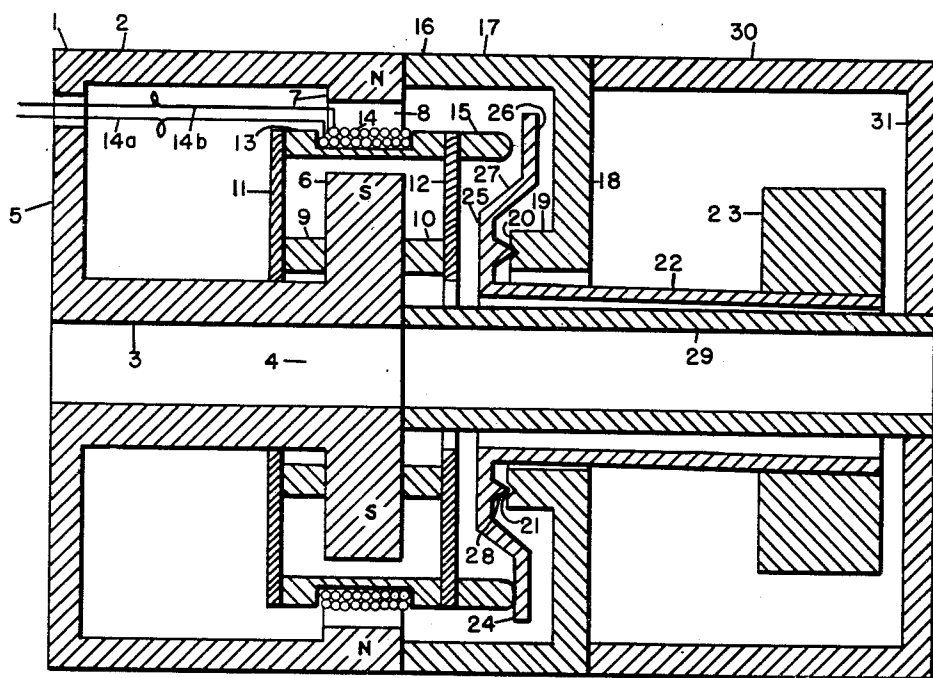


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A. N. STANTON
VERTICAL-VIBRATION PICKUP

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VERTICAL-VIBRATION PICKUP

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My invention relates to devices for transmitting only one component of general vibrational motion and more particularly to devices for translating only the vertical component of general vibrational motion into horizontal motion.

The present application is for the same invention disclosed in my abandoned application filed January 25, 1947, Serial Number 724,327.

In many applications, such as seismic systems, it is desirable to convert only the vertical component of general vibrational motion into electrical energy. It is necessary that the converting device be relatively unresponsive to components of vibration along horizontal axes and it is desirable that the converting device function properly regardless of its angular position about a horizontal axis.

Accordingly, it is an object of my invention to provide a new and improved means for transmitting only one component of general vibrational motion.

It is another object of my invention to provide a new and improved means for translating only the vertical component of general vibrational motion into horizontal motion.

It is another object of my invention to provide a new and improved means for translating only the vertical component of general vibrational motion into horizontal motion regardless of the angular position of said means about a horizontal axis.

It is still another object of my invention to provide a new and improved means for converting only the vertical component of general vibrational motion into electrical energy.

Briefly stated, in the illustrated embodiment of my invention, I provide an improved energy translating device which comprises a magnetic field structure provided with an annular air gap and a movable coil disposed in the annular air gap and yieldably mounted for movement. Movement is imparted to the coil by a dished structure which is mounted for pivotal movement about a knife edge and to which is rigidly fixed a mass which maintains a relatively fixed position when the device as a whole is displaced vertically. Upon such displacement, the coil is moved within the annular air gap by the dished structure cutting the magnetic flux passing across the annular air gap and inducing a voltage in the coil. The dished structure and the mass are mounted upon opposite sides of the knife edge pivot and produce substantially no motion of the coil in response to horizontal vi-

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brations or horizontal components of general vibrational motion.

For a better understanding of my invention, reference may be had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

The single figure of the accompanying drawing is a longitudinal central section of a preferred form of my invention.

