March 21, 1944. R. K. FRAZIER 2,344,689

VARIABLE CAPACITOR

Filed March 12, 1942 2 Sheets-Sheet 1

FIG. 1.

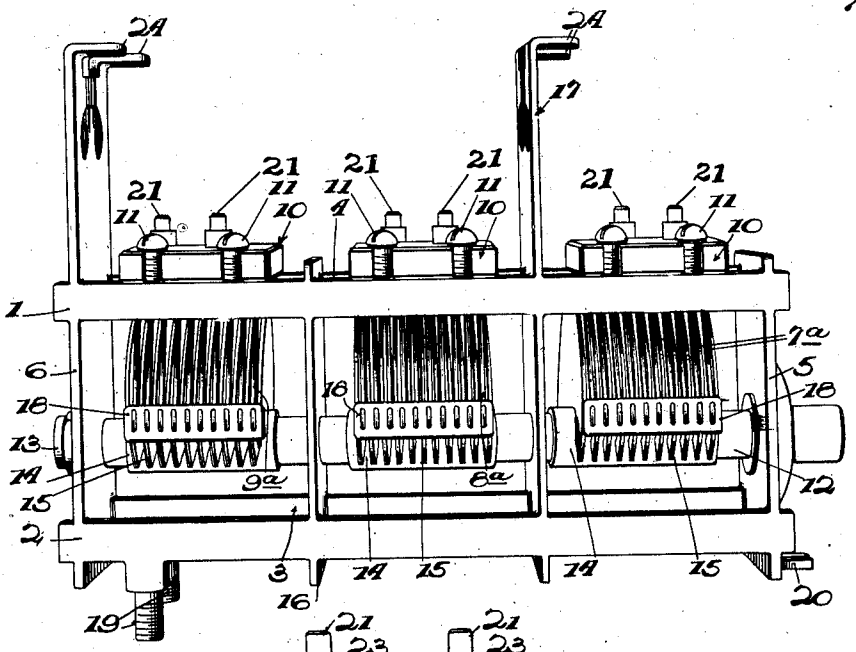
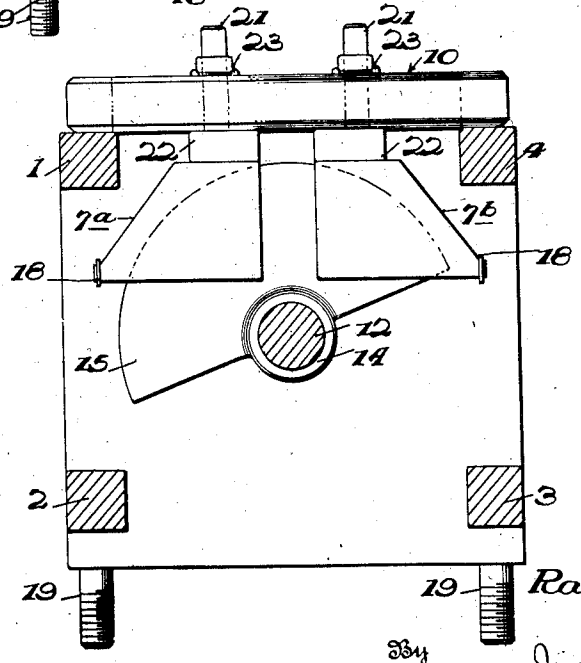


FIG. 2.



Inventor

Radford K. Frazier.

By Joseph A. Stanfield

Attorney

March 21, 1944. R. K. FRAZIER 2,344,689

VARIABLE CAPACITOR

Filed March 12, 1942 2 Sheets-Sheet 2

FIG. 3.

