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J. D. DURKEE

2,691,749

VIBRATING REED ASSEMBLY WITH DAMPING

Filed April 22, 1952

2 Sheets-Sheet 1

Fig. 1.

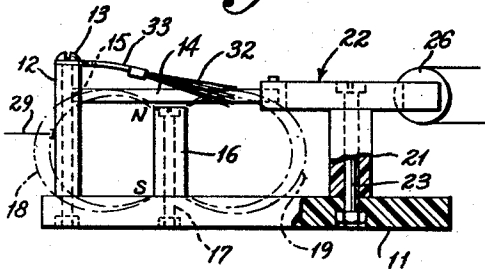


Fig. 2.

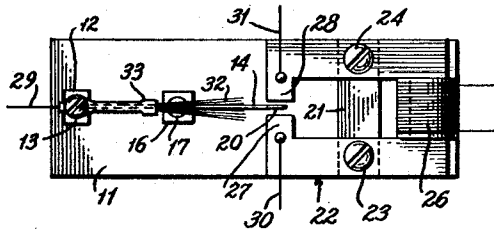


Fig. 9.

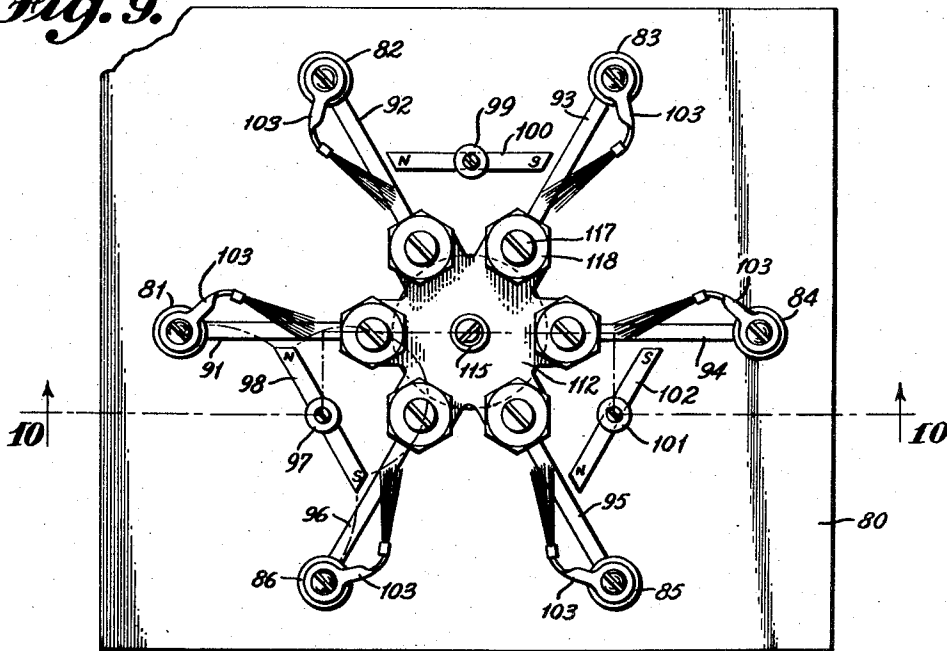
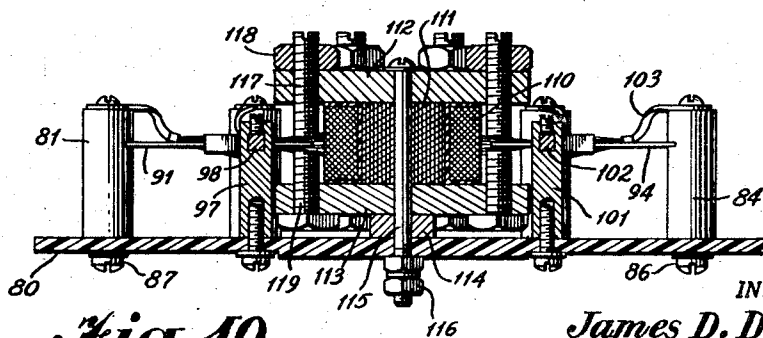


Fig. 10.

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2 Sheets-Sheet 2

Fig. 3.

