphragm creates a self-sustained diaphragm vibration for generation of electricity by the piezo-electric material.

7 Claims, 3 Drawing Figures



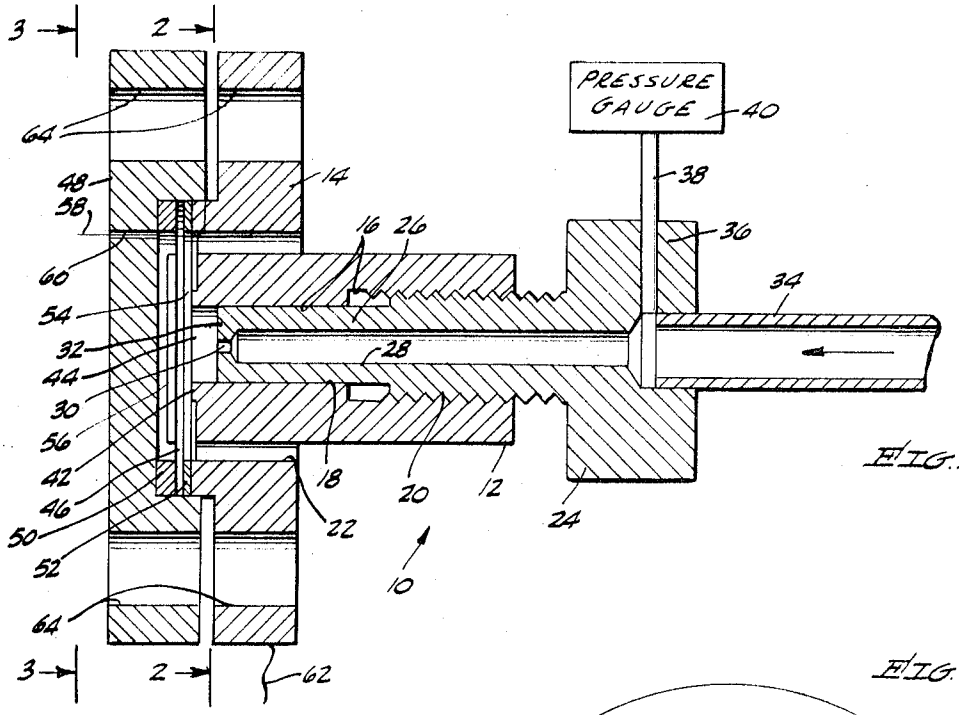


FIG. 1.

FIG. 2.

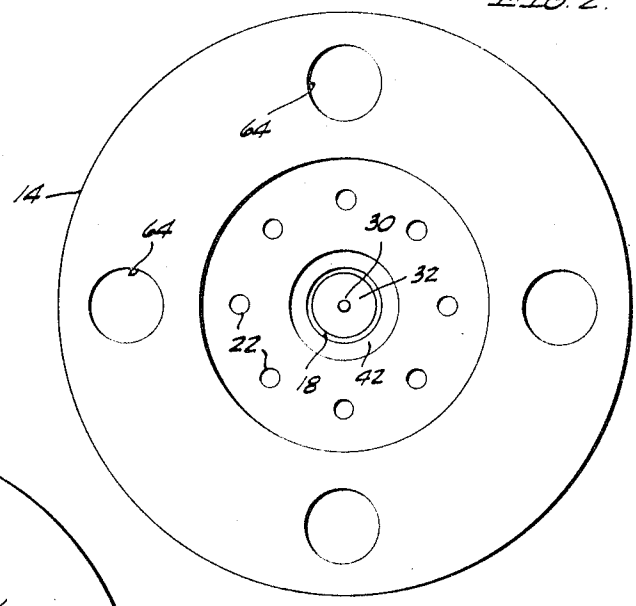
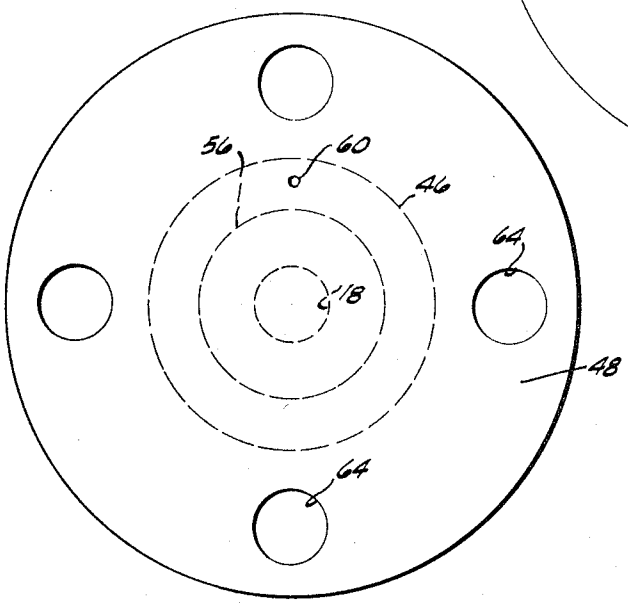


FIG. 3.



