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VARIABLE INDUCTOR

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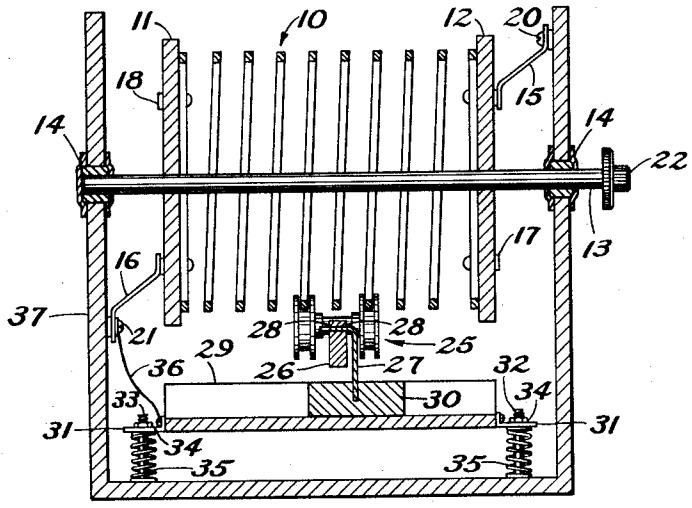


FIG 1

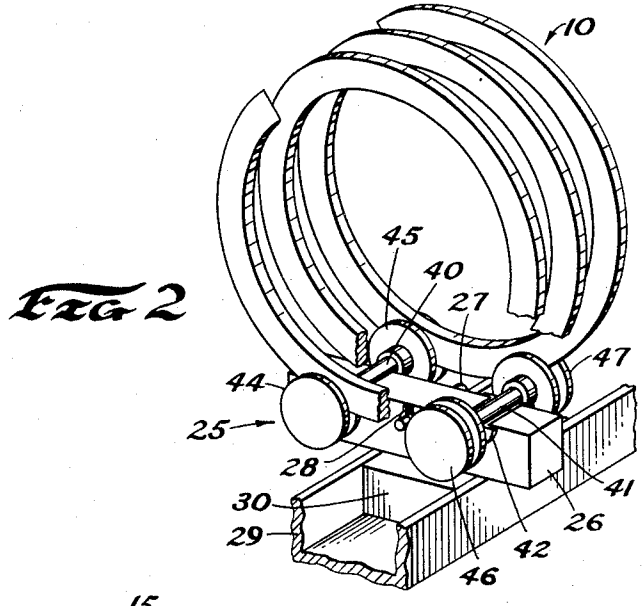


FIG 2

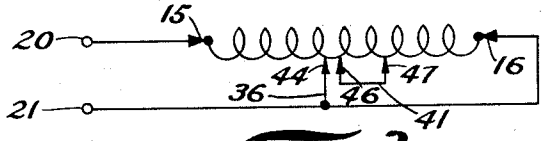


FIG 3

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VARIABLE INDUCTOR

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2 Claims. (Cl. 336—139)

This invention relates to variable inductor devices and more particularly to contact roller arrangements.

Prior art devices for variable inductors used in tank circuits in the high power class have usually comprised a rotatably-mounted coil of self-supporting wire and two contact rollers, one used for circuit connection and the other to short circuit a portion of the coil in conjunction with the circuit roller. In some circuit arrangements the short-circuit current becomes appreciably higher than the tank currents. Under this condition contactors handling both tank currents and shorted turns current become overloaded, heat, arc, and generally fail. This failure occurs in inductors used in radio frequency transmitters of as low a power as one kilowatt.

Accordingly, it is an object of this invention to provide a contact roller arrangement which greatly reduces the burning of contacts due to heating and arcing during use.

It is a further object of this invention to provide a roller contact arrangement which separates the shorted-turns current from the tank current and so provides a more reliable contact roller system.

It is a further object of this invention to minimize the effect of the short circuit on the Q, or quality factor, of the coil.

It is a feature of this invention that a plurality of rollers are used, each for separate purposes, with insulation provided in appropriate places to prevent mutually undesired currents.

It is a further feature of the invention that the rollers are mounted so as to have equalized contact pressures.

Further objects, features, and advantages of the invention will become apparent from the specification and claims when read in conjunction with the drawing, in which:

Figure 1 shows a section view of a rotary variable inductor,

Figure 2 shows a perspective view of the details of the roller contact system, and

Figure 3 shows an equivalent circuit diagram for the inductor.

In Figure 1 a self-supporting coil **10** is mounted between insulating end plates **11** and **12**. Coil **10** is shown having rectangular cross section wire with the wide dimension of the wire in the radial direction of the coil. Other forms of wire may be used as long as they are self-supporting, and do not deflect unduly because of the spring pressure of the roller contacts. The wire will preferably be copper with a silver plating for improvement of high frequency conductivity and corrosion resistance. The coil may have longitudinal supporting strips in some applications, provided the strips do not interfere with the contact rollers.