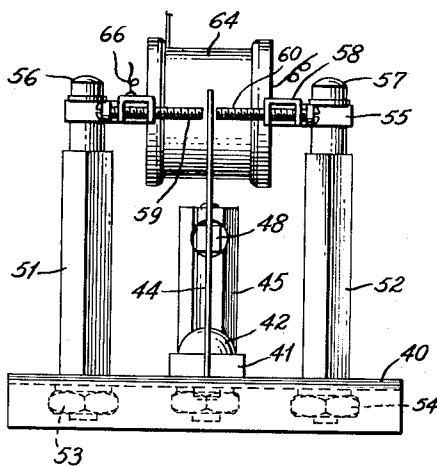


Fig. 4.

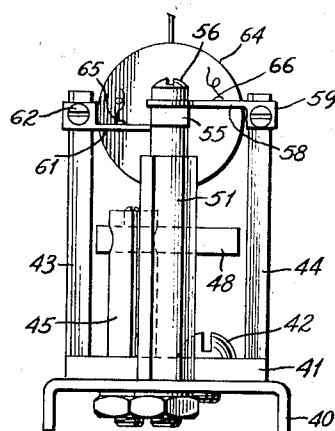


Fig. 5.

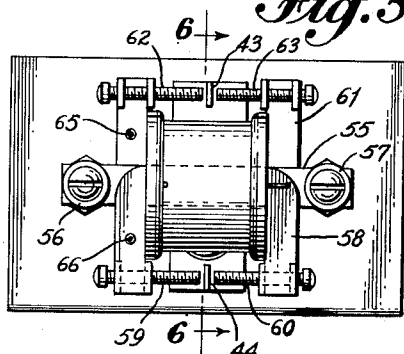


Fig. 6.

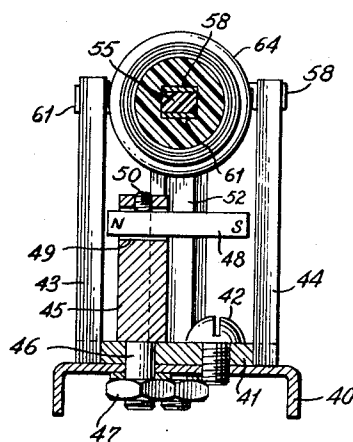


Fig. 7.

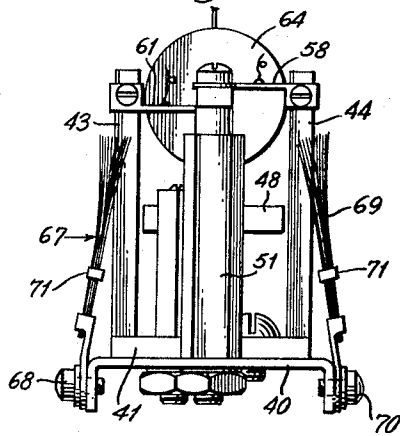
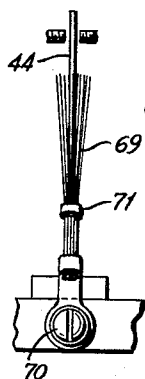


Fig. 8.



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UNITED STATES PATENT OFFICE

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VIBRATING REED ASSEMBLY WITH
DAMPING

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Application April 22, 1952, Serial No. 283,626

11 Claims. (Cl. 317—182)

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The present invention relates to improve-
ments in vibrating reed assemblies in which one
or more vibrating reeds are caused to vibrate at
their natural mechanical or resonant frequency.
Such assemblies have many fields of utility. 5
One field of utility in which I am particularly
interested is the reception of signals in telecom-
munication systems. In such systems a fre-
quency sensitive reed or reeds may be caused to
vibrate electromagnetically by the flow of alter-
nating current through a coil having a core pro-
vided with pole pieces adjacent the free end or
ends of the reed or reeds. A reed will be caused
to vibrate when current having a frequency
equal to the resonant frequency of the reed is
caused to flow through the coil with which the
reed is associated.

