

April 15, 1947.

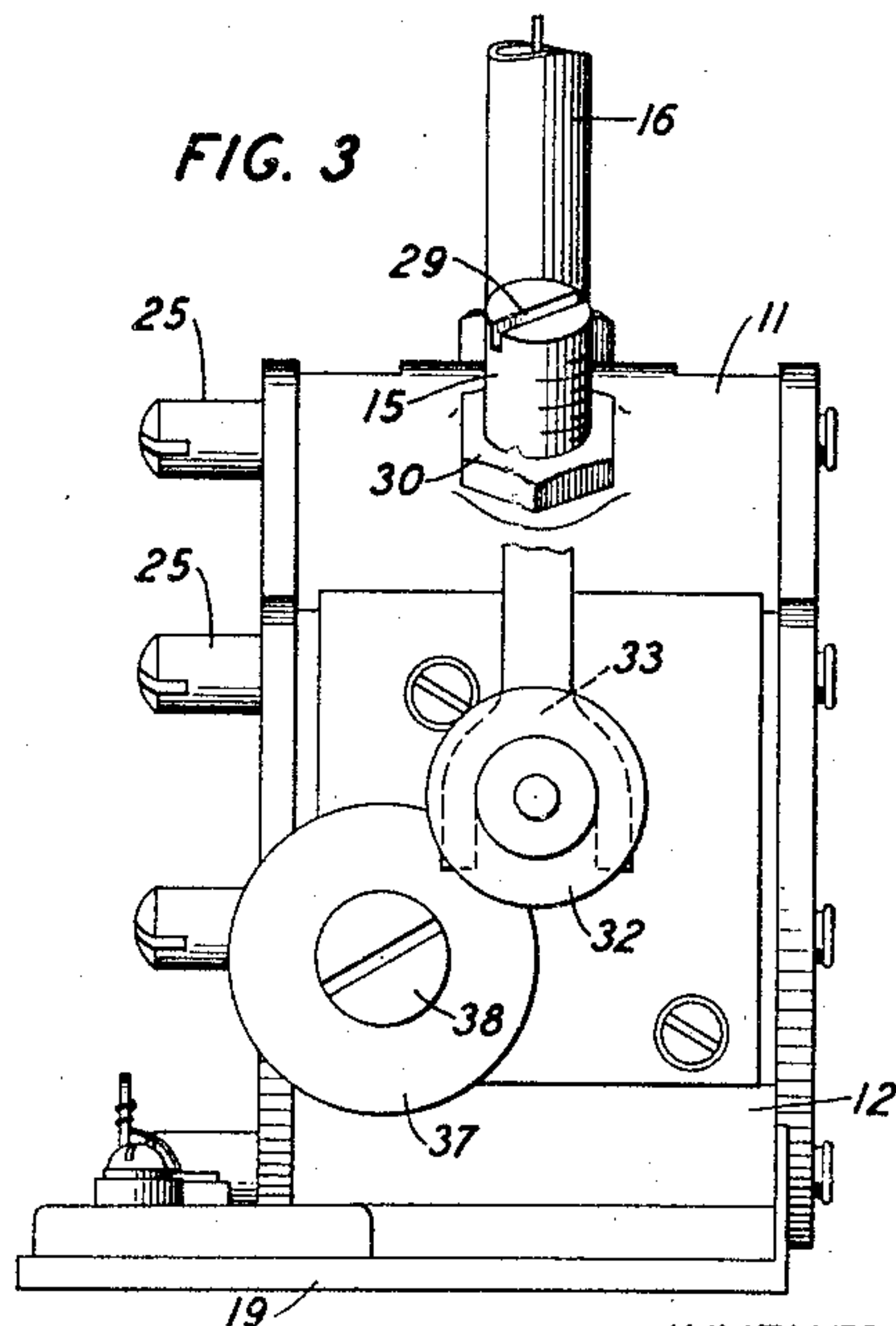
