Oct. 28, 1941. P. WARE 2,260,877

TUNING DEVICE

Filed June 26, 1939

Fig. 1

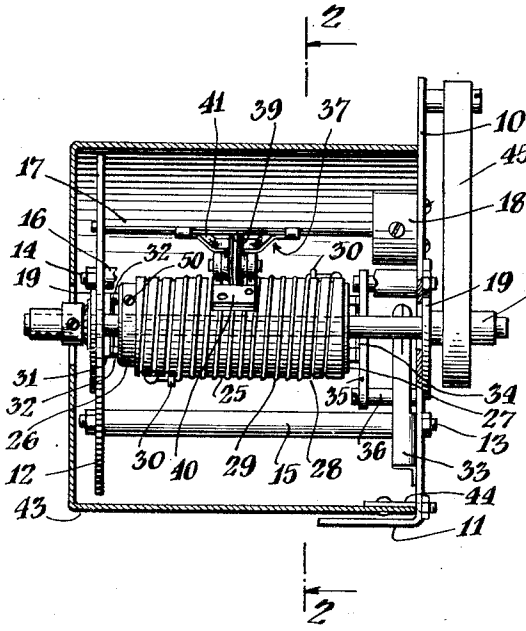


Fig. 2

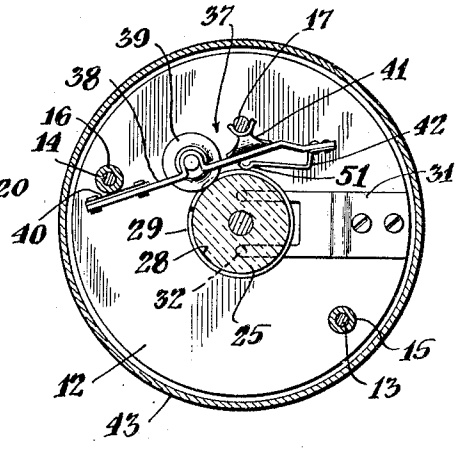


Fig. 3

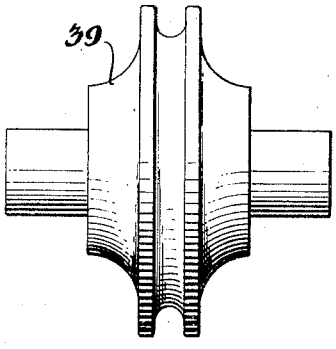
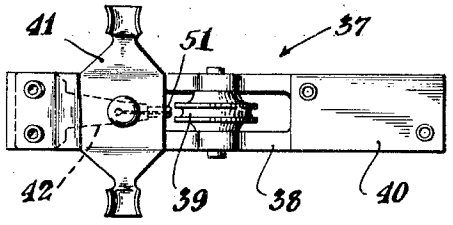


Fig. 4



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TUNING DEVICE

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4 Claims. (Cl. 171—242)

This invention relates to continuously variable slide-wire inductance devices.

An object of the invention is to improve slide wire variable inductance devices of the type described, and the contactor assemblies therefor.

The present application is a continuation in part of my co-pending application S. N. 94,927, filed August 8, 1936, and S. N. 95,332, filed August 11, 1936 now respectively Patents 2,163,645 and 2,163,647, June 27, 1939.

Other objects of the invention will be apparent from the following description and accompanying drawing taken in connection with the appended claims.

The invention comprises the features of construction, combination of elements, arrangement of parts, and methods of manufacture and operation referred to above or which will be brought out and exemplified in the disclosure hereinafter set forth, including the illustrations in the drawing.

In the drawing:

Figure 1 is a side elevation, partly in section, of a continuously variable slide-wire variable inductance device embodying features of my invention;

Figure 2 is a section on the line 2—2 of Figure 1;

Figure 3 is an elevation of an insulating wheel guide; and

Figure 4 is a top view of the contactor carriage.

A feature of my invention resides in a novel contactor carriage structure particularly well adapted to use with inductance coils of small diameter. Other features reside in the structure and structural details of the entire device illustrated, including the metallic case and shield therefor.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the construction of parts without departing from the spirit of the invention. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to the drawing the slide wire variable inductance device illustrated comprises a frame including a front plate 10 of sheet metal the lower part of which may be bent back at right angles, as shown, to afford a mounting base portion 11. The frame also includes a circular rear plate 12 rigidly supported in spaced parallel relation to the front plate by a pair of tie rods 13 and 14 surrounded by spacing sleeves 15 and 16, respectively. A third rod 17 extends between the plates and is in good electric contact with both, the rod 17 being tapped into the rear plate 12 and a short sleeve 18 clamping the rod firmly with respect to the front plate. Rod 17 is plated with a smooth layer of silver over which is applied a thin coating of tarnish resistant lubricant.

