Oct. 22, 1963 R. S. SOLOFF 3,107,647

TOROIDAL ACOUSTIC REFLECTOR

Filed July 9, 1962

FIG. 1

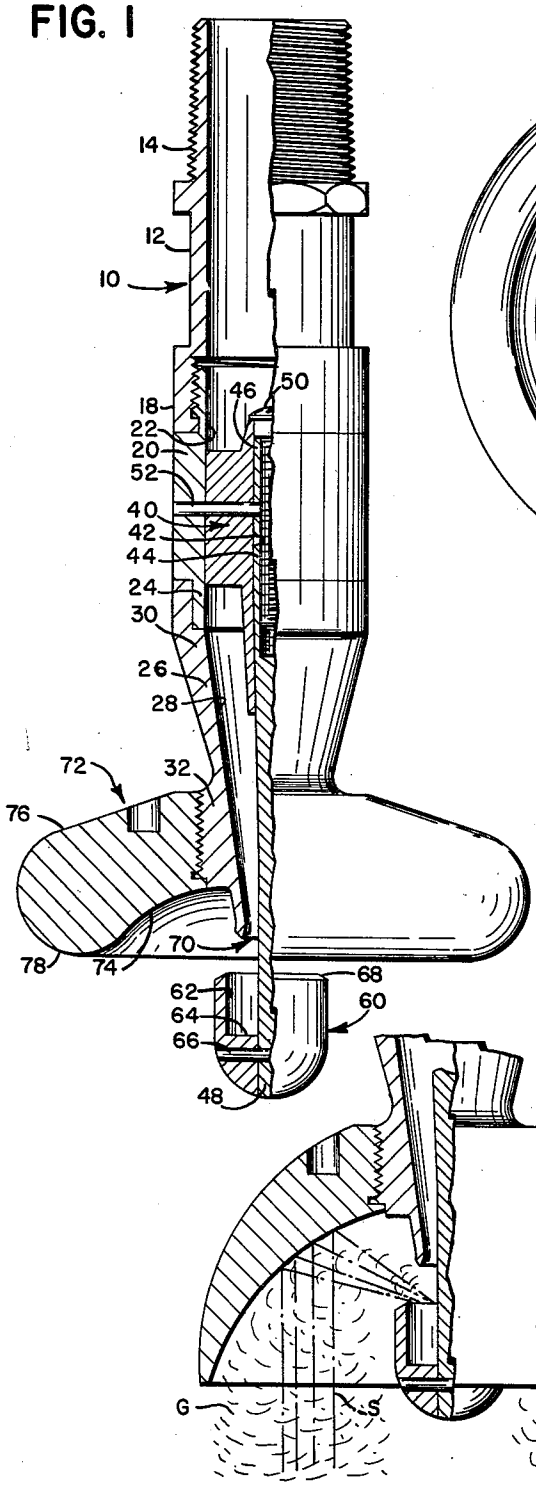



FIG. 2

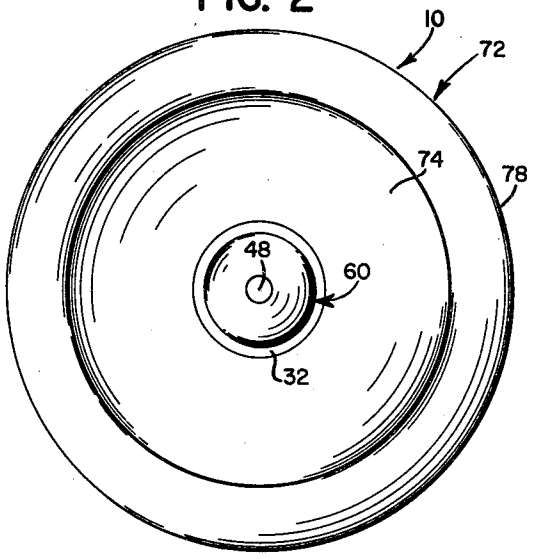
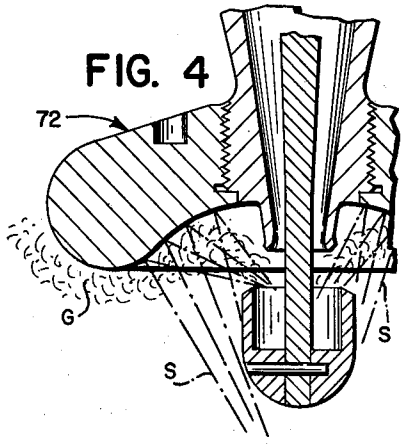