Referring to the single figure of the drawing, the illustrated embodiment of my invention comprises a magnetic field structure 1 having an outer cylindrical wall 2 and an inner cylindrical wall 3. The inner cylindrical wall forms a passage 4 through which a cable may be passed. An annular end wall 5 connects walls 2 and 3 at one end of the magnetic field structure 1 and a wall 6 extends outwardly from wall 3 at the other end of magnetic field structure 1 toward a wall 7 extending inwardly from wall 2 to form an annular air gap 8. Walls, 2, 3, 5, 6 and 7 are formed of magnetic material and may constitute a single integral element. Magnetic field structure 1 is a permanent magnet with walls 5 and 7 being poles of opposite polarities so that magnetic flux flows across the annular air gap 8.

Secured to opposite sides of wall 6 near its juncture with wall 3 are rings 9 and 10 to which are fixed the inner ends of annular springs or resilient diaphragms 11 and 12, respectively. A cylindrical bobbin 13 is secured to and between the outer ends of annular springs 11 and 12 and is disposed within air gap 8 with its central axis coinciding with the longitudinal axis of magnetic field structure 1. A coil 14 is wound as a helix on bobbin 13. Bobbin 13 and coil 14 are movable within the annular air gap 8 since bobbin 13 is mounted upon springs 11 and 12. It will be apparent to those skilled in the art that a horizontal movement of coil 14 will cut the magnetic flux passing across the annular air gap 8 and induce a voltage in coil 14. The coil 14 is provided with leads 14a and 14b to transmit the induced voltage to any desired instrument or device. An annular extension 15 is secured to the outer end of annular spring 12 to serve as a means for transmitting motion to bobbin 13 and coil 14. The free edge of extension 15 is rounded to reduce friction. While I have shown bobbin 13 supported for motion upon two annular springs 11 and 12, it is obvious that bobbin 13 may be yieldably mounted for movement along a horizontal axis in a number of different ways, for example, upon only one spring, without de-

parting from the spirit and scope of my invention.

I provide a housing 16 secured to wall 2 adjacent wall 7 which comprises a cylindrical wall 17, an inwardly extending annular wall 18 secured to wall 17, and an annular wall 19 secured to wall 18 and extending toward the magnetic field structure 1 in parallel relationship with wall 17. Wall 19 has a flat end 20 with a circular V-shaped groove 21 whose function will be described later. Magnetic field structure 1 and housing 16 constitute a main structure which supports all moving elements.

In order to actuate extension 15 and bobbin 14 in accordance with the vertical component of any general vibrational movement to which the device may be subjected, I provide a tubular arm 22 which has a mass 23 at one end and a dished structure 24 at the other end. The dished structure 24 comprises an inner annular portion 25 and an outer flat flange 26 connected by a conical wall 27. The inner end of annular portion 25 is secured to tubular arm 22 and an annular knife edge 28 is secured to annular portion 24 and engages in the circular V-shaped groove 21. Circular V-shaped groove 21 is of the same diameter as knife edge 28 but has a larger included angle than knife edge 28. Both knife edge 28 and wall 19 are formed of hard material to prevent excessive wear. Knife edge 28 is yieldingly urged into engagement with groove 21 by annular springs 11 and 12 and extension 15 which contacts flange 26 of dished structure 23. The face of flange 26 which contacts extension 15 is coplanar with the sharp edge of knife edge 28.

I provide a dished structure in order to achieve the coplanar relation of one face of flange 26 and the sharp edge of knife edge 28. The thrust or force to which bobbin 13 is subjected upon motion between magnetic field structure 1 and mass 23 is therefore substantially parallel to the longitudinal axis of the magnetic field structure 1 and bobbin 13 is not subjected to any substantial components of thrust in planes not parallel to the longitudinal axis of the magnetic field structure 1. A flat annulus or disk could, of course, be employed instead of dished structure 24 but the point of thrust against extension 26 would not be coplanar with the sharp edge of knife edge 28. Bobbin 13 would therefore be subjected to a thrust having substantial components of force in planes not parallel to the longitudinal axis of the magnetic field structure 1. A flat annulus or disk would therefore make the device less sensitive and less efficient.

