Feb. 4, 1958 R. C. EHLERS ET AL 2,821,955

ULTRASONIC TRANSMITTER

Filed March 11, 1957

Fig. 1

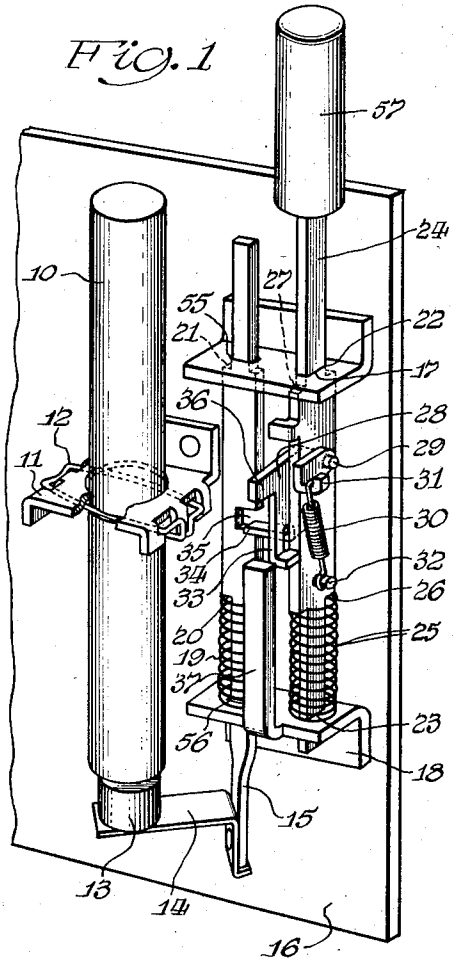


Fig. 2

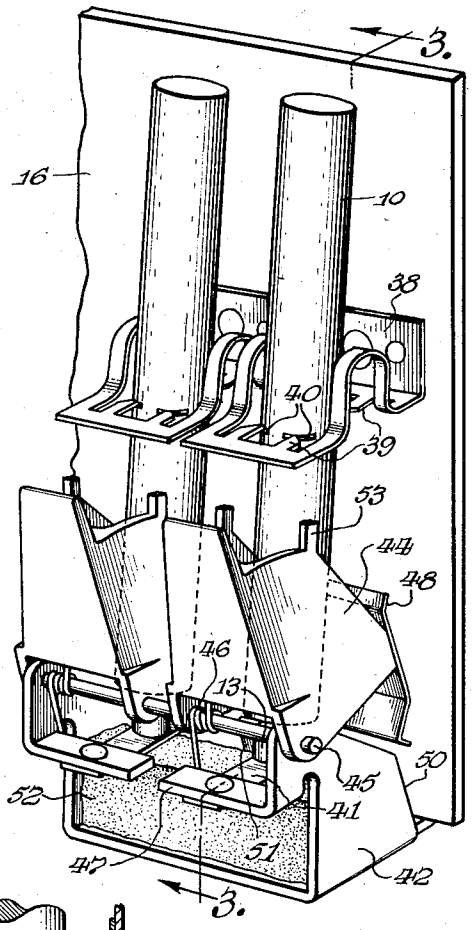
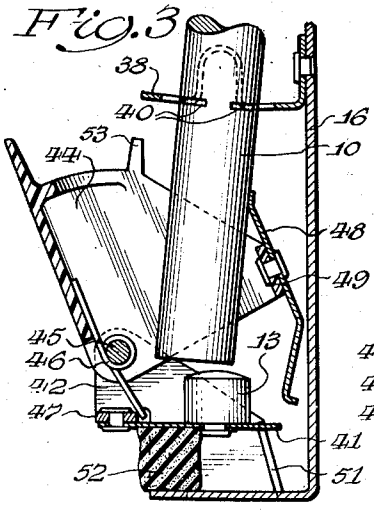


