March 22, 1966 K. R. WOOLLEY 3,242,296

CONTACT DEVICE FOR ENGAGING VIBRATORY MEMBER

Filed Sept. 19, 1963

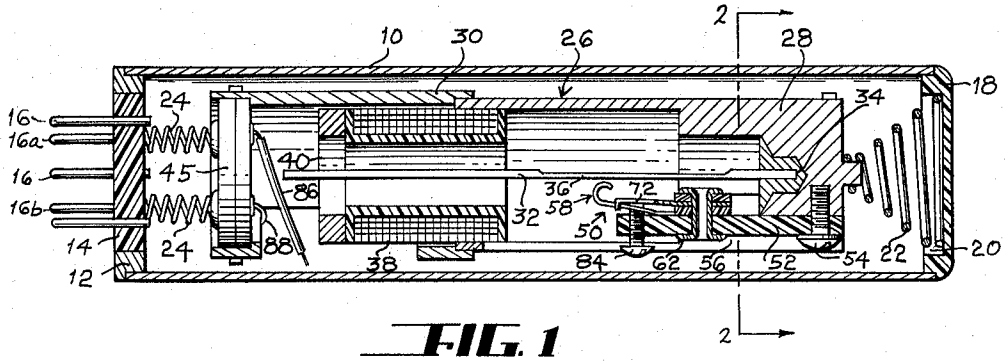


FIG. 1

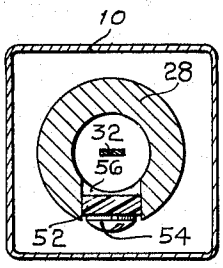


FIG. 2

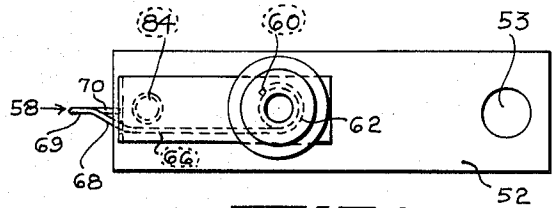


FIG. 3

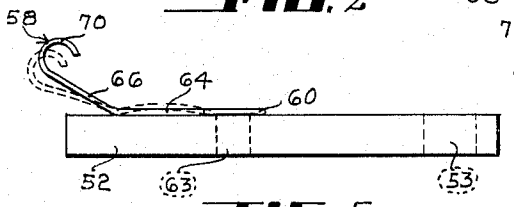


FIG. 5

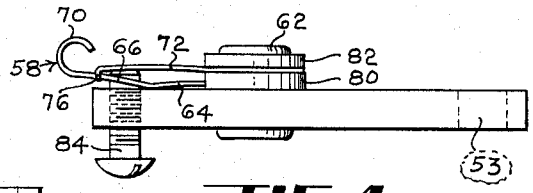


FIG. 4

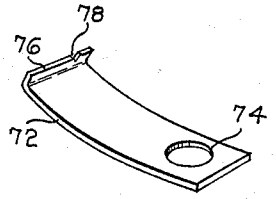


FIG. 6

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CONTACT DEVICE FOR ENGAGING VIBRATORY MEMBER

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This invention relates to an improved reed contact and more particularly to a contact adapted to engage cantilever supported vibratile reed elements. However, the invention is not necessarily so limited.

Resonant reed devices of the type improved by the present invention typically comprise a ferromagnetic reed element supported in a varying magnetic field, such as the field of a solenoid coil having an alternating voltage input, and a contact means positioned adjacent the reed to detect vibration of the reed. Frequently the reed is supported as a cantilever and has a frequency of resonant vibration dependent upon its length, mass, resiliency and other structural properties. The contact is spaced from the reed so as to engage the reed only when the amplitude of reed vibration is great, and more specifically only when the reed is in resonance with a signal frequency passing through the solenoid coil.

In the construction of resonant reed relays of this type it has been found that the construction of the contact which engages the reed during periods of resonant reed vibration has an important bearing on the performance of the relay device. If the contact is too rigid the vibrating reed tends to bounce off the contact and the vibratory motions of the reed become irregular and unpredictable. On the other hand, if the contact is too flexible, the contact tends to bounce off the reed, and to vibrate independently with the result that the contact does not engage the reed at regular intervals and the signal produced by the relay device becomes erratic.

An object of the present invention is to provide a new and improved contact assembly for engaging vibratile elements.

