Sept. 16, 1947. S. D. LAVOIE 2,427,563

COMBINED TUBE SOCKET AND BY-PASS CONDENSER UNIT

Filed July 3, 1944 2 Sheets-Sheet 1

FIG. 1.

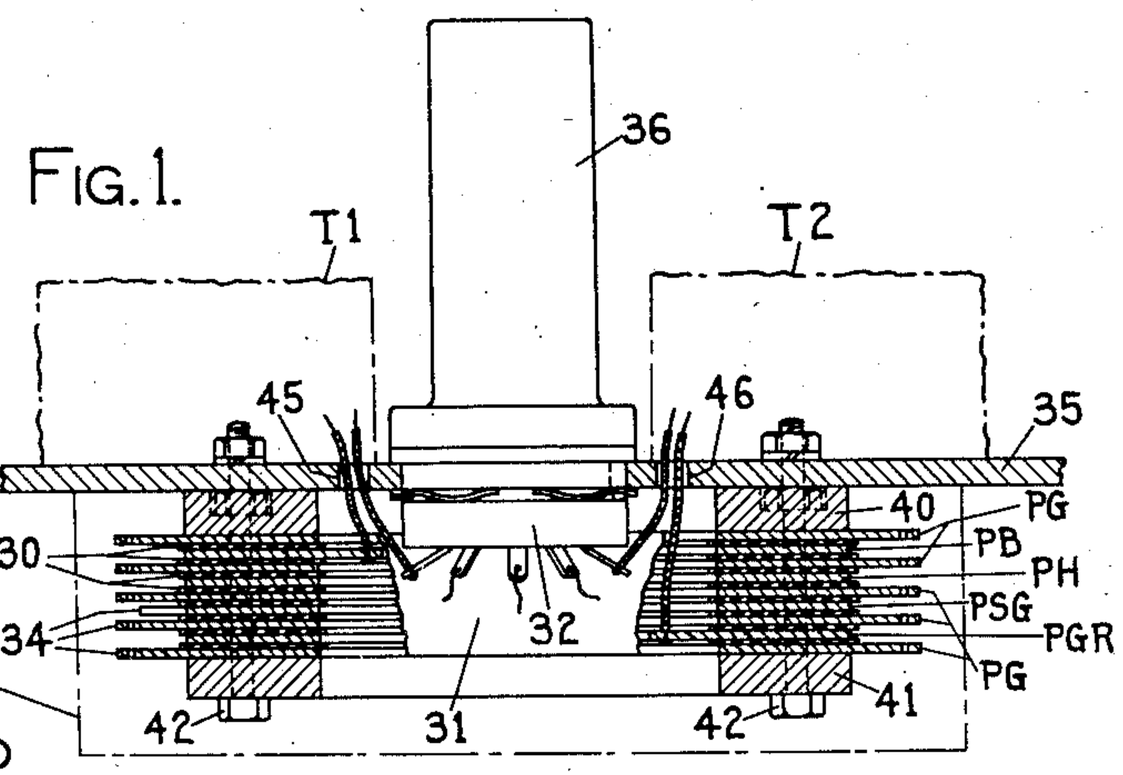



FIG. 2.