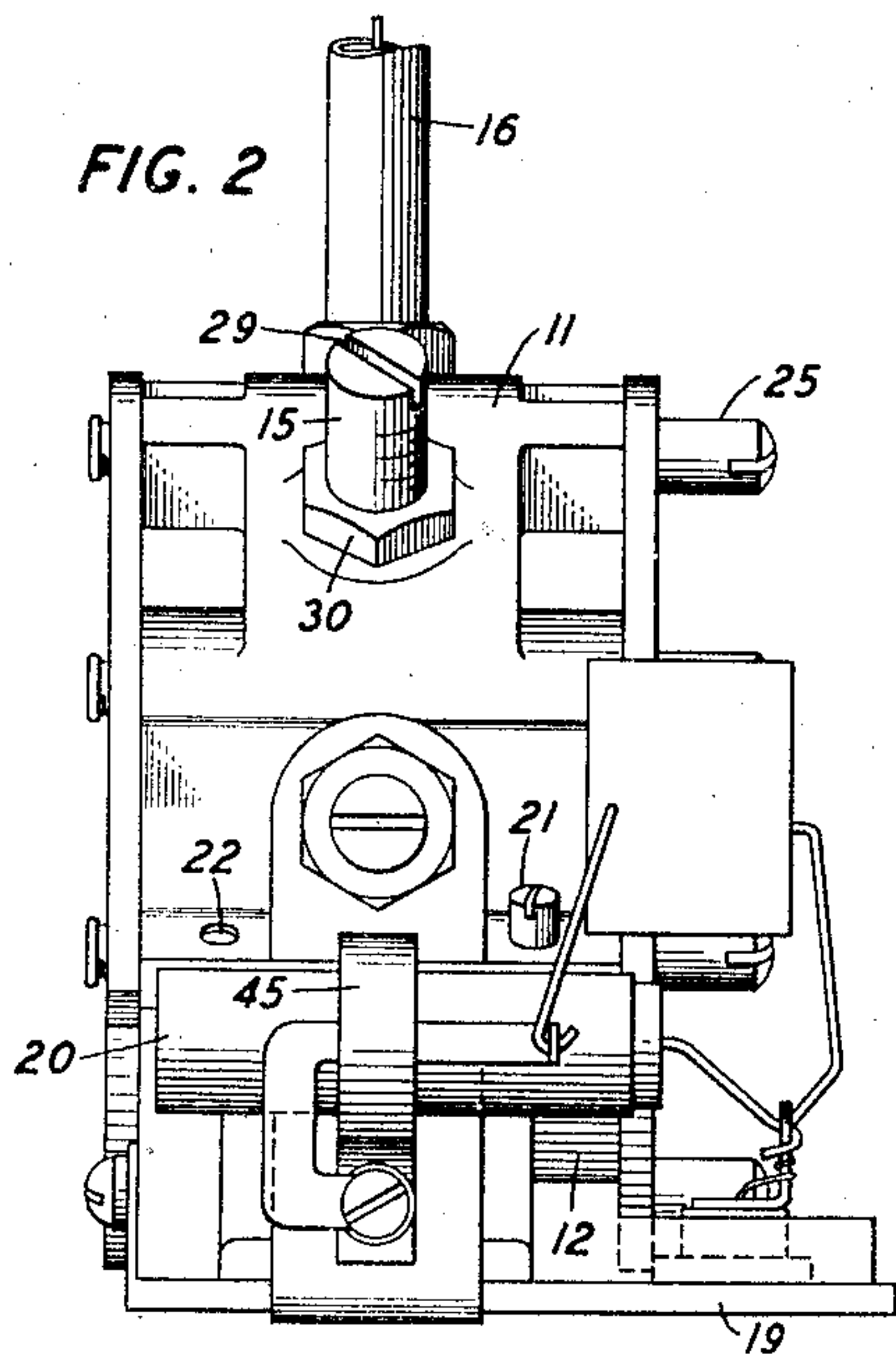
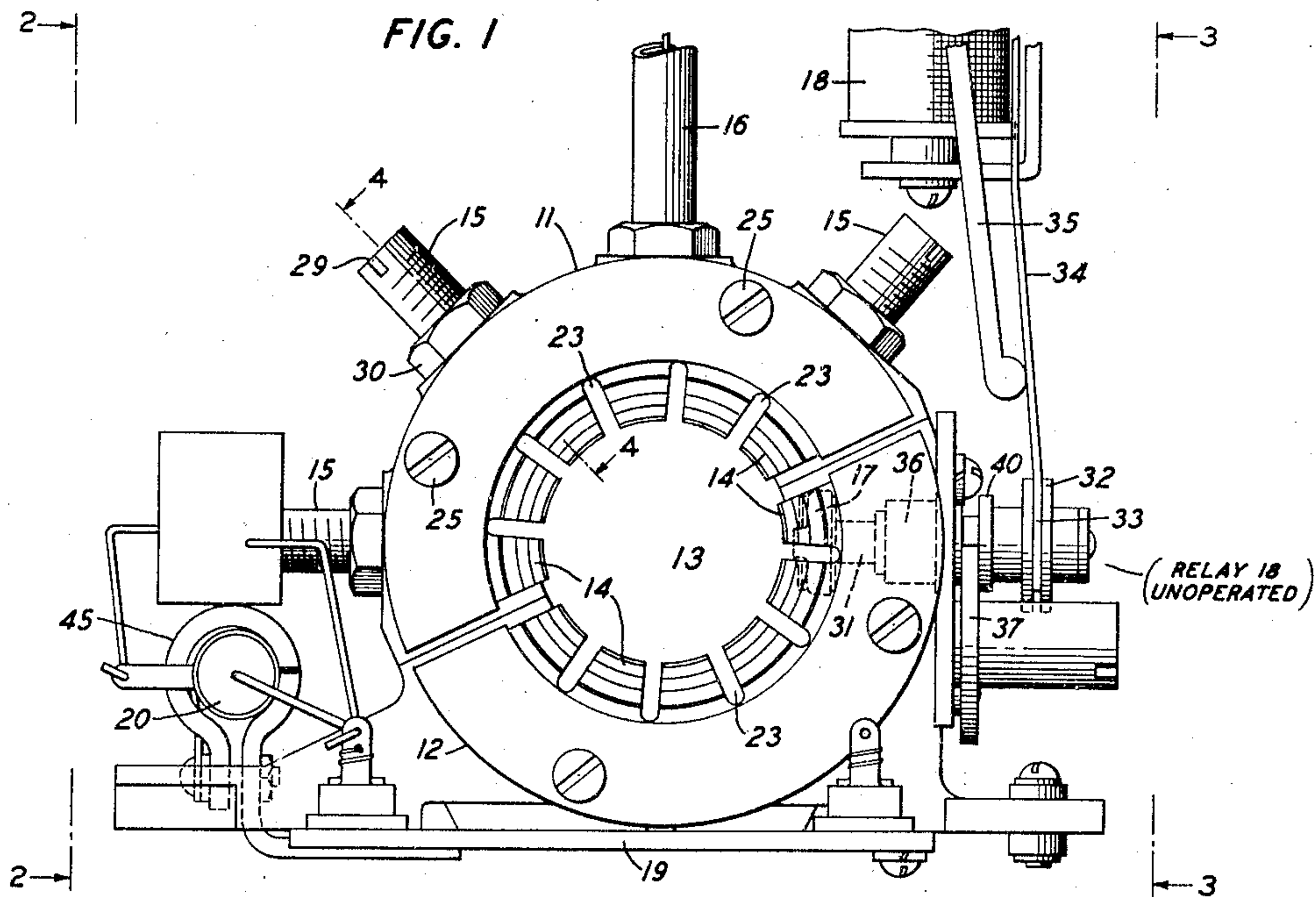
R. S. JULIAN