FIG. 4




PRIOR ART

FIG. 3




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# TOROIDAL ACOUSTIC REFLECTOR

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The present invention relates to an improved sonic generator provided with reflector means adapted to focus the sonic output. This results in a large axial intensity of sonic energy as well as redistribution of the gaseous driving medium exhaust, whereby the driving medium gas blast is separated from the sound propagation field.

The sonic generator is adapted to generate a high energy vibratory sound field when a tuned cavity resonator is excited into resonance under the influence of an impinging supersonic jet stream. Such a resonator will periodically load and discharge violently at the imposed resonator frequency. Thus, the high velocity jet stream is converted or transduced into a high intensity sonic output. Devices utilizing such sonic energy have proven very efficient in fields such as spray drying, defoaming, cleaning, atomization, etc., in many instances showing marked advantage over conventional devices utilizing much higher pressures and complex mechanical or electronic components.

The operating frequency may vary over a rather wide range of frequency due to the varying pressure of gas into the resonator. Thus, a typical sonic transducer device utilizing an inlet pressure varying from 35 to 50 p.s.i. will have an operating frequency of 7600 to 9400 c.p.s. It will be appreciated therefore that the configuration of the nozzle and the resonator cavity must be such that sonic waves are generated over a rather wide fluctuation of pressure to permit continuous reliable operation of the device. Reference is made to U.S. Patent No. 2,519,619, issued to Yellott and Savory, for a description of a suitable acoustic generator. For efficient utilization of the energy, it is desirable in most applications that the sonic waves be reflected and focused in a selected direction. Normally, the sonic shock wave emanates from the periphery of the resonator lip in a semi-spherical wave shape radiating outwardly with equal intensity in all directions. However, it will be appreciated that this involves loss of useful power in the direction of the nozzle. It is therefore customary to provide an accoustical reflector where it is desired to focus the maximum intensity of the sound field away from this point. It should be noted that such a reflector will in effect provide an obstruction for the jet flow discharging from the cavity, which necessarily is evacuated due to pressure of the incoming jet stream from the nozzle. This discharge stream will normally be redirected towards the nozzle, causing turbulence and pressure instability which, in turn, can lead to frequency instability, as pointed out hereinabove.

It is therefore a primary object of the present invention to provide improved reflector means for a sonic generator while simultaneously providing for improved gas distribution means, whereby increased frequency stability is maintained.

It is a further object of the present invention to provide means for increasing acoustical power in a sonic generator.

These and other objects and advantages of the present invention will be pointed out with further particularity, or will be evident from the following description and the drawings appended thereto in which:

FIG. 1 is a partially sectioned view taken in elevation of a device of the present invention.

FIG. 2 is an end view of the device of the present invention.



FIG. 3 is a fragmentary elevational view of a prior art resonator and a curved reflector, partly in section, showing schematically the interaction between the air stream and sound field.

FIG. 4 is a fragmentary, sectional elevational view of the resonator and the toroidal reflector of this invention showing the independent action between air stream and sound field.

Referring more particularly to the drawings, there is shown in FIGS. 1 and 2 a device of the present invention characterized generally by the numeral **10** comprising a conduit member **12** externally threaded at its upper end **14** for coupling with a suitable pressure source and internally threaded at its lower end **18** for coupling with body member **20**, having provided therein a longitudinal bore **22**. Rigidly attached to body **20**, at its lower end **24**, is a tapered sleeve **26** having a tapered inner diameter **28** congruent at its upper and larger end **30** with bore **22** and narrowing down to a lower and smaller end **32**.

Force fit within bore **22** of body **20** is a spider **40** having force fit within its own longitudinal bore **42** a supporting stem **44** provided with upper and lower ends **46** and **48**, respectively. Stem **44** may be moved axially by means of adjusting screw **50**, threadedly engaged in the upper end **46** of stem **44**. When a suitable axial position is attained, as indicated by a desired spray pattern, a hole is drilled into both stem **44** and screw **50**, using a predrilled hole in body **20** and spider **40** as a pilot. Locking pin **52** is used to retain body, spider, stem and screw in a fixed relative position.