Fig. 3



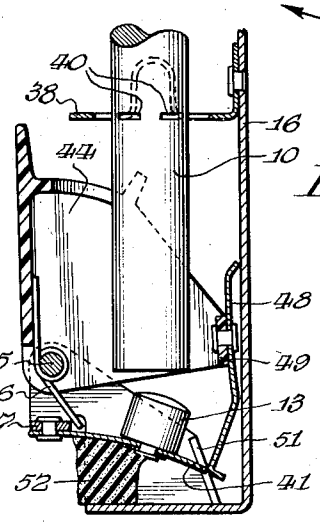


Fig. 4

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2,821,955

ULTRASONIC TRANSMITTER

Robert C. Ehlers, Lombard Villa, and Clarence W. Wandrey, Wheaton, Ill., assignors to Zenith Radio Corporation, a corporation of Illinois

Application March 11, 1957, Serial No. 645,091

13 Claims. (Cl. 116—137)

The present invention relates to an ultrasonic transmitter of the type using a mechanical resonator element to generate a signal of predetermined frequency above the normal sonic range. More particularly, it relates to a new and improved mechanism for imparting mechanical energy to the resonator element of such a transmitter.

As is well known, signals having frequencies well above the normal sonic range can be generated by imparting mechanical energy to a rod or the like. If this energy is delivered to a portion of such a rod or resonator in the form of a sharp blow, vibrations occur in the resonator at a frequency determined by the physical dimensions of the resonator and the propagation velocity of sound in the material from which the resonator is formed. In such a device it is desirable that the hammer or striking element contact the resonator only during the actual delivery of mechanical energy thereto. Should the striking element be permitted to contact the resonator subsequent to the delivery of a discrete blow, it is obvious that a portion of the vibratory energy delivered to the resonator will be reabsorbed by the striking element, resulting in effective damping of the resonator vibration. This damping is undesirable in that it tends to reduce the amount of vibratory energy available for radiation in performing any desired remote control function.

In keeping with this consideration, it is desirable that the striking element occupy an unenergized or reference position a predetermined distance from the resonator. The actuating mechanism should be so constructed as to cause the striking element to deliver a single discrete blow to the resonator for each actuation of the mechanism. To aid in accomplishing this end, it is desirable to provide some means for absorbing the residual kinetic energy remaining in the striking element after delivery of the blow. By so doing, the striking element is prevented from making multiple contact with the resonator thus preventing the aforementioned undesired damping.

Accordingly, it is an object of the present invention to provide a new and improved ultrasonic transmitter of the type using a mechanical resonator element to generate a signal of predetermined frequency above the normal sonic range.

More particularly, it is an object of the present invention to provide a new and improved mechanism for delivering mechanical energy to the resonator element used in such transmitters.

It is a further object of the present invention to provide a new and improved mechanism capable of delivering a single discrete blow to such a resonator for each actuation of the mechanism.

It is a still further object of the present invention to provide a new and improved mechanism in which the striking element does not contact the resonator prior to or after the delivery of the single discrete blow.

Another object of the present invention is to provide a new and improved remote transmitter which is insensitive to its spatial orientation and which is entirely mechanical.

An ultrasonic transmitter constructed in accordance with the present invention comprises a mechanical resonator element having a predetermined natural resonant frequency. A striking element is provided and is supported, by a resilient member, in proximity to but spaced from the resonator. Means including an actuating mechanism are provided for deflecting the resilient member to cause the striking element to impinge sharply on the resonator in response to a single operation of the actuating mechanism. The restoring force of the resilient member is made sufficient to preclude multiple contacts between the striking element and the resonator. The impingement of the striking element on the resonator results in the generation of a train of vibrations in the resonator at a frequency equal to the predetermined natural frequency of the resonator for transmission and utilization in performing a remote control function.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The organization and manner of operation of the invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

Figure 1 is a perspective view of an ultrasonic transmitter constructed in accordance with the present invention;

Figure 2 is a view similar to that of Figure 1 of another embodiment of the invention;

Figure 3 is a partial sectional view of the device of Figure 2 taken through plane 3—3; and

Figure 4 is a view similar to that of Figure 3, showing the device in a partially actuated state.