The front and rear plates are provided with centrally-disposed aligned apertures over which are secured bearing plates 19 of Bakelite or other suitable insulating material. Smaller aligned apertures are located in the centers of plates 19. A shaft 20 of copper or other low loss radio frequency material extends through the frame from front to rear, the apertured Bakelite plates serving as bearings therefor.

A coil form 25 comprising a hollow cylinder of insulating material which may be Bakelite, ceramic or other suitable insulating material, is mounted on the shaft 20 between the end plates. Where a Bakelite form of thin tubing is used, a short metal cylinder or ring 26 having an aperture to slidably fit the shaft 20 is employed at the rear end to support and center the form 25, the cylinder 26 having a press fit with the inside of the form. Set screw 50 holds the coil in position on shaft 20. At the front end a metal ring 27 is pressed into the end of the form. Ring 27 has a central aperture larger than the shaft and secures an insulating disc within the aperture which disc is apertured to fit the shaft. Thus metal ring 26 is grounded to the shaft 20 while ring 27 is insulated from the shaft.

In some cases it is preferred to use two shaft sections for shaft 20, one for the front and one for the rear of the assembly respectively, each shaft extending only for a sufficient distance to afford a rigid assembly but the two shaft sections being spaced by an intervening gap.

Form 26 has cut on its outer cylindrical surface a spiral groove 28 of suitable pitch and a coil 29 of silver plated hard-drawn copper wire is wound onto the form in this groove the ends of the coil being hitched around metal pins or screws 30 and soldered to the heads of other pins in end rings 26 and 27 respectively. In the case of the Bakelite form shown in Figures 1 and 2 the screws extend through the Bakelite shell to the underlying metal rings. The wire is coated with a tarnish resisting lubricant.

The end faces of rings 26 and 27 are silver plated and burnished. Ring 26 is grounded to

the frame by a bifurcated phosphor-bronze spring 31 having sliding contact discs 32 of a silver-graphite composition brazed to the ends of two arms and slidably engaging the silver-plated face of ring 26. A tarnish resistant lubricant coats the burnished silver surfaces. The spring 31 is mounted against rear plate 12 with screws. The rear end of coil 29 is thereby grounded to the frame.

Shaft 20 is also thereby grounded. Shaft 20 may be further grounded to the front plate 10 and for this purpose a bifurcated bronze spring 33 is provided which is screwed onto the plate 10 and has the bifurcations at its end slidably engaging shaft 20.

A bifurcated contact spring 34, generally similar to spring 31 and similarly provided with silver-graphite contacts is mounted on an insulating plate 35 supported in spaced parallel relation with front plate 10 by sleeved screws 36. The contacts slidably engage ungrounded end ring 27. The outer end of spring 34 attaches to copper strip that extends out at the side of the frame and serves as the ungrounded terminal of the variable inductance device.

A moving contactor carriage, designated generally by the numeral 37, is disposed against the side of the coil held and guided by rod 17 and the sleeve 16 on rod 14. Carriage 37 comprises a metal frame 38 formed of an elongated piece of sheet metal having a central portion thereof slotted longitudinally, the sides of the slot being bent into similar U-shaped loops. They thus provide a pair of aligned bearings, in which rest the two end spindle bearings of a grooved insulating wheel 39.

Figure 3 shows the details of the insulating wheel 39, which preferably consists of a single piece of molded or turned Bakelite. The groove thereof straddles the wire of coil 29 and the flanges roll on the form 25.

A Bakelite plate 40 is riveted to the face of frame 38 at one end and slidably engages sleeve 16. Intermediate of the opposite end of frame 38 and wheel 39 is riveted the mid-portion and antler-shaped metal spring 41, the two arms or antlers thereof having ends bent into generally U-shaped longitudinal channels which slide along rod 17.

The end of frame 38, beyond antler-spring 41, is provided with a jog bend as shown, and a thin phosphor bronze spring 42 is riveted to this end and extends to a position of contacting engagement with the wire of coil 29. Spring 42 may be of phosphor bronze or other metallic spring material and is tapered to a bifurcated contact portion 51 slightly wider than the diameter of the wire of coil 29. Contact portion 51 is bent into a U-shaped form so as to provide a convex surface in contact with the wire. The main body of contact spring 42 is preferably parallel to a tangent of the coil 29 at the point of contact. The end 51 of contactor 42 is split along its center line for a short distance back from the point of contact to provide slightly spaced, parallel, semi-independent contacting portions pressing against the surface of the wire of coil 29. The trolley wheel groove width and bearings are held to such maximum additive tolerances that contactor 42 is held in contact with an individual turn of the coil with both nibs sliding thereon and in no instance is there contact to two succeeding turns at one time.

