

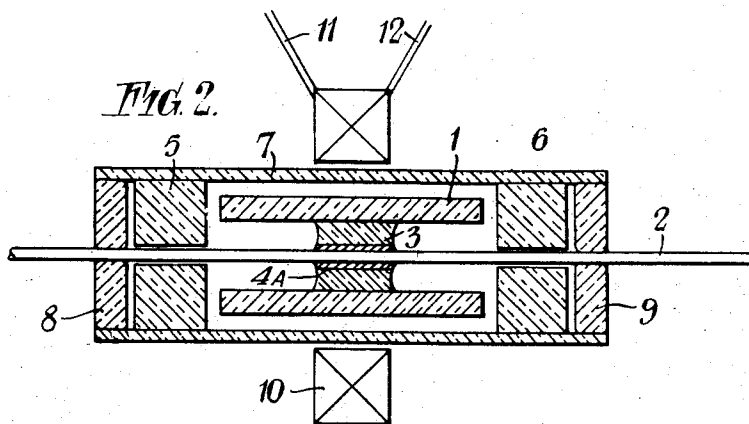
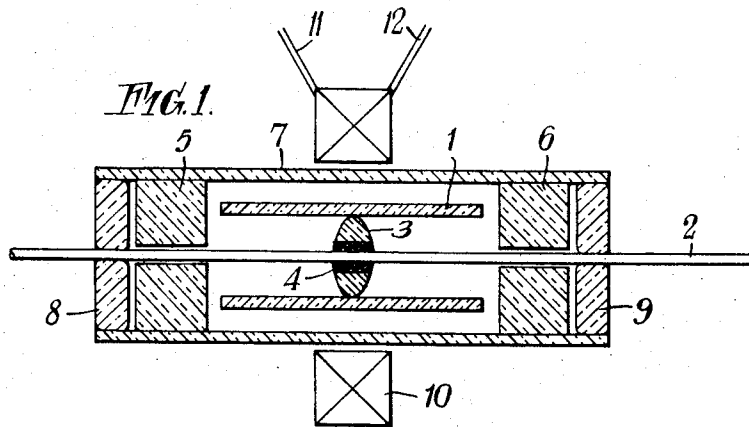
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MAGNETO-STRICTIVE RESONATORS

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MAGNETO-STRICTIVE RESONATORS

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8 Claims. (Cl. 333-71)

This invention relates to magnetostrictive resonators and more specifically to frequency selective resonant electrical filters of the kind employing magnetostrictive mechanical resonators. The invention has for its object to provide improved filters of this kind and which shall be of relatively simple and economical construction, and of high Q value, i.e. of low damping.

According to the present invention there is provided a resonant filter of the kind referred to having a hollow cylindrical mechanical resonator made of a magnetostrictive ferromagnetic ceramic material which is magnetized with lines of force running round the annulus which constitutes the cross section of the resonator, a support wire for said resonator, the wire running axially of the resonator, means comprising an insulating member whose mechanical hardness is of the same order as that of the material of said resonator, said means being attached to the support wire and to the resonator so as to support the latter centrally of the length thereof, and at least one coil arranged to excite said resonator to oscillate in torsion.

Preferably the insulating member is a borate bead fused to the support wire and to the inside of the resonator.

Preferably the borate bead is keyed to the support wire by thickening the latter where the bead is to be positioned, or by providing the wire in the said position with a few turns of fine copper or other wire thereon or with a short length of sleeve thereon.

For a better understanding of the invention and to show how the same may be carried into effect reference will now be made to the accompanying drawing in which:

Fig. 1 is a sectional elevation of a resonator, secured to a support wire by a first fixing arrangement, and

Fig. 2 shows the resonator of Fig. 1, when secured to the support wire by a different fixing arrangement.

Referring to Fig. 1 of the drawing the mechanical resonator portion of the device therein shown consists of a hollow elongated cylinder 1 of ferromagnetic magnetostrictive ceramic material, for example the material commercially known as "ferroxcube grade B." The length of the cylinder is substantially equivalent to a half wave length at the desired resonant frequency which, to quote a practical example, might be between say 80 kc./s. and 120 kc./s. The cylinder 1 is supported from a support wire 2 which passes axially therethrough and may conveniently be made of the material known as Nichrome. The cylinder is carried from the wire by means of a borate bead 3 which is fused on to the wire 2 and also to the inside of the cylinder 1 as nearly as possible midway along the same. The bead 3 is of the same order of hardness as the cylinder 1. The fusing is effected to give firm contact without slip between the bead 3 and the wire 2 and especially between the bead 3 and the cylinder 1. The area of contact between bead 3 and cylinder 1 is made as small as is compatible with

