Dec. 10, 1968 L. J. HAVILAND 3,416,050

VARIABLE CAPACITOR

Filed Oct. 9, 1967

Fig. 1.

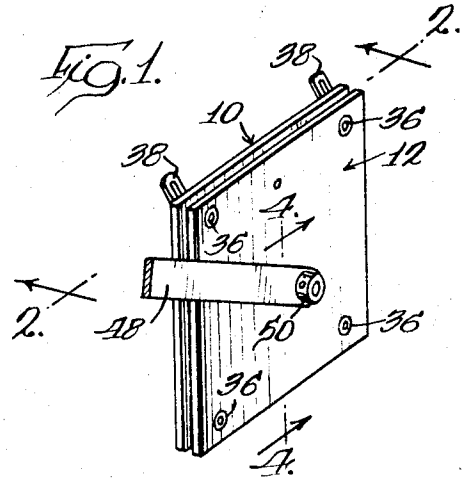


Fig. 2.

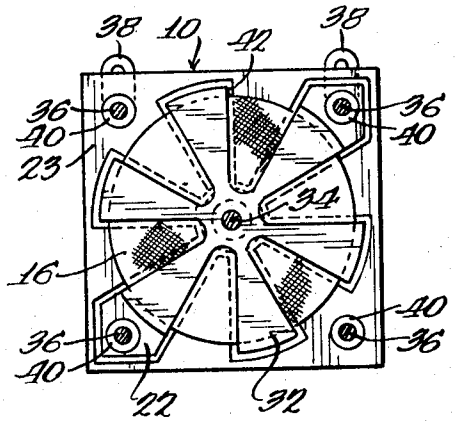


Fig. 3.

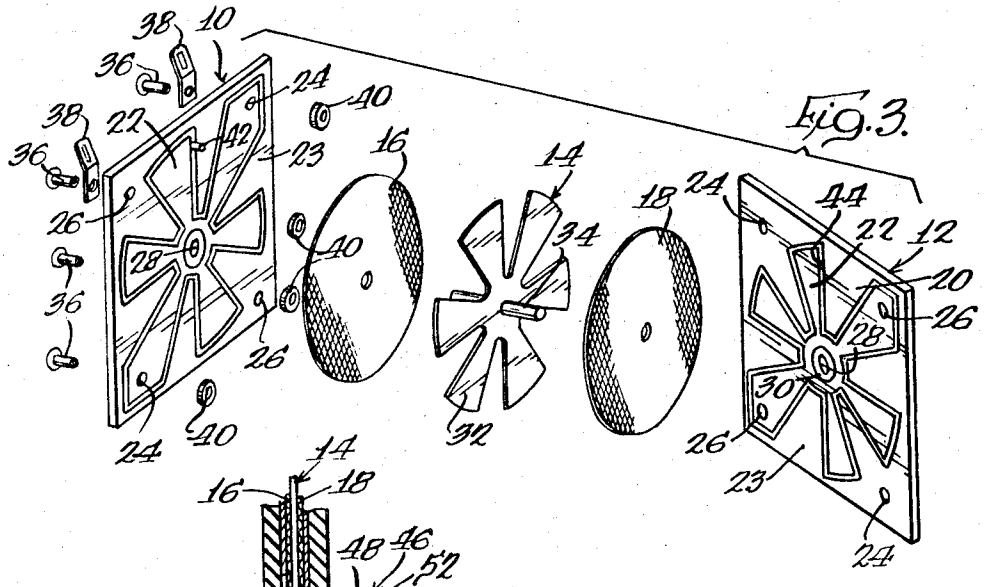
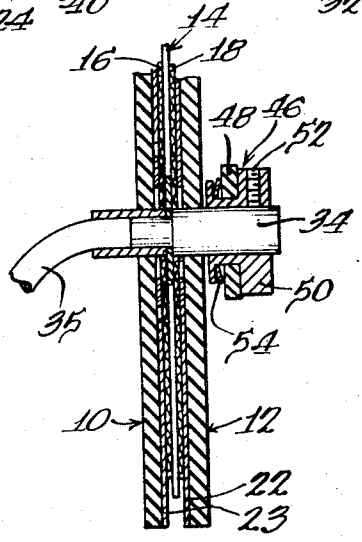


Fig. 4.



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VARIABLE CAPACITOR

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ABSTRACT OF THE DISCLOSURE

An organ swell control mechanism that is essentially a double variable capacitor which is adapted to be rotated to proportion the capacitative coupling between one circuit and two other circuits on the basis of a relatively small degree of arcuate movement between its coupling limits, such that it can be mechanically connected to the swell shoe of an organ by very simple linkage which need not include motion multiplying means. The capacitor includes multiple stator and rotor or scanner elements which are evenly arcuately displaced and a solid dielectric so as to achieve close and fixed interplate spacing.