A system of telecommunication developed by
me involves the transmission of a plurality of
impulses of different frequencies. The nature
of the combinations of such impulses determines
the character of intelligence transmitted. For
example, a given combination of frequencies
may designate a particular letter of the alpha-
bet while a different combination of frequencies
may designate a different letter of the alphabet.
The impulses may be simultaneously or sequen-
tially received at a receiving station. The thus
received composite signal may be fed to the coil
associated with a plurality of reeds having dif-
ferent resonant vibrating frequencies. Those
reeds having frequencies corresponding to the
frequencies of the various impulses making up
the composite signal will be vibrated, while reeds
having other frequencies will not be affected by
the particular composite signal under consid-
eration. Subsequently received signals composed
of impulses of other frequencies will, of course,
cause other reeds to vibrate. The number of
reeds in a signal receiving apparatus should
preferably correspond to the number of different
frequencies which may be used in various com-
binations in making up the composite signal. It
will be apparent that with this system a large
number of different characters may be trans-
mitted and received by the use of various com-
binations of impulses of the different frequencies.

It is frequently important for the apparatus
used in the reception of signals according to the
foregoing system to be compact, simple in con-
struction, and inexpensive. It is frequently
necessary for the receiving apparatus to be port-
able or capable of being used on moving air, wa-
ter or land craft. It is also essential to speed of
transmission and reception that the reeds be
capable of very rapidly beginning to vibrate at
their resonant frequency upon the passage of

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current corresponding to their resonant fre-
quency through the associated driving coil. It is
also essential that the vibration of the reeds
cease abruptly or quickly after termination of
flow of current corresponding to their frequency
through the associated coil. In order to realize
the full benefits of their frequency selectivity,
the reeds should completely or substantially
cease vibrating before the next signal is received
in order to eliminate the possibility that the
reeds will respond to impulse currents of other
than their resonant frequencies.

One of the primary objects of my invention
is to provide an electromagnetically driven vi-
brating reed assembly in which a reed can very
quickly begin vibrating at its resonant fre-
quency upon passage of an electric current cor-
responding to its resonant frequency through its
associated coil.

Another important object of the invention is to
provide mechanical damping means which will
cause a vibrating reed to quickly cease its vibra-
tion after its driving force has been removed.

Still another object of the invention is to pro-
vide mechanical damping means for a vibrating
reed which provides a minimum of interference
to vibration of the reed at its resonant frequency,
but which quickly damps the vibration after re-
moval of that force tending to drive the reed.

Still another important object of the invention
is to provide an assembly which includes a plu-
rality of reeds having different resonant fre-
quencies and in which a single coil is used as a
driving coil for all of the reeds. This arrange-
ment contributes greatly to the simplicity, com-
pactness, and economy of apparatus involving a
plurality of electromagnetically driven vibrating
reeds. The use of a single coil concentrates in
the field of the single coil the energy necessary
to drive all of the reeds rather than supplying
that energy to each of a plurality of coils.

Other objects and advantages of the invention
will be apparent from the following detailed de-
scription of exemplary forms of my invention.
This description has reference to the accom-
panying drawings, wherein:

Figure 1 is a side elevational view of a form
of my invention involving a single vibrating reed;

Figure 2 is a top plan view of the apparatus
shown in Figure 1;

Figure 3 is a side elevational view of a form
of apparatus embodying the invention and in-
cluding a pair of vibrating reeds having a single
driving coil;

Figure 4 is an end elevational view of the ap-
paratus shown in Figure 3;

Figure 5 is a top plan view of the apparatus
shown in Figures 3 and 4;

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Figure 6 is a vertical sectional view taken in the direction of the arrows along the line 6—6 of Figure 5;

Figure 7 is a view similar to Figure 4, but illustrating mechanical vibration damping means to dampen vibration of the reeds;

Figure 8 is a fragmentary detail view in side elevation illustrating one of the reeds and its associated damping means;

Figure 9 is a top plan view of a further apparatus embodying the invention and including six vibrating reeds having a single driving coil; and

Figure 10 is a sectional view taken in the direction of the arrows along the line 10—10 of Figure 9.