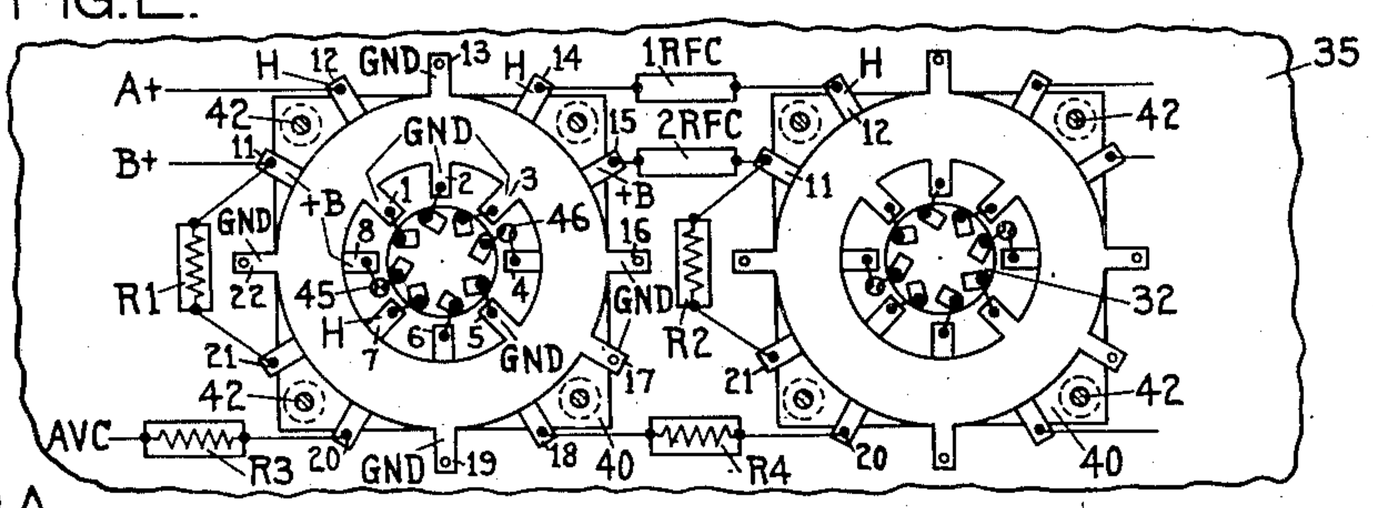



FIG. 3A.

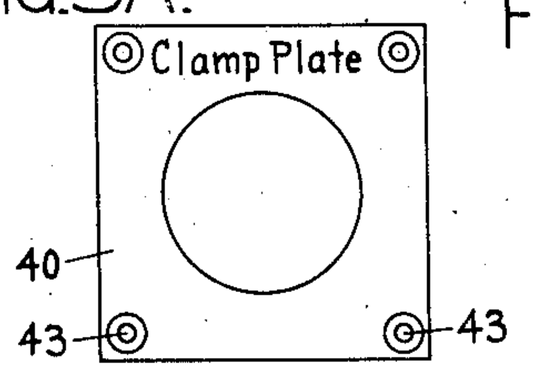



FIG. 3B

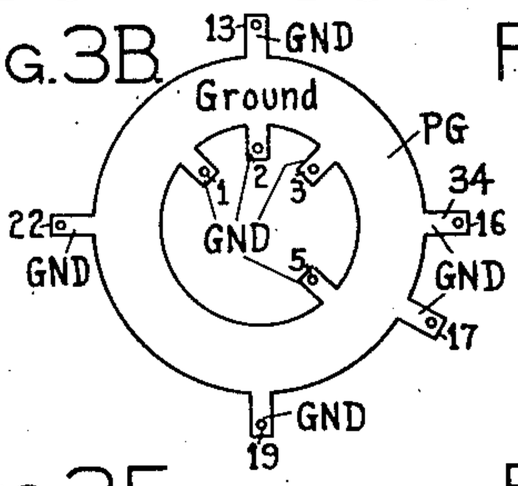



FIG. 3C.

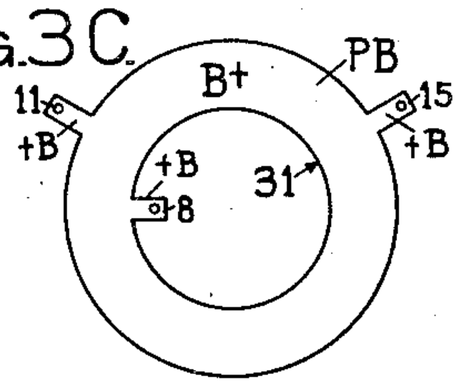



FIG. 3D.