The device of Figure 1 is an ultrasonic transmitter constructed in accordance with the present invention and comprises a cylindrically shaped longitudinal-mode mechanical resonator or vibrator **10** which is centrally supported in a bracket **11** by means of a resilient clamp element **12** and which has a predetermined resonant frequency which may be established by the method fully described and claimed in the copending application of Robert Adler, Serial No. 654,064, entitled "Ultrasonic Resonator," filed concurrently herewith and assigned to the same assignee as the present application; in that application there is described a longitudinal-mode mechanical resonator, preferably a rod of aluminum or other material having an inherent low internal damping factor, which is centrally supported in a bracket by means of a resilient mount. The details and advantages of the resonator mount are fully described and claimed in the copending application of Ole E. Wold, Serial No. 645,310, entitled "Ultrasonic Generator," filed concurrently herewith and assigned to the same assignee as the present application. A striking element **13** is provided in proximity to but spaced from the lower end of resonator **10**. Details and advantages of the resonator, the striking element and the operating mechanism therefor are disclosed in a copending application of Robert Adler, Serial No. 578,333, filed April 16, 1956, entitled "Control System," and assigned to the same assignee as the present application. This striking element is cylindrical in shape and is affixed to a resilient support member **14**, preferably in the form of a leaf spring as shown. The end of resilient spring member **14** remote from striking element **13** is affixed to the lower end of a trip rod **15**.

A supporting base plate **16** is provided and has affixed thereto, in any well known manner, a pair of L-shaped brackets **17** and **18**. Trip rod **15** is slidably mounted in a pair of rectangular apertures **55** and **56** which pass through brackets **17** and **18** at appropriate points. A

helical return spring **19** surrounds a portion of trip rod **15** in a manner such that it operatively engages a shoulder **20** and the upper surface of bracket **18**. The force thereby exerted on trip rod **15** urges a second shoulder **21** against the underside of bracket **17** which accordingly acts as a fixed stop member. Since the engagement of shoulder **21** and the underside of bracket **17** limits the upward travel of trip rod **15**, it establishes a reference position of striking element **13** relative to the lower end of resonator **10**.

A second pair of rectangular apertures **22** and **23** are provided in brackets **17** and **18** respectively. A trigger mechanism comprising a push rod **24**, having a push button **57** affixed thereto, is slidably supported in these apertures and is maintained in a reference or unenergized position by a second helical return spring **25**. Return spring **25** accomplishes this end by engaging a shoulder **26** on push rod **24** and urging a second shoulder **27** against the underside of bracket **17**.

A cam member **28** is pivotally mounted on push rod **24** by means of a pin **29** which passes through push rod **24** at approximately its midpoint. A helical bias spring **30** is connected between a finger **31**, which forms a part of cam member **28**, and a peg **32** which is affixed to push rod **24**. Bias spring **30** exerts a downward force on finger **31** causing an arm **33** of cam member **28** to bear against the outer edge of push rod **24**. Thus arm **33** serves to establish a limit on the pivotal motion of cam member **28** in a counter-clockwise direction.

A second arm **34** is provided on cam member **28** and is positioned to operatively engage a slot **35** provided in trip rod **15**. A third arm **36** is provided on cam member **28** and projects outwardly with its outer end positioned directly above a trip bar **37** which projects vertically from the outer edge of bracket **18**.

The mechanism described is shown in its normal or unactuated state. Trip rod **15** and push rod **24** are maintained in their uppermost positions by the urging of return bias springs **19** and **25**. When a downward force is applied to push button **57** of sufficient magnitude to overcome the upward bias of spring **25**, push rod **24** moves downwardly, guided by slots **22** and **23** in brackets **17** and **18** respectively. Arm **34** of cam member **28** engages the lower surface of slot **35** thereby causing trip rod **15** to move downwardly in a like manner. This motion of trip rod **15** causes striking element **13** to be withdrawn from its normal position in proximity to the end of resonator **10** by a like amount. During the downward travel of push rod **24** and trip rod **15**, energy is stored in return bias springs **19** and **25**.