The form of the invention illustrated in Figures 1 and 2 includes the principal features of the apparatus disclosed in my copending application Serial No. 229,975, filed June 5, 1951, entitled "Polarized Relay" (now abandoned) of which this application is a continuation-in-part. A base 11 of non-magnetic and insulating material is provided at one end with an upwardly extending reed supporting standard 12 of non-magnetic but electroconductive material. The reed supporting standard 12 may be of tubular form and may be secured to the base 11 by means of a bolt 13. A vibrating reed 14 of magnetic and conductive material has one of its ends fixed at 15 to the reed supporting standard 12. The reed 14 extends generally parallel to the base 11 and is capable of vibrating in a plane which is parallel to that base.

A permanent magnet 16 extends upwardly from the base 11 and may be secured thereto by any suitable means such as a bolt 17. The permanent magnet 16 has one of its poles positioned closely adjacent the approximate midportion of the reed. The opposite pole of the magnet 16 is adjacent the base 11 and is positioned a substantial distance from the reed 14.

The flux paths induced by the permanent magnet 16 are illustrated by the dot-dash lines 18 and 19. The location of one pole of the permanent magnet 16 adjacent the mid-portion of the reed 14 and the location of the opposite pole of the magnet remote from the reed, plus the fact that the polar axis of the permanent magnet 16 extends at approximately a right angle to the longitudinal axis of the reed 14 serves to establish magnetic flux of the same polarity in both ends of the reed 14. This positioning of the permanent magnet 16 also serves to provide substantial symmetry of flux distribution longitudinally of the reed 14. The maximum amplitude of vibratory movement of the reed 14 occurs at the free end 20 of the reed. This amplitude of movement diminishes greatly toward the mid-portion of the reed, and I have found that there is very little amplitude of vibratory movement of that portion of the reed 14 immediately overlying the adjacent pole of the permanent magnet 16. For this reason, vibration of the reed causes very little disturbance of a symmetrical distribution of the lines of flux laterally of the reed 14.

A core supporting block 21 of non-conducting and non-magnetic material extends upwardly from the base 11. A generally U-shaped flux core 22 is supported at the upper end of the member 21 and is secured thereto and to the base by means of bolts 23 and 24. A coil 26 is positioned around the closed end of the flux core 22. The flux core is provided with pole pieces 27 and 28 disposed on opposite sides of the free end 20 of

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the reed 14 and in the plane of vibration of the reed.

The reed 14 is a tuned reed which vibrates at a resonant frequency or at its natural mechanical period of vibration. When alternating current of a frequency corresponding to the resonant frequency of the reed 14 is supplied to the coil 26, the reed will very quickly begin to vibrate at its resonant frequency. If, however, alternating current of a frequency different from the resonant frequency of the reed 14 is supplied to the coil 26, the reed will not begin to vibrate. The reed is thus selective in that it will vibrate only when alternating current corresponding to its resonant frequency is supplied to the coil 26. Composite signals involving a plurality of different frequencies can be supplied to the coil 26 and the reed 14 will vibrate only when the signal includes a component of the frequency corresponding to the natural or resonant frequency of the reed.

Vibration of the reed can be detected by the opening and closing of an electric circuit during vibration of the reed. The circuit to be opened and closed can be connected as shown at 29 to the reed supporting standard 12. The circuit can also be connected as indicated at 30 or 31 to either or both of the pole pieces 27 and 28. Current can thus flow through the reed and the pole pieces at any time that the reed is in contact with either pole piece 27 or 28, and under such conditions the circuit will be closed. The circuit will, of course, be open while the free end 20 of the reed is not in contact with either pole piece.

The manner in which applicant's permanent magnet 16 is positioned and arranged relative to the reed 14 provides several important advantages. The symmetry of distribution of the lines of flux induced by the permanent magnet 16 have been mentioned above. I find that this symmetry is not appreciably interfered with by the presence of the pole pieces 27 and 28 of the core 22. Those pole pieces 27 and 28 are prevented from receiving any substantial magnetic lines of force from the permanent magnet 16, except those lines of force which pass through the reed 14. In this way applicant's pole pieces are not influenced by the permanent magnet 16 except by the flux passing through the reed. Those pole pieces are, however, influenced by the magnetic condition of the free end of the reed, which magnetic condition tends to be substantially constant. The substantially constant magnetic condition of the free end of the reed enables the reed to be delicately responsive to the changing magnetic conditions of the pole piece resulting from the flow of alternating current through the coil 26. Since the pole pieces 27 and 28 are not influenced by the permanent magnet 16 except by the flux passing through the reed, the pole pieces are readily able to change their polarity or magnetic condition in response to the flow of feeble current through the coil 26. These features have been found to be of extreme importance in permitting the reed to be rapidly started and effectively driven with a minimum of power in the coil 26. It has also been found that there is no tendency for the reed to freeze to either pole piece. There is no strongly effective permanent magnetic field between the pole pieces 27 and 28 which can influence the free end of the reed. This absence of an effective permanent magnetic field permits applicant's reed to be driven at its true mechanical fre-

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quency which tends toward frequency stability.