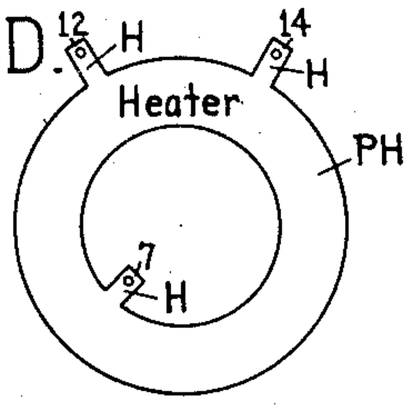



FIG. 3E.

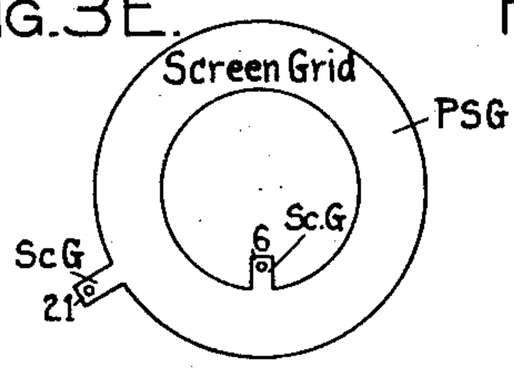



FIG. 3F.

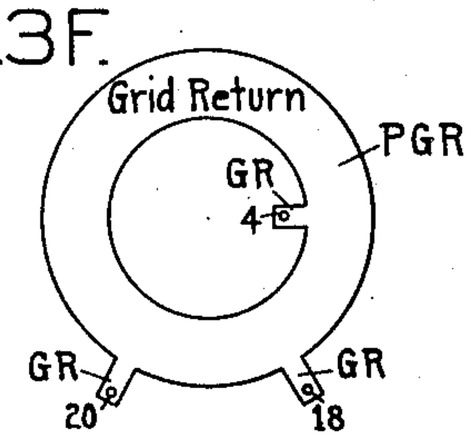
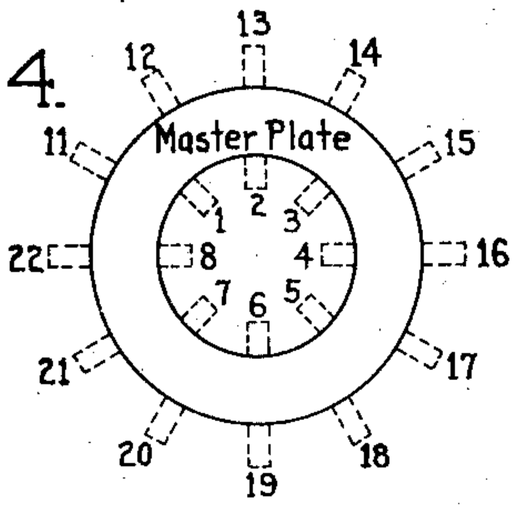



FIG. 4.