After the downward translation of push rod **24** a distance equal to the original spacing between the end of trip bar **37** and the underside of cam arm **36**, the arm and trip bar operatively engage in a manner that causes further downward motion of push rod **24** to pivot cam member **28** about pin **29** and thereby to slidably withdraw arm **34** from slot **35** in trip rod **15**. When arm **34** becomes fully disengaged from slot **35** the energy stored in return bias spring **19** causes trip rod **15** to be rapidly returned to its initial or reference position with shoulder **21** abutting the underside of bracket **17**. This rapid upward travel of trip rod **15** results in a like travel of striking element **13** which thereby acquires a degree of momentum determined by its mass and terminal velocity. When shoulder **21** is urged sharply against the underside of bracket **17**, the momentum acquired by striking element **13** causes resilient member **14** to deflect permitting striking element **13** to impinge sharply and percussively on the end of resonator **10**. The predetermined spacing which existed between the end of resonator **10** and the upper face of striking element **13** in its reference position and the restoring force (or stiffness) of resilient member **14** are proportioned to prevent contacts between striking element **13** and resonator **10** beyond the initial single sharp impingement or impact. The kinetic energy remaining in striking element **13** subsequent to this initial impingement is dissipated within the material of resilient element **14** in the form of inter-molecular friction.

A release of the force applied to push button **57** permits return bias spring **25** to urge push rod **24** in an upward direction returning it to its reference position with shoulder **27** abutting the underside of bracket **17**. During this return motion cam arm **36** disengages from trip bar **37**, permitting bias spring **30** to urge arm **34** against the front surface of trip rod **15**. When push rod **24** approaches the top of its travel, slot **35** in trip rod **15** appears under arm **34** permitting bias spring **30** to return cam member **28** to its original position with arm **34** engaging slot **35** and arm **33** abutting the edge of push rod **24**. Accordingly, the overall mechanism is in its original or unenergized state and striking element **13** can be caused to again impinge on resonator **10** by again applying a downward force to push button **57**.

An operative example of the device in Figure 1 which exhibits all of the desirable properties can be constructed using the following enumerated materials and dimensional relationships. Resonator **10** is of the type described in the previously identified copending applications and may comprise an aluminum rod of a length corresponding to one-half wavelength at the selected frequency. Striking element **13** is formed from cold rolled steel and has an axial length of .250 inch and a diameter of .312 inch; steel is of course a material capable of delivering percussive energy to resonator **10** when impinged sharply thereagainst, the resonator in turn generating in the air ahead of the unit ultrasonic vibrations in response to the percussive energy delivered. Resilient element **14** is formed from .012-inch thick spring steel and has a width of .188 inch. Striking element **13** is affixed to resilient member **14** at a point .510 inch removed from trip rod **15** and is spaced .045 inch from the end surface of resonator **10** when in the unactuated or reference position. Return bias spring **19** is formed from .013-inch diameter music wire and comprises 12 turns having a free height of .750 inch and a solid height of .156 inch resulting in a spring constant of 1.4 lbs. per inch. Cam member **28** and trip bar **37** are physically arranged to provide for a .250 inch downward motion of striking element **13** from its reference position before trip rod **15** and cam arm **34** become disengaged. The use of these materials and dimensions results in the delivery of a single discrete blow to the end of resonator **10** for each actuation of the mechanism. The preceding is given merely by way of example and not by way of limitation since many combinations of dimensions and materials exist which are capable of providing equally satisfactory results.

The embodiment shown in Figure 2 is constructed to produce the same end result as that of Figure 1 but utilizes a pivotal rather than a linear actuating mechanism. As shown the transmitter includes two complete operative units each of which is identical with the other. Accordingly the structure and operation of the right-hand unit will be described with the understanding that the description applies equally to both.