The foregoing factors contribute to the rapid beginning or "onset" of vibration of the reed 14 when alternating current of a frequency corresponding to the resonant frequency of the reed is caused to flow through the coil 26. It is also essential, as pointed out above, to cause vibration of the reed to rapidly cease or "decay" when current of a frequency corresponding to the resonant frequency of the reed ceases to flow through the coil 26. The rapid onset and rapid decay of vibration is essential to speed of transmission and reception in the telecommunication system in which the assembly is intended to be used. It is, therefore, advisable to provide means for effectively damping vibration of the reed immediately upon cessation of the driving force. This damping of vibration must be accomplished without effectively interfering with the ability of the reed to vibrate, without altering its resonant frequency and without interfering with the rapid onset of vibration of the reed. I have found that such damping can be accomplished by positioning a plurality of generally parallel, flexible, filamentary energy absorbing elements in positions such that at least some of those elements are contacted by and absorb energy from the reed during its vibration. This absorption of energy quickly dissipates the residual energy stored in the reed after the driving force has been removed. Such filamentary energy absorbing elements are designated generally by the reference numeral 32. They preferably take the form of nylon bristles, although other filamentary substances may be used. The energy absorbing elements are bundled at one end in the manner of a brush by means of a filament holder 33. The filament holder is preferably of flexible metal, and it may be secured to the upper end of the reed supporting standard 12 by means of the bolt 13. The flexibility of the filament holder 33 permits the position of the filaments 32 to be adjusted to obtain the appropriate degree of damping action. The filaments 32 are illustrated in Figures 1 and 2 as being generally parallel to the reed 14 with the free ends of the filaments lying on either side of the reed in the plane of vibration thereof.

Figures 3 to 7 illustrate a modification of the invention in which the features and advantages of the form of the invention described above are retained, but in which the apparatus includes a pair of vibrating reeds in a compact assembly. Compactness and economy are achieved by utilizing a single permanent magnet and a single driving coil. The vibrating reeds have different resonant frequencies, and they will respond to different frequencies of current which may be supplied to the coil.

A base 40 is provided with a reed supporting sub-base 41 which is secured to the base by means of a screw 42. Vibrating reeds 43 and 44 have their lower ends secured in opposite ends of the sub-base 41. The reeds 43 and 44 extend upwardly in parallel relationship. A magnet holder 45 is secured to the base 40 and sub-base 41 by means of a threaded lower end 46 and a nut 47. A permanent magnet 48 is supported within an opening 49 in the upper end of the magnet support 45 and is rigidly held therein by means of a set screw 50. The magnet 48 has one of its poles positioned adjacent the mid-portion of reed 43 while its opposite pole is positioned adjacent the mid-portion of the reed 44. The magnet is disposed at right angles to both

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of the reeds and is also disposed at right angles to the planes of vibration of the reeds. The base 40, the sub-base 41 and the magnet support 45 should be of non-magnetic, electroconductive material. In all illustrated forms of the invention the reeds are both magnetic and electroconductive.

A pair of spaced core supporting standards 51 and 52 extend through the base 40 and are rigidly secured thereto by means of nuts 53 and 54. The core supporting standards 51 and 52 extend upwardly from the base in parallel relationship to each other. A coil supporting bar 55 of insulating material extends from the upper end of the standard 51 to the upper end of the standard 52 and is rigidly secured to those standards by cap screws 56 and 57. A generally U-shaped core 58 is positioned above the coil supporting bar 55 and is provided with adjustable pole pieces in the form of screws 59 and 60 which are threaded into the free ends of the core 58. The pole pieces 59 and 60 are positioned on opposite sides of the free upper end of the reed 44. A similar generally U-shaped core 61 is positioned beneath the coil supporting bar 55. The core 61 is provided with adjustable pole pieces 62 and 63 which are similar to the pole pieces 59 and 60 described above. The pole pieces 62 and 63 are positioned on opposite sides of the free upper end of the reed 43. A coil 64 surrounds the coil supporting bar 55 and the closed end of each of the cores 58 and 61.