Field of the invention

Swell control mechanisms for electrical musical instruments.

Description of the prior art

One of the basic types of swell control mechanisms used for many years in electrical organs is set forth in Patent No. 2,646,468 issued to John M. Hanert for Ear Response Compensated Volume Control Apparatus. As set forth in that patent, the principal idea is to regulate the signal coupling between a pair of input circuits and an output circuit by means of a variable capacitor arrangement. The capacitor system shown in that patent is effective for the purpose of fading between two signal circuits and has been used for many years without fundamental change, but inspection will show that the structure is comparatively expensive to manufacture.

Summary of the invention

The principal idea behind the present invention is to provide a swell control variable capacitor system which has substantially the attributes of the system described in the before mentioned patent, but which is much less expensive to manufacture and which occupies much less space while still obtaining the advantages of variable capacitative coupling.

It is, therefore, an object of the present invention to provide an organ type swell control variable capacitor system which is inexpensive and compact and which is adapted for direct mechanical connection to the organ swell pedal without motion multiplying means, and which is substantially noise free in operation.

Other advantages and features of the invention will become apparent from the following description of a preferred embodiment of the invention.

Brief description of the drawing

In the drawings in which similar characters of reference refer to similar parts throughout the several views:

FIG. 1 is a perspective view of the swell control capacitor with a portion of the control lever broken away;

FIG. 2 is a sectional view which may be considered as taken in the direction of the arrows substantially along the line 2—2 of FIG. 1;

FIG. 3 is a perspective exploded view showing the principal elements of the swell control device disassembled, but properly oriented relative to each other; and

FIG. 4 is a transverse sectional view which may be considered as taken in the direction of the arrows substantially along the line 4—4 of FIG. 1.

Description of the preferred embodiment

The capacitor mechanism includes two identical side plates **10** and **12** which provide the stator sections and a rotor or scanner **14** positioned between and spaced from the plates **10** and **12** by thin dielectric discs or wafers **16** and **18**. Both the stator elements **10** and **12** and the scanner **14** are star shaped for a purpose which will appear presently.

Each of the side plates **10** and **12** is generally square and is made from a piece of flat insulating material which is copper clad on one side. For this purpose a suitable material is a paper base phenolic laminate about 3/64 of an inch thick which has what is referred to in the trade as a one ounce copper cladding on one side. This is a standard article of commerce, and therefore needs no additional description. Although the size of these plates will necessarily vary somewhat depending upon the capacity required, it has been found that for the particular purpose envisioned, plates a little over 1½ inches square are appropriate.

Using common circuit board techniques, a serpentine line **20** is etched through the copper cladding so as to separate the copper surface of each of the plates into two separate areas which are insulated from each other. As is apparent from the drawing, the serpentine line is so arranged so as to provide twelve equi-angularly spaced radial lines which are alternately interconnected near the center and near the periphery so as to provide a paddle-bladed six-pointed star **22** surrounded by the remaining copper surfaces, which for convenience will be referred to as a hollow star **23**. Essentially, the star **22** and the hollow star **23** are the same electrically with respect to the rotor, excepting that one is rotated 30° relative to the other. Also, whereas the blades of the star **22** are interconnected at the center, the blades of the hollow star **23** are interconnected at the periphery of the plates **10** and **12**.

Holes are formed near the corners of the plates for the purpose of securing the plates together and the star **22** is laid out in such fashion that two of the opposite blades are somewhat longer than the others and extend toward opposite corners sufficiently to encompass two of the holes just referred to. These two holes through blades of the star **22** are indicated by the numeral **24**, the other holes having the numeral **26**. The reason for extending two of the star blades to encompass the holes **24** is that it facilitates providing electrical connections to the star **22**, whereas the other holes **26** facilitate providing electrical connections to the hollow star **23**.

The two plates **10** and **12** are alike and so when they free each other the star **22** of one faces the hollow star **23** of the other.

A hole **28** is provided at the center of each plate for passage of the rotor axle, the two holes **28** being in alignment when the plates are face to face. The etching process is conducted so as to remove a small circular area **30** of the copper material around the holes **28** so that an axle passed through the holes **28** will be electrically insulated from the copper surfaces.