A cavity resonator **60** comprising a substantially cylindrical inside wall **62** and a bottom wall **64** is secured to lower end **48** of stem **44** by means of locking pin **66**. At its top or open end, cavity resonator **60** is provided with a beveled edge **68**. Adjacent cavity resonator **60** in a particular position, the location of which was hereinbefore described, is a nozzle **70** formed by the closely spaced concentric relationship of sleeve end **32** and stem end **48**.

Toroidal reflector **72** is rigidly attached by means of internal threads to the lower end of sleeve **26** and is disposed circumferentially about nozzle **70**. Reflector **72** is provided underneath with a concave portion **74** proximate nozzle **70** and on the opposite, or upper, side a convex portion **76**. Lip portion **78** of reflector **72** is spherical in cross-section and lies in a plane substantially intermediate nozzle **70** and bevel edge **68** of resonator **60**.

The lip portion **78** of the toroidal member is rounded to afford minimal impedance to the jet stream discharging from resonator **60**. This jet stream is also normally redirected axially towards the nozzle. The configuration illustrated in FIG. 1 permits the exhaust gas discharged from the resonator to be diverted away from the region of the nozzle, since the reflector is provided with an aerodynamical contour tending to promote this effect.

The aerodynamical contour of the deflector creates a high velocity laminar discharge over the toroidal configuration which carries the exhaust gas stream away from the sound field.

In FIGS. 3 and 4, the gas discharge flow patterns for a typical elliptical reflector **73** and the toroidal reflector **72** of this invention are shown for comparison.

In FIG. 3, typical of the prior art, the interaction between the exhausted driving gas G and the sonic energy field S is obvious. On the other hand, the configuration of FIG. 4 provides clear separation of the exhaust gas G and sonic energy field S.

There is an important advantage to this configuration in that the exhaust gas is directed away from work

being processed by the sonic energy beam. Further, it has been empirically established that a noticeable increase in acoustic power is observed when this deflection of exhaust is provided. Simultaneously, the concave portion of the toroidal reflector concentrates the sonic energy axially to the area below the resonator, where in many applications it is desired that the maximum intensity of sonic energy be focused.

The position of the toroidal reflector in relation to the nozzle and resonator is critical. Thus, it has been known in the art to provide a dish-like reflector to redirect sonic energy axially. The lip portion **78** of the reflector is substantially coplanar with a point midway between the orifice of the nozzle and the rim of cavity resonator **60**. The gain in power of this configuration over a reflector having its lip portion disposed axially beyond the plane of the cavity resonator is 75% to 100%. It will thus be apparent that considerable improvement in the efficiency of the device has been achieved by the present invention.

There has been disclosed heretofore the best embodiment of the invention presently contemplated and it is to be understood that various changes and modifications may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. An improved sonic generator comprising:

a conduit member adapted to carry gas under pressure, said conduit terminating in a nozzle, whereby said gas is emitted in a supersonic jet stream;

a sonic cavity resonator axially aligned with said nozzle and disposed in spaced opposition thereto, said gas being directed at said cavity resonator whereby a sonic wave field is generated, said gas thereafter being normally redirected from said resonator towards said nozzle; and

a toroidal member disposed circumferentially about said nozzle and normal thereto, said toroidal member being formed with a concave portion proximate to said nozzle and a convex portion merging with said concave portion, to define a generally concave-convex configuration in cross-section, wherein the outer rim of said concave portion of said toroidal member is generally coplanar with the orifice of said nozzle, whereby said toroidal member is adapted to focus and reflect a substantial portion of the said sonic wave field generated by said sonic generator and is adapted to induce a laminar discharge layer of gas over said toroidal member to thereby carry said discharge gas away from said sonic wave field.

2. A device as in claim 1 wherein said toroidal member comprises an internally threaded annular member disposed circumferentially about said nozzle and said nozzle is provided with an externally threaded portion adapted to register with said internally threaded portion of said toroidal member in the assembled condition.



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