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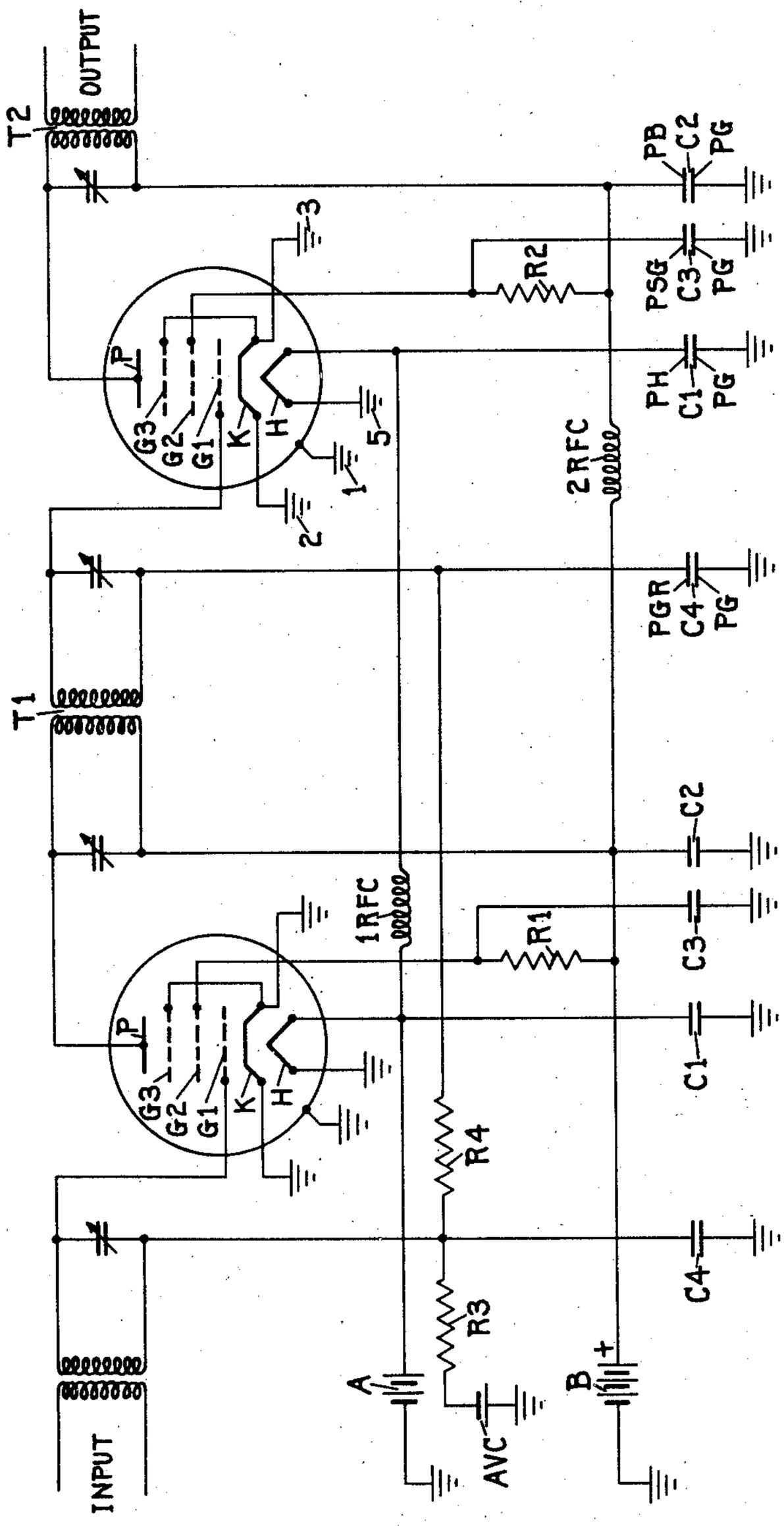
Sept. 16, 1947. S. D. LAVOIE 2,427,563

COMBINED TUBE SOCKET AND BY-PASS CONDENSER UNIT

Filed July 3, 1944 2 Sheets-Sheet 2

FIG. 5.

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2,427,563

## COMBINED TUBE SOCKET AND BY-PASS CONDENSER UNIT

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Application July 3, 1944, Serial No. 543,244

6 Claims. (Cl. 250—16)

1

This invention relates to amplifiers, oscillators, and like apparatus employing electron tubes, and more particularly to a combined by-passing condenser and connector structure for affording paths of low impedance at the higher frequencies for such connections between tube elements, circuit components and ground as may be required.

In the various applications of electron tubes to amplifiers, oscillators and the like, it is important to provide paths of very low inductive and capacitive reactance to ground for certain connections to tube elements and common power sources which should be by-passed to ground, and also to keep the length and inductance of the leads to the tube elements and between stages to a minimum. This is particularly important for the higher frequencies, such as the very high and ultra-high frequencies above 30 megacycles, where extremely low impedance paths to ground and a minimum inductance in the leads to the tube elements and between the stages are essential to avoid objectionable regeneration and parasitic oscillations by stray electrostatic or magnetic coupling and by the effect of a common impedance between stages due to the use of a single power supply.

In view of these and other conditions, generally known by those skilled in the art and needing no further discussion, it is proposed in accordance with this invention to provide a simple and yet effective structure for performing the functions of a plurality of by-passing condensers and a connector, which will afford paths to ground of very low impedance even for frequencies in the very high and ultra-high frequency range, and which will provide connecting leads of minimum length and impedance to the tube elements and component parts of the circuit.