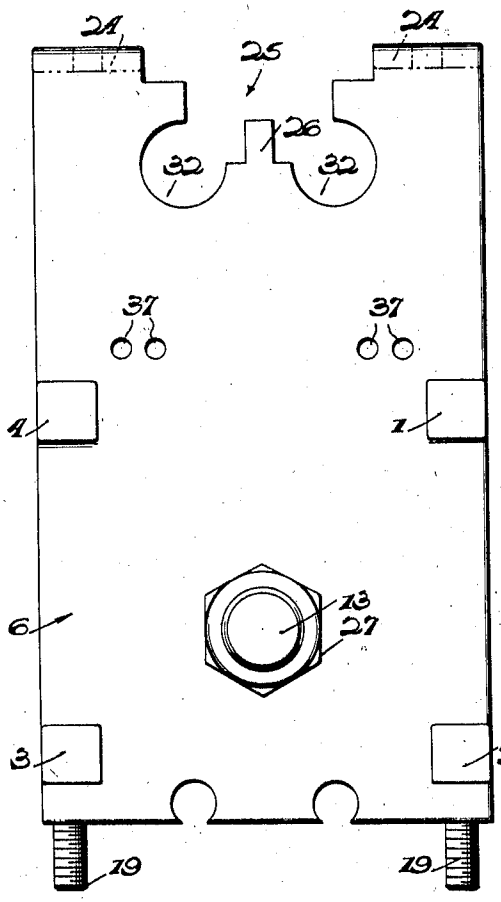
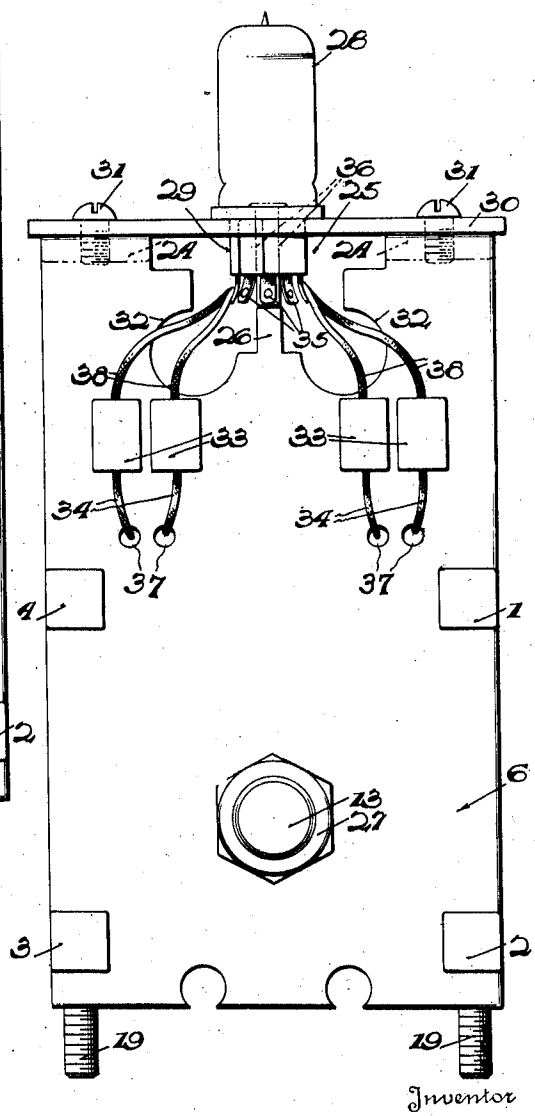


FIG. 4.



Inventor

Radford K. Frazier

By Joseph Q. Stainfield

Attorney

Patented Mar. 21, 1944

2,344,689

UNITED STATES PATENT OFFICE

2,344,689

VARIABLE CAPACITOR

Radford K. Frazier, Towson, Md., assignor to Bendix Aviation Corporation, South Bend, Ind., a corporation of Delaware

Application March 12, 1942, Serial No. 434,370

4 Claims. (Cl. 250—16)

This invention relates to variable capacitors and more particularly to variable capacitors for employment in radio equipment designed for use at very high frequencies.

In the design of radio receivers having tuned radio frequency amplifiers operating at ultra high frequencies, i. e., 80 megacycles per second and higher, problems are encountered which have no counterpart in the low and medium frequency range of operation. These problems have their origin in the fact that conductive materials no longer define equipotential surfaces at frequencies whose free-space wave-length is appreciable with respect to the dimensions of the conductor. Therefore, except under certain very special conditions, the potential distribution along a wire is no longer uniform in phase or in amplitude unless its length is negligible with respect to the free space wave-length, and in like manner, a metallic plate or chassis is not at the same potential over its entire surface.

As a direct consequence of the foregoing, the use of long leads in making connections between a tuned circuit and the input element of a vacuum tube results in heavy loading of the tuned circuit at frequencies such that the inductance of the leads resonates with the input capacitance of the vacuum tube, and is therefore to be avoided at all costs. As a further result, the returning of all circuit grounds to a single metallic plate is no longer absolute assurance of freedom from undesired coupling, because that metallic plate no longer defines a unipotential surface.

To provide vacuum tubes having very high input impedance at the ultra-high frequencies, manufacturers have steadily reduced their physical size, thereby diminishing the effects of electron transit time and reducing the lengths of the leads making connections to the elements. As a consequence of this reduction in size, the input and output terminals have inevitably approached each other more and more closely, and, accordingly, the capacity between them has increased while the rise in operating frequencies has, at the same time, tended to decrease the isolating impedance between these two important points. For the realization of the absolute minimum of input-output coupling capacitance the tube manufacturers have separated the respective electrode connections as widely on the base of the tube as possible, and have interposed between them, the connections to normally grounded elements. In furtherance of the same aim, socket manufacturers provide sockets having a central metallic sleeve which is grounded to reduce the inter-terminal capacity of the socket. Up to this time, however, the grounding has been performed with the usual size of wire employed in the filament and anode circuits of radio receivers, which wire has contributed little or nothing in the way of additional shielding.