The transmitter comprises a longitudinal mode mechanical resonator **10** which is centrally supported by a unitary clamp **38** which is formed from a resilient material. The clamp is provided with four prongs **39** adapted to engage four shallow transverse milled slots **40** which are symmetrically disposed about a transverse plane which passes through the physical center of resonator **10**. As is clearly shown in Figure 3, a striking element **13'** is provided in proximity to but spaced from one end of resonator **10**. Striking element **13** is affixed to a resilient cantilever spring member **41**, one end of which is immovably affixed to a frame member **47** which forms a part of the overall frame **42**. A supporting base plate **16** is provided to which clamp **38** and frame **42** are anchored. A push button **44** is pivotally mounted

on a shaft 45 which is in turn supported by frame 42. Push button 44 is maintained in an undepressed or unactuated condition by a spring element 46 which is supportably located by shaft 45 and is adapted to engage the underside of push button 44 and the inner edge of frame member 47. A resilient cam member 48 is affixed to a cross bar 49, which forms a part of push button 44, and is adapted to forcibly engage the lateral surface of resonator 10 when push button 44 is in the undepressed condition. As can be clearly seen in Figure 3, the force exerted on resonator 10 by member 48 causes resilient mount 38 to be slightly deflected, resulting in a slight cocking of resonator 10 relative to base plate 16; the purpose for this will be explained later. The end of cam member 48 remote from that which engages the surface of resonator 10 is adapted to engage the end of resilient member 41 remote from frame member 47 when push button 44 is depressed. A finger 51, which forms a part of frame 42, and the frame edge 50 are canted in a manner to define a cam surface slidably engageable with the outer edges of cam member 48 as push button 44 is depressed.

Resilient member 41 is backed, over a portion of its length, by a sponge rubber cushion 52 which is affixed to the inner surface of frame member 42. Thus, cushion 52 is affixed to a surface of member 41 facing away from the resonator. Fingers 53 are provided on push button 44 and serve to limit the outward travel of push button 44 under the urging of spring 46 by engaging an appropriately placed member of the housing which normally encloses the overall transmitter. This housing is not shown, for the sake of clarity.

When it is desired that striking element 13 impinge on resonator 10, an inward force is applied to push button surface 54 which causes push button 44 to pivot about shaft 45. The initial movement causes the force exerted on the surface of resonator 10 by resilient cam member 48 to be relaxed, permitting the restoring force of resilient mount 38 to restore resonator 10 to its operative position as is shown in Figure 4. Further depression of push button 44 causes the lower edge of resilient cam member 48 to engage the unsupported end of resilient member 41 and thereby to deflect member 41 and striking element 13 associated therewith to store energy in member 41. Further depression of push button 44 causes resilient cam member 48 to slidably engage the canted edge 50 and finger 51 of frame member 42. This, in turn, causes the end of resilient cam member 48 to be slidably removed from the free end of resilient cantilever member 41, permitting the energy stored in this member to cause striking element 13 to impinge sharply on the end of resonator 10. Figure 4 shows the relative position of the various elements at the instant prior to the release of resilient member 41 by resilient cam element 48. The deflection of resilient member 41 and the deformation of sponge rubber cushion 52 is clearly shown.

The restoring force of resilient member 41 and the predetermined spacing between striking element 13 and the end of resonator 10, when in the unenergized state, are proportioned to preclude multiple contacts subsequent to the initial impingement. The residual kinetic energy remaining in striking element 13 after impingement on resonator 10 is dissipated by the combined internal losses of resilient member 41 and sponge rubber cushion 52, since sponge rubber cushion 52 has a high internal damping characteristic.

As the force on the now fully depressed push button 44 is released, spring member 46 causes push button 44 to pivot about shaft 45 and accordingly to return to its normal unenergized position. During this return motion, the inner surface of cam member 48 rides over the free end of resilient element 41 by virtue of its resilient nature and the upper end engages and cocks resonator 10. This engagement between the upper end of cam member 48 and the lateral surface of resonator 10 acts to damp the mechanical vibration within the resonator thus giving the oeprator the ability to determine the duration of the generated signal. If push button 44 is maintained fully depressed, resonator 10 is free to vibrate for a period determined by the natural losses within the resonator material. This vibration may be rapidly terminated at any earlier time, however, by the release of push button 44 and the consequent contact of the cam member and the resonator.