Generally speaking, and without attempting to define the nature and scope of the invention, it is proposed to provide a stacking of plates, separated by a suitable dielectric so as to constitute plates of condensers, which may be connected to ground and to the appropriate components of the circuit to provide the desired low impedance paths to ground, these condenser plates having connector lugs or ears which are arranged with respect to the spatial relation of the tube elements and the external circuit connections in a manner to provide the necessary electrical connections to the tube elements and between stages of minimum length and impedance.

Various other objects, characteristics and attributes of the invention will be in part pointed out, and in part apparent, as the description of

2

one specific embodiment of the invention progresses.

The accompanying drawings illustrate one specific embodiment of the invention for one particular field of application, the parts being illustrated in a manner to facilitate an understanding of the nature of the invention, rather than show the exact proportioning of parts and structural details preferably employed in practice.

In these drawings,

Fig. 1 is a fragmentary view illustrated in vertical section a stacking of plates constituting the by-passing condensers and interstage connector structure of this invention, and arranged to be used in connection with a metal tube of conventional construction and mounted on the underside of the chassis plate supporting the tube.

Fig. 2 is a diagrammatic bottom view of the by-passing condensers and connector structure for two stages of a conventional amplifier for the purpose of illustrating how the arrangement of connector lugs serves to provide short leads to the tube elements, resistors, and other component parts of the circuit for the different stages.

Figs. 3A to Fig. 3F show typical shape for the separate condenser plates of the stacking for the particular amplifier application assumed;

Fig. 4 is a diagrammatic view illustrating the number of spacing of the soldering tabs suitable for this particular amplifier application; and

Fig. 5 is a diagrammatic illustration of two stages of a conventional transformer-coupled radio frequency amplifier, and illustrates the by-pass condensers afforded by the particular structure shown.

While this invention is readily adapted to various types of amplifiers, oscillators and other organizations employing electron tubes, it is convenient for purposes of explanation to assume one particular application of the invention; and Fig. 5 illustrates diagrammatically the circuit components for two stages of a conventional transformer coupled amplifier employing pentode tubes and suitable for the radio frequency or intermediate frequency stages of a radio receiver. Since amplifiers of the type indicated in Fig. 5 are well known in the art, it is not necessary to explain in detail its functions and mode of operation; and it will be sufficient for an understanding of the present invention to point out the application and use of the combined by-passing condensers and connectors of the invention to such an amplifier organization.

Referring to Fig. 5, the heaters H of the tubes

are energized from a common source, such as a battery A, in the usual way, with radio frequency chokes 1RFC in the battery connections to minimize feed-back of radio frequencies between stages and regeneration. Also, in accordance with prevailing practice, the heater of each tube is connected to ground through a by-pass condenser C1 afforded by the structure of this invention.

The primaries of the coupling transformers T1, T2 are connected to a common source indicated as a battery B, with suitable radio frequency chokes 2RFC; and the screen grids G2 are likewise connected to this common source through resistors R1, R2 affording the desired screen grid voltage. Each of these +B and screen grid connections are by-passed to ground by condensers C2 and C3 afforded by the structure of this invention. The grid return connections from the control grids G1 are through series resistors R3, R4 to an automatic volume control bus AVC; and each of these grid returns are likewise connected to ground by a by-pass condenser C4.

In amplifiers of the type indicated in Fig. 5, for reasons generally familiar to those skilled in the art, it is necessary to provide by-pass or decoupling capacitors C1 to C4 for the heater, +B, grid return path, and screen grid, in order to minimize potential differences and common impedance couplings which will give rise to feed-back or regeneration effects interfering with the operation of the amplifier, and sustaining parasitic oscillations under favorable phase conditions and high amplification, particularly where it is attempted to provide an amplifier having a high gain for the higher frequencies.