Another object of the present invention is to provide a new and improved reed relay contact assembly having a prestressed contact element.

Still another object of the present invention is to provide a new and improved reed relay assembly having a prestressed contact element which, upon engagement with the vibratory reed of the relay device, is driven to a position of increased stress.

A further object of the present invention is to provide a new and improved contact assembly for use in reed relay devices, the contact assembly including a bias means which pre-stresses the contact element and the bias means, including means to guide the contact element to a fixed position for engagement with the vibratory reed of the relay device.

Other objects and advantages reside in the construction of parts, the combination thereof, the method of manufacture and the mode of operation, as will become more apparent from the following description.

In the drawings:

FIGURE 1 is a longitudinal sectional view of a reed relay device embodying the present invention.

FIGURE 2 is a transverse sectional view taken substantially along the line 2—2 of FIGURE 1.

FIGURE 3 is a plan view of a contact assembly employed in the device of FIGURE 1.

FIGURE 4 is a side elevation view of the contact assembly of FIGURE 3.

FIGURE 5 is a side elevation view illustrating a partial assembly of the contact assembly of FIGURE 3 and illustrating in phantom detail the distortion occurring in a spring wire contact element upon completion of the contact assembly.

FIGURE 6 is a perspective view of a biasing spring employed in the contact assembly of FIGURE 3.

Referring to the drawing in greater detail, reference numeral **10** designates a protective housing for the reed relay assembly, this housing being rectangular in cross section as illustrated in FIGURE 2. One end of the housing is enclosed with an annular metal plate **12** having an insulating plastic insert **14**. The insert **14** supports prongs **16** which are adapted to fit into a conventional tube socket.

The opposite end of the housing **10** is enclosed by an insulating plate **18** having a circular recess **20** in the interior surface thereof which receives the base of a spring wound spirally but convergently so as to have a conical shape. The spring **22** engages one end of an interior frame which supports the reed relay assembly. The opposite end of the frame **26** is supported by four coil springs **24**, each of which makes electrical contact with one of the prongs **16** and each of which seats in an insulating disc **45** at said opposite end of the frame **26**. Only two of the four coil springs **24** appear in FIGURE 1, the other two springs being located in the portion of the assembly which has been removed to produce the sectional view illustrated.

The frame **26** comprises two telescoping, hollow, cylindrical sections **28** and **30**, both sections being of metallic construction. An elongate reed **32** is disposed coaxially within the sections **2** and **30** and secured at a central position to the interior of the end wall for the section **28** by soldering as illustrated at **34**. The reed is thus supported as a cantilever. To provide the cantilever supported reed with a frequency of resonance in the desired range, the reed may be undercut adjacent its fixed end as illustrated at **36**, thereby increasing the flexibility of the reed. As can be observed in FIGURE 2, the reed is essentially rectangular in cross section.

Surrounding the reed **32** near its free end is a solenoid coil **38** and adjacent the coil **38** is an annular permanent magnet **40** slip-fitted within the section **30** of the frame **26** and secured by a suitable cement. The solenoid coil **38** is adapted to receive an electrical signal through conductors connected with two of the springs **24** and two of the prongs **16**. These conductors have been omitted from the drawing so as not to obscure the details therein.

The annular permanent magnet **40** has diametrically opposed north and south poles, these poles being disposed opposite the flat surfaces of the reed **32**. When an alternating voltage signal is impressed upon the coil **38**, the free end of the reed **32** alternately receives induced north and south magnetic polarities with the result that the reed is alternately attracted to and repelled from the magnetic poles in the permanent magnet **40**. When the frequency of the signal received by the coil **38** matches the natural resonant frequency of the reed **32**, as determined by the undercut **36**, the reed vibrates with large amplitude.

As is apparent from the foregoing description, the reed relay device illustrated has been suspended by means of springs in a supporting container, such that the reed relay device has been substantially isolated from external

vibrations. Suspended reed relay devices of this type are especially useful in the mobile communications field, since they may be operated in moving vehicles without interference attributable to vibrations produced by the vehicle itself.

It is to be understood that the reed relay device of FIGURE 1 merely illustrates one possible application for the present invention, which invention resides principally in the contact construction for the relay device. The description of this contact assembly, as associated with a reed relay device especially constructed for mobile applications, is not intended to limit the scope of applications for the present contact assembly in any manner.

