Nov. 9, 1965 G. E. GEE ETAL 3,217,277

VARIABLE CORE TUNING INDUCTOR

Filed June 18, 1962

Fig. 1.

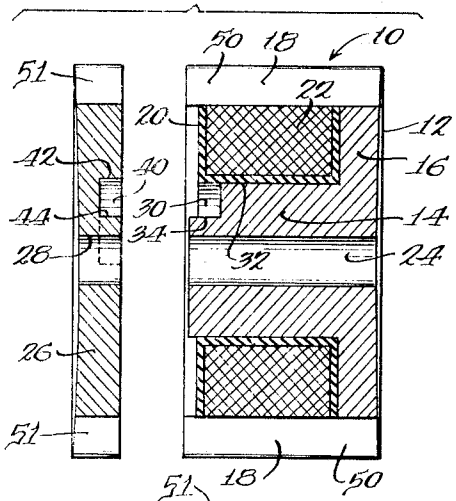


Fig. 2.

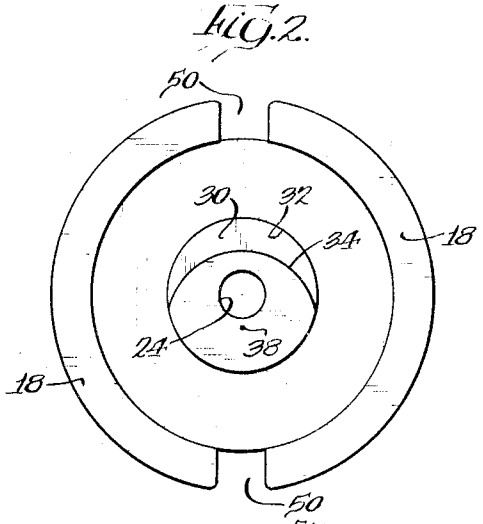


Fig. 3.

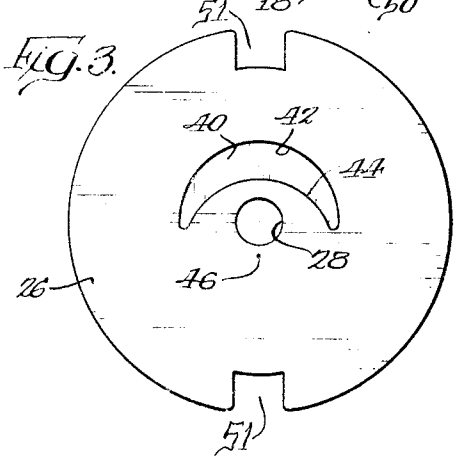


Fig. 4.

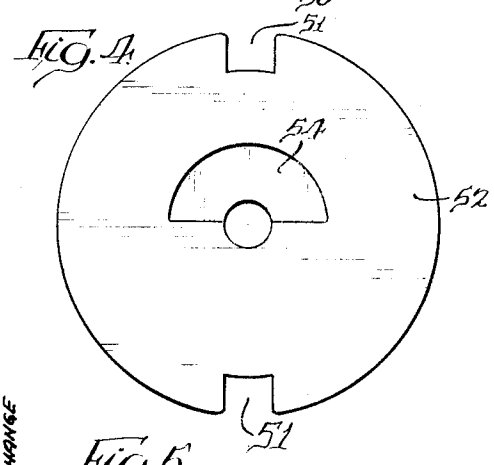


Fig. 6.

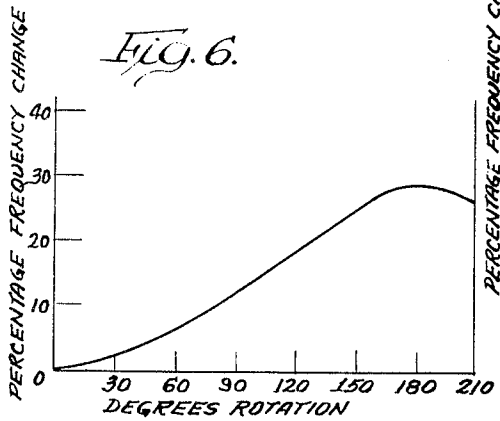
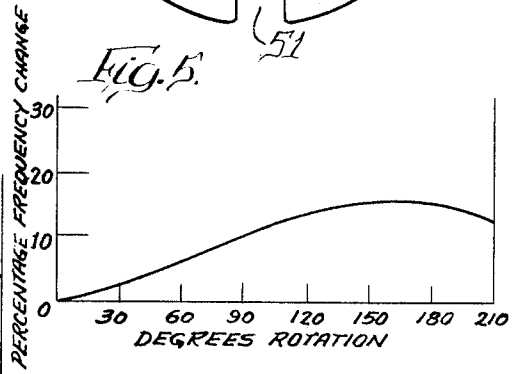


Fig. 5.