Also, it is important in such amplifiers to keep the length of the leads and connecting wires to a minimum, to avoid electrostatic or magnetic stray coupling between the stages sufficient to create objectionable regeneration. For frequencies in the very high and ultra-high frequency range, exposed or unshielded connecting leads even as short as an inch frequently cause impedance drops or stray couplings sufficient to interfere with the performance of the amplifier, and at least limit the gain available under stable conditions. This desirable reduction in the length and impedance of the connecting leads applies not only to the usual connections to the tube elements and circuit components, but also to ground connections, including connections to ground from the plates of the by-pass condensers. On account of space limitations, it is difficult to provide connecting leads short enough and with sufficient surface area for the desired low impedance at very high frequencies by following the ordinary practice of separate leads soldered in place.

With this explanation of the purpose and requisites of a desirable condenser by-passing and connector structure for an amplifier, consideration may now be given to the preferred form and arrangement of parts in accordance with this invention. Generally speaking, the by-passing condensers and connector structure of this invention comprises a stacking of thin annular metallic plates PG, PB, etc., in Fig. 1 separated by sheets of a suitable dielectric material indicated at 30, and having a central opening 31 large enough to receive a tube socket 32 and lead-in connections to its terminal, so that the inner edges of the plates of the stacking are close to the terminals of the socket. Electrical connections are made to these condenser plates PG, PB, etc., at various points around their inner and



outer edges; and for this purpose these condenser plates are preferably formed with integral soldering lugs or ears 34 projecting radially at predetermined points around both the inside and outside edges of the plates, as shown in Figs. 3B to 3F. The complete stacking of condenser plates PG, PB, etc. may be supported under the top plate 35 of the chassis structure supporting the tube socket 32 and its tube 36, as illustrated in Fig. 1, and also if desired, provided with a grounded shield indicated at S by dot-and-dash lines.

The condenser plate stacking comprises five ground plates PG, such as shown in Fig. 3B, arranged alternately with four different connector plates PB, PH, PSG and PGR shown in Figs. 3C to 3F, with intervening sheets of mica or other suitable dielectric, as indicated at 30 in Fig. 1. The whole stacking is clamped together by upper and lower clamping plates 40, 41 pulled together by bolts, such as indicated at 42 in Figs. 1 and 2 through holes 43 in the corners of these clamp plates. The various condenser plates are preferably thin sheets of silver-plated copper; and the dielectric sheets are of mica. However, various other types of condenser materials may be employed, such as copper plates sprayed with a ceramic, or ceramic sheets sprayed with silver or other conductive material, or in fact any desired arrangement of alternate layers of electrically conductive and dielectric materials which will form a satisfactory condenser at the frequencies employed.

The integral ears or lugs 34 on the condenser plates PG, PB, etc., are preferably perforated and tinned to facilitate the bolting and soldering of connecting wires or strips thereto; and the location and spacing of the outer and inner lugs for the different condenser plates, such as illustrated in Figs. 3B and 3F, are chosen for the particular application to make the circuit connections to the tube elements, resistors and the like as short as possible. In the arrangement shown, each one of the condenser plates PG, PB, etc. may have one or more internal and external lugs located in the spaces indicated in the diagram of Fig. 4, the spaces or points of location for the internal lugs being conveniently numbered from 1 to 8, and those for the external lugs from 11 to 22.

Considering the factors determining the location and spacing of the soldering lugs for the condenser plates, Fig. 2 is a diagrammatic illustration of the connections to the various soldering lugs of the stackings of the condenser plates for the two stages of the amplifier shown in Fig. 5, viewed looking upward toward the bottom and assuming a particular type of octal socket for the pentode tubes employed. Referring to Fig. 2, the five external lugs marked GND in spaces 13, 16, 17, 19 and 22 for the several ground plates PG of Fig. 3B in the stacking are all bolted and soldered together and grounded to the chassis plate. The four internal lugs GND in spaces 1, 2, 3, and 5 of these ground plates PG of Fig. 3B are similarly connected together and connected respectively to the shell of the tube, one end of the cathode, to the other end of the cathode and its internal connection with the suppression grid, and to the grounded end of the heater element, in accordance with circuit of Fig. 5. Thus, the necessary ground connections are made to the tube elements over metallic paths of minimum length and having substantial surface areas to

afford ground connections of low impedance to high frequencies.