The double-nibbed design of spring contactor 42 greatly minimizes the possibility of noise introduced into the circuit by irregularities on the surface of the coil 29. With a single contacting surface a slight hump or depression in the surface of the wire may frequently result in momentarily breaking the contact between the end of the spring and the wire at the moment the end jumps over the irregularity in the wire during tuning. With two parallel contact surfaces resting side-by-side on the wire as provided by the arrangement described the possibility of momentary break in the contact is very greatly reduced since two parallel irregularities in the wire surface are not encountered in first-class plated and processed wire. If a minute surface irregularity causes a break in the contact between one of the nibs and the wire the other nib will serve to maintain the circuit closed. The two contacting nibs of spring 42 must slide in parallel along the length of the wire since they determine the amount of wire of coil 29 that is in the tuning circuit and hence the frequency of the circuit. With this arrangement therefore one nib can be raised without altering the tuning, whereas if the points of contact of the nibs were arranged sequentially along the wire only the one nearer the right end of coil 29 would determine the tuning frequency and the other nib would be considerably less operative in determining the frequency.

The stiffness and biasing of spring 42 are preferably so adjusted as to give a total contact pressure between the spring 42 and the wire of coil 29 of approximately 50 grams, or 25 grams for each contact tip. This low pressure is made feasible by the uniform position in which the contactor spring is held relative to the wire. This pressure is found to be sufficient to insure a reliable contact with two sliding nibs and yet be well under a value that will cause excessive wear or seizing.

In tests made with a coil of hard drawn copper wire plated with silver and a phosphor bronze double-nibbed contact spring I have discovered that a pressure of 50 grams per nib causes excessive wear of the surface of the conductors resulting in a tearing loose of particles of metal and rapid destruction of the unit. On the other hand a pressure of 10 grams per nib was insufficient to maintain reliable contact and tended to cause excessive noise. With pressure in the order of 25 grams per nib reliable contact was obtained and after thousands of round trip operations of the device wherein the contactor travelled from end to end the device still functioned as intended and did not show excessive wear.

In order that the contact pressure shall be independent of the direction of rotation of the coil and that no danger of mechanical oscillation of the contact spring during rotation of the coil shall be possible the main body of spring 42 is arranged to extend in a direction substantially tangent with the coil at the point of contact therewith.

By arrangement shown the trolley wheel 39 maintains the distance between the bifurcated tip 51 of spring 42 and the frame 38 substantially constant during tuning. Otherwise there would exist the possibility of undue mechanical working of the spring metal resulting in excessive wear in the wire plating and the nibs. Any eccentricity in the running of the coil form 25 is compensated for by the flexing of spring antler member 41 and not by the flexing of spring 42. Only slight flexing of spring 42 is needed due to

the small eccentricity existing between form 25 and coil 29.

Whereas considerable variation in pressure between spring 41 and contact bar 17 is not detrimental because spring 41 slides a comparatively short distance along bar 17, it would result in rapid failure of the contact and the wire of coil 29 if the pressure of spring 42 were to vary to any great extent. The pressure of spring 42 against the coil 29 must be relatively slight in order to prevent excessive wear and disruptive action between the contact spring and the wire during use which may involve a total contact travel measured in miles. In order to keep down wear the spring pressure must be lighter than would normally produce reliability if the sliding contact were not accurately positioned by the trolley wheel with respect to the wire at all times and were not bifurcated so that one contact nib will remain in contact even if the other is momentarily lifted off.

Any slight tendencies of motion of the contactor assembly 37 other than that required for operation are largely confined to slight rotation of the contactor assembly about an axis located approximately at the center of and parallel to the wire over which the trolley and the tips of spring 42 are pressing. Such motion as may take place in this manner, however, is insufficient to permit either of the contact nibs to leave the wire or to cause a "short" with an adjacent turn of the wire coil 29.

It will be apparent that contact spring 42 connects the point on coil 29 which it engages with the frame through carriage frame 38, antler spring 41 and slide rod 17.

In my prior applications I have described contactor carriage assemblies for slide wire variable inductance coils having two trolley wheels cooperating with a single coil. The single wheel carriage assembly described in the present application provides a more satisfactory contactor for small diameter coils.

Moreover, the single wheel carriage assembly may be used interchangeably with only slight alteration on the coils of differing diameters, whereas a different two-wheel carriage structure is required for each diameter of coil.

The carriage is preferably so proportioned that the numerical value for the friction on silver rod 17 multiplied by its lever arm to the trolley wheel approximates the product of the friction of the Bakelite slide 40 on sleeve 16 and its lever arm to the trolley wheel.

By this relationship and the guiding influence of antler spring 41 on the silvered rod 17, the carriage assembly is constrained to move at a fixed angle to the coil axis and on a plane parallel to the coil axis whenever the coil is rotated.