Resonant vibration of the reed **32** is detected by means of the contact assembly designated generally by the reference numeral **50**. This assembly includes an elongated, insulating plastic plate **52** having an aperture **53** adjacent one end thereof which receives a screw **54** threaded into the section **28** of the inner frame **26**. As best seen in FIGURE 2, the section **28** has an axial slot **56** therein to receive the plate **52**.

The plate **52** is adapted to support a spring wire contact **58**, best seen in FIGURES 3 and 5. The wire of this contact is of a material suitable to the requirements of electrical contacts such as well known alloys of the platinum group. At one end the wire of the contact **58** is curved to form a hook **60** thereon, which is adapted to encircle the stem of a rivet **62**, passed through an aperture **63** in the plate **52**. As best seen in FIGURE 5, the contact **58**, when relaxed, i.e., not stressed, has a portion **64** projecting outwardly from the hook **60**, but remaining in the plane of the hook **60**. Beyond the portion **64** the wire of the contact **58** is bent upwardly from the plane of the hook **60** to form a portion **66** which projects angularly upwardly from the plate **52**. As best seen in FIGURE 3, the portion **66** connects to a laterally inclined portion **68**, which in turn connects to a portion **69** disposed axially parallel to the portions **64** and **66**. The portion **69** terminates with a reentrantly curved and upwardly projecting contact portion **70**. The radius of curvature of this contact portion is deliberately small enough that the contact portion will not yield significantly or collapse under pressure from the vibrating reed **32**.

As best seen in FIGURE 4, an annular spacer **80** overlies the hook **60** formed on the contact **58**. Overlying the spacer **80** is a biasing spring member **72** having an aperture **74** therein for receiving the stem of the rivet **62**. As best seen in FIGURE 6, the spring member **72** is generally flat and has a slight curvature along its longitudinal axis. The biasing spring terminates at the end opposite the aperture **74** with a flange **76** projecting outwardly from the convex side of the spring **72**. The flange **76** has a V-shaped notch **78** formed therein adjacent one end thereof.

For assembly of the flat spring **72** on the plate **52**, the spring **72** is laid over the spacer **80** with its concave surface opposite the plate **52**. Then a spacer **82** is placed over the spring **72** and the rivet **62** swaged into position. The spacers **80** and **82** have a relatively large area of contact with the spring **72** and thereby curb any tendency of the spring to pivot about the stem of the rivet **62**. The V-shaped notch in the spring **72** is so located with respect to the spring wire contact **58** that the laterally inclined portion **68** of the spring wire contact seats in the notch **78**. The curvature of the spring **72** is such that with swaging of the rivet **62** into position, the spring wire contact **58** is pressed downwardly toward the plane of the plate **52**. The resulting stressed condition of the spring wire contact is illustrated in phantom detail in FIGURE 5, and there it can be noted that the portion **66** of this contact has been forced to pivot downwardly, with the angular bend between the portions **64** and **66** acting as a fulcrum and with the result that the portion **64** is caused to arch upwardly a slight distance. While not clearly shown in the drawings, the pressure applied by swaging of the rivet may partially embed the hooked portion **60** of the spring wire contact **58** into the surface of the plastic plate **52**.

For accurate positioning of the contact portion **70** of the spring wire contact **58**, a threaded screw element **84** is fitted into a suitable, internally threaded aperture in the plastic plate **52** and advanced upwardly against the flat spring **72**. By this device the flat spring **72** may be elevated so as to relieve the biasing pressure on the spring contact **58** and thereby permit the contact portion **70** thereof to move upwardly from the plate **52**. By adjustment of the screw **84** the contact portion **70** may therefore be advanced closer to the reed **32** or by reversal of the direction of rotation of the screw **84**, backed away from the reed **32**.

To satisfy the objectives of the present contact construction, it is desirable that the force constant of the spring **72** be substantially greater than the force constant for the spring wire contact **58**. Due to the fact that the spring **72** is a flat and relatively broad member as compared to the diameter of the spring wire in the contact **58**, this condition is readily obtained.

To eliminate any tendency of the spring **72** to twist upon adjustment of the position thereof by the screw **84**, it is desirable that this screw engage the spring **72** midway between the sides thereof, as shown in FIGURE 3. At the same time, for the particular structure illustrated, it is desirable that the contact portion **70** of the spring wire contact **58** be aligned centrally with respect to the sides of the plate **52**. It is to satisfy both of these objectives that the spring wire contact **58** is provided with the laterally inclined portion **68**, which permits the portion **66** to pass to one side of the screw **84** while locating the contact portion **70** centrally with respect to the plate **52**.

