Aug. 31, 1954 A. S. HOLZINGER ET AL 2,688,059

ELECTROMECHANICAL DEVICE

Filed Aug. 14, 1950

Fig. 1.

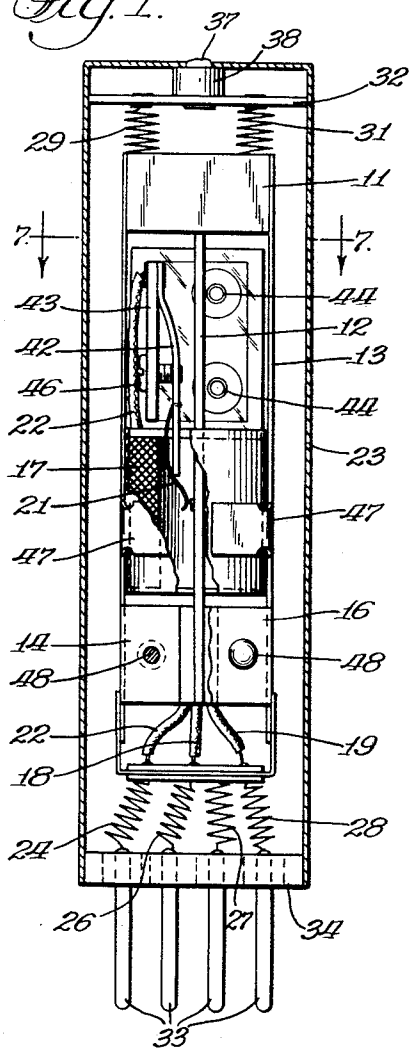
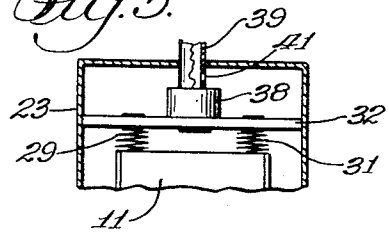


Fig. 5.



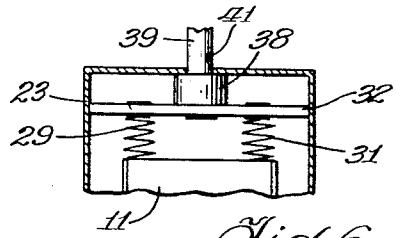


Fig. 6.

Fig. 7.

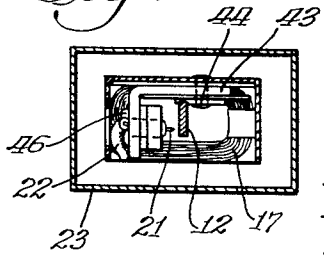


Fig. 2.

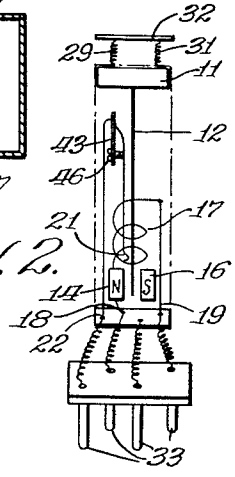
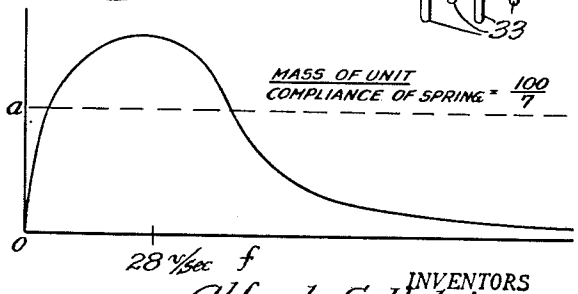


Fig. 4.



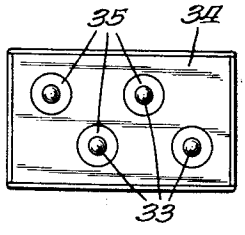


Fig. 3.