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ELECTRIC POWER SOURCE

This application is a continuation of copending application, Ser. No. 725,726, filed May 1, 1968, now abandoned, for Electric Power Source.

The present invention relates to a source for producing electrical power and, more particularly, to such a source obtained from vibrating a piezo-electric material by impacting a fluid thereon.

The flow of a gaseous fluid, such as air, may be used in various ways to produce a vibration in a cavity or in a mechanical structure. In whistles and in certain musical instruments, such as the flute, the flow of air over a sharp edge produces a turbulent condition which is reinforced by a resonant cavity to create an oscillation in the air column and a musical tone. In other devices a reed is used, mounted within an opening in such a manner that motion of the reed modulates the flow through the opening. The pressure variations set up by this valving action of the reed causes a sustained vibration of the reed and the modulated flow produces a musical tone. In certain reed instruments, such as the harmonica and the accordion, the tone produced depends upon the physical characteristics of the reed itself. Each reed produces only one tone and a multiplicity of reeds is required for a range of tones. In other reed instruments, such as the clarinet, a single reed is used together with a resonant cavity. An interaction between the reed and the oscillation in the air column of the cavity causes the motion of the reed to be governed by the length of the cavity, controlled by covering and uncovering openings. In this way a range of tines may be produced by a single reed.

In another example, a jet of air directed axially against the end of a reed will produce an oscillation of the reed at its natural frequency due to a turbulence in the air flow.

The present invention utilizes still another principle to produce a mechanical vibration of a flexible member to which a piezo-electric material is secured. When the piezo-electric material vibrates with the flexible member, electrical energy is produced. This principle utilizes the flow of a fluid against the flexible member to produce the vibration and is described in detail hereinafter.

It is, therefore, an object of the present invention to provide a source of electrical power.

Another object is the provision of such an electrical power source by the combination of a piezo-electric material and a motion produced by gaseous fluid flow.

Another object is to provide electrical power from a piezo-electric material through flexure produced by gaseous fluid flow utilized in an improved manner to provide increased power from a given flow of fluid.

Other aims and objects, as well as a more complete understanding of the present invention will appear from the following explanation of exemplary embodiments and the accompanying drawings thereof, in which:

FIG. 1 is an elevational view in section of the present invention;

FIG. 2 is a view of the invention taken along lines 2—2 of FIG. 1; and

FIG. 3 is a cross-section of the present invention taken along lines 3—3 of FIG. 1.

Accordingly, a source **10** of electrical power comprises a body **12** having a flange **14**. Body **12** is provided with a through bore **16** having a step in diameter to produce a small diameter bore **18** of smooth interior and an internally threaded large diameter bore **20**. An attachment **24** threadedly engages bore **20** and is provided with a nose **26** which fits closely within narrow bore **18**. An inlet bore **28** extends through attachment **24** and is provided with an orifice **30** formed by end wall **32** of the attachment for control of the inlet flow to device **10**. A fluid conduit **34** threadedly engages the other end **36** of the attachment for supply of a fluid from a source. A pressure gage tap **38** extends from bore **28** to a pressure gage **40** to detect the pressure of the fluid entering source **10**.

Exhaust from the source is effected by a plurality of exhaust ports **22** extending through flange **14** and spaced around the outer circumference of body **12**.

An annular shoulder **42** is provided at the outlet end of bore **18** and defines with end wall **32** of nose **26** a chamber or recess **44**. The recess is partially closed off by a flexible diaphragm **46** which is affixed in position at its outer edges between flange **14** and an end plate **48**. Annular shims **50** and **52** are placed on both sides of the edges of the diaphragm to insure free support of diaphragm **46**. Shims **52**, between diaphragm **46** and flange **14**, provide a proper spacing for a gap **54** between the diaphragm and annular shoulder **42**. In order to provide the proper flexibility of the diaphragm, the diaphragm is formed of a suitable material such as a beryllium-copper alloy.

A piezo-electric disc **56** is cemented and grounded to diaphragm **46** in electrical contact therewith and a lead **58**, connected to piezo-electric disc **56**, extends through a hole **60** in end plate **48** for connection to a device to be electrically driven by source **10**. A second lead **62** extends from device **10** to complete the power source.