INVENTORS:
Gordon E. Gee
Ray B. Schrecongost
By
Wupper, Gradolph & Love,
Attys

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VARIABLE CORE TUNING INDUCTOR

Gordon E. Gee and Ray B. Schrecongost, Park Ridge, Ill., assignors to Hammond Organ Company, Chicago, Ill., a corporation of Delaware

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1 Claim. (Cl. 336—135)

This invention relates in general to variable core inductors and more particularly relates to an audio frequency ferrite core inductor which is tuned by rotational movement to provide a comparatively linear change in frequency for use in tuning organ oscillators.

One typical previous practice for deriving an audio frequency tone in an organ oscillator involved the use of an iron core tuning inductor. The inductor comprised a core of stacked laminations which was longitudinally reciprocated to vary the gap in the magnetic circuit and therefore the nominal frequency of the associated oscillator. This arrangement was somewhat diffcult to adjust precisely, and in addition, since a number of such inductors were mounted in adjacent positions, considerable magnetic interaction might occur unless special preventive techniques were used. The difficulty in adjusting or tuning an inductor of the type described is that its reactance varies in such a manner that minute changes in the air gap result in great changes in oscillator frequency so that precise tuning is difficult to achieve while any subsequent slight misalignment results in a considerable variance in the output frequency from what is desired.

Another type of widely used tuning inductor incorporates a so-called ferrite core and cap, with the core being cup-shaped and having a center post about which the coil is mounted. The center post projects toward the cap which is rotatable. The cap is provided with a D-shaped recess, and the post is provided with a similarly shaped portion so that when the cap is rotated, the area of the gap therebtween is altered to vary the frequency of the associated oscillator. This arrangement, however, is subject to wide fluctuations in the amount of frequency variation per increment of rotation of the cap if a substantial percentage range of tuning is to be provided. Thus if a large over all change in frequency is to be provided, the cap must be rotated over an arc which brings the edge of the cap recess into proximity with an edge on the core, resulting in considerable flux leakage and local saturation so that the frequency may change very abruptly in response to slight movement of the cap.

It is therefore an object of the present invention to provide a variable reluctance inductor which may be rotatably adjusted to provide linear percentage frequency changes in the output of an associated oscillator.

It is another object of the present invention to provide a variable reluctance inductor utilizing a rotatable cap element for adjustment, which may be rotated over a considerable arc to provide a large linear change in frequency while at the same time the sensitivity of the inductor is reduced to the point where incremental movement of the cap does not give rise to a large percentage shift in frequency.

Briefly, the objects of the present invention are accomplished by providing a ferrite cup having a center post or core with the coil carried between the core and cup wall. The core has a predetermined shape formed at one end and cooperates with a rotatable ferrite cap element having another predetermined shape formed therein to provide a substantially linear change in the output frequency of the associated oscillator when the cap is rotated relative to the core. Thus the inductive effect is controlled by rotatably varying the area of close proximity between opposing surfaces of the core and cap in such a manner

that edge areas are not alone maintained in close coupled relationship.

In the drawings:

FIG. 1 is a cross sectional view of one embodiment of the inductor illustrating the relationship between the tuning cup and cap;

FIG. 2 is a front elevational view of the tuning cup;

FIG. 3 is a front elevational view of the cap;

FIG. 4 illustrates another embodiment of the cap;

FIG. 5 is a graph illustrating percentage frequency shifts for various positions of the cap relative to the cup shown in FIG. 1; and

FIG. 6 is a graph illustrating percentage frequency shifts for various positions of the cap shown in FIG. 4.

In FIG. 1 a variable tuning core inductor incorporating the principles of the invention is illustrated by the reference character **10**. It comprises a ferrite cup **12** having a center post or core **14** projecting from a back wall **16**, and a pair of spaced apart semicircularly shaped walls **18** separated at their edges by narrow slots **50** which are convenient for passing leads to the coil **22** and coaxial with post **14**. A bobbin **20** havin a coil **22** is seated in the cup between the core **14** and the walls **18**.