2,418,839

WIDE RANGE TUNER FOR CAVITY RESONATORS

Filed May 12, 1943

2 Sheets-Sheet 1



INVENTOR
R. S. JULIAN
BY
Franklin Mohr
ATTORNEY

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R. S. JULIAN

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WIDE RANGE TUNER FOR CAVITY RESONATORS

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2 Sheets-Sheet 2

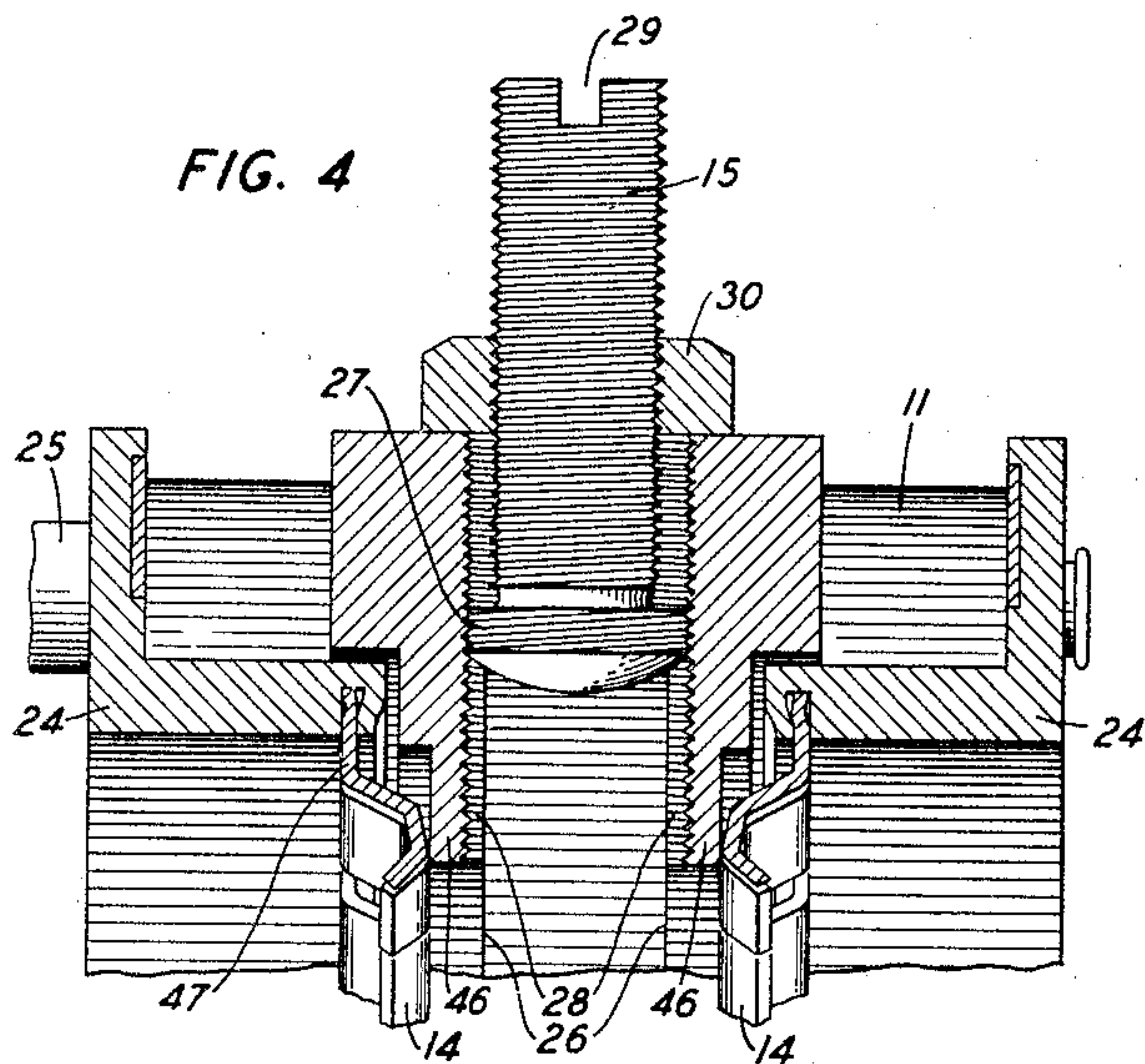


FIG. 7

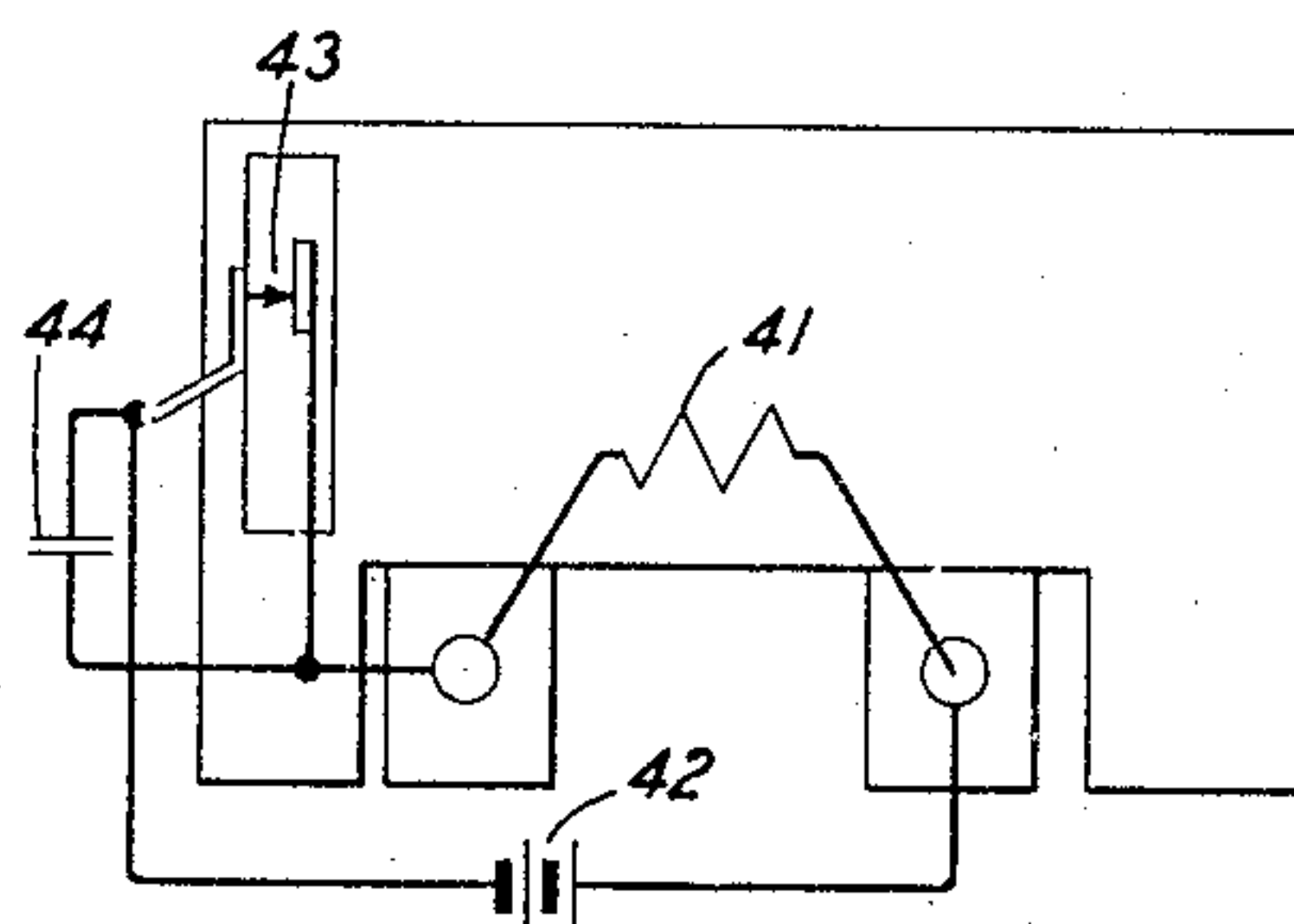


FIG. 8

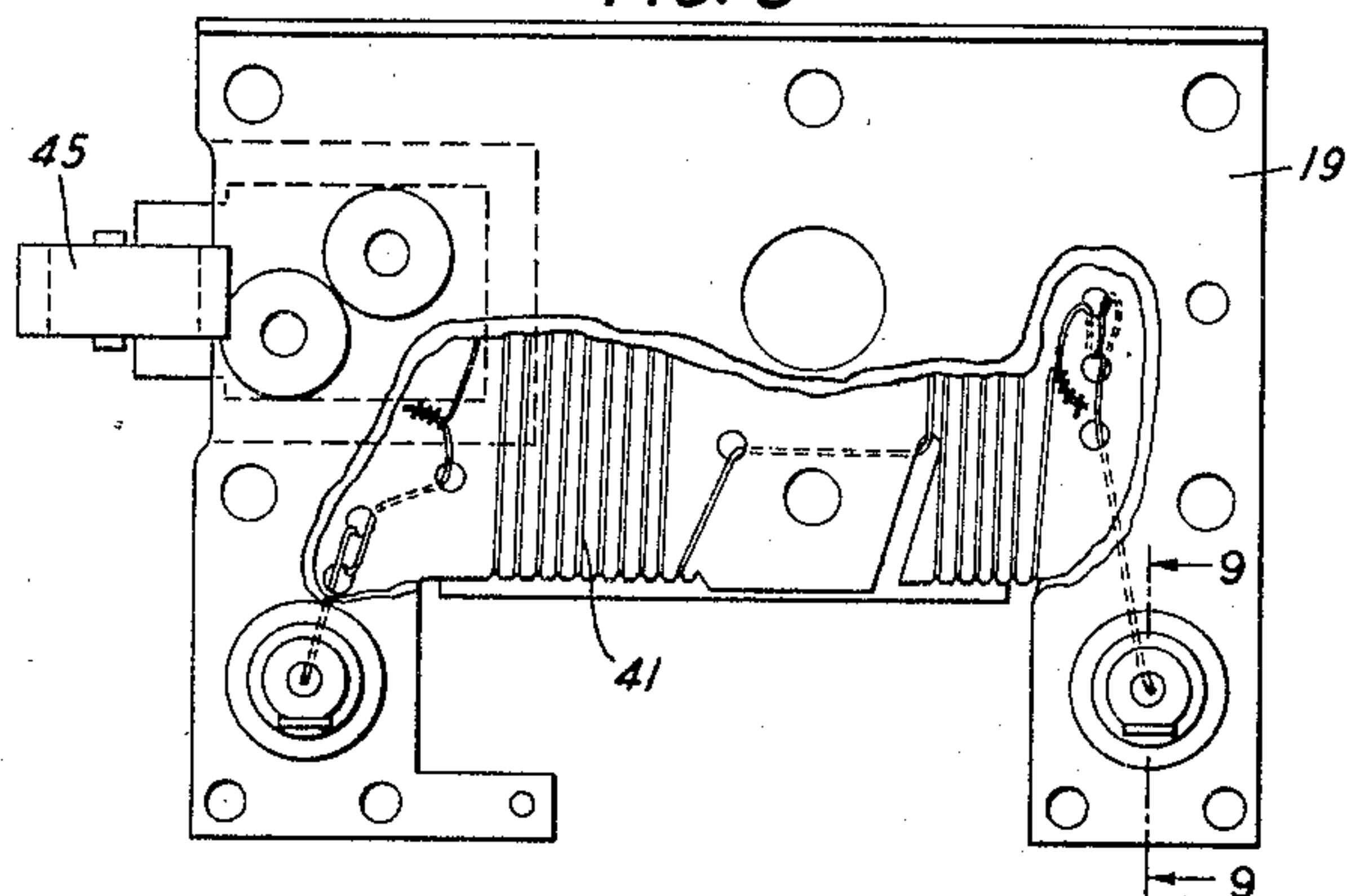


FIG. 5
(RELAY 18 OPERATED)