The rotor or scanner **14** is a six bladed regular star formed of soft copper sheet about .020" thick. This star is also paddle bladed with the blades having substantially the same size and shape as the fixed stars **22**, excepting for the star **22** extensions to the holes **24**. The scanner is fixed upon an axle **34** in any suitable manner and the axle fits the holes **28** previously mentioned. As shown, the shaft **34** is formed of two telescoping pieces which are pressed and soldered together. During the soldering operation a pigtail flexible lead **35** can also be connected to provide

an electrical connection to the scanner. Prior to assembly the scanner element with the shaft **34** secured thereto is placed between flat faces in a hardened steel fixture and coined so as to insure that the blades are flat and of the proper thickness and that the shaft **34** is true.

At each side, the blades **32** of the scanner are insulated from the copper surfaces of the side plates **10** and **12** by the previously mentioned insulating wafers **16** and **18**. Although other similar substances could be substituted, one suitable material which is readily available is a uniform thickness epoxy resin bonded woven glass fiber fabric about three thousandths of an ich thick. Other thicknesses could be used, depending upon the blade areas and the capacity desired. The diameter of these discs is slightly less than the diameter of the scanner, an eighth of an inch or so, to provide clearance for a stop pin to be mentioned presently.

Assembly is accomplished by putting one of the insulating wafers, the disc **16** for instance, on its end of the shaft **34** and inserting this end of the shaft through the hole **28** in the plate **10**. Fastening elements **36**, such as hollow rivets, are inserted through the holes **26** and **24** from the outside of the plate **10** and two of these elements at adjacent corners pass through clips **38** for forming the electrical connections, one to the star **22** of plate **10** and the hollow star **23** of plate **12**, and the other to the star **22** of plate **12** and the hollow star **23** of plate **10**. Conductive spacing washers **40** which are accurately held as to thickness are then press fitted over the rivets. The other insulating wafer **18** is then put in place over its end of the shaft **34** and the plate **12** placed thereon. The rivets are then headed to secure the plates **10** and **12** together. The spacing washers electrically interconnect the stars and the hollow stars of the plates **10** and **12** and provide connections to the terminals **38** by way of the rivets **36**.

The thickness of the spacing elements **40** is equivalent to the thickness of the scanner **14** plus the thickness of the two insulating wafers **16** and **18**, plus about .004" to insure clearance, so that although the shaft **34** can turn easily to rotate the scanner **14**, the scanner cannot wobble and change capacity for any particular angular setting. Note that if any slight wobble motion does take place, this is largely compensated for by the symmetrical construction from front to back, and also around the axis of rotation.

In one position of the scanner **14**, all of its blades overlie and align with the blades of the star **22** of plate **10** and the hollow star **23** of plate **12**, whereas rotation of 30° will bring all of the blades of the scanner **14** in alignment with blades of the hollow star **23** of plate **10** and the star **22** of plate **12**. To limit the travel between these two extreme positions, it is convenient to drill a hole **44** through the two plates in alignment, the hole passing through one of the etched lines in a position just inside the periphery of the circle defined by the ends of the scanner plates **32** and outside the periphery of the insulating discs **16** and **18**. An insulating pin **42** formed of nylon or similar material passes through this hole and is cemented in place. It is positioned through one of the slots between the scanner blades and thus limits the travel of the scanner to 30° if as is suggested, the pin has a diameter approximately equal to the etched line **20** width.

When the device is assembled as indicated, it will be seen that in one limit position of the scanner where the blades **32** are opposite the blades **22** of plate **10**, maximum capacity is established from the scanner **14** to the star **22** of plate **10** and the hollow star **23** of plate **12**. Under these conditions there will be extremely little capacity existing from the scanner **14** to the star **22** of plate **12** and the hollow star **23** of plate **10**. When the scanner is turned 30° to its other extreme position, the plates **32** will be lined up with the blades **22** of plate **12** and very little capacity will exist from the scanner **14** to the star **22** of plate **10** and the hollow star **23** of plate **12**, whereas maximum capacity will be established from the scanner **14** to the star **22** of plate **12** and the hollow star **23** of plate **10**.

The scanner shaft **34** is connected to an actuating lever **48** by means of a slip clutch indicated generally by the numeral **46** which may be of any suitable construction. As shown, the clutch is made up of a collar **50**, secured to the shaft by a set screw **52** and providing a face against which the lever **48** is pressed by a spring washer **54**. This clutch is so arranged that as the lever **48** is moved, the scanner **14** will turn therewith until one of the star edges engages the pin **42**. Thereafter, the lever **48** will overtravel without straining any of the capacitor elements. Similarly, when the lever **48** is moved in the opposite direction, the scanner **14** will turn therewith until the opposite edge of the adjacent blade strikes the pin **42** and thereafter the lever **48** will overtravel.