An operative example of the device of Figure 2 which exhibits all of the desirable properties can be constructed using the following enumerated materials and dimensional relationships. Striking element 13 is formed from cold rolled steel and has an axial length of .250 inch and a diameter of .312 inch. Resilient cantilever member 41 is formed from .008-inch thick spring steel and has a width of .312 inch. Striking element 13 is affixed to resilient member 41 at a point spaced .468 inch from the point at which the resilient member 41 is anchored to frame member 47. A spacing of .040 inch is provided between striking element 13 and the end surface of resonator 10 when striking element 13 is in the unactuated or reference position. Finger 51 and frame edge 50 are canted at an angle of 20 degrees relative to base plate 16 to cause cam member 48 to release resilient member 41 when it has been deflected to the point at which a .125 inch spacing exists between the end surface of resonator 10 and the nearest point on the striking surface of striking element 13. Again, the preceding is given merely by way of illustration and not by way of limitation since, as was the case in the example given for the device of Figure 1, there are many material and dimensional combinations which provide equally satisfactory results.

Accordingly, it is clear that both of the illustrated mechanisms provide a striking element actuation cycle in which the striking element does not contact the resonator except during the delivery of a single discrete blow for each actuation of the mechanism. This results in minimum damping of the resonator and insures maximum radiation of the vibratory energy for use in performing any desired remote control function. Further, it should be clear that the specific spatial orientation of either device is unimportant since both operate satisfactorily irrespective of the position in which held.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

We claim:

1. In combination with an ultrasonic wave transmitter comprising an elongated longitudinal-mode vibrator, an exciter operatively associated with an end of said vibrator, resilient means mounting said exciter in spaced relation with respect to said end, exciter tensioning means operatively associated with said exciter and movable longitudinally with respect to said vibrator, manually operable moving means operatively connected to said exciter tensioning means, and trip means responsive to movement of said moving means to release said tensioning means to permit said exciter to strike said vibrator.

2. In combination with an ultrasonic wave transmitter comprising an elongated longitudinal-mode vibrator, an exciter operatively associated with an end of said vibrator, resilient means mounting said exciter in spaced relation with respect to said end, exciter tensioning means operatively associated with said exciter and movable longitudinally with respect to said vibrator, manually operable moving means operatively connected to said exciter tensioning means, and trip means responsive to movement of said moving means to release said tensioning

means to permit said exciter to move from a reference position spaced from said one end by a predetermined distance and to strike said vibrator, said resilient means having a restoring force proportioned with respect to said predetermined distance to restrict contact between said exciter and vibrator to a single impact.

3. In combination with an ultrasonic wave transmitter comprising an elongated longitudinal-mode vibrator, an exciter operatively associated with an end of said vibrator, resilient means mounting said exciter in spaced relation with respect to said end, exciter tensioning means operatively associated with said exciter and movable longitudinally with respect to said vibrator, manually operable moving means operatively connected to said exciter tensioning means, and trip means engageable by said moving means in response to tensioning movement of said moving means to release said tensioning means to permit said exciter to strike said vibrator.

4. In combination with an ultrasonic wave transmitter comprising an elongated longitudinal-mode vibrator, an exciter operatively associated with an end of said vibrator, resilient means mounting said exciter in spaced relation with respect to said end, exciter tensioning means operatively associated with said exciter and movable longitudinally with respect to said vibrator, manually operable moving means operatively connected to said exciter tensioning means, and trip means engageable by said moving means in response to tensioning movement of said moving means to release said tensioning means to permit said exciter to move from a reference position spaced from said one end by a predetermined distance and strike said vibrator, said resilient means having a restoring force proportioned with respect to said predetermined distance to restrict contact between said exciter and vibrator to a single impact.

