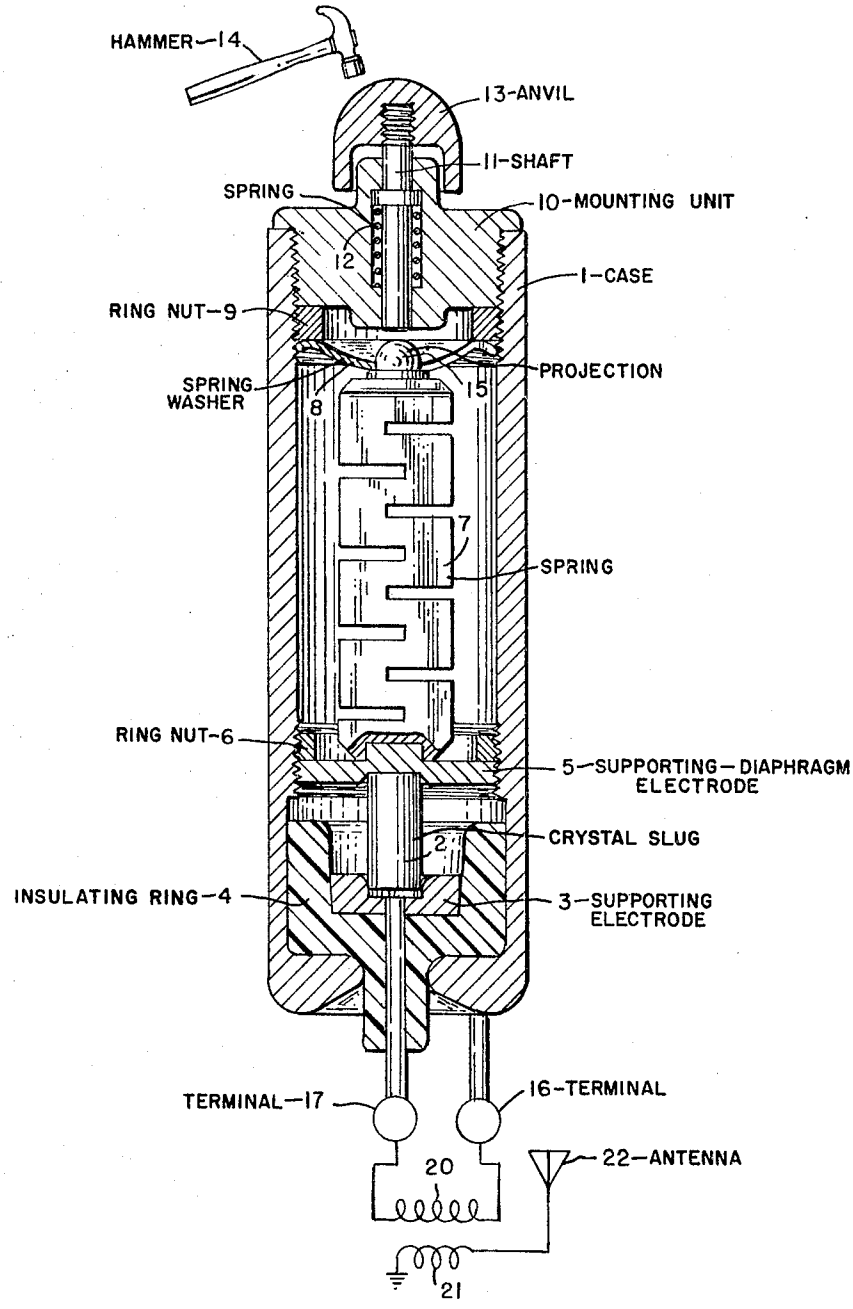
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MECHANICALLY-ACTUATED RADIO TRANSMITTER

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INVENTORS,
KURT IKRATH
WILHELM A. SCHNEIDER
GOTTFRIED F. VOGT
BY Harry M. Saragovitz,
Edward J. Kelly,
Herbert Berl & Julian C. Kyperka ATTORNEYS.