With the contact assembly positioned as illustrated in FIGURE 1, the contact portion **70** on the spring wire contact **58** is positioned adjacent the undercut portion of the reed **32**, and the separation determined by the adjustment of the screw **84**. Desirably the separation is great enough that random vibrations of the reed **32** induced by signal frequencies in the coil **38** outside the resonant frequency range are insufficient in amplitude to permit the reed to engage the contact portion **70**. The contact portion **70** is positioned close enough to the reed, however, that when a signal of the resonant reed frequency passes through the coil **38**, causing the reed to vibrate at its resonant frequency, the reed will actually strike the contact portion **70**. When this occurs the reed **32** moves the contact downwardly as viewed in FIGURE 1, i.e., in a direction of greater stress in the spring wire. Preferably, the force constant of this spring wire, even in its stressed condition is small enough in relation to the momentum of the reed during resonant vibration that the reed experiences no appreciable resistance upon engaging the contact element **58**. As the reed returns upwardly, after reaching an extreme of downward movement in its resonant vibration, the spring wire contact **58** follows the reed upwardly until it reaches the notch **78** in the flange **76** of the flat spring **72**. As the spring wire contact moves into this notch, the side walls of the notch guide the spring wire contact to a fixed position at the side wall juncture or apex of the notch **78**, this juncture serving as an abutment for limiting further upward movement of the spring wire contact. Due to the fact that the walls of the notch **78** always return the spring wire contact to the same position, the contact and reed always engage at the same point in each successive cycle of operation. To minimize disturbance to the reed movement, it is desirable that the point of engagement between the reed and the contact is substantially midway between the narrow sides of the reed.

To minimize the extent to which the pre-stressed spring wire contact **58** can interfere with the vibration of the reed **32**, the contact assembly is placed relatively close to the

fixed end of the cantilever supported reed, and when the reed has been undercut as illustrated at **36**, it is desirable that the contact portion **70** engage the reed in the vicinity of the undercut. This reduces the effect of contact pressure on the reed as compared to the magnetic signal. Thus, it is the magnet **40** which, in effect, drives the reed, and this driving force being applied near the free end of the reed has a much greater leverage than the spring contact.

Due to the fact that the spring contact **58** is prestressed and is not permitted to move into its relaxed position, the frequency for resonant vibration of the spring contact is very much greater than the resonant frequency of the reed **32**, and, accordingly, it is not possible for the reed by repeatedly striking the contact **58** to induce chatter or independent vibration of this contact. This provides great reliability of operation in that the spring contact **58** returns to a stable position in the notch **78** in a much shorter time interval than that required for the reed to complete a cycle of its own operation to reengage the contact.

In the illustrated assembly, the reed **32** is connected electrically to the inner frame **26**, by virtue of the soldered connection therewith. In turn, the inner frame is connected to the prong **16**–*b* through conductor **88** and one of the springs **24**. The contact element **58** is connected electrically to the prong **16**–*a* through another of the springs **24** and a conductor **86** which connects to the rivet **62**. Conductor **86** is only partially shown so as not to obscure detail in the drawing. Resonant vibration of the reed **32** may be sensed by an intermittent shorting across the prongs **16**–*a* and **16**–*b*, utilizing conventional circuits devised for this purpose.

Although the preferred embodiment of the device has been described, it will be understood that within the purview of this invention various changes may be made in the form, details, proportion and arrangement of parts, the combination thereof and mode of operation, which generally stated consist in a device capable of carrying out the objects set forth, as disclosed and defined in the appended claims.

Having thus described my invention, I claim:

1. In combination with a vibratile reed element mounted to execute vibratory motion between opposite extremes disposed along a repeated path, a contact assembly for engaging said reed element adjacent one extreme of said vibratory motion, said contact assembly comprising an elongated resilient contact element, support means fixedly supporting one end of said contact element, said contact element projecting from said support means and terminating at its outer end with a contact portion disposed in said path adjacent said one extreme for engaging said reed upon movement of said reed toward said one extreme, bias means supported fixedly with respect to said support means and having an abutment portion contacting an intermediate portion of said contact element and projecting into the position which would normally be occupied by said intermediate portion in the relaxed state of said contact element, whereby said contact element is displaced from its relaxed state and thereby stressed, the direction of displacement of said contact element being in the direction said reed travels in moving toward said one extreme from its other extreme, whereby said reed, upon engaging said contact portion adjacent said one extreme, exerts a pressure on said contact portion tending to move said contact element away from said abutment and to further stress said contact element.