Considering the heater circuit, the path for the flow of current in this circuit from battery A may be traced in Fig. 2 from the external lug H in space 12 of the plate PH of Fig. 3D to inner lug H in space 7 of this plate which is connected with the heater terminal of the tube socket a suitable soldered strip or the like. Another external lug H in space 14 on the heater condenser plate PH of Fig. 3D affords a connection and support for one end of the radio frequency choke 1RFC, the other end of which is connected to the lug in the space 12 of the plate PH of the stacking for the next stage. The plate PH and its adjacent ground plate PG, with the intervening dielectric, affords a by-passing condenser of the desired capacity; and since the plate PH is directly connected to the heater and the plate PG to ground, the desired condenser by-pass for the heater to ground is provided. In this connection, it will be noted that the connections to the plates of this condenser are much shorter than when external connections are made to the terminals of individual by-passing condensers in accordance with the usual practice.

The connections to the common source of plate voltage, such as the battery B, which is also commonly used as shown in Fig. 5 to provide the desired screen grid voltage, are the usual source of an objectionable common impedance between the stages of an amplifier; and it should be noted how the structure of this invention affords the appropriate by-passing condensers to ground, low impedance drop in the circuit, and a minimum length of exposed or unshielded leads. The circuit path for plate current may be traced in Fig. 2 from B+ to the external lug +B in space 11 of the plate PB of Fig. 3C to the internal lug in space 8 on this plate, over an external lead through an opening 45 in the chassis plate 35 to the primary of the coupling transformer T1 and associated tuning condenser and back through this same opening 45 to the plate terminal of the tube. Another external lug +B in space 15 on this plate PB is connected by a radio frequency choke 2RFC to the lug in space 11 of the plate PB for the adjoining stage, where the same connections are provided to the coupling transformer and plate of the tube.

It will be noted that the entire surface of the plate PB in both directions around it constitutes the circuit path between the external lugs providing the interconnections between stages, as well as the circuit path between an external lug and an internal lug for tube element connections. Also, these plates PB not only constitute one plate of the by-passing condensers, but also constitute the larger part of the circuit path between stages, so that this part of the circuit is by-passed to ground, leaving very little unshielded circuit portions for establishing objectionable magnetic or electrostatic stray coupling.

The circuit connections for the screen grid may be traced in Fig. 2 from the lug marked +B in space 11 of the plate PB through a resistor R1 to an external lug in position 21 on the other condenser plate PSG for the screen grid, and from an internal lug in position 6 on this plate PSG to the screen grid terminal of the tube circuit. The plate PSG and its associated ground plate PG afford the by-passing condenser C3 for the screen grid shown in Fig. 5.

In a similar way, the control grid return connection may be traced in Fig. 2 from the automatic volume control bus AVC which of course is connected to a suitable source of grid biasing voltage indicated as a battery of Fig. 5, through a resistor R3, constituting one of the elements of the grid filter organization commonly used, to the external lug in position 20 on the grid return condenser plate PGR to an internal lug on this same plate in position 4, through an opening 46 in the chassis plate 35 to the input circuit and back through this same opening 46 to the terminal on the socket for the control grid G1. This plate PGR and its associated ground plate PG provide the by-passing condenser C4 for the grid return connection as indicated in Fig. 5.



From the foregoing, it can be readily understood that the structure shown and described as one embodiment of the invention affords by-pass condensers of desired capacity in a simple and compact structure, which is so organized and arranged to provide leads to the tube elements and connections to other stages through resistors and the like of minimum length. Also, the greater portion of the total length of the various circuit paths is through the condenser plates in both directions around their peripheries, and these condenser plates have the necessary surface area to be of low inductive reactance even for the higher frequencies.

The particular arrangement and construction of parts shown and described represents only one typical embodiment of the invention for one specific application; and it should be understood that various adaptations, and modifications may be made in the structure illustrated, without departing from the invention.