End plates **11** and **12** are insulators and may be ceramic or plastic as desired. End plates **11** and **12** are mounted on a shaft **13** which is rotatably mounted in bearings **14**. Bearings **14** may be sleeves such as solid or sintered bronze operating on the steel shaft **13**. Roller or ball bearings may be used as desired, such as

where high radial loads are involved. Necessarily, bearings **14** will also provide for control of shaft end-play, necessary for proper contact pressures of contacts **15** and **16**. The thrust from the force required to move the roller assembly must also be accommodated. Contacts **15** and **16** run on slip rings **17** and **18**, respectively, which are connected to the ends of the coil **10**. Slip rings **17** and **18** may be of copper with silver plating or may have a plating such as chromium or rhodium for improvement of wear resistance against the rubbing wear of the brushes. Brushes **15** and **16** may be made of springy beryllium copper alloy with a plating such as silver to enhance the high frequency conductivity and to improve corrosion resistance. Brushes **15** and **16** are mounted on insulated posts or terminals **20** and **21**, respectively, which are available for connection with the rest of a circuit, such as a tuned circuit.

A knob **22** is shown mounted on shaft **13** for illustration of the rotation of the coil **10**. Rotary positioning means, manually or automatically operated, or coupling onto other rotated shafts, may be used to rotate coil **10**.

Contacting the central portion of coil **10** is a roller assembly **25**. This roller assembly consists of a pair of axles, each having a pair of rollers. A bar **26** carries these four rollers by their axles. This bar **26** is pivotally mounted on a post **27** having the shape of an inverted L. The transverse portion of post **27** carries bar **26** and has retainers **28** on either side to keep bar **26** in place. Post **27** is mounted in a block **30**. This block closely fits and is carried by channel **29**. Bar **26**, post **27**, block **30**, and channel **29** each may be metallic, such as brass or copper or possibly non-metallic if the occasion calls for it, but have in any case a plating of silver for improvement of the conductivity at high frequencies. Bar **26** is freely movable on post **27**, pivoting about the short leg of post **27**. Block **30** is a close fit in channel **29** but is readily moved along, parallel to the axis of the inductor **10**. Block **30** has sufficient clearance to move along freely, relative to the strength of turns of the coil **10** to provide the advancing force, yet has sufficient contact pressure against channel **29** to make a good contact.

Channel **29** is mounted by extensions either of the channel itself or by separable extensions **31** which are mounted on the channel. Extensions **31** are carried on bolts **32** and **33**. These bolts have nuts **34** on top and springs **35** below the extensions **31**. Springs **35** are under compression to the extent needed to provide the desired contact pressure of contact roller assembly **25** against coil **10**. Nuts **34** prevent the assembly from coming apart, and also provide stops to prevent further deflection of the coil such as when the contact assembly is at the middle. A flexible lead **36** connects channel **29** electrically to the same terminal **21** as brush **16**. The channel may have other terminals thereon in accord with the requirements of the circuit. A frame **37** is arranged in any desired manner to support the shaft **13** and the channel **29** in the cooperative relation shown.

Figure 2 shows a perspective view of the coil **10** and contact roller assembly **25**. Here the supporting channel **29** can be seen supporting a block **30**. Post **27** is barely visible but supports bar **26** and positions it through the use of retaining rings **28**. Bar **26** has notches therein spaced parallel and substantially parallel also to the axis of the coil **10**. In these notches are supported two axles **40** and **41**. Axle **40** is metallic or ultimately has a conductive metal coating. This coating conducts high frequency currents to bar **26** from roller **44**, and may be either silver, rhodium or other, as the use demands. Axle **41** is insulated by a plastic insert **42** such as nylon or Teflon, preferably Teflon. Nylon and Teflon are well-known plastics having high wear strength, good di-

electric qualities and low chemical activity. Nylon is a plastic composed of polyamide resins, while Teflon is a solid polymer of tetrafluoroethylene.

On axle **40** are mounted two rollers. One, **44**, is conductive or has a conductive surface connected to axle **40**; the other, **45**, is of insulating material or has at least an insulating surface. Roller **45** may be made of a solid plastic as noted above, and is preferably all Teflon. Roller **44** is designated the signal or load current roller. That is to say, the load current, or the tank current where the inductance is in a resonant circuit tuned by the variable tap to coil **10**, is carried by roller **44** from the coil **10** through axle **40**, bar **26**, post **27**, to channel **29** and on to the external circuit. Roller **45** does not carry any current by virtue of being an insulator. Roller **45** provides a balancing force to that of roller **44** so that axle **40** is kept aligned and the rollers in contact with the coil **10**. Axle **40** has somewhat of a pivotal relation relative to bar **26** so that the pressure is equalized between the two rollers **44** and **45**.