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3,270,283 MECHANICALLY-ACTUATED RADIO TRANSMITTER

Kurt Ikrath, Elberon, Wilhelm A. Schneider, Fair Haven, and Gottfried F. Vogt, Lincroft, N.J., assignors to the United States of America as represented by the Secretary of the Army

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

This invention relates to crystals and particularly to mechanically-actuated, crystal oscillation. More particularly, this invention relates to the mechanical excitation of a crystal to produce radio frequency energy.

Crystal oscillation is well-known and it may be electrically or mechanically actuated. Electrical actuation of crystal oscillations requires a source of electrical power and introduces complications that would limit the use of a crystal transmitted to conditions compatible with electric or electronic devices. Mechanical actuation of crystal oscillations is limited to the frequency of the crystal, and only a single, decaying burst of radio-frequency energy will be possible for a given, manual application of energy.

It is therefore an object of this invention to provide an improved, mechanically-actuated, radio-frequency, crystal transmitter.

It is a further object of this invention to provide an improved, manually operated, mechanically-actuated, radio-frequency, crystal transmitter that gives a substantial amount of easily-detectable, radio-frequency signals for each application of mechanical energy.

These and other objects are accomplished by mechanically coupling a low-frequency, heavy-duty, mechanically-vibratory element to a crystal that produces radio-frequency energy when mechanically excited. Means are provided for striking the mechanically-vibratory element and for electrically coupling the crystal output to an antenna radiator.

This invention will be better understood and further objects of this invention will become apparent from the following specification and the drawing which shows a cross-section of a typical embodiment of this invention.

Referring now to the drawing, the metallic mounting case or cylinder **1** contains a piezo-electric, crystal slug **2**, with a metallic supporting electrode **3** suitably positioned with respect to and insulated from the metallic case **1** by the insulating ring **4**.

A second metallic supporting electrode **5** is a hard diaphragm that engages the other end of the crystal slug **2** and positions it within the cylindrical metallic case **1**.

A rotating ring nut **6** is threaded within the cylindrical case **1** and holds the diaphragm **5** in contact with the crystal. One end of the mechanically-vibratory element **7** is seated against the diaphragm **5**. The other end of the mechanically-vibratory element is positioned within the case by means of the spring washer **8** which is urged against the vibratory element by the adjustable ring nut **9**.

A threaded mounting unit **10** holds the shaft **11**, which is also held in place by the spring **12**.

The electrodes **3** and **5** connect to the terminals **15** and **16** which are connected across the coil **20**, which is inductively coupled to the coil **21**, which is connected between ground and the antenna **22**.

In operation, the hammer **14** is made to strike the anvil **13** to drive the shaft **11** against the projection **15** which is part of the element **7**. The force of the hammer blow is thereby applied, through the element **7**, to the diaphragm **5** and to the crystal **2**.

The force of the hammer blow sets up mechanical oscillations in the crystal, which build up an alternating voltage across the terminals **16** and **17**, which connect the alternating voltage across the terminals of the coil **20**, which induces an alternating voltage in the coil **21**, which is connected to the antenna **22**.

The alternating voltage, at the frequency of the crystal or one of its harmonics, continues until the natural, mechanical and electrical damping of the crystal reduces it to an insignificant value. However, the compressed, mechanically-vibrating element **7** still continues to vibrate at a slower rate, and, during each complete cycle of its motion, it strikes the crystal again, through the diaphragm **5** to restore the mechanical oscillations of the crystal and its alternating voltage output.

If the frequency of the mechanically-vibratory element is fairly close to that of the crystal, and the crystal is still oscillating when the mechanically-vibrating element strikes it again, it is obvious that the mechanical motion of the crystal must be in phase with the mechanical motion of the vibrating element. If not, each subsequent blow would dampen the crystal oscillations rather than reinforce them. In other words, the frequency of the crystal must be a harmonic of the frequency of the vibratory element. This is the case in the embodiment taught here, with the crystal oscillating at the third harmonic of the frequency of the mechanically-vibratory element.