An aperture or passageway **24** is provided in the center post **14** and back wall **16** for the purpose of enabling the generally circular tuning cap **26** having a central aperture **28** to be rotatably mounted on the cup. The cap **26** is normally engaged flush with the walls **18** and is shown separated therefrom in FIG. 1 primarily for the purpose of clarity. The coil **22** is thus maintained in a substantially completely shielded environment whereby coupling between adjacent inductors is substantially minimized.

It will be noted that the center post **14** does not extend as far from the back wall **16** as do the walls **18** so that there is a slight air gap between the post **14** and cap **26** to thereby minimize the interaction therebetween and reduce the sensitivity of the assembly. In addition, the center post is provided with a recess or cut away portion **30** defined by the peripheral wall **32** of the center post and a circular wall **34** whose radius extends from the axis passing through point **38** offset from the axis of the center post, as seen in FIG. 2.

The cap **26** is also provided with a recess **40**. This recess **40** is crescent shaped and formed by a pair of intersecting radial walls **42** and **44**, with wall **42** having its axis of rotation coaxial with the aperture **28** and the wall **44** having its axis offset therefrom as shown by point **46** concentric with point **38**. Both of these points lie on a plane passing through a diameter of the cap and core.

In assembling the cup **12** and cap **26** for use, the slots on spacing **50** between cup walls **18** and a pair of spaced apart recesses **51** in the edge of cap **26** are used to align the cap so that a line from point **46** bisecting the recess **40** is aligned at 90° to a similar line bisecting recess **30**. This position should normally result in the reluctance of the air gap between the cup and cap being such that the inductance is tuned to a desired audio frequency to be supplied in an organ with the frequency being dependent on the parameters of the coil. However, it often happens that the tolerance of the various components has been exceeded or that characteristics may vary. It therefore becomes necessary to adjust the relative position of the cap and cup so that the relationship between the recesses is changed.

FIG. 5 illustrates characteristic percentage shifts in frequency in the approximate ranges of 250–450, 500–825, and 1300–1500 cycles when the cap is rotated relative to the core. From 90° to 60° approximately a 5% linear shift in frequency occurs, while from 90° to 120° a similar linear percentage shift in frequency occurs in the other direction. The 90° axis corresponds to the de-

scribed assembled relationship between recesses **30** and **40** so that rotation of the cap in either direction from the assembled position will provide slight linear changes in frequency thereby permitting facile adjustment.

FIG. 4 illustrates another cap **52**. The cap **52** is similar to cap **26** except that a D-shaped recess **54** is provided therein. The straight leg of the D lies adjacent or parallel to the diameter of the cap, and the radial leg of the recess **54** is coaxial with the center of the cap.

The arrangement shown in FIG. 4 is assembled to the cup **12** in the same manner as described for cap **26** with a line bisecting the straight leg of the D lying at 90° to a line bisecting recess **30**. This corresponds to the 90° line indicated by the graph in FIG. 6, and it will be noted that rotation in either direction results in a substantially linear percentage shift in frequency for frequencies between approximately 1400–1800 cycles as shown in FIG. 5, but with a higher slope.

Thus, having described our invention, but believing the same capable of numerous modifications and adaptations, there is appended hereto a claim which is believed to incorporate the inventive concept.

We claim:

A variable inductor comprising a one piece ferrite cup providing an end wall, a cylindrical post extending upwardly from the end wall, side wall structure extending upwardly from the end wall concentric with the post to provide an annular space between the post and the side wall structure, a coil in said annular space surrounding the post, the upper edge of the side wall structure being flat and the upper end of the post having a flat surface generally parallel to the side wall flat surface, a ferrite cap having a flat lower face engaging substantially the entire flat upper edge of the side wall structure and overlying the post end, the end of the cylindrical post and the juxtaposed central portion of the cap when the cup and cap are together in alignment forming a pair of opposed generally circular regions, the cap within said region having a D shaped recess having a convex edge occupying substantially half the circular region and the post end having a crescent shaped recess having a convex edge at one side, the convex edge of the crescent shaped recess having the same radius of curvature as the post cylindrical surface, and the convex edges of both recesses having a common center of curvature which is substantially at the common axis of the cup and cap, said cap being rotatable relative to said cup to overlap said recesses to a greater or lesser extent.

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JOHN F. BURNS, *Primary Examiner.*