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ELECTROMECHANICAL DEVICE

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5 Claims. (Cl. 200—91)

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This invention relates generally to selective electro-mechanical switching or contacting devices. More particularly, the invention relates to a frequency selective electric switch of the type having as one of the contacts thereof a vibrating reed which is adapted to distinguish between electrical signals having closely adjacent frequencies.

The use of systems for remote signalling and remote control are now well known and are continually finding new applications. The need for simple and dependable structures and systems which are highly selective has become more acute. As an example, in two-way communication systems, and particularly in a two-way mobile communication system, it is necessary to provide some means for advising one station that another station desires to communicate with it. For operational reasons, it is essential that such means utilize the normal communication channel and be completely automatic, in that it utilizes the received calling signal to actuate a light or other indicating device, or to condition a receiver for operation when its particular calling signal is received. In the past such selective systems have utilized electrically operable selective switching or contacting mechanisms having a vibrating reed as one of its contacts. It is well known that if a reed is physically distorted and released, it will mechanically vibrate at a natural frequency determined mainly by its physical dimensions. By providing selective switches in each of the stations with vibrating reeds having natural or resonant frequencies, different than the resonant frequencies of the reeds of other stations, such a calling system can be provided. In order that the system operate satisfactorily, however, each of the vibrating reed structures must be sufficiently selective so that it responds only to a desired calling signal having a frequency substantially equal to the resonant frequency of the reed, but is substantially unresponsive to other calling signals having frequencies relatively closely adjacent its resonant frequency. This characteristic is referred to as the selectivity of the reed.

There are two important factors which determine the ultimate selectivity of vibrating reed contact making devices. The first factor is the resonant frequency of the reed, or the frequency at which the reed will vibrate at its maximum amplitude for a given driving force, and the second is the sensitivity or the amount driving force necessary to cause the contacts to open and close when the driving force is at the resonant frequency.

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The resonant frequency of a vibrating reed is determined by several factors, all of which must be considered when designing a switch to respond to a particular calling frequency. In known selective switches of this type these factors have been satisfactorily accounted for, with the exception that difficulty has been encountered in providing a mounting for the working mechanism, or reed structure itself, which prevents transfer of vibrations through the mounting to the reed structure. By providing a very heavy and solid mounting, this difficulty has been overcome to some extent, but such a mounting results in outside loading effects, is not completely effective in shielding the reed from outside vibrations, and further adversely affect the selectivity of the switch. Additionally, the range of frequencies covered by switches having reeds mounted in this fashion, is limited because of manufacturing complications arising in the higher frequency units.

It is therefore one object of the present invention to provide a small, compact and inexpensive selective switch mechanism for use in mobile communication equipment, having a vibrating reed contact for providing frequency selective operation.

Another object of this invention is to provide an electrically operable, vibrating reed selective switch mechanism for use in mobile communication equipment, and having improved frequency selectivity characteristics.

A further object of the invention is to provide a vibrating reed switch mechanism having a novel means for mounting the vibrating reed structure on a supporting chassis which is effective to prevent the transfer of reed vibrations to bodies other than the reed structure, and to prevent the transfer of disturbances having frequencies in the vicinity of the calling frequency, to the reed.

A feature of the invention is the provision of a vibrating reed structure having resilient spring mounting means for supporting the reed structure from a supporting chassis.

Another feature of the invention is the provision of a spring mounted, mechanical vibrating reed structure contained within a housing having an orifice therein, the spring mounting means for the reed being utilized to close a valve mechanism over the orifice in the housing.

Other objects, features, and many of the attendant advantages of this invention will become apparent from a consideration of the following description taken in connection with the accompanying drawings, wherein:

Fig. 1 is a longitudinal sectional view of a novel selective electric switch constructed in accordance with the invention;

Fig. 2 is a schematic diagram showing the functional elements of the mechanism illustrated in Fig. 1;

Fig. 3 is a bottom view of the switch mechanism;

Fig. 4 is a graph illustrating the amplitude of vibration versus the frequency characteristic of a portion of the switch mechanism shown in Fig. 1;

Fig. 5 is a fragmentary sectional view of a novel valve structure made possible by the invention, and showing the valve structure in the first of its operative positions;

Fig. 6 is a fragmentary sectional view of the valve structure showing the same in a second of its operative positions; and

Fig. 7 is a cross sectional view of the novel switch mechanism taken through plane 7—7 of Fig. 1.