The manner of operation of the form of the invention illustrated in Figures 3 to 7 is essentially the same as that described above. When alternating current of a frequency corresponding to the resonant frequency of the reed 43 is fed to the coil 64, the reed 43 will be caused to vibrate at its resonant frequency while the reed 44 will not vibrate. Conversely, the reed 44 will be caused to vibrate when alternating current corresponding to its resonant frequency is fed to the coil 64. The apparatus may be used to open and close a pair of electrical circuits. A contact which is common to both circuits may be connected to the base 40 by any suitable means such as by clamping between the nut 54 and the lower surface of the base. The current can flow from such connection to both of the reeds 43 and 44. The individual circuits are connected respectively to the cores 58 and 61 by any suitable means such as by soldered contacts 65 and 66. In this manner the circuit connected to the core 61 will be intermittently closed during vibration of the reed 43, while the circuit connected to the core 58 will be intermittently closed during vibration of the reed 44.

Figures 7 and 8 illustrate the manner in which the mechanical damping means can be applied to the form of the invention illustrated in Figures 3 to 6. A brush of filaments similar to those described above is attached to the mid-portion of either side of the base 40. A brush designated generally by the reference numeral 67 is secured to the base by means of the screw 68 and is positioned so that portions of its filaments lie on either side of the reed 43 and in the plane of vibration thereof. A similar brush 69 is secured to the opposite side of the base by means of a screw 70, and is similarly positioned with respect to the reed 44. The brushes 67 and 69 may be provided with hoops 71 which surround the filaments and which are slidable longitudinally thereof. Adjustment of the hoops 71 along the length of the filaments effects adjustment

of the energy absorbing capacity and damping characteristics of the brushes 67 and 69.

A further form of the invention is illustrated in Figures 9 and 10. In this form of the invention the number of vibrating reeds has been increased to six. Three permanent magnets are associated with the vibrating reeds while a single coil is used to drive the reeds. The reeds have different resonant frequencies, and any given reed will be vibrated when an alternating current corresponding to its frequency is supplied to the coil which is common to all of the reeds.

A base plate 80 is constructed of non-magnetic and non-conductive material. Reed supporting standards 81, 82, 83, 84, 85 and 86 are secured to the base 80 by any suitable means such as screws 87 and these standards extend upwardly from the base in parallel equally spaced relationship, as best illustrated in Figure 9. Each of the standards 81 to 86 has a vibrating reed secured thereto, these reeds being designated by the reference numerals 91, 92, 93, 94, 95 and 96, respectively. A magnet support 97 extends upwardly from the base 80 between the reeds 91 and 96. The magnet support 97 rigidly supports a permanent magnet 98. One pole of the permanent magnet 98 is disposed adjacent the mid-portion of the reed 91 while the opposite pole of the magnet is disposed adjacent the mid-portion of the reed 96. The polar axis of the magnet 98 extends at substantial angles to the longitudinal axes of the reeds 91 and 96 and also extends at substantial angles to the planes of vibration of those reeds. A magnet support 99 supports a permanent magnet 100 in a similar position between the reeds 92 and 93 while a magnet support 101 supports a permanent magnet 102 between the reeds 94 and 95. In spite of the fact that the permanent magnets are not strictly at right angles to their associated reeds, this arrangement subjects all of the reeds to magnetic effects similar to those discussed above in connection with the description of the form of the invention illustrated in Figures 1 and 2.

The reeds 91 to 96 are provided with mechanical damping means 103 which are similar to those described above and which are secured to the upper ends of the reed supporting standards.