5. In combination with an ultrasonic wave transmitter comprising an elongated longitudinal-mode vibrator, an exciter operatively associated with an end of said vibrator, resilient means mounting said exciter in spaced relation with respect to said end, exciter tensioning means operatively associated with said exciter and movable longitudinally with respect to said vibrator, moving means operatively connected to said exciter tensioning means, and trip means engageable by said moving means to release the connection between said moving means and said tensioning means to permit said exciter to strike said vibrator.

6. A portable ultrasonic wave remote control transmitter comprising: a support member; a plurality of elongated longitudinal-mode ultrasonic parallel vibrators mounted on said support member parallel to each other in a group to expose one end of each for longitudinal-mode mechanical impact excitation; resilient energy-storage means; a travelling carrier mounted on said support member and coupled to said energy-storage means; a striker; a spring coupling said striker to said carrier; push button actuating means coupled to said energy-storage means and mounted for movement in a fixed path generally parallel to said vibrators for storing energy in said energy-storage means during an initial phase of said movement; and trip means engageable by said actuating means to release the stored energy to said striker via said spring during a later phase of said movement to drive the striker into percussive over-travel impact against the end of a selected one of said vibrators; said spring being adjusted to retract said striker from the selected vibrator, after a single impact, to prevent a repeated impact thereof.

7. A portable mechanical remote control transmitter for generating a train of vibrations in air at a predetermined ultrasonic frequency, said transmitter comprising: a support member; an elongated longitudinal-mode mechanical ultrasonic vibrator; means mounting said vibrator on and spaced from said support member; an exciting device and a manually operable push button both carried by said support member with said push button mounted to move in a continuous path from a first position to a second position, said exciting device including a striking element, energy storage means coupled to said striking element, and spring means holding said striking element in a position spaced from one end of said vibrator; moving means, coupled to said push button and to said energy storage means and movable longitudinally with respect to said vibrator, responsive to movement of the push button through a first portion of said path to store energy in said energy storage means; and trip means, engageable by said moving means, responsive to movement of said push button through a second and subsequent portion of said path to release the stored energy to deflect said striking element from a reference position spaced a predetermined distance from said one end of said vibrator toward and percussively against said vibrator end, said spring means having a restoring force proportioned with respect to said predetermined distance to restrict contact between said striker and said vibrator to a single momentary impact for each such movement of said push button.

8. A portable mechanical remote control transmitter for generating a train of vibrations in air at a predetermined ultrasonic frequency, said transmitter comprising: a support member; an elongated longitudinal-mode mechanical ultrasonic vibrator; means mounting said vibrator on and spaced from said support member; an exciting device and a manually operable push button both carried by said support member with said push button mounted to move in a continuous path from a first position to a second position, said exciting device including a striking element, energy storage means coupled to said striking element, and spring means holding said striking element in a position spaced from one end of said vibrator; moving means, coupled to the said push button and to said energy storage means, responsive to movement of the push button through a first portion of said path to store energy in said energy storage means; and trip means responsive to movement of said push button through a second and subsequent portion of said path to release the stored energy to deflect said striking element from a reference position spaced a predetermined distance from said one end of said vibrator toward and percussively against said vibrator end, said spring means having a restoring force proportioned with respect to said predetermined distance to restrict contact between said striker and said vibrator to a single momentary impact for each such movement of said push button.

9. An entirely mechanical portable remote control transmitter for generating a train of vibrations in air at an accurately predetermined ultrasonic frequency comprising: a support member; an elongated longitudinal-mode vibrator; means for mounting said vibrator on and spaced from said support member; a resilient cantilever member coupled at one end to said support member and affixed to said striking element to hold said striking element in a reference position in proximity to and spaced from one end of said vibrator by a predetermined distance; an actuating mechanism mounted on said support member and comprising a movable flexible cam member engageable with the free end of said resilient member to deflect the latter a predetermined distance from said reference position in a direction away from one end of said vibrator; means defining a cam surface disposed to engage said cam member and deflect said cam member to release said resilient member and permit the latter to percussively impinge said striking element against said one end of said vibrator, said resilient member having a restoring force proportioned with respect to said predetermined distance to restrict contact

between said striking element and said vibrator to a single contact.