In practicing the invention, a selective electric switch mechanism is provided including an outer housing supporting an inner housing therein. A reed member constructed of magnetizable material, and supported at one end, is secured within the inner housing along with a permanent magnet having its poles positioned on either side of the free end of the reed member. An electrically operable coil is positioned adjacent the magnet and surrounding the reed member. A flexible contact having a mounting for suppressing vibrations thereof is positioned to be engaged by the reed and the reed and contact are connected in an electrical circuit. The dimensions of the reed are selected so that a predetermined natural frequency of vibration is provided, and when an electrical signal is applied to the coil, having a frequency substantially equal to the frequency of vibration of the reed, the reed vibrates to close the electrical circuit through the switch contact. To prevent transfer of vibrations from the inner housing to the second or outer housing, the former and all of its component parts are supported within the outer housing by resilient spring means, and the mass of the inner housing taken in connection with the spring means has a frequency of vibration which is substantially lower than the lowest frequency used in the system in which the vibrating reed switch structure would be applied. The mounting therefore tends to prevent application of frequencies within the reed range from being applied from an external source, to the reed structure and to prevent the loading effect of external bodies on the reed vibrations. The resilient spring means are also utilized as lead in electrical connections for the mechanism and for providing a valve for closing an opening in the outer housing.

Referring now to Fig. 1 of the drawings, the switching mechanism includes a base member 11, and a lever member or vibrating reed 12 constructed of a magnetizable material. The vibrating reed 12 is rigidly secured to the base 11, and, generally speaking has considerably less mass than the pedestal. The reed 12 and base member 11 are positioned in a first, or inner sheet metal housing 13 of rectangular construction, with the vibrating reed 12 extending along the longitudinal axis of the housing. Housing 13 also contains a permanent magnet means having one pole 14 positioned on one side of the free end of reed 12, and the other pole 16 positioned on the opposite side of reed 12. Physically disposed adjacent permanent magnet 14—16, and surrounding reed 12, is a coil winding 17 which may be connected by a pair of lead-in conductors 18 and 19 to a source of calling signals derived from a radio receiver, or the like. Housing 13 also contains an electric switch contact assembly including a fine wire contact 21 connected to a lead-out electrical conductor 22, and physically disposed adjacent one side of reed 12 so as to be engaged by the reed upon the same being pulled towards it. Upon connecting the reed 12 to one side of an electrical circuit to be controlled, and the conductor 22 to the remaining side of the same circuit, the mechanism heretofore described will operate as a selective switch for controlling the application of electric energy thereto. Referring next to Fig. 2, the components of the selective switch described in Fig. 1, are illustrated schematically. When an alternating electric signal is applied through conductors 19 and 18 to coil 17, a varying magnetic field is produced around the coil in accordance with the principles of electromagnetism. This field either adds to, or subtracts from the field produced by permanent magnets 14 and 16, depending upon which half cycle, the signal applied to coil 17 is passing through. As previously stated, reed 12 is constructed of a magnetizable material, and is normally positioned midway between poles 14 and 16. During one half cycle of the applied signal, the combined field of magnets 14 and 16, and coil 17, causes the end of reed 12 to be pulled to one side, and upon the applied signal passing through the next succeeding half cycle, opposition of the two fields allows the reed to flex back toward its normal position. It is apparent, that if the signal applied to coil 17 is of the same frequency as the resonant frequency of vibration of reed 12, the varying magnetic field thus produced, will cause reed 12 to vibrate at its resonant frequency. This is due to the fact that the natural flexure of the reed 12 will be in phase with, and augment the motion produced therein by the varying magnetic field. Reed 12 thereby vibrates at a maximum amplitude, and serves to close the electrical circuit through contact 21 during a portion of each vibration period; thereby controlling the application and energization of the electrical circuit in which the switch formed by contact 21 and reed 12 is included.