I have found that the performance of a tuned radio frequency amplifier at ultra-high frequencies is materially improved by making all bypassing and shielding connections associated with a given stage to a single surface of sufficiently small dimensions to insure that it is substantially equipotential, and that the best results are attained by using a separate surface for each stage. In a condenser tuned variable frequency amplifier, I have found that superior results are achieved by mounting the resonating inductance and the vacuum tube directly on the condenser, utilizing extended shielding partitions not only to shield the capacitor sections from one another, but also to provide complete interstage shielding and a substantially unipotential grounding surface for each stage. In addition, by mounting the vacuum tube in cooperation with a specially shaped aperture in the intersection capacitor shield, further reduction in the input-output circuit coupling has been accomplished.

One of the principal objects of this invention is to provide apparatus for the reception and amplification of ultra high frequency electric signals which has improved stability and selectivity and more reliable tracking.

Another object of this invention is to provide a variable capacitor making possible the construction of a tuned radio frequency amplifier in which the length of the circuit connecting leads is reduced from previous practice.

Still another object of this invention is to provide an ultra high frequency amplifier in which the amplifier stages are better separated and isolated from each other.

A further object of this invention is to provide a tuned radio frequency amplifier having the bypassing and shielding grounds for each stage connected to a substantially separate unipotential surface.

Yet another object of this invention is to provide a variable condenser wherein the intersection shielding provides mounting means for the amplifier tubes of the stages with which it is utilized, and which also serves as a grid-plate shield for the amplifier tubes so mounted.

Other objects and advantages will in part be disclosed and in part be obvious when the following specification is read in conjunction with the drawings in which:

Figure 1 is a view in perspective of a split stator capacitor incorporating my invention.

Figure 2 is a detail view showing the relation of the stators and the rotor.

Figure 3 is a view of the rear endplate of the capacitor.

Figure 4 shows a vacuum tube mounted on the rear endplate of the capacitor.

It is to be understood that these drawings are intended to illustrate one of the many forms in which the invention may be utilized and are not to comprise a limitation in the content or scope of the invention.

In the drawings, like parts are designated by like reference characters.

Referring to Figure 1, a three section split stator variable capacitor having insulated rotors is shown. The side bars 1, 2, 3, and 4 and the end plates 5 and 6 comprise the frame of the capacitor. The stators 7*a*, 8*a*, 9*a* are secured to the stator mounting insulators 10, and these insulators are, in turn, secured to the side bars 1 and 4 by the screws 11 passing through recesses in the stator insulators. The stator insulators are preferably constructed of a suitable low loss ceramic or styrene material. A shaft 12 constructed of a non-conducting substance, which may be of the type known to the trade as mycalex, is journaled in the end plates 5 and 6, the bearing in the end plate 6 being provided with a threaded adjustable bearing retainer 13 for the adjustment of the overall end play of the shaft. The metallic sleeves 14 are secured to the shaft 12, these sleeves being grooved to receive the rotor plates 15, which are soldered into place after insertion into the grooves. Inter-section shielding between the various units of the capacitor is provided by the metallic partitions 16 and 17 soldered to the side bars of the frame, partition 17 being extended substantially beyond the electric field of the capacitor and of special form for a purpose to be later described. To secure the maximum stability of the electrical characteristics of the capacitor sections, the stator plates of each section are secured to the tie bar 18 associated with that section. To provide mounting means, the lugs 19 are attached to the side bars 2 and 3 and a perforated ear 20 is extended from the end plate 5.

The relation between the stators and the rotor of a given section is shown more clearly in Figure 2 where the stators 7*a* and 7*b* are shown secured to the stator mounting insulator 10 by sweating the extensions 21 of the stator plate mounting blocks 22 to the eyelets 23 passing through the insulator. The ends of extensions 21 are so formed that they serve as soldering lugs for making electrical connection to the stators, and in the final assembly the tuning coil is affixed directly thereto. The mounting blocks 22 are provided with a number of parallel grooves spaced along the axis of the capacitor and, in fabrication, the stator plates are inserted in these grooves and soldered into place, much after the manner of the rotor construction. The tie bars 18 are then slipped over the ends of the stator assemblies and also soldered into position, the whole making a very rigid unit. The shaft 12, with its surrounding metal sleeve 14 and the rotor 15 attached thereto is also readily seen.