All of the vibrating reeds 91 to 96 point toward the center of the base 80 and a driving coil with appropriately positioned pole pieces is positioned above the center of the base. The coil is designated by the reference numeral 110 and is provided with a laminated magnetic core 111 in the form of a coiled strip of magnetic material. An upper pole plate 112 is positioned above the coil 110 while a lower pole plate 113 is positioned below the coil. A spacer member 114 is positioned between the lower pole plate 113 and the base 80. A bolt 115 extends through the pole plates 112 and 113, through the laminated core 111, the spacer member 114 and the base 80, and these elements are rigidly clamped together by means of a nut 116. The bolt 115 maintains the ends of the laminated core 111 in intimate contact with the magnetic pole plates 112 and 113.

The pole plates 112 and 113 are provided with a pair of adjustable pole pieces for each of the reeds 91 and 96. Since these pole pieces are identical it will be sufficient to describe one pair of the pole pieces in detail. An adjustable pole piece 117 is threadably secured in the upper pole plate 112 and extends downwardly to terminate adjacent the free end of the reed 91. A lock nut

118 may be used to retain the pole piece 117 in its adjusted position. A lower pole piece 119 is threadably secured in the lower pole plate 113 and extends upwardly to terminate beneath the free end of the reed 91.

The arrangement illustrated in Figures 9 and 10 can be used to control the periodic opening and closing of six circuits. A contact common to all six of the circuits may be electrically connected to the pole plates 112 and 113 by connecting it to the bolt 115. This common contact is thus electrically connected to all six sets of pole pieces. Contacts which are individual to each circuit may be connected in electrical contact with the reeds 91 and 96 by connecting those contacts to the reed supports 81 and 86, respectively.

Except for the greater number of reeds and magnets involved and the fact that more circuits are controlled, the operation of this form of the invention is the same as that described above.

I have illustrated and described what I now consider to be the preferred embodiments of my invention. It will be understood, however, that various modifications and alterations may be resorted to without departing from the broader scope of the invention as defined by the following claims.

Having thus described my invention, I claim:

1. In a polarized relay, a pair of spaced movable members of magnetic material each of which is fixedly supported at one end and free to move at the other end, both of said movable members lying in a common plane and being free to vibrate in separate planes perpendicular to said common plane, a magnet stationarily positioned with its polar axis in said common plane and with a first pole thereof in juxtaposition to an intermediate portion of the length of one of said movable members and with the second pole thereof in juxtaposition to an intermediate portion of the other of said movable members, the polar axis of said magnet being disposed at a substantial angle to the longitudinal axis of each of said movable members, and means for inducing movement of the free end of each movable member, said movement inducing means comprising a core having pole pieces disposed on opposite sides of each movable member near the free end and in the plane of movement thereof, and a coil surrounding said core.

2. A vibrating reed assembly comprising a pair of spaced vibratile reeds of magnetic material each of which is fixedly supported at one end, said movable members lying in a common plane and being free to vibrate in separate planes perpendicular to said common plane, a magnet stationarily positioned with its polar axis in said common plane and with a first pole thereof in juxtaposition to an intermediate portion of the length of one of said reeds and with the second pole thereof positioned adjacent an intermediate portion of the length of the other of said reeds, the polar axis of said magnet being disposed at substantial angles to the longitudinal axes of said reeds to thus establish magnetic fluxes of like polarity in both ends of each of said reeds but with the flux in the ends of one reeds being of opposite polarity to the flux in the ends of the other reed, and electromagnetic means for inducing vibration of said reeds.

3. A vibrating reed assembly comprising a pair of parallel vibratile reeds of magnetic material fixedly supported at one of their ends, said reeds lying in a common plane and being capable of

vibrating in spaced parallel planes perpendicular to said common plane, a magnet stationarily positioned with its polar axis lying in said common plane perpendicular to the planes of vibration of said reeds, a first pole of said magnet being in juxtaposition to an intermediate portion of the length of one of said reeds and the second pole of said magnet being in juxtaposition to an intermediate portion of the other of said reeds, to thus establish magnetic fluxes of like polarity in both ends of each reed but with the flux in the ends of one reed being of opposite polarity to the flux in the ends of the second reed, electromagnetic pole pieces on opposite sides of said reeds near the free ends thereof and in the planes of vibration of the reeds, and an electrical conductor surrounding the magnetic flux paths through said electromagnetic pole pieces.