As previously stated, for proper operation of a unit as described above, it is necessary to prevent outside loading of the reed, as well as the mechanical application of disturbances thereto which are of frequencies closely adjacent to that of the reed, and might therefore cause vibration of the reed. In structures which are directly connected to a chassis or other support the effect of vibration transfer may be reduced by making the mass tof the entire structure much greater than the mass of the reed. However, as the reed frequency goes up, the mass thereof increases and the ratio of the mass of the mounting to the mass of the reed tends to decrease. To overcome this, attempts have been made to secure the contactor structure rigidly to a large body such as a supporting chassis but it is apparent that the effective mass of the unit in such case depends upon the rigidity of the securing means. These problems are overcome in the system which provides a resilient mounting for the switch structure which is resonant at a frequency much lower than the frequencies selected and bypasses higher frequencies to thereby isolate the reeds

from external vibrations of the frequencies to which the reeds respond.

Adverting again to Fig. 1, the first or inner housing 13 is contained within an outer housing 23 of copper or the like, and is freely supported therein by resilient spring means. The resilient spring means includes a first group of electrically conductive, resilient springs 24, 26, 27 and 28, physically connected between inner housing 13 and outer housing 23, and a second group of resilient springs 29 and 31 physically connected to inner housing 13, and to an insulating plate 32 secured to outer housing 23 in a manner to be described hereinafter. Springs 24, 26, 27 and 28, are electrically connected to conductors 22 and 18, inner housing 13, and conductor 19 respectively, and serve to energize contact 21, reed 12 and coil 17, as well as to provide physical support for inner housing 13. The remaining ends of springs 24, 26, 27 and 28 are connected to a plurality of prongs 33 which, as is best shown in Fig. 3, are mounted in the base 34 of outer housing 23, by means of a plurality of insulating bushings 35 secured to base 34. The end of housing 23 opposite base 34 has an orifice 37 centrally disposed therein for a purpose, hereinafter to be explained. Orifice 37 is closed by a cylindrical disc 38 centrally mounted on plate 32, and biased into a position to close orifice 37 by means of springs 29 and 31. In a completed structure, the metallic disc 38 is soldered to the top of outer housing 23, and permanently closes orifice 37. By this construction, a compact self-contained selective switch is provided, which may be easily installed on a supporting chassis of the equipment with which it is to be used.

By properly proportioning the mass of inner housing 13 including base 11, reed 12, permanent magnet means 14 and 16, coil 17, adjustable contact 21, and conductors 18, 19 and 22 to the compliance of springs 24, 26, 27, 28, 29 and 31, the reed 12 can be effectively isolated from external loading, thereby greatly improving its selectivity. The ratio of the mass of housing 13 and all its components to the compliance of the spring, hereafter called the ratio of mass over compliance, is relatively critical, as this ratio controls the resonant frequency of the housing 13 plus all its components and the springs, hereinafter called the unit, for satisfactory operation, it must be such that resonant frequency of the unit is lower than the lowest calling frequency used to actuate the switch. It has been determined that structures in accordance with the invention can be constructed with the ratio of the mass of the unit to the compliance of the springs of approximately 100:7, and the resonant frequency of the unit will then be around 28 cycles. This is substantially below the range of frequencies which will normally be used in a calling system as they start at about 100 cycles.

Referring now to Fig. 4 of the drawings wherein the frequency of vibration of the unit is plotted along the y axis and the amplitude of oscillation or vibration is plotted along the x axis, the response of the unit to varying vibration frequencies is shown. It can be seen that the maximum amplitude of vibration occurs at approximately 28 cycles, and thereafter drops considerably below the amplitude of vibration of the reeds, as indicated by the dotted line. The amplitude of vibration is substantially constant at a very low order amplitude throughout the remaining portion of the frequency spectrum. From this graph it can be seen that above approximately 60 cycles, the effect of vibration of the mass of the unit on the vibration of any one of the reeds, is negligible, and is substantially constant for all higher frequencies, thereby effectively isolating the response of any one of the reeds from the response of the mass of the unit, and rendering all of the frequencies above 60 cycles available for use as calling frequencies.