The end view of Figure 3 reveals the exact form of the end plate 6 which, together with the partition 17, is provided with drilled and tapped mounting ears 24 (see Figure 1) for the mounting of a plate carrying a radio tube socket. The four side bars 1, 2, 3, and 4 of the condenser frame are secured to the end plate 6 by soldering or other suitable means. Between the mounting ears 24 there is provided the aperture 25 having the tongued projection 26 and the recessed lobes 32; and adjacent to the side bars 1 and 4 the end plate 6 carries the apertures 37 which receive the grounded terminals of the heater, cathode and screen bypass condensers in the completed amplifier assembly. All the apertures just described are common to both the end plate 6 and partition 17. The adjustable bearing retainer 13 on end plate 6 is also seen in this view, with its locking nut 27.

Turning now to Figure 4, there is shown an end view of the variable capacitor with the amplifier tube 28 inserted in the socket 29, which is secured to the socket mounting plate 39, this plate in turn being secured to the end plate 6 by the mounting screws 31 passing through the socket mounting plate and into the tapped mounting ears 24 on the end plate 6. The grounded leads 34 of the bypass capacitors 33 are passed through the apertures 37 and soldered to the end plate 6, thus the bypass grounds for the amplifier stage are all made to a single metal surface sufficiently small to be at substantially uniform potential throughout. The other leads 38 from the capacitors 33 are connected to the appropriate terminals 35 of the socket 29. The terminals 35 project into the recessed lobes 32, where there is adequate clearance for them. The central, cylindrically shaped shielding member 36 of the socket 29 is soldered to the tongue 26, this tongue effectively providing an extension of the shielding member and thereby further reducing the grid-anode capacitance introduced by the socket and the connections thereto. The grid and anode connections to the vacuum tube are located on opposite sides of the socket 29, and the socket is so mounted that they are spaced along the axis of rotation of the shaft 12, thus the grid connection is on one side of the end plate 6 and the anode connection is located on the other side, and all the input circuits may then be located on the grid side while the output circuits are located on the anode side, effecting that degree of isolation which is so essential to stable, high gain operation of ultra-high frequency amplifiers.

A second amplifier tube with its associated circuit elements may be mounted on the partition 17 in substantially the same manner as above described. The side bars 1, 2, 3, and 4, by reason of their length, effectively provide a satisfactory degree of isolation between the substantially unipotential surfaces afforded by the end plate 6 and the shielding partition 17 which is still further improved when the lugs 19 are grounded to a metallic chassis in mounting the entire capacitor.

The operating procedure employed with an amplifier utilizing this variable capacitor is the same as that employed with any similar capacitor, the received frequency being varied by rotation of the tuning shaft 12, thus varying the amount of capacitance in the tuned circuits. The quality of operation from the standpoint of sensitivity and selectivity has been found very obviously superior to that obtainable with previously available capacitors, due largely to the excellent interstage isolation provided by the

use of separate unipotential surfaces for the grounding of each stage and to the improved grid-anode circuits isolation accruing from the use of the cooperating mounting and shielding member.

It is to be understood that this construction may be employed with benefit on a single section or on a multiple section capacitor having any desired number of elements.

It will be obvious that many changes and modifications may be made in the invention without departing from the spirit thereof as expressed in the foregoing description and in the appended claims.

I claim:

1. In a multi-section variable capacitor adapted for adjustment of capacity by rotation of a shaft common to all sections, a plurality of metal plates adjacent said sections and substantially perpendicular to the axis of rotation of said shaft, said metal plates being formed and perforated to provide mounting shielding and grounding means for the parts of a plurality of amplifier stages, metallic side bars parallel to said axis of rotation and secured to said plates, and combined mounting and grounding means secured to a plurality of said side bars intermediate two of said metallic plates carrying the parts of separate amplifier stages.

2. In combination with a variable capacitor, a metallic end plate having an aperture in one side thereof, a tongued extension of said end plate projecting into said aperture substantially perpendicular to the boundary defining said side, a radio tube socket having a central shielding member, and means for mounting said radio tube socket on said end plate with said shielding member substantially collinear with said tongued extension.

3. In combination with a variable capacitor having a plurality of sections, a metallic intersection shield having an aperture in one side thereof, a tongued extension of said intersection shield projecting into said aperture substantially perpendicular to the boundary defining said side, a radio tube socket having a central shielding member, and means for mounting said radio tube socket on said end plate with said shielding member substantially collinear with said tongued extension.

4. In combination with a variable capacitor having a rotatable control shaft, a substantially plane metallic shield member connected to said capacitor transversely of the axis of rotation of said shaft and having an aperture in one side thereof, a tongued extension of said metallic member projecting into said aperture, a circularly symmetrical vacuum tube socket having terminals, and means for supporting said socket with the center of symmetry thereof in alignment with said tongued extension at a level interposing said extension in the electric field produced by said terminals, whereby inter-terminal coupling is substantially reduced.

RADFORD K. FRAZIER.