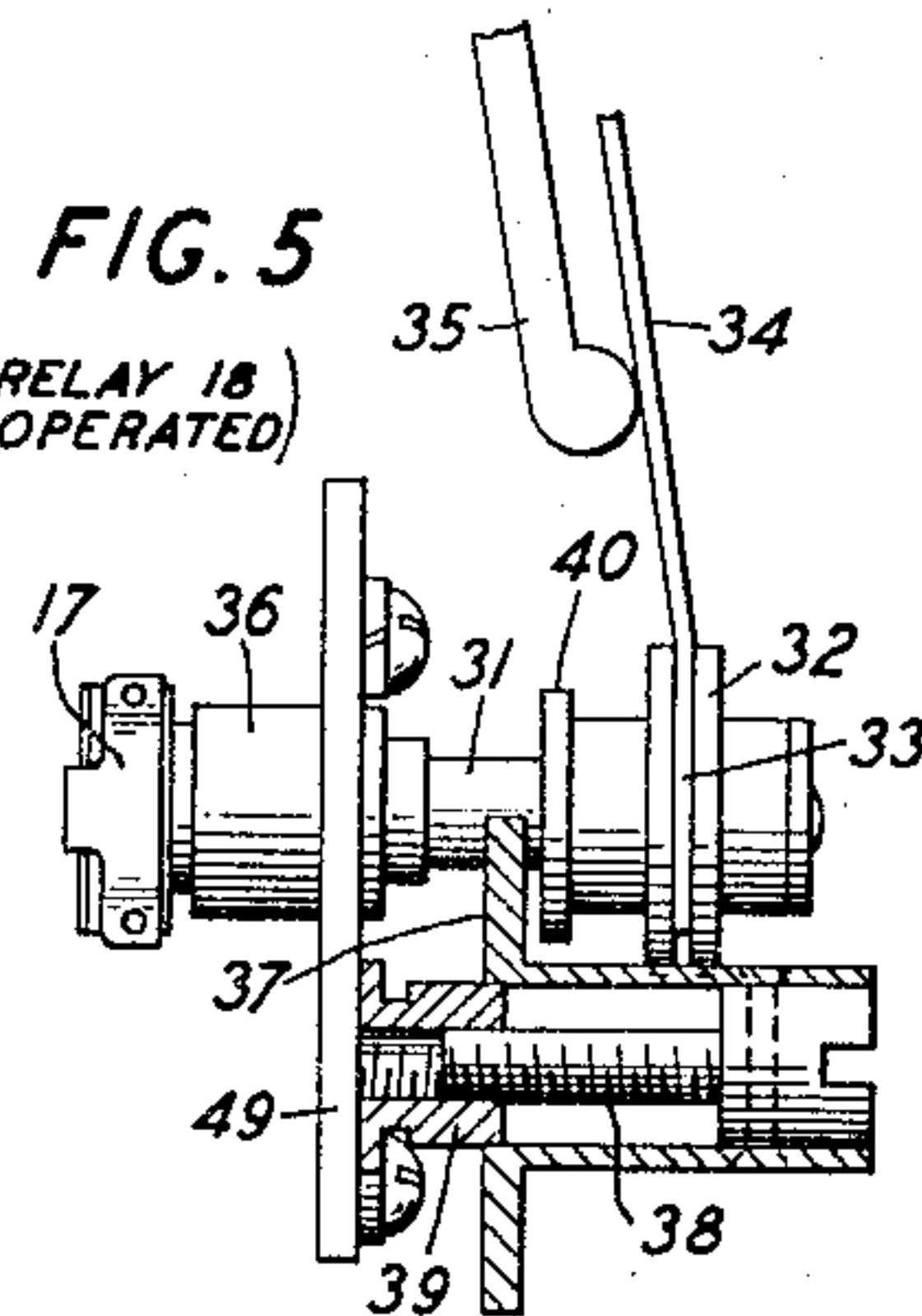


FIG. 6

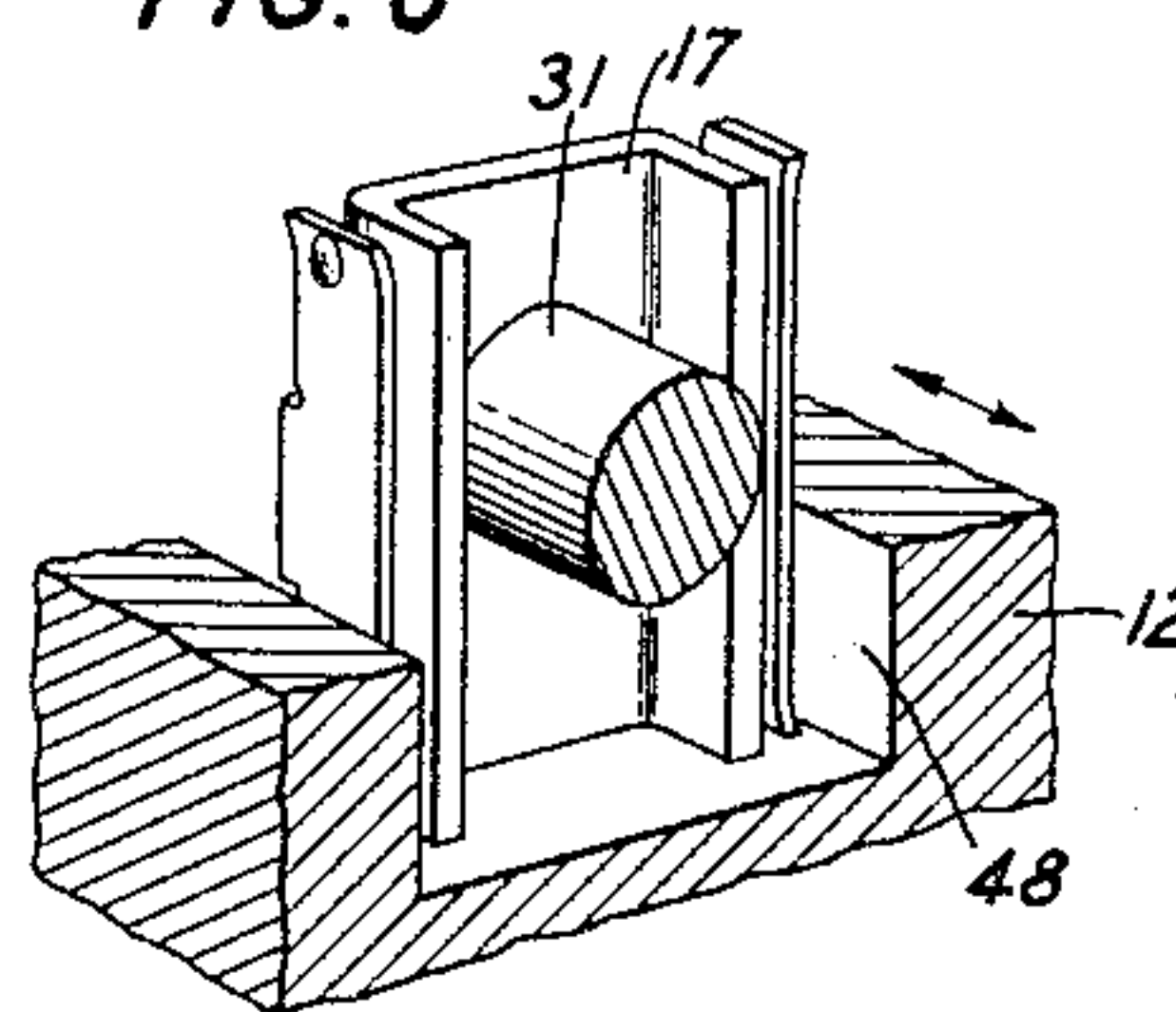
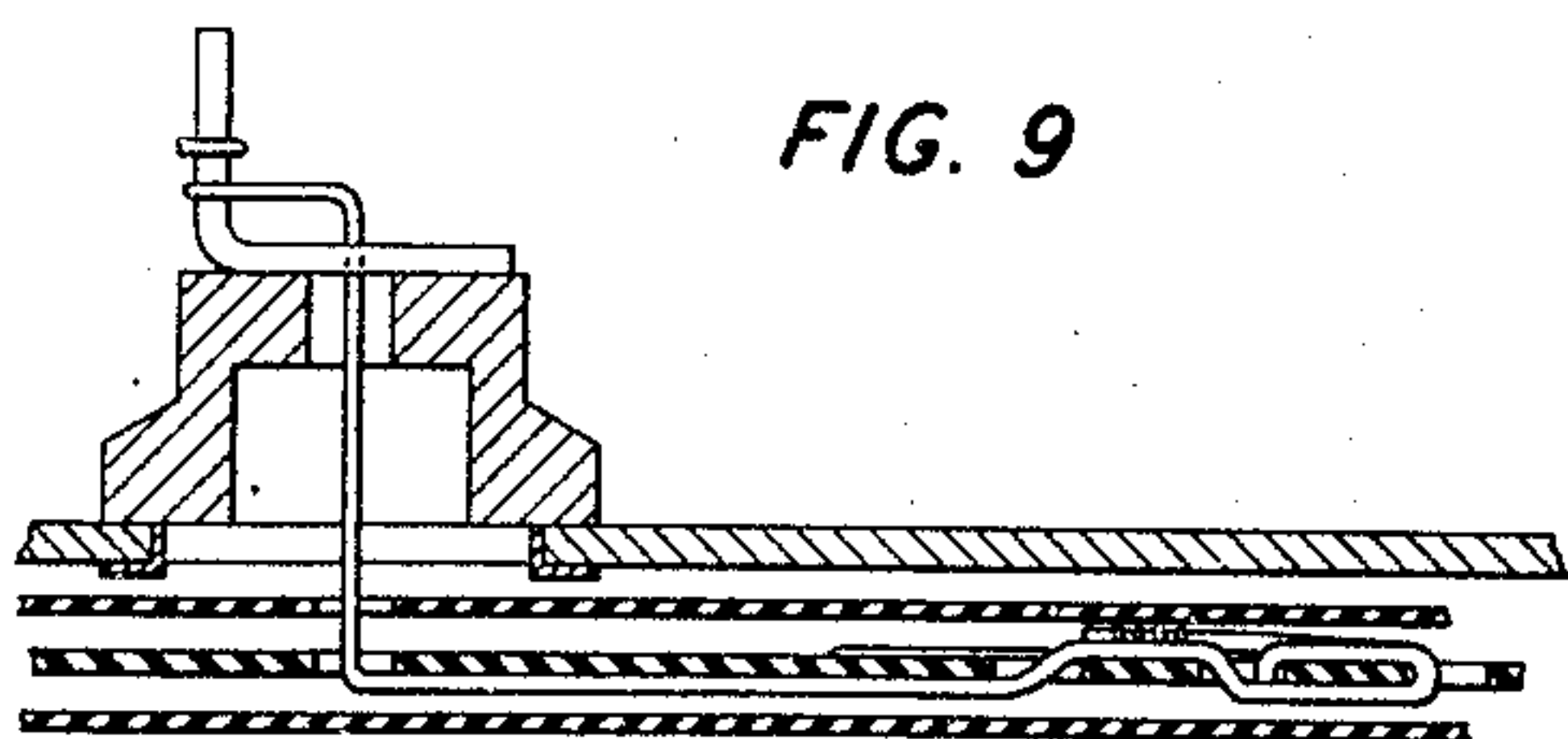
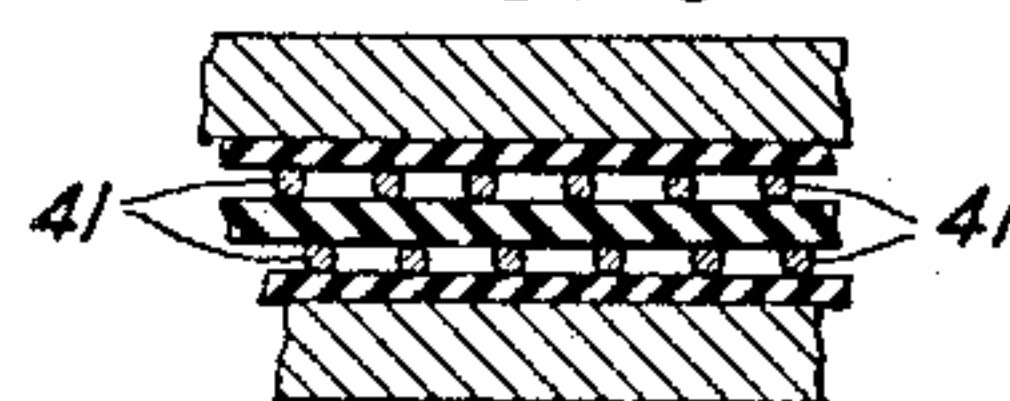


FIG. 10



INVENTOR
R. S. JULIAN
BY
Franklin Mohr
ATTORNEY

UNITED STATES PATENT OFFICE

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WIDE RANGE TUNER FOR CAVITY
RESONATORS

Renne S. Julian, Morristown, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

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5 Claims. (Cl. 178—44)

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This invention relates to resonating chambers or cavity resonators for electromagnetic waves and more particularly to tuning and regulating arrangements for such resonating devices.

An object of the invention is to make the tuning of a cavity resonator effective over a relatively wide range of frequencies with a simple mechanical adjustment.

Another object is to secure good electrical contact between the tuning member and the body of the cavity resonator at any desired setting.

A further object is to render any desired setting of the tuning element secure against accidental displacement due to vibration, jarring or similar causes.

A feature of the invention is a rod-like element or tuning screw having an enlarged threaded portion that meshes with corresponding threads or partial threads in opposite walls of the resonator. The enlarged portion has relatively few turns to the thread and may be drawn into good electrical contact with the walls by means of a lock-nut engaging a small diameter threaded portion of the rod and bearing against the exterior of the cavity resonator to tighten the engagement of the enlarged threaded portion with the corresponding threads in the walls.

A single tuning element may be used for relatively fine adjustment of the resonant frequency while coarser adjustments may be made by using a plurality of similar elements.

A shift in frequency from one predetermined value to another may be made in the resonant chamber by moving a plunger between two set positions by means of an electromagnetic relay, without disturbing the above-mentioned tuning screws.