As a further feature, the invention renders possible a novel means for dehumidifying the inside of the outer housing 23. In mechanically operating devices, it is essential that the device be mounted in a substantially moistureproof container to prevent spoilage from rusting, and the like. The moisture-proofing of such devices can be a relatively expensive operation. Because of the valve means provided by the construction of insulating plate 32, cylindrical disc 38, springs 29 and 31, and orifice 37, the dehumidification of the interior of outer housing 23 is easily accomplished. Referring now to Fig. 5, when the selective switch mechanism shown in Fig. 1 is assembled, a tube 39 is inserted in the orifice 37 of the outer housing 23, and cylindrical disc 38 depressed away from the housing. The tube 39 has an orifice 41 in one side of the end thereof, and may be connected to a source of nitrogen or the like. By this means the interior of housing 23 can be filled with nitrogen, which is moisture absorbing and which removes the moisture when it escapes. Upon retracting tube 39 from orifice 37, disc 38 automatically closes the orifice, in the manner shown in Fig. 6, thereby sealing the interior of the housing. Disc 38 may then be soldered to outer housing 23, and the housing permanently sealed against the entrance of moisture and air.

In order that the selective switch function properly over a sustained period, electric switch contact 21 is mounted on an adjustable arm 42 secured to an L-shaped member 43, fixed to inner housing 13 by rivets 44 in the fashion shown in Fig. 7. Adjustable arm 42 is secured to plate 43 in a cantilever fashion and is adjustable by means of a set screw 46 to position the contact 21 to be engaged by vibrating reed 12 upon the same being vibrated. Contact 21 comprises a very fine Phosphor-bronze wire secured to adjustable arm 42 at a point in from the end thereof, and bent in such a manner that it bears against the end of adjustable arm 42. By this structure the end of the adjustable arm 42 damps the contact 21 and prevents vibration thereof after it is disengaged by the reed 12. As a further precaution, coil 17 is rigidly secured in place by a pair of bent over ears 47, and permanent magnets 14 and 16 secured in place by rivets 48. Reed 12 is cast integral with its mounting pedestal 11, or, if desired, may be positioned in a well in the pedestal and soldered or welded thereto. The pedestal 11 is of course rigidly secured to inner housing 13 by soldering or the like.

From the foregoing disclosure, it can be appreciated that the invention provides a switch mechanism having a highly selective frequency response characteristic. By reason of the novel manner of mounting the mechanism, the selectivity of the switch mechanism is relatively unaffected by the support on which it is mounted. Further, the novel mounting means for the mechanism provides a unit in which the frequency spectrum for use in selective switch devices may be extended, and proper operation of the switch will be provided in such extended portions of the spectrum. Additionally, the inven-

tion makes possible a novel method of dehumidifying the entire interior of the switch mechanism container, thereby resulting in lower manufacturing costs.

Obviously, other modifications and variations of the invention will be suggested to those skilled in the art by the above teachings. It is therefore to be understood that such changes are within the intended scope of the invention as defined by the appended claims.

I claim:

1. A frequency responsive vibrating device for selectively responding to a predetermined signalling frequency including in combination, a first completely enclosed housing having an orifice therein through which a dehumidifying gas may be passed and which may thereafter be sealed; a second housing contained within said first housing and including a vibratory member constructed of magnetizable material, a permanent magnet having its poles positioned on either side of the free end of said vibratory member, and a coil winding disposed adjacent said permanent magnet and surrounding said vibratory member; a first group of resilient springs secured to both of said housings; a second group of resilient springs secured to said second housing and to a movable plate within said first housing, and valve means secured to said plate and cooperating with the aforesaid orifice to close the same, said resilient springs of said first and second groups freely supporting said second housing within said first housing, and the resonant frequency of vibration of said vibratory member being greater than the resonant frequency of vibration of said second housing and said resilient springs.