A plurality of holes **64** are formed in flange **14** and end plate **48** for reception of bolts therethrough in order to secure the diaphragm **46** in place. It is to be understood, however, that flanges **14** and **48** may be made unitary when the dimensions of gap **54** have been predetermined and that attachment **24** and body **12** may also be made unitary when the dimensions of chamber **44** have been predetermined.

The proper operation of the invention is primarily dependent upon the cooperation among shoulder **42**, chamber **44**, orifice **30**, and gap **54** between diaphragm **46** and the annular shoulder. The width of the shoulder is important since this width influences the amount of damping in the movement of diaphragm **46** and, since a minimum of damping is desired, the width of the shoulder is adjusted accordingly. In addition, the size of cavity **44**, along with the dimensions of gap **54** and of orifice **30**, bears a direct relationship as to the maximum desired flexure of diaphragm **46**. In general, since shoulder **42** and orifice **30** are already formed, attachment **24** is moved back and forth by means of the threaded engagement with body **12** to vary the length and, hence, the volume of cavity **44**.

Assuming proper adjustment of all parts, air or other fluid is brought to one side of diaphragm **46** through orifice **30** and into cavity **44**, the fluid being supplied through conduit **34**. The fluid escapes through gap **54** between the diaphragm and annular shoulder **42**. When the above adjustments are suitably made, an instability occurs as the air passes between the shoulder and the diaphragm. At first, the air causes diaphragm **46** to move and to open gap **54** thus permitting a large volume of air to escape chamber **44**. The pressure within the chamber consequently drops and the diaphragm thereafter moves to close gap **54**, thus permitting pressure within chamber **44** to increase. The diaphragm again moves to open gap **54**. Therefore, flexure of the diaphragm changes the pressure within cavity **44** and, hence, the cavity pressure is a function of the in-flow through the orifice and the outflow through gap **54**. Vibration of the diaphragm produces a pressure fluctuation in the cavity with a phase shift depending upon the volume of the cavity. When adjustments are properly made, this phase shift is in the direction to produce self-sustained vibration of the diaphragm.

Although the invention has been described with reference to a particular embodiment thereof, it should be realized that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A source of electrical power having spaced inlet means and outlet means and comprising a flexible member, a piezo-electric element secured to said member and flexible therewith, said member and said element having a natural frequency in flexure, a source of fluid coupled to said inlet means, and pressure variation means including said member, a resonant cavity, and exit means coupled to said outlet means, said pressure variation means positioned between said outlet means and said inlet means and generating pressure variations in response to flow of the fluid to cause vibration of said member and said element at the natural frequency.

2. A source of electrical power comprising a body having an inlet and an outlet, said outlet being distinct from said inlet; a flexible diaphragm supported at the edges thereof in said body; a piezo-electric element secured to said diaphragm and flexible therewith; a source of fluid; and pressure variation means positioned between the inlet and the outlet; said pressure variation means including said diaphragm, a chamber bounded by the outlet and the inlet, an annular shoulder on said body at the outlet of said chamber and spaced closely from said diaphragm, and orifice means at the inlet of said chamber and coupled to said fluid source whereby flow of the fluid causes changes in pressure of said pressure variation means including self-sustained vibration of said diaphragm and said element.

3. A source of electrical power comprising a body provided with inlet means connected to a source of fluid and terminating in orifice means; a flexible member secured at its periphery to said body and spaced from said orifice means; a piezo-electric element secured to said member and flexible therewith; a chamber including said flexible member disposed in said body and opening to said inlet means through said orifice means; an annular shoulder formed on said body and spaced from said flexible member and from said orifice means to provide termination means having variable opening means for said chamber; and exhaust means coupled to the termination means; said member and said element vibrating in response to variations of fluid pressure in said chamber as the fluid flows through said orifice means into said chamber and past the termination means between said shoulder and said flexible member.

4. A source as in claim 3 wherein said inlet means comprises an attachment moveable in said body for adjustment of the size of said chamber.

5. A source of electrical power comprising pressure resonant cavity means, a flexible member forming a wall for said cavity means, a piezo-electric element secured to said member and flexible therewith, a source of fluid, gap means adjacent said member and terminating said cavity means for exit of the fluid, orifice means as said source of fluid and forming an opening into said cavity means, said gap means, said orifice means and said cavity means being so dimensioned as to enable the provision of variations in pressure in said cavity and concurrent self-sustained vibration of said member and said element upon the flow of said fluid from said source, through said orifice means and cavity means, and out past said gap means.

6. A source as in claim 5 wherein said gap means comprises an annular shoulder spaced closely from said member.

7. A source as in claim 6 wherein said flexible member comprises a diaphragm supported at the periphery thereof.

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