I provide an extension tube 29 secured to wall 3 of the magnetic field structure 1 to provide an extension of passage 4 and prevent the cable which passes through passage 4 from interfering with the motion of arm 22. A cylindrical cover 30 is secured to wall 17 of housing 16 and has an annular end wall 31 whose inner end abuts one end of the extension tube 29. Extension tube 29, cover 30 and housing 16 shield all moving parts from foreign matter.

When my device is placed with its longitudinal axis in a horizontal position, the weight of the mass 23 will cause mass 23 to fall slightly below its position of symmetrical relation with respect to magnetic field structure 1. The circular V-shaped groove 21 being rigidly secured to magnetic field structure 1, the upper arc portion of circular knife edge 28 will be pressed into close engagement with the upper arc portion of

circular V-shaped groove 21 and the lower arc portion of knife edge 28 will move slightly away from the lower arc portion of groove 21. The flange 26 will then be forced against annular extension 15 displacing annular extension 15, bobbin 13 and springs 11 and 12 to a position where the strain in the springs 11 and 12 balances the stress caused by the weight of mass 23. If my device as a whole is now subjected to vertical vibrations, the magnetic field structure 1 and the elements rigidly secured to it are displaced vertically in accordance with the vibrations. Mass 23, however, because of its mass and its pivotal mounting will not remain substantially displaced. A relative movement between magnetic field structure 1 and mass 23 about the upper arc portion of knife edge 28 will take place and the lower portion of flange 26 will impart a horizontal movement to extension 15 and bobbin 13. In this manner vertical vibrations imparted to my device will result in a horizontal movement of bobbin 13 and will induce a voltage in coil 14.

If my device as a whole is subjected to horizontal vibrations parallel to its longitudinal axis, magnetic field structure 1 and the elements rigidly secured to it are displaced horizontally in accordance with the vibrations. Mass 23 and springs 11 and 12 exert forces sufficiently great to maintain knife edge 28 in constant engagement with groove 21 of wall 19. As a result, the only relative movement possible between mass 23 and magnetic field structure 1 is pivotal movement about an arc portion of knife edge 28. Horizontal vibrations parallel to the longitudinal axis of my device will result in movement of mass 23, dished structure 24 and bobbin 13 relative to magnetic field structure 1 only to the extent that they control mass 23 to move pivotally about the upper arc portion of knife edge 28. Only a very small percentage of the horizontal motion imparted to my device as a whole by vibrations parallel to the longitudinal axis of my device is translated into horizontal movement of bobbin 13 because the vertical distance from the point of pivot, the upper arc portion of knife edge 28, to the center of mass of the mass 23 is small and the horizontal distance from the point of pivot to the center of mass of the inertia 23 is relatively large.

If my device as a whole is subjected to horizontal vibrations perpendicular to the horizontal longitudinal axis of my device, the bobbin 13 will not be displaced horizontally along, and parallel to the longitudinal axis of magnetic field structure 1 because such vibrations will merely shift the point of pivot of knife edge 28 in groove 21 and will not result in movement of mass 23 about the pivot formed by an arc portion of knife edge 28.

In the above analysis the effects of individual vibrations along each of the major axes were discussed. A general vibrational motion which has components of vibration along two or more axes can be examined in the same way by examining the effects of individual components of vibration. In each case the vertical component of the general vibrational movement will effect a horizontal movement of bobbin 13 relative to magnetic field structure 1 along the longitudinal axis of my device while the horizontal component will produce substantially no horizontal movement of bobbin 13 relative to magnetic field structure 1 along the longitudinal axis.

The preferred embodiment of my invention

comprises a circular knife edge 28 and a circular V-shaped groove 21. At any one time, however, only a small arc portion of knife edge 28 is engaged with a corresponding small arc portion of circular V-shaped groove 21. A complete circular knife edge and corresponding complete circular V-shaped groove are therefore not essential to the successful practice of my invention. A small segment of the circular knife edge and a corresponding small segment of the circular V-shaped groove can be employed where some provision is made to place the device in the necessary angular position about a horizontal axis. Coinciding flat surfaces could be provided on magnetic field structure 1, housing 16, and cover 30 to make certain that the arc portion of knife edge 28 would always be in an upper position with respect to the earth. In a similar way, annular extension 15 and dished structure 24 could be replaced by coating segmental portions of these elements. The use of cylindrical and circular elements, however, has the advantage that the device can be positioned in any angular position about a horizontal axis and still remain operative.