10. A portable mechanical ultrasonic transmitter comprising: a supporting base plate; an elongated longitudinal-mode vibrator; a resilient mount affixed to said base plate and to the midpoint of said vibrator to mount said vibrator spaced from and parallel to said base plate; a striking element; a resilient cantilever member coupled at one end to said base plate and affixed to said striking element to hold said striking element in a reference position spaced from one end of said vibrator by a predetermined distance; a pivotally mounted push button; a spring coupled to said push button to urge the latter to a reference position; a flexible cam member affixed to said push button and disposed to forcibly engage a side surface of said vibrator and angularly displace the latter with respect to said base plate when said push button is in said reference position and responsive to pivotal depression of said push button to move away from said vibrator and into engagement with the free end of said resilient member to deflect the latter a predetermined distance from said reference position in a direction away from said vibrator; and means defining a cam surface engageable with said cam member in response to further depression of said push button to deflect said cam member and permit release of said resilient member to percussively impinge said striking element against said one end of said vibrator, said resilient member having a restoring force proportioned with respect to said predetermined distance to restrict contact between said striking element and said vibrator to a single impact.

11. A mechanical portable ultrasonic transmitter comprising: a support member; an elongated longitudinal-mode vibrator mounted on said support member; a striking element; a spring mounted on said support member and affixed to said striking element to hold said striking element in a position spaced from one end of said vibrator by a predetermined distance; a cushion carried by said support member and disposed to contact a surface of said spring facing away from said one end of said vibrator; an actuating mechanism operatively associated with said striking element to percussively impinge said striking element against said vibrator in response to a single operation of said actuating mechanism, said resilient member having a restoring force proportioned with respect to said predetermined distance to restrict contact between said striking element and said vibrator to a single impact.

12. A portable mechanical ultrasonic transmitter comprising: a support member; an elongated longitudinal-mode vibrator mounted on said support member; an exciting device carried by said support member and comprising a resilient member, a striking element coupled to an end of said resilient member, and an energy storage means coupled to said striker; a manually operable push button movable at will in a continuous path from a first position to a second position; motion-translating means, coupled to said push button and operatively associated with said exciting device, responsive to movement of said push button through an initial portion of said path to store energy in said energy storage means; and trip means operatively associated with said motion-translating means and responsive to movement of the push button through a subsequent portion of said path to release said stored energy to deflect said striking element from a reference position spaced from said vibrator by a predetermined distance toward and into percussive impingement with one end of said vibrator, the restoring force of said resilient member being proportioned with respect to said predetermined distance to prevent further impact of said striking element against said vibrator.

13. A portable mechanical ultrasonic transmitter comprising: a support member; an elongated longitudinal-mode vibrator mounted on said support member; an exciting device carried by said support member and comprising a rigid member, a resilient member having one end affixed to said rigid member, and a striking element coupled to the other end of said resilient member; a cocking spring coupled to said exciting means; a manually operable push button movable at will in a continuous path from a first position to a second position; motion-translating means, coupled to said push button and operatively associated with said rigid member, responsive to movement of said push button through an initial portion of said path to store energy in said cocking spring; trip means operatively associated with said motion-translating means and responsive to movement of said push button through a subsequent portion of said path to launch said exciting means towards said vibrator; and stop means mounted on said support member and disposed in a position to abruptly stop said rigid member in a reference position in which said striking element is spaced from said vibrator by a predetermined distance, the momentum of said striking element permitting it to flex said resilient member and percussively impinge against said vibrator, and the restoring force of said resilient member being proportioned with respect to said predetermined distance to prevent further impact of said striking element against said vibrator.

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"Popular Mechanics," October 1956, page 153.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,821,955 February 4, 1958

Robert C. Ehlers et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, line 58, after "support member;" insert -- a striking element; --; column 9, line 46, for "resilient member" read -- spring --.

Signed and sealed this 24th day of March 1959.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON

Commissioner of Patents