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good mechanical strength. In order to give a firm keying of the bead on to the wire 2 a few turns of copper wire 4 are first wound on to the said wire 2. This copper wire 4 in effect provides a key for the borate bead 2. Instead of fixing the cylinder to the support wire by the arrangement shown in Fig. 1, a sleeve may be provided on the support wire as shown in Fig. 2, where the sleeve is indicated at 4A. In Fig. 2 like parts are referred to in Fig. 1 and are indicated by like numbers. An alternative means for fixing the resonator to the support wire is to locate a thickened portion of the support wire midway along the resonator instead of using the sleeve 4A or fixing wire 4. Outwardly of the ends of the cylinder 1 are two plugs 5 and 6 also of ferroxcube material but of non-magnetostrictive quality, e.g., grade A material. These plugs 5 and 6 are centrally bored to pass the wire 2. They serve to reduce stray magnetic fields and, therefore, undesired coupling between one filter and another, similar adjacent one. They also serve to ensure substantially constant coupling conditions between the coils (not yet referred to) and the mechanical resonators of filters of the same general design but different operating frequencies. Such filters of different operating frequencies will, of course, have cylinders of different lengths. By providing ferro-magnetic plugs 5 and 6 at the ends of the cylinders a series of devices of the same general design but different resonant frequencies may be made with uniform coupling conditions throughout as between the mechanical resonators and the associated coils.

Protection for the ferroxcube material against dirt, grease and the like is provided by a glass tube 7 and glass end sealing beads 8 and 9 as shown, the plugs 5 and 6 and the beads 8 and 9 being fixed in position by any suitable cement securing them to the tube 7. The plugs 5 and 6 also serve to hold support wire 2 in position.

The device shown has two coils, an input coil and an output coil, in a coil circuit 10 on the glass cylinder midway along the length of the ferroxcube cylinder 1. The input or primary coil will normally be of relatively few turns wound at right angles to the axis of the resonator and positioned midway along the length of the resonator and serves for energizing the mechanical resonator into torsional vibration. The secondary or output coil will generally have considerably more turns and is for the purpose of coupling the vibrating resonator to the utilization circuit though, of course, the number of turns in primary and secondary will depend upon design requirements. The connections to the primary are represented at 11 and those to the secondary at 12.

The mechanical resonator 1 vibrates in a torsional mode because of the resultant helical magnetic field produced by the cylindrical permanent magnetism of the resonator combined with the axial magnetic field produced by the energized primary winding. Magnetization is easily effected in the magnetostrictive cylinder by passing a short pulse of current through the support wire 2.

It has been found in practice that with a device as illustrated and designed for a frequency of the order of 80 to 120 kc./s., a Q value of the order of 4000 to 6000 was readily obtainable while the device itself was small, compact, relatively simple to manufacture and relatively economical. A series of devices as illustrated but resonant at different adjacent frequencies provides a most convenient and compact frequency spectrum analyzer costing substantially less than, occupying less space than, and giving a sharpness of frequency selectivity as good or better than those obtainable with known apparatus.

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

I claim:

1. A frequency selective resonant electrical filter comprising a hollow cylindrical mechanical resonator made of a magneto-strictive ferromagnetic ceramic material which is permanently magnetized and having lines of force running round the annulus which constitutes the cross section of the resonator, a support wire for said resonator, the wire running axially through the resonator, means for supporting said wire adjacent its ends, means comprising an insulating member whose mechanical hardness is of the same order as that of the material of said resonator, said means being attached to the support wire and to the resonator so as to support the latter centrally of the length thereof, a first coil wound axially round the resonator and positioned midway along the length of the resonator whereby when the coil is energized by alternating current it produces an axial alternating magnetic field and the resonator is excited to vibrate in torsion and a second coil arranged near to said resonator whereby said second coil is energized by the vibrating resonator.

2. A frequency selective resonant electrical filter as set forth in claim 1, wherein the insulating member is a borate bead.

3. A frequency selective resonant electrical filter as set forth in claim 1, wherein the insulating member is a borate bead fused to the support wire and to the inside of the resonator.

4. A frequency selective resonant electrical filter as set forth in claim 1, wherein the insulating member is a borate bead keyed to the support wire by thickening the latter at the location where the bead is to be positioned.

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5. A frequency selective resonant electrical filter as set forth in claim 1, wherein the insulating member is a borate bead keyed to the support wire by providing around the latter a number of turns of wire at the location where the bead is to be positioned.

6. A frequency selective resonant electrical filter as set forth in claim 1, wherein the insulating member is a borate bead keyed to the support wire by providing a sleeve on the support wire at a location where it is desired to position the bead.

7. A frequency selective resonant electrical filter as set forth in claim 1, wherein means are provided adjacent each end of the resonator for minimizing the effect of stray magnetic fields upon the oscillations of the resonator, said last mentioned means being displaced away from the magnetic fields produced by said coils.

8. A frequency selective resonant electrical filter as set forth in claim 1, wherein means are provided adjacent each end of the resonator for minimizing the effect of stray magnetic fields upon the oscillations of the resonator, said last mentioned means being located away from the magnetic field provided by said coils and including plugs bored to pass the support wire, the plugs being formed from a non-magneto-strictive material.

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