Nov. 9, 1948. F. H. McCALL ET AL 2,453,148

SHIELD BOX AND TUNING MECHANISM FOR ELECTRON TUBES

Filed July 29 1943 3 Sheets-Sheet 1

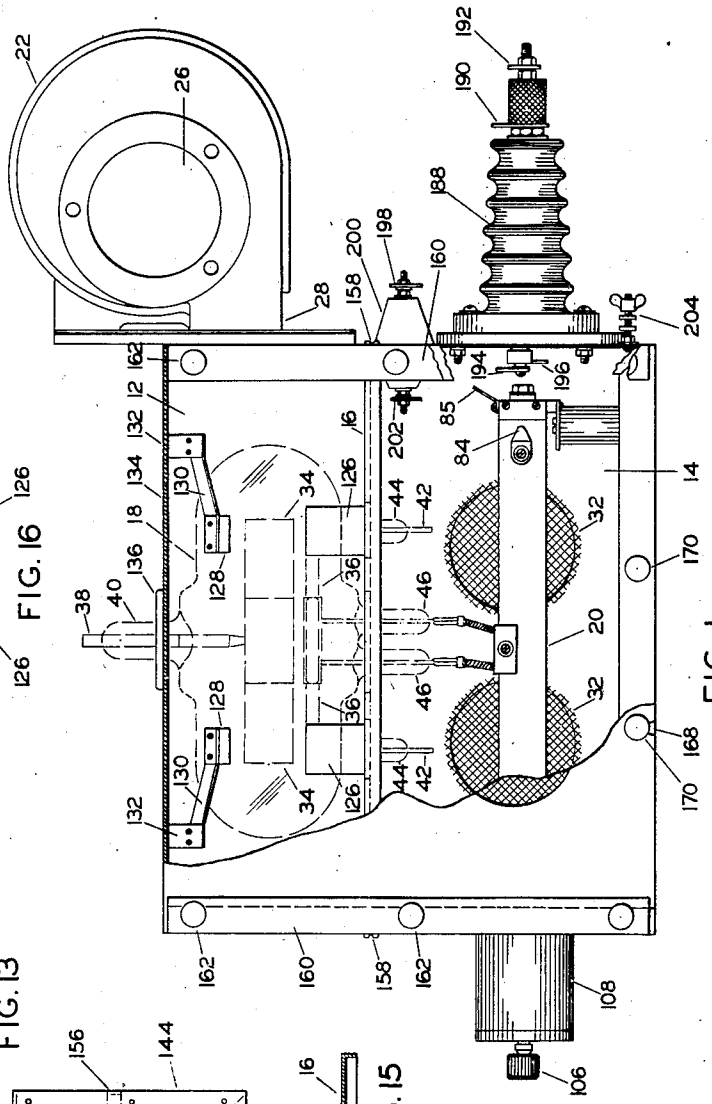


FIG. 1

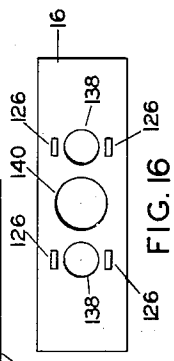


FIG. 16

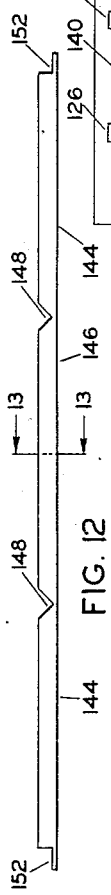


FIG. 12

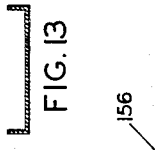


FIG. 13