The wheel 39, together with its spindles comprises a single piece of Bakelite or other insulating material. By making the spindle of insulating material as well as the wheel I have discovered that a certain amount of undesirable electrical noise is eliminated in tuning. Where a metal spindle is used I have found that a small part of the inductance coil's radio frequency current was induced in it and since the wheel is close to the coil it was found to introduce an undesirable noise due probably to ununiform contact of the wheel spindle with the carriage frame. By eliminating the metal spindles the undesirable noise is avoided.

Drawn or extruded metal case 43 covers the assembly, the case being secured to front plate 10 by spade bolts 44 and having a suitable aperture in its side wall allowing copper terminal 34 to extend out of the case.

Case 43 likewise has a suitable aperture in the center of its rear wall through which the rear end of shaft 20 extends. It is thereby possible to gang together by rigid or flexible couplings several shielded variable inductance devices. The shield illustrated has the further advantage of being removable without disturbing the internal adjustments of the device.

It is well known that more than two bearings are difficult to align in a rotatable structure especially of the character described herein where three variable coils might be ganged end to end in a UHF tuning assembly. Such an arrangement would result in six bearings because each coil is fitted with closely spaced bearings to maintain the mechanical stability needed for UHF operation. The alignment difficulty is experienced due to manufacturing tolerances that must be reasonable to obtain economy and is manifest in slight eccentricities during rotation. The structure described lends itself readily to multiunit ganging by enabling attachment of each tuning unit to a common base or chassis by way of the flange 11 at bottom of front plate 10. The units are mounted in line with shafts parallel and attached by shaft couplings. While three units in such an assembly would have six bearings, in effect there are only three bearings, because of the slight weaving that is possible due to mounting of the units by their front plates only. Each unit in itself is rigid enough to maintain its proper internal adjustment. The shield is attached to the front plate only and hence does not interfere with such slight weaving motion of each unit. At the same time the structure is such that the shield may be removed from a single unit, or from any unit in a ganged assembly provided there is no unit directly in the rear of it.

Housing 45 secured in spaced relation in front of the front wall 10 encloses a suitable Geneva gear mechanism for preventing rotation to a point where the carriage contact spring 42 or wheel 39 runs off the end of the coil. A suitable dial or turn counter may also be associated with the gear mechanism.

While the present invention, as to its objects and advantages, has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. A variable inductance device comprising a substantially cylindrical insulating form and a bare helical conductive coil wound thereon, means supporting said form for rotation about its axis, a pair of parallel metal rods spaced from said form and parallel to the axis thereof, both of said rods being on the same side of a plane through the axis of said form, and a moving contactor carriage interposed between said rods and the side of said form, said carriage comprising a frame, insulating means thereon movably engaging one of said rods, a spring thereon slidably engaging the other of said rods, an insulating wheel thereon rolling on said form along the conductor thereon and a resilient contact thereon sliding on said coil along the conductor thereof.

2. A variable inductance device comprising a substantially cylindrical insulating form and a bare helical conductive coil wound thereon, means

supporting said form for rotation about its axis, a pair of parallel metal rods spaced from said form and parallel to the axis thereof, both of said rods being on the same side of a plane through the axis of said form, and a moving contactor carriage interposed between said rods and the side of said form, said carriage comprising a frame, insulating means thereon movably engaging one of said rods, a spring thereon slidably engaging the other of said rods, an insulating wheel thereon rolling on said form along the conductor thereon and a resilient contact thereon sliding on said coil along the conductor thereof, said wheel being pivoted in said frame at a point intermediate the two rods.

3. A variable inductance device comprising a substantially cylindrical insulating form and a bare helical conductive coil wound thereon, means supporting said form for rotation on its axis, a pair of parallel metal rods spaced from said form and parallel to the axis thereof, both of said rods being on the same side of a plane through the axis of said form, and a movable contactor carriage wedged between said rods and the side of said form, said carriage comprising a frame, an insulating member thereon slidably engaging one of said rods, a spring thereon slidably engaging the other of said rods, an insulating wheel pivoted therein and rollably engaging said form so as to roll along the conductor of said coil, and a resilient contact thereon slidably engaging said coil so as to slide along the conductor thereof, the numerical value of the friction between said insulating member and its cooperating rod multiplied by the distance between the point of frictional engagement and the pivot for said wheel being substantially equal to the friction of said spring with its associated rod multiplied by the distance therefrom to said pivot.

4. A variable inductance device wherein a bare helical conductive coil is mounted for rotation about its longitudinal axis and a contact bar is mounted parallel to the side of the coil and spaced therefrom, and a moving contactor carriage is interposed between said bar and the side of said coil and comprises contacts respectively engaging said bar and said coil, characterized by the fact that there is combined with said carriage an insulating wheel pivoted for rotation in said carriage and guided by the conductor of said coil, said wheel comprising an insulating circular wheel portion and insulating spindle bearings axially projecting from both sides thereof.

PAUL WARE.