The effects of temperature changes upon the resonant frequency of the device may be controlled by an electrical heating element mounted in thermal conducting contact with the exterior of the resonating chamber in conjunction with a thermostat.

In the drawings:

Figs. 1, 2, and 3 are elevational views of a cavity resonator embodying tuning and regulating means in accordance with the invention;

Fig. 4 is an enlarged detailed view of a cross-section of the resonator showing a tuning screw in elevation and a lock-nut in section;

Fig. 5 is a fragmentary view of a relay operated tuning plunger with stops for determining two tuning positions;

Fig. 6 is a fragmentary view of the tuning plunger of Fig. 5 and the slot in which it works;

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Fig. 7 is a schematic diagram of the heating unit and thermostat associated with the resonator;

Fig. 8 is a plan view, partly broken away, of the heating unit;

Fig. 9 is a fragmentary view showing a section of the heating element and the thermal connection between the heater and the thermostat; and

Fig. 10 is a typical cross-section of a portion of the heating element.

Referring more particularly to Figs. 1, 2 and 3, a resonating chamber is illustrated which comprises two separable halves 11 and 12 which may be clamped about a vacuum tube, the latter occupying the central space 13. The halves may be milled or otherwise hollowed out to form a cavity of the desired proportions. The vacuum tube is preferably of a type having disc electrodes sealed into and through the insulating envelope of the tube. The discs are adapted to be clamped in good electrical contact with the walls of the resonating chamber, the discs serving not only as electrodes but also as end plates to complete the closure of the resonating chamber when the tube is in position. Aligned apertures in the disc electrodes serve to admit an electron beam into, through and beyond the resonating chamber, in known manner. The electron beam may be reflected by a repeller electrode within the vacuum tube so as to traverse the cavity a second time, thereby serving to sustain electromagnetic oscillations within the chamber as is now well known in the art and needs no further description. The specific use made of the resonating chamber is not a part of the present invention and many appropriate uses will suggest themselves. Accordingly, and for the sake of clarity in the drawing, the vacuum tube has been omitted therefrom. Spring contact members having fingers 14 are provided for exerting pressure between the disc electrode of the vacuum tube and a flange 16 on the body of the resonating chamber. The relation of the contact fingers and flange is best shown in Fig. 4.

A plurality of tuning screws 15 are provided for effecting either coarse or fine adjustment of the tuning of the chamber. The tuning screws may be employed in either half of the chamber although in the embodiment shown in the drawing, they appear only in the upper half 11. A coaxial cable connection 16 may be provided for leading off electromagnetic waves generated within the resonating chamber for transmission to any suitable external load. A tuning plunger

17 may be employed when it is desired to provide a rapid means of selection of two predetermined operating frequencies. An electromagnetic relay 18 may be provided for operating the tuning plunger 17. A heating unit 19 may be provided in thermal conductive relation to the resonating chamber under the control of a thermostat 20 to maintain the resonating chamber at a substantially constant temperature.

The halves 11 and 12 may be fastened together by screws or dowels in any suitable manner. A screw 21 and a dowel 22 for this purpose are shown in Fig. 2, fitted into suitable flanges on the halves 11 and 12. The spring contact fingers 14 are conveniently formed by cutting slots 23 in semi-circular arcuate members 47 which may be keyed into semi-annular flanged members 24. A pair of members 24 are shown clamped to the upper half 11 of the resonating chamber by a plurality of screws 25 as appears most clearly in Fig. 4.

The interior of the resonating chamber preferably has parallel walls 26 as shown in enlarged section in Fig. 4. The tuning screw 15 shown in elevation in Fig. 4 has an enlarged threaded portion 27 which meshes with partial threads 28 in the wall 26. The shank of the screw 15 is also threaded over at least a portion of its length and has the same pitch of thread as the portion 27. A screwdriver slot 29 may be provided in the end of the shank of the screw 15 which protrudes from the resonating chamber. It will be noted that the diameter of the threaded portion 27 is necessarily slightly greater than the spacing between the walls 26.

To tune the resonating chamber by means of the tuning screw 15, the screw may be adjusted to the desired position by means of a screwdriver and may be locked in position by any suitable thread-locking device such as a lock-nut 30, which bears against the exterior of the chamber structure and meshes with the threaded shank portion of the screw 15. It will be evident that when the lock-nut 30 is tightened, the enlarged portion 27 of the screw 15 is drawn up tightly against the threads 28, providing a good electrical contact between the innermost end portion of the screw 15 and the walls 26. The lock-nut also provides security against accidental change in the setting of the screw 15 in the well known manner of thread-locking devices. The enlarged portion 27 preferably contains a minimum of turns of the screw thread in order to insure that the actual contact will occur very near the innermost end of the screw 15. It is evident that if the entire length of screw 15 were of uniform diameter and meshed with threads in the wall, the position of best contact between the threads when the lock-nut was tightened would be determined by accidental irregularities in the shape and pitch of the threads. Consequently, there would be no assurance of good electrical contact at the desired point on the innermost end of the screw.

It has been found that a tuning rod a free end of which projects into a resonating chamber generally has a relatively small effect upon the resonant frequency of the chamber. To obtain a wide range of frequency adjustment a large number of such rods may be required. Accordingly, tuning plungers have been extensively used to secure wide frequency variation with a single moving element. The feature of the plunger type tuner that enables it to effect large changes of frequency is the good electrical contact which

the plunger maintains with the wall of the resonating chamber. The tuning rod, on the other hand, has only a slight capacitive coupling with the wall and its effect upon the frequency is accordingly reduced. Applicant has discovered that the advantages of a tuning plunger may be combined with the simplicity of a rod or tuning screw by the use of the enlarged threaded head 27 and the meshing threads in the wall, together with a locking means such as the lock-nut 30 for drawing the threads of the portion 27 into good electrical contact with the threads in the wall. This contact takes the place of the wiping contact afforded by a plunger. It will be evident that the screw 15 may be used in place of a circular plunger in a circular hole or tube, in which case the partial threads 28 may be replaced by a complete thread.

A relatively fine adjustment may still be secured by using a single tuning screw 15 with a thread of low pitch while a coarser adjustment may be obtained by employing a plurality of tuning screws 15 with a thread of greater pitch, as desired. In any case, a tuning screw arranged in accordance with the invention will provide a considerably wider range of adjustment than a rod or screw of the same diameter and pitch that makes only capacitive connection or a poor conductive connection with the walls of the chamber.