2. A selective frequency responsive switch including a first completely enclosed housing having an orifice therein through which a dehumidifying gas may be passed and which may thereafter be sealed and further having a plurality of electrically conductive prongs secured thereto, a second housing contained within said first housing and including a lever member constructed of magnetizable material, a permanent magnet having its poles positioned on either side of the free end of said lever member, a coil winding disposed adjacent said permanent magnets and surrounding said lever member, and an adjustable electric contact adapted to engage said lever member, said selective switch further including electrically conductive resilient spring means secured to both of said housings for freely supporting said second housing within said first housing and for supplying electrical energy to said coil and the switch formed by said lever member and said adjustable contact, said spring means also being electrically connected to said prongs, and valve means fixed to said spring means and cooperating with said orifice for closing the same, the resonant frequency of vibration of said lever member being greater than the resonant frequency of vibration of said second housing and said spring means.

3. A frequency responsive switch adapted to respond to a predetermined signalling frequency above 60 cycles per second including in combination, a switch structure including a housing having a vibratory member made of magnetizable material supported therein, said vibratory member being mechanically resonant at a predetermined frequency above 60 cycles per second, electrically operable means within said housing for producing a fluctuating magnetic field about said vibratory member in response to the application of signaling frequencies thereto, with a field fluctuating at said predetermined frequency causing vibration of said member, said switch structure including a resilient contact positioned to be engaged by said vibratory member when the same is operated and forming therewith the contacts of an electric switch, a supporting chassis for said switch structure, and resilient mounting means including a plurality of coil springs for supporting said housing on said supporting chassis, said springs providing electrical connection to said electrically operable means and said switch contacts, the ratio of mass over compliance of said switch structure and said resilient mounting means being such that the resonant frequency of vibration of said switch structure and resilient mounting means as a unit is approximately 28 cycles per second.

4. A frequency responsive vibrating device for selectively responding to signals of a predetermined frequency above 60 cycles per second including in combination, frame means, a vibratory member of magnetizable material mechanically resonant at said predetermined signalling frequency above 60 cycles per second mounted on said frame means, electrically operable means mounted on said frame means for producing a magnetic field about said vibratory member fluctuating at a rate determined by the signals applied thereto, whereby said vibratory member is caused to vibrate by a field fluctuating at said predetermined frequency, a supporting chassis, and resilient coil spring means for supporting said frame means on said supporting chassis, said frame means and the parts mounted thereon and said supporting spring means forming a resonant vibrating system, said resonant vibrating system having a predetermined mass and a predetermined compliance such that the ratio of said mass to said compliance imparts a natural frequency of vibration to said vibrating system which is less than one-half said predetermined resonant frequency of said vibratory member and reduces to a minimum external loading effects on said vibratory member at said predetermined frequency.

5. A frequency responsive vibrating device for selectively responding to signals of a predetermined frequency above 60 cycles per second including in combination, frame means, a vibratory member of magnetizable material mechanically resonant at said predetermined signalling frequency above 60 cycles per second mounted on said frame means, electrically operable means mounted on said frame means for producing a magnetic field about said vibratory member fluctuating at a rate determined by the signals applied thereto, said field causing vibration of said member in response to fluctuation thereof at said predetermined frequency by a signal of said predetermined frequency, a supporting chassis, and resilient spring means for mounting said frame means on said supporting chassis, said frame means together with the parts mounted thereon and said resilient spring means forming a vibrating system, said vibrating system having a predetermined mass and a predetermined compliance such that the ratio of said mass to said compliance imparts a natural frequency of vibration to said vibrating system which is less than one-half said predetermined resonant frequency of said vibratory member and substantially eliminates external loading effects on said vibratory member at said predetermined frequency.

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