While I have shown and described a preferred embodiment of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention, and I, therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. In a device for converting mechanical vibrations into electrical energy; a magnetic field structure provided with an annular air gap; a movable coil yieldingly mounted on said magnetic field structure and disposed in said annular air gap; a housing comprising a cylindrical wall having one end rigidly secured to said magnetic field structure adjacent said annular air gap, an annular wall extending inwardly from the other end of said cylindrical wall, and a circular wall extending perpendicularly from said annular wall in telescoped relation with said cylindrical wall, said circular wall having an end provided with a circular V-shaped groove; a dished structure having an inner annular portion and an outer flange connected by a conical wall, said inner annular portion having a circular knife edge extending perpendicularly from said inner portion into said circular V-shaped groove; a tubular arm extending perpendicularly from said inner portion in the same direction as said circular knife edge; a mass on said tubular arm; and an annular extension operatively connecting said outer flange and said coil for maintaining an arc portion of said circular knife edge in pivotal engagement with an arc portion of said circular V-shaped knife edge and for imparting movement to said coil upon relative vertical movement between said magnetic field structure and said mass.

2. In a device for converting mechanical vibrations into electrical energy: a magnetic field structure arranged about a longitudinal axis and having an annular air gap concentric with respect to said axis; an annular spring mounted on said magnetic field structure and disposed concentrically with respect to, and in a plane normal to, said axis; an annular coil mounted on said spring concentrically with respect to said axis and projecting from the plane of said an-

nular spring to lie in said annular air gap; an extension operatively associated with said coil; a wall rigidly secured to said magnetic field structure and having a surface in a plane normal to said axis, said surface being provided with an arced V-shaped groove concentric with respect to said axis; and an arm having an extension at one end and a mass on the other end said second mentioned extension extending in a plane normal to the longitudinal axis of said arm, one side of said second mentioned extension being in operative contact with said first mentioned extension and the other side of said second mentioned extension having an arced knife edge of the same radius as said arced V-shaped groove extending perpendicularly from said second mentioned extension into said arced V-shaped groove, said annular spring and said mass cooperating to maintain a portion of said arced knife edge in pivotal contact with a portion of said arced V-shaped groove.

3. In a device for translating vertical motion into horizontal motion: a main structure arranged about a longitudinal axis; resilient means mounted on said main structure; a member mounted on said resilient means in a plane parallel to said axis; a wall rigidly secured to said main structure having a surface in a plane normal to said axis; said surface being provided with an arced V-shaped groove concentric with respect to said axis; an arm lying in a plane substantially parallel to said axis and having an extension on one end and a mass on the other end of said arm, said extension extending in a plane normal to said axis, one side of said outward extension being operatively associated with said member and the other side of said outward extension having an arced knife edge of the same radius as said arced V-shaped groove extending perpendicularly from said other side of said outward extension into said arced V-shaped groove, said resilient means and said mass cooperating to maintain the uppermost portion of said arced knife edge in pivotal engagement with the corresponding portion of said arced V-shaped groove.

4. In a device for translating vertical motion into horizontal motion: a main structure having a horizontal axis; a member resiliently mounted on said main structure for horizontal movement along, and in a plane parallel to, said horizontal axis; a substantially vertical member having an arced knife edge pivot means mounted on said main structure for horizontal movement about said pivot means, said arced knife edge pivot means being concentric with respect to said horizontal axis, said vertical member moving about a horizontal axis perpendicular to said first mentioned horizontal axis; and a mass rigidly secured to said vertical member and vertically movable about said pivot means, said vertical member being operatively associated with said member for imparting horizontal movement to said member upon relative vertical movement between said mass and said main structure.

5. In a device for translating vertical motion into horizontal motion: a main structure having a horizontal axis, said main structure comprising a surface in a plane normal to said horizontal axis provided with an arced V-shaped groove concentric with respect to said axis; a member resiliently mounted on said main structure for horizontal movement along, and in a plane parallel to, said horizontal axis; a substantially vertical member having an arced knife edge pivot means engaging said arced V-shaped groove, said

vertical member moving about said pivot means and about a horizontal axis perpendicular to said first mentioned horizontal axis; and a mass rigidly secured to said vertical member and vertically movable about said pivot means, said vertical member being operatively associated with said member for imparting horizontal motion to said member upon relative vertical movement between said mass and said main structure.