A relay operated arrangement for rapidly selecting either of two predetermined operating frequencies, is shown in Figs. 1, 3, 5 and 6, and is well adapted as an auxiliary to the tuning screws of the present invention. The tuning plunger 17 works in a slot 48 which is part of or opens into the resonating chamber, executing a small reciprocating motion to change from one operating frequency to the other. A detail of the plunger 17 operating in the slot 48 is shown in Fig. 6. The plunger 17 is attached to a shaft 31 carrying a slotted washer 32 which engages a fork 33 which may be integral with a spring 34 anchored to the fixed portion of the relay 18. A lever arm 35 actuated by the armature of the relay 18 is arranged to press against the spring 34. The spring tends to move the plunger 17 inwardly toward the center of the resonating chamber through the linkage provided by the shaft 31, washer 32 and fork 33, while the relay when actuated overcomes the spring 34 and moves the plunger 17 outwardly from the center of the resonating chamber. The shaft 31 is slidably mounted in a gearing 36.

Suitable stops may be provided to limit the travel of the plunger 17 in each direction. In the arrangement shown in the drawing, the outward motion of the plunger 17 is limited by a fixed stop while the inward motion is controlled by an adjustable one. The fixed stop is provided by the inner end of the bearing 36. The adjustable stop is formed by a flanged member 37 attached to a screw 38 which engages an internal thread in a stud 39. The flanged member 37 projects into the path of travel of a washer 40 attached to the shaft 31. A plate 49 may serve to close the slot 48 as well as to mount the bearing 36 and the stud 39.

Fig. 1 shows the relay 18 unoperated and the flange stop 37 in the innermost position thereby permitting maximum travel of the plunger 17.

Fig. 5 shows the condition when the relay 18 is operated. In this figure, also, the flange stop 37 has been adjusted to approximately its outermost position, restricting the plunger 17 to a

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minimum travel distance. In Fig. 5 the plunger 17 is pressed against the bearing 36 and the flange stop 37 is free from contact with the washer 40.

The relay-actuated frequency changing arrangement above described is particularly useful in conditions where it is desired to employ, in conjunction with a standard operating frequency which is not subject to change, a second frequency which may be changed from time to time. To set up the system on this basis, the relay 18 is first operated and the resonating chamber adjusted to the fixed standard frequency by means of the tuning screws 15. The relay 18 is then placed in the non-operated position and the flange stop 37 is adjusted, without disturbing the setting of the screws 15, to bring the resonating chamber into resonance with the second desired frequency. Thereafter, the fixed frequency is automatically tuned in when the relay is operated and the second frequency is had with the relay in the unoperated position. Subsequent changes in the second frequency are taken care of by readjustment of the stop 37.

A simple temperature regulating system may be provided as shown in Figs. 7 to 10, inclusive, in order to improve the frequency stability of the apparatus. Fig. 7 is a schematic of the temperature control circuit, which is of a well-known type. A heating winding 41 is connected in series with a suitable source of electromotive force, represented here by a battery 42, and with the contact 43 of the thermostat 20. A condenser 44 may be provided in parallel with the contact 43 in accordance with well-known practice. The heating winding is disposed in the heating unit 19 which may serve also as a base plate for the resonating chamber. The unit 19 may be screwed to the lower half 12 of the resonating chamber and in addition to such screw any desired further provision may be made for proper conduction of heat from the unit 19 to the body of the resonating chamber. A thermal conductor 45, such as a metal strip, may be provided for conducting heat from the unit 19 to the thermostat 20. The strip 45 may be looped about the casing of the thermostat as shown in Fig. 1.

Fig. 8 is a plan view of the heating unit 19, partly broken away to show the heating winding 41. Fig. 9 is a cross-sectional view through one of the electrical terminals of the winding 41, and Fig. 10 shows a typical cross-section of the heating unit 19 taken through the winding 41.

What is claimed is:

1. A cavity resonator having a pair of substantially parallel wall portions, a tuning rod extending into said cavity with the axis of the rod parallel to said parallel wall portions, said rod having an enlarged threaded portion within said cavity engaging corresponding threads on the said parallel walls and said rod having a second threaded portion of smaller diameter, and a lock-nut engaging said second threaded portion of the rod and bearing against the exterior of the cavity resonator to tighten the engagement of the enlarged threaded portion of the rod with the said parallel walls, whereby a good conductive contact is obtained therebetween at any setting of the rod over a tuning range.

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2. A cavity resonator having a pair of substantially parallel wall portions, a tuning rod extending into said cavity with the axis of the rod parallel to said parallel wall portions, said rod having an enlarged threaded portion within said cavity engaging corresponding threads on the said parallel walls and said rod having a second portion of smaller diameter, and means external to the cavity resonator to control the pressure between the enlarged threaded portion of the rod and the corresponding threaded portions of the parallel walls, whereby a good conductive contact may be secured at any desired setting of the rod over a tuning range.

3. A cavity resonator having a pair of substantially parallel interior walls, and a tuning rod extending into said resonator and having an enlarged portion at the inner end, said enlarged portion having a diameter slightly greater than the distance separating said walls of the resonator, and said enlarged portion being threaded to engage a similarly threaded portion of the said walls.

4. A cavity resonator having a pair of substantially parallel side wall portions, and a tuning rod having at one end a portion of diameter slightly greater than the distance separating said wall portions, said end portion of the rod extending into said resonator with the axis of the rod parallel to said wall portions, and said end portion of the rod and said wall portions of the resonator having intermeshing threads whereby electrical contact is maintained between said rod and said wall in any position of said rod over a tuning range.

5. A tuning element cylindrical at one extreme end and threaded with a small number of turns only, beginning at said end, a tuning chamber into which said tuning element projects with its threaded end innermost, said chamber having internally threaded portions to match the said threaded portion of the tuning element over an area of suitable extent and suitably disposed to support said tuning element and to permit the same to be propelled along the thread through a desired working distance, said tuning element being so shaped beyond said externally threaded portion away from the end having said cylindrical portion to permit propulsion along the thread as aforesaid, and means to maintain pressure between the respective threads of said tuning element and the wall of the chamber to secure good electrical contact between the threaded end of the tuning element and the wall of the chamber at any desired position of said tuning element.

RENNE S. JULIAN.

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