4. A vibrating reed assembly as described in claim 3 in which each of said vibratile reeds is a tuned reed which is caused to vibrate only upon passage through said electrical conductor of an alternating current having a frequency corresponding substantially to the tuned frequency of the reed.

5. A vibrating reed assembly as defined in claim 3 including mechanical means for damping vibration of each of said vibratile reeds, said damping means comprising a plurality of flexible, filamentary, energy absorbing members in generally parallel relationship and so positioned that at least a portion of said filamentary members contacts the reed during vibration thereof.

6. A vibratory reed assembly comprising a plurality of pairs of vibratile reeds disposed in a common plane and fixedly supported at their outer ends with their free inner ends converging toward but stopping short of a central axis perpendicular to said plane, said reeds being free to vibrate in planes perpendicular to said common plane, a magnet stationarily positioned with its polar axis in said common plane between the reeds of each pair with the first pole of the magnet being adjacent a mid-portion of one of the reeds of the associated pair and with the second pole of the magnet being adjacent the second reed of the pair, an electrical coil having a core coinciding with said central axis, and pole pieces on opposite sides of the free inner end of each reed, said pole pieces being in the path of flux induced by flow of current through said coil.

7. A vibrating reed assembly as described in claim 6 in which each of said vibratile reeds is a tuned reed which is caused to vibrate only upon passage through said electrical conductor of an alternating current having a frequency corresponding substantially to the tuned frequency of the reed.

8. A vibrating reed assembly as defined in claim 6 including mechanical means for damping vibration of each of said vibratile reeds, said damping means comprising a plurality of flexible, filamentary, energy absorbing members in generally parallel relationship and so positioned that at least a portion of said filamentary members contacts the reed during vibration thereof.

9. A vibrating reed assembly comprising a vibratile reed of magnetic material fixedly supported at one end and free to vibrate in a plane, a magnet stationarily positioned with its polar axis lying in a plane perpendicular to said plane of vibration and with a first pole thereof in juxtaposition to an intermediate portion of the length of said reed and with the polar axis of said mag-

net disposed at a substantial angle to the longitudinal axis of said reed to thereby position the second pole of said magnet a substantially greater distance than said first pole from said reed to thus establish a magnetic flux of like polarity in each end of said reed, electromagnetic means for inducing vibration of said reed, and mechanical damping means for said reed comprising a plurality of flexible, filamentary, energy absorbing members in generally parallel relationship and so positioned that at least a portion of said filamentary members contacts said reed during vibration thereof.

10. A vibrating reed assembly comprising a vibratile reed of magnetic material fixedly supported at one end and capable of vibrating in one plane, a magnet stationarily positioned with its polar axis lying in a plane passing through said reed and perpendicular to the plane of vibration of said reed, said polar axis of said magnet forming a substantial angle with the plane of vibration of said reed, a first pole of said magnet being in close juxtaposition to an intermediate portion of the length of said reed but slightly displaced from the plane of vibration thereof, and the second pole of said magnet being spaced from the plane of vibration of said reed a substantially greater distance than said first pole to thus establish a magnetic flux of like polarity in each end of said reed, electromagnetic pole pieces on opposite sides of said reed near the free end thereof and in the plane of vibration of the reed, and an electrical conductor surrounding the magnetic flux path through said electromagnetic pole pieces.

11. A vibrating reed assembly comprising a vibratile reed of magnetic material fixedly supported at one end and capable of resonant vibration in one plane, electromagnetic pole pieces on opposite sides of said reed near the free end thereof and in the plane of vibration of the reed, a magnet stationarily positioned with its polar axis lying in a plane passing through said reed and perpendicular to the plane of vibration thereof, said polar axis forming a substantial angle with the plane of vibration of said reed, a first pole of said magnet being in juxtaposition to the approximate mid-portion of the length of said reed but slightly spaced from the plane of vibration thereof, and the second pole of said magnet being spaced from said reed and from said pole pieces a substantially greater distance than said first pole to thus establish a magnetic flux of like polarity in each end of said reed, and an electrical conductor surrounding the magnetic flux path through said electromagnetic pole pieces to cause said reed to vibrate at its resonant frequency upon passage of alternating current of such frequency through said conductor.

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