On the other hand, if the frequency of the crystal is high enough, compared with that of the vibratory element, and the crystal is nearly damped before the next blow, then each succeeding blow produces a separate train of damped oscillations, and a harmonic relationship between the crystal and the vibratory element is not essential.

In either case, the limited amount of mechanical energy that can be applied to a crystal to be dissipated in mechanical oscillation and in the generation of alternating electrical energy, is supplemented by the considerable amount of mechanical energy that can be stored in a mechanically-vibratory element, such as a heavy spring, when it is struck by a hammer. The crystal will continue to generate radio frequency energy until the mechanically-vibrating element has also been damped below a useful level.

While a typical embodiment of the invention is shown here, it is obvious that many variations of the invention are possible and will be apparent to anyone skilled in the art. For example, the blow on the anvil **13** may be struck by other means than a hammer, and other types and shapes of mechanically-vibratory elements may be used as long as such elements can be set into a vigorous vibration that is strong enough to repeatedly excite the crystal.

Other types and shapes of mechanical support may be used in place of the metallic cylinder, as long as the anvil, vibrating element, crystal and necessary electrical circuitry are held securely enough and in the correct relationship to cooperate in the production of modulated radio frequency energy.

The coils **20** and **21** are shown as a typical means for matching the output impedance of the crystal to the input impedance of the antenna radiating element. The turns ratios and the inductive coupling may be varied in accordance with well-known techniques.

The pressure of the diaphragm-like electrode **5** on the crystal, and of the spring **9** on the vibrating element may be adjusted by the corresponding ring nuts to provide the optimum mechanical coupling for the maximum effective output. For example, if the diaphragm **5** is too loose, it will not transmit the full force of the element **7**

to the crystal; and if the spring **8** is too loose, the element **7** may not hit the diaphragm **5** with enough force to the crystal. On the other hand, if the spring **8** is too tight, the vibrating element will be too quickly damped to provide an easily detectable signal.

While a considerable mechanical force can be applied to this device, with a hammer or otherwise, and very heavy springs are available to accumulate this force, the crystal remains the practical limitation of the device. A crystal small enough to oscillate at radio frequencies will not be heavy enough to withstand the maximum shock that can be applied. Consequently, the crystal must be as heavy and as strong as practicable, an it must be mounted in the best possible way to accommodate the mechanical shock.

In the typical embodiment of this device the crystal frequency was 90,000 cycles, and the frequency of the vibratory element was 30,000 cycles per second. A hammer blow on the anvil **13** could produce several thousand volts of alternating current across the terminals **16** and **17** when they were open-circuited.

Having thus described our invention, what is claimed is:

1. A mechanically-actuated radio transmitter, comprising a rigid, tubular, supporting case; an elongated spring positioned within said case; a piezo-electric slug positioned within said case adjacent to one end of said spring; a movable striking pin extending through one end of said case, said pin having one end, inside of said case, positioned adjacent to the other end of said spring; means for striking the other end of said pin, outside of said case; an antenna positioned outside of said case; and means for coupling said antenna to said piezo-electric slug, through the other end of said case; whereby said pin, when struck, sets up vibrations in said spring to repeatedly hit said piezo-electric slug to maintain said slug in a state of oscillation, which generates radio frequency signals, which are applied to said antenna.

2. A mechanically actuated radio transmitter comprising a rigid supporting case; an elongated spring, having a a first resonant frequency, positioned within said case; a piezo-electric slug positioned within said case adjacent to one end of said spring, said piezo-electric slug having a second resonant frequency substantially higher than said first resonant frequency; means, extending through said case, for striking the other end of said spring; an antenna positioned outside of said case; and means for coupling said antenna to said piezo-electric slug whereby said spring, when struck, will vibrate to repeatedly hit said piezo-electric slug, which maintains said slug in a state of oscillation, and which generates radio frequency signals, which are applied to said antenna.

3. A mechanically actuated radio transmitter as in claim **2** wherein said second resonant frequency is an harmonic of said first frequency.

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DAVID G. REDINBAUGH, *Primary Examiner.*

JOHN W. CALDWELL, *Examiner.*