What I claim is:

1. A condenser by-passing structure for high frequency amplifiers and the like comprising, a stacking of annular metallic plates separated by a dielectric material, said stacking having a central opening for receiving a vacuum tube socket and leads to its terminals, means for connecting certain alternate plates of said stacking together and to ground at a plurality of spaced points to provide a plurality of ground connections, a lug on each of the other plates projecting internally at points around their peripheries corresponding with the location of the terminals of the tube socket to which that plate is to be connected, and external circuit connections for each of said other plates, whereby each of said other plates acts both as a current carrying element and as an element of a capacitor.

2. A combined condenser by-passing and connector structure for high frequency amplifiers and the like comprising, a stacking of annular metallic plates separated by a dielectric and surrounding a tube socket, certain alternate plates of said stacking having lugs projecting internally and externally at points around their peripheries for establishing connections to the terminals of said tube socket and to the components of an external circuit organization with a minimum length of lead, and means for connecting each of the remaining plates of said stacking together at a plurality of spaced points to a ground connection, whereby circuit paths of low impedance for the higher frequencies may be provided to ground and between the tube elements and external circuit components.

3. A by-passing capacitor and connector structure comprising, a stacking of metallic annular plates separated by a dielectric material and constituting a plurality of condensers, said stacking forming an inner opening adapted to receive elec-

trical connections, means for grounding certain of said plates at a plurality of points around their outer edges, and means for connecting the other plates separately to the elements of a tube and associated external circuit components, said connecting means including lugs on said plates projecting radially from both the inner and outer edges of said plates at different points around their peripheries corresponding to the space relationship of said tube elements and circuit components to be connected to said plates.

4. In a radio frequency amplifier, the combination with a chassis mount and a tube socket supported thereby, of a stacking of annular plates disposed to form an opening to receive said socket and supported by said chassis mount, said stacking including ground plates arranged alternately with connector plates and intervening sheets of dielectric material to provide a plurality of separate condensers, each of said ground plates having a plurality of lugs spaced around its inner edge and projecting radially for establishing ground connections to certain terminals of the tube socket, and each of the other connector plates of said stacking having integral lugs radially projecting from both their inner and outer edges at different points spaced around their peripheries for establishing connections to other terminals of said socket and to the external circuit components of the amplifier.

5. In a by-passing condenser and electrical connector structure for high frequency amplifier organizations having a plurality of stages operating on the same radio frequency, a by-pass condenser for each stage comprising a stacking of annular metallic plates separated by sheets of dielectric material and having a central opening adjacent the terminals of a vacuum tube socket, means for connecting alternate plates to ground at a plurality of spaced points around their outer edges, an integral lug on each of the other plates projecting inwardly into said opening at differently spaced points and connected respectively to the different terminals of said socket, and outer integral lugs on each of said other plates located at spaced points around the outer edges of said plates for connection to the respective external components of the associated amplifier organization, whereby low impedance connections are provided for said socket terminals with the desired by-passing condenser effect for said connections



with respect to ground evenly distributed around said socket to eliminate interstage leakage of radio frequencies.

6. In a by-passing condenser and electrical connector structure for a high frequency amplifier organization having a grounded chassis with a plurality of tube sockets located within openings in said chassis, a by-pass condenser organization for each socket comprising, a stacking of circular metallic discs separated by discs of dielectric material, said stacking having end-plates of metal of substantial thickness, and said discs and end-plates having central openings substantially in line with said opening in said chassis, mechanical means for compressing said end-plates toward each other to hold said discs in their proper relationships, means also acting to mount said stacking to said chassis and provide a ground connection thereto, integral lug connectors on both the inner and outer peripheries of said discs at spaced radial positions, means for connecting together the outer lugs of alternate discs including the discs adjacent to said end-plates to thereby effectively ground said alternate discs, means connecting the outer lugs of said other plates to the external circuit components of the amplifier organization, means connecting the terminals of said socket to their respective inner lugs, whereby certain of said terminals are grounded by connections to said alternate discs and whereby the other terminals are connected to the proper external circuit components by multiple conducting paths of low impedance and highly distributed capacity with respect to ground.

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