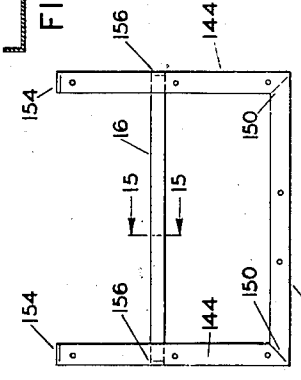


FIG. 14

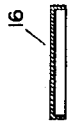


FIG. 15

BY

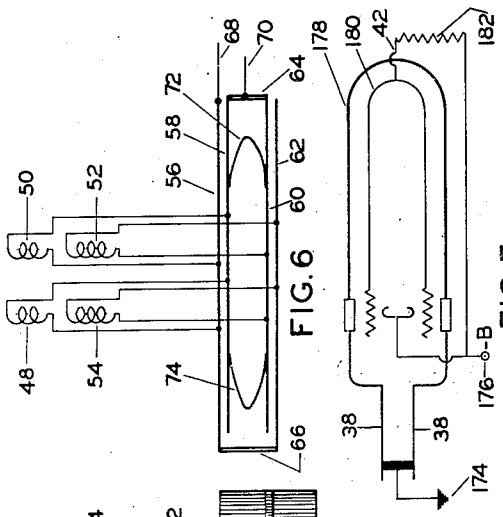
INVENTOR
FRED H. McCALL
PETER DEVREOTES

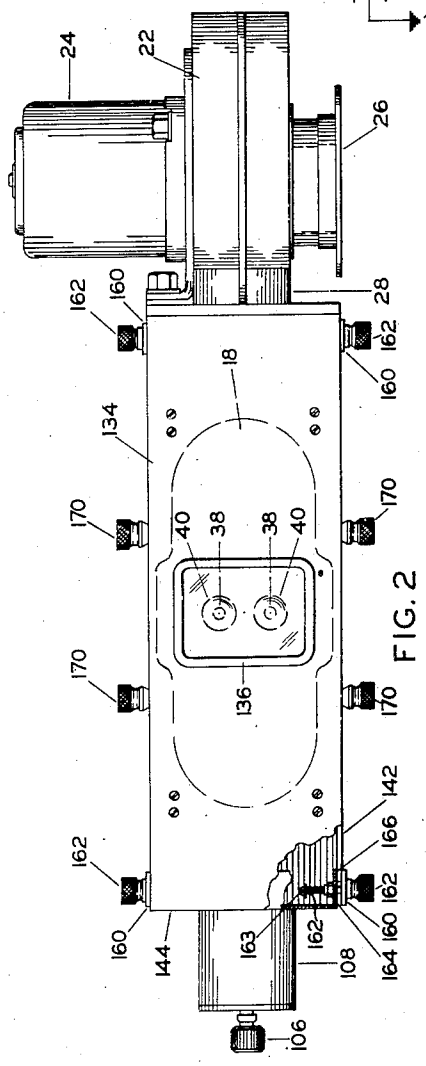
William D. Hall
ATTORNEY

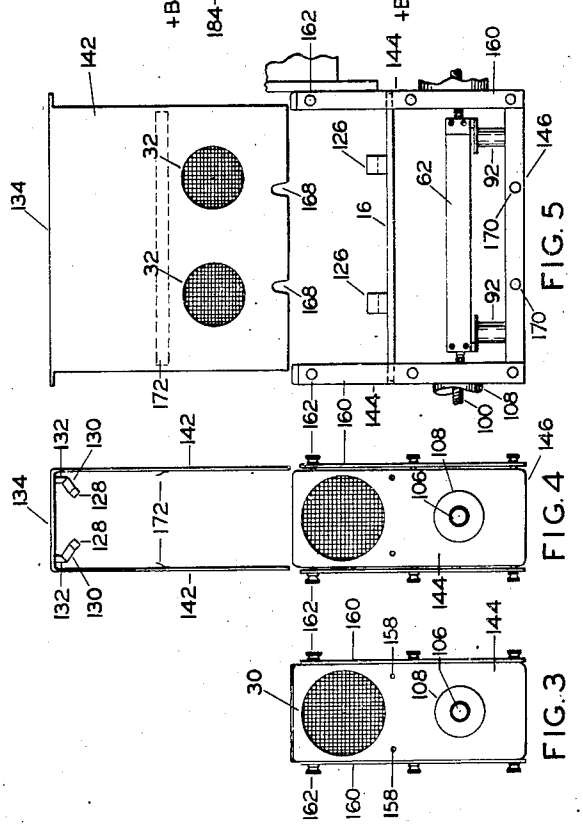
Nov. 9, 1948. F. H. McCALL ET AL 2,453,148