6. In a device for translating vertical motion into horizontal motion: a main structure having a horizontal axis, said main structure comprising a surface in a plane normal to said horizontal axis, said surface being provided with a circular V-shaped groove concentric with respect to said horizontal axis; a member resiliently mounted on said main structure for horizontal movement along, and in a plane parallel to, said horizontal axis; a substantially vertical member having a circular knife edge, said circular knife edge extending into said circular V-shaped groove and having an arc portion in contact with a portion of said circular V-shaped groove, said vertical member pivoting about said arc portion of said knife edge and about a horizontal axis perpendicular to said first mentioned horizontal axis; and a mass rigidly secured to said vertical member and vertically movable about said arc portion of said circular knife edge, said vertical member being operatively associated with said member for imparting horizontal motion to said member upon relative vertical movement between said mass and said main structure.

7. In a device for converting mechanical vibrations into electric energy; a magnetic field structure having a horizontal axis and an annular air gap concentric with respect to said axis; an annular coil resiliently mounted on said magnetic field structure for horizontal movement in said annular air gap along, and in a plane parallel to, said horizontal axis; a substantially vertical member pivoted for movement about a horizontal axis perpendicular to said first mentioned horizontal axis; a mass rigidly secured to said vertical member and vertically movable about said second mentioned horizontal axis; and means operatively associated with said coil and said vertical member for imparting horizontal motion to said coil upon relative vertical movement between said mass and said magnetic field structure.

8. In a device for converting mechanical vibrations into electric energy; a magnetic field structure having a horizontal axis and an annular air gap concentric with said axis; an annular coil resiliently mounted on said magnetic field structure for horizontal movement in said annular air gap along, and in a plane parallel to, said horizontal axis, a substantially vertical member having an arced knife edge pivot means mounted on said magnetic field structure for horizontal movement about said pivot means, said vertical member moving about a horizontal axis perpendicular to said first mentioned horizontal axis; and a mass rigidly secured to said vertical member and vertically movable about

said pivot means, and said vertical member being operatively associated with said coil for imparting horizontal movement to said coil upon relative vertical movement between said mass and said magnetic field structure.

9. In a device for converting mechanical vibrations into electric energy; a magnetic field structure having a horizontal axis and an annular air gap concentric with respect to said horizontal axis; an annular coil resiliently mounted on said magnetic field structure for horizontal movement in said annular air gap along, and in a plane parallel to, said axis; a wall rigidly secured to said magnetic field structure having a surface in a plane normal to said horizontal axis provided with an arced V-shaped groove concentric with respect to said horizontal axis; a substantially vertical member having an arced knife edge pivot means engaging said arced V-shaped groove, said vertical member moving about said pivot means and about a horizontal axis perpendicular to said first mentioned horizontal axis; a mass rigidly secured to said vertical member and vertically movable about said pivot means; and means operatively associated with said coil and said vertical member for imparting horizontal motion to said coil upon relative vertical movement between said mass and said main structure.

10. In a device for translating vertical motion into horizontal motion: a magnetic field structure having a horizontal axis and an annular air gap concentric with respect to said axis; an annular coil resiliently mounted on said magnetic field structure for horizontal movement in said air gap along, and in a plane parallel to, said axis; a wall rigidly secured to said magnetic field structure having a surface in a plane normal to said horizontal axis provided with a circular V-shaped groove concentric with respect to said horizontal axis; a substantially vertical member having a circular knife edge, said circular knife edge extending into said circular V-shaped groove and having an arc portion pivotally engaging an arc portion of said circular V-shaped groove, said vertical member pivoting about said arc portion of said knife edge and about a horizontal axis perpendicular to said first mentioned horizontal axis; a mass rigidly secured to said vertical member and vertically movable about said arc portion of said circular knife edge; and means operatively associated with said coil and said vertical member for imparting horizontal motion to said coil upon relative vertical movement between said mass and said magnetic field structure.

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