The lever **48** is connected to the organ swell pedal by any suitable intervening linkage mechanism, such as that shown in the previously referred to patent for instance, so that when the shoe is pressed downwardly, the lever **48** is moved in one direction, whereas, when the shoe is returned the lever **48** will move in the opposite direction.

Since this potentiometer type variable capacitor system may be substituted for the variable capacitor shown in the previously mentioned patent, the same or generally similar electrical circuits may be used. Those not familiar with such circuits are referred to that patent for a discussion of their structure and theory of operation. The two terminals **38** provide connections to the two stators and the pigtail **35** the connection to the scanner. This supplies all of the terminals required for substitution in the circuit shown in the previously granted patent which essentially provides for varying the coupling as between an input circuit and an amplifier and also includes an arrangement for coupling the amplifier input progressively to a third circuit as the main input circuit is decoupled. This third circuit changes the frequency response of the system to accommodate for varying frequency response characteristics of the ear at various loudness levels.

Although I have described my invention on the basis of a preferred embodiment, it will be appreciated that variations in the structure may be made without departing from the spirit and scope of the invention and that, therefore, the limits of the invention are to be determined by analysis of the accompanying claims. For example, all stars can have four or eight blades, and the angular motion of the rotor will be correspondingly increased or decreased. Also, the shapes of the blades of either the stars or the hollow stars can be varied if it is desired to provide different capacitance values in the two extreme positions for the outside circuits.

Having described my invention, what I claim is new, useful and desired to secure by Letters Patent of the United States is:

1. A capacitor mechanism comprising a pair of fixed flat plates of insulating material, a flat rotatable scanner plate disposed between said fixed insulating plates, said fixed plates on the faces adjacent said rotatable plate being clad with conductive material, a wafer of insulating material disposed between each of said conductive faces and said rotatable plate, each of said conductive faces being divided into a pair of separate conductive elements insulated from each other, one of said conductive elements being formed as a star with the blades of the star interconnected adjacent the center, the other of said conductive elements being formed to provide a hollow star with the blades interconnected at the periphery, the blades of said star being alternated with the blades of said hollow star with an insulating space providing a serpentine band therebetween, said rotatable plate being formed as a star similar to the fixed stars, a shaft extending through said insulating plates at the center of said fixed stars and connected to said rotatable plate, said fixed stars having clearance around said shaft to insulate said fixed stars from said shaft, means connecting said insulating

plates together including means providing a space therebetween to accommodate the thickness of said rotatable plate and said wafers, means providing electrical connections to the stars and hollow stars in opposed sets, means providing an electrical connection to said rotatable plate, and means for oscillating said shaft.

2. A capacitor mechanism as called for in claim 1 in which the means for oscillating said shaft includes a slip clutch device permitting overtravel of the last said means relative to said shaft.

3. A capacitor mechanism as called for in claim 1 in which the fixed stars, the hollow stars and the rotatable plate all have a like plurality of blades.

4. A capacitor mechanism as called for in claim 1 including a stop member disposed outside the periphery of said wafers and inside the periphery of said rotatable plate to limit arcuate movement of said plate to the included angle between the blades of said plate.

5. A capacitor mechanism comprising a pair of flat plates of insulating material, a flat rotatable plate disposed between said insulating plates, said insulating plates on the faces adjacent said rotatable plate being clad with conductive material, a wafer of insulating material disposed between each of said conductive faces and said rotatable plate, each of said conductive faces being divided into a pair of separate conductive elements insulated from each other, one of said conductive elements being formed as a paddle bladed star with the blades of the star regularly arcuately distributed and interconnected adjacent the center, the other of said conductive elements being formed to provide a hollow paddle bladed star with the blades interconnected at the periphery, the blades of said star being alternated with the blades of said hollow star with a narrow insulating space providing a serpentine band therebetween, said rotatable plate being formed substantially to the shape of said paddle bladed stars, a shaft extending through said insulating plates at the center of said stars and connected to said rotatable plate, said stars having clearance around said shaft to insulate said stars from said shaft, means connecting said insulating plates together with the stars on one plate opposing the hollow stars on the other plate including means providing a space therebetween to accommodate the thickness of said rotatable plate and said wafers, means providing electrical connections to said stars and hollow stars in opposed sets, means providing an electrical connection to said rotatable plate, and means for oscillating said shaft.

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U.S. Cl. X.R.

317—249; 334—82