Axle **41** carries two conductive rollers **46** and **47**. Rollers **46** and **47** may also be made of insulating material with a conductive coating. Axle **41** is contacted electrically by both rollers for conduction of currents between the turns contacted by the two rollers. Rollers **46** and **47** are designated the shorted-turns current carrying rollers, and contact the coil in the inactive portion. These rollers are intended to carry the current between the coil turns which they contact and short together. Axle **41** has somewhat of a pivotal relation with respect to bar **26** also. Bar **26**, as stated before, is pivotally mounted on the short leg of post **27**. Thus, the pressure of springs **35**, seen in Figure 1, urges channel **29** in radially, toward the coil. This pressure is transmitted to block **28** from channel **29**. The pressure on block **28** is transmitted through post **27**, bar **26**, axles **40** and **41**, to the four rollers which contact coil **10**.

Thus it can be seen why coil **10** must have considerable rigidity. Since the coils requiring this type of shorting treatment generally require a large wire size because of the high radio-frequency currents involved, there is little difficulty in making the coil strong enough also for the contact pressure of the roller assembly **25**. The shape of the grooves of the contact rollers is made to correspond with the shape of the wire used.

Figure 3 shows the effective circuit diagram of the assembly shown in Figures 1 and 2. Terminal **20** has the same number as the corresponding terminal in Figure 1; likewise, terminal **21**. Roller **44** is the variable tap of the inductance; the current conducting path from roller **44** through lead **36** is connected to terminal **21**. Brushes **16** and **15** make the contacts to the ends of the coil. Shorting rollers **46** and **47** and axle **41** make the similarly numbered shorting loop seen in Figure 3.

In operation, the coil is rotated by shaft **13**. Rollers **44**, **45**, **46**, and **47** roll freely and follow the helix of the coil. The rollers are moved axially along the inductance by rotation thereof. The contact rollers make a continuous contact between the coil and the frame as seen in Figure 3.

The active portion of the coil between terminals **20** and **21** is the inductance available to the circuit external to these two terminals. The inductive coupling from the active portion of the coil into the inactive portion is reduced substantially to zero by the two shorted turns encompassed between rollers **46** and **47**. In actual use there is little discernible difference between the end of the coil contacted by brush **16** being connected to terminal **21** or being left free without any connection. When a load or tank current flows through the active portion of the coil, a shorted-turns current is induced in the section of the coil between rollers **46** and **47**. There is also a coupling to the inactive portion of the coil between contact roller **44** and the end. The coupling into the varying inactive portion is reduced, however, to substantially zero by the counter electromagnetic flux generated in the shorted turns. One or more than two turns are similarly effective. A one turn short, however, causes unduly high currents, while more than two turns does not provide a great enough short-circuit current to buck out completely coupling to the unused part of the coil. This, of course, is a function of the operating frequency and is proportionate to the coil characteristics.

As a result of this invention, a variable inductance is made available with no coupling to an inversely variable unused portion of the coil, which ordinarily produces undesirable effects such as loading, variation of Q, and undesirably high induced voltages where the turns ratio becomes great. These advantages are made available with a considerable reduction of contact heat. Further, by the shorting rollers being isolated from the load current roller and contacting the unused portion of the coil, the Q of the coil in circuit is not adversely affected.

Although this invention has been described with respect to particular embodiments thereof, it is not to be so limited because changes and modifications may be made therein which are within the full intended scope of the invention as defined by the appended claims.

I claim:

1. A variable inductance comprising a self-supporting helical conductor supported at the ends by rotatable means, a contact roller assembly comprising two pairs of rollers elastically urged against said helical conductor, means pivotally mounting each pair of rollers, movable means pivotally mounting said pivotal means, said movable means being movable substantially parallel to the axis of said helix, a fixed terminal, one roller of one pair of rollers being conductively connected to said fixed terminal through said parallelly movable means, the other roller of said one pair being insulating at its contact with said coil, the rollers of said other pair being conductively interconnected so as to short-circuit turns of the helix contacted, and insulation means between said other pair of rollers and said pivotal mounting means.

2. A variable inductor comprising a helical conductor, insulating means bounding said inductor at each end, rotatable means mounting said insulating means so that said helix may be rotated about its axis of formation, contact roller means for contacting a selected point on said helix, said contact means comprising a first pair of rollers mounted on a first axle, a second pair of rollers mounted on a second axle, one of said first pair of rollers being conductive, the second of said first pair of rollers being insulating, said second pair of rollers and axle being conductive, pivotal mounting means carrying said first and second axles, insulating means supporting said second axle in non-conductive relation to said pivotal means, sliding contact means carrying said pivotal means, means mounting said sliding contact means adjacent said helix, said roller assembly being movable along the axis of said coil, and terminal means connected to said slideable mounting means whereby a conductive path from said conductive roller of said first pair of rollers to said terminal means is established from said point selected by rotation of said helix about its axis.

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