SHIELD BOX AND TUNING MECHANISM FOR ELECTRON TUBES

Filed July 29, 1943 3 Sheets-Sheet 2







INVENTOR
FRED H. McCALL
PETER DEVREOTES
BY William D. Hall
ATTORNEY

Nov. 9, 1948. F. H. McCALL ET AL 2,453,148

SHIELD BOX AND TUNING MECHANISM FOR ELECTRON TUBES

Filed July 29, 1943 3 Sheets-Sheet 3

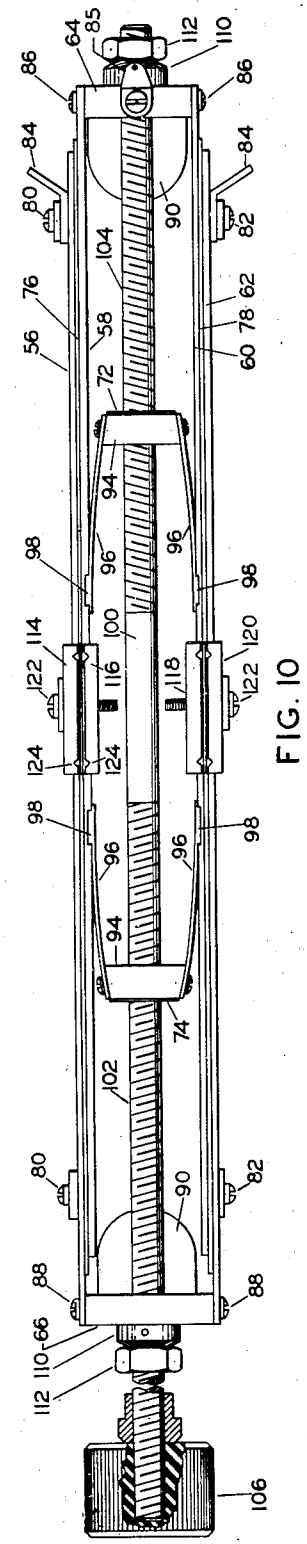


FIG. 10

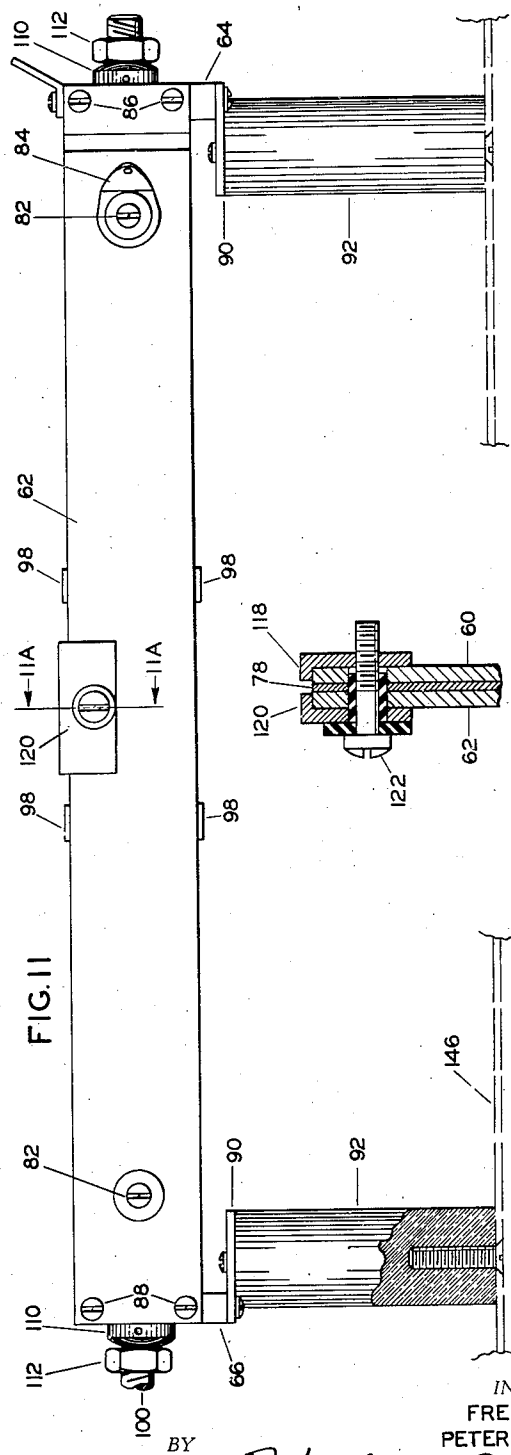


FIG. 11

FIG. 11A

INVENTOR
FRED H. McCALL
PETER DEVREOTES

BY William D. Hall.
ATTORNEY

Patented Nov. 9, 1948 2,453,148

UNITED STATES PATENT OFFICE

2,453,148

SHIELD BOX AND TUNING MECHANISM FOR ELECTRON TUBES

Fred H. McCall, Neptune, and Peter Devreotes, Eatontown, N. J.

Application July 29, 1943, Serial No. 496,653

16 Claims. (Cl. 250—36)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

1

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

This invention relates to apparatus using electron tubes, and more particularly to a shield box and tuning mechanism therefor.

The primary object of our invention is to generally improve radio apparatus using electron tubes, and more specifically the shielding and tuning thereof.

An ultra high frequency oscillator tube of good performance is that known as the VT–158. This tube is described in a co-pending application of Harold A. Zahl, Serial Number 473,556, filed January 25, 1943. One object of our invention is to improve generally the shielding and operation of the said tube. Another object of the invention is to improve the tuning of the cathodes of the said tube, and more especially to provide a cathode tuning unit which is disposed in a horizontal position for compactness; which will provide symmetrical tuning loops; and which may be made up as a rigid structure, rigidly supported at both ends, without necessitating the use of R. F. insulators across the tuning loop.

Other objects are to shield the tube; to shield the cathode tuner, and to shield the tube and tuner from one another.

A further object is to provide a shield box which may be readily and rapidly opened, and which when opened exposes the tube and tuner and their connections inside the shield box so fully and widely as to facilitate rapid change to a new tube when the old one has worn out.