2. The combination according to claim **1** wherein said abutment portion has a notch therein having walls which diverge from a juncture therebetween in the direction of displacement of said contact element, said notch receiving said contact element between said diverging walls, whereby said contact element in seeking to return to its relaxed state is guided by the walls of said notch to a fixed position adjacent the juncture of said walls.

3. The combination according to claim **1** wherein said bias means comprises an elongated cantilever supported spring element having said abutment portion at the free end thereof and including adjustable means supported by said support means and engaging said bias means in spaced relation to said abutment portion, said adjustable means being adjustable so as to vary the position of said abutment portion and thereby vary the position of said contact portion with respect to said one extreme.

4. In combination with a vibratile reed element attached at one end thereof to a supporting frame so as to have the properties of a cantilever beam, said reed being adapted to execute vibratory motion between opposite extremes disposed along a repeated path, a contact assembly for engaging said reed element adjacent one extreme of said vibratory motion, said contact assembly comprising a support plate fixed with respect to said supporting frame and positioned adjacent said reed but outside its path of vibratory motion, an elongated spring wire contact element, means securing one end of said contact element to said support plate, the free end of said contact element projecting away from said support plate and terminating in a contact portion for engaging said reed, a bias means secured fixedly with respect to said support plate and having an abutment portion engaging said contact element in spaced relation to the contact portion thereof, said abutment portion projecting into the position which would normally be occupied by said contact element in its relaxed state, whereby said contact element is displaced from its relaxed state and thereby stressed, the direction of displacement of said contact element being in the direction said reed travels in moving towards said one extreme from its other extreme, whereby said reed on engaging said contact portion adjacent said one extreme exerts a pressure on said contact portion tending to move said contact element away from said abutment, so as to further stress said contact element.

5. The combination according to claim **4**, wherein said bias means comprises an elongated flat spring element secured at one end to said support plate so as to be mounted as a cantiliver beam, the longitudinal axis of said flat spring element being substantially parallel to the longitudinal axis of said reed, said spring element having at the free end thereof an angularly disposed flange directed away from said reed, said flange having a V-shaped notch therein having side walls which are divergent in the direction away from said reed and which are adapted to receive said spring wire contact element therebetween, said flat spring element displacing said spring wire contact away from said reed, whereby the restoring torque in said spring wire contact element presses said contact element into said V-shaped notch and the side walls of said notch guide said spring wire contact into a fixed position at the apex of said notch.

6. The combination according to claim **5** including a screw element threadedly engaged in said support plate and engaged at one end thereof with said cantilever supported flat spring element in spaced relation to the fixed end thereof, said screw element being adjustable with respect to said support plate so as to vary the position of the free end of said cantilever supported flat spring and thereby adjust the displacement of said spring wire contact element.

7. A contact assembly for engaging a vibratile element comprising a support member, an elongate resilient contact element, means fixedly securing one end of said contact element to said support member, said contact element having an intermediate portion projecting from said support member and terminating in an outer end portion spaced from said support member and adapted to contact said vibratile element, bias means anchored to said support member and having an abutment portion projecting into the position which would normally be occupied by said intermediate portion of said contact element in its relaxed position whereby said contact element is displaced from its relaxed position and thereby stressed, said abut-

ment portion having a notch therein, said notch having side walls diverging from a juncture thereof and receiving said intermediate portion of said contact element therebetween, said side walls diverging in the direction of displacement of said contact element whereby the restoring torque in said contact element urges said intermediate portion into said notch and the diverging walls of said notch guide said intermediate portion into a fixed position adjacent the juncture therebetween, the construction and arrangement being such that upon said contact assembly being supported adjacent said vibratile element and located with the outer end portion of said contact element in the path of vibratory movement of said vibratile element in such fashion that the displacement of said contact element away from its relaxed position is increased by contact with said vibratile element, said contact element, yields to vibratory movements of said vibratile element

while at the same time said bias means prevents oscillatory movement of said contact element through its relaxed position and thereby prevents resonant vibration of said contact element.

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