To the accomplishment of the foregoing general objects, and other objects which will hereinafter appear, our invention resides in the shield box and cathode tuner elements and their relation one to the other as are hereinafter described in the following specification. The specification is accompanied by drawings in which:

Figure 1 is a partially sectioned elevation of a shield box embodying features of our invention;

Figure 2 is a plan view thereof;

Figure 3 is a front end elevation thereof, drawn to a reduced scale;

Figure 4 is a similar elevation showing how the box is opened;

Figure 5 is a side elevation with the box opened;

Figure 6 is a schematic wiring diagram explanatory of the wiring for filament heating;

Figures 7, 8 and 9 schematically show how the shield box may be used for either cathode, anode or grid keying;

2

Figure 10 is a partially sectioned plan view of the cathode tuner;

Figure 11 is a partially sectioned side elevation of the same;

Figure 11–A is a section taken in the plane of the line 11A—11A of Figure 11;

Figure 12 is explanatory of the method of making the lower part of the shield box;

Figure 13 is a section taken in the plane of the line 13—13 of Figure 12;

Figure 14 is a side elevation of the lower part of the shield box;

Figure 15 is a section taken in the plane of the line 15—15 of Figure 14; and

Figure 16 is a plan view of the partition used in the shield box.

Referring to the drawing and more particularly to Figures 1 and 2, the shield box is a metal enclosure divided into an upper compartment 12 and a lower compartment 14 by means of a metal partition 16. The VT–158 tube, indicated in broken lines at 18, is housed in the upper compartment 12. A filament-tuning loop generally designated 20 is housed in the lower compartment 14. The shelf or partition 16 serves not only to support the tube 18 but also to shield the tube and the tuning loop 20 from each other. (This is in addition to the shielding of both the tube and the tuning loop from external fields.) The tube is cooled by means of an air blower 22 driven by a motor 24 (Figure 2). The air-intake and the air-outlet of the blower are shown at 26 and 28 respectively. The outlet opens directly into the rear end of the shield box, thus blowing a stream of air directly around the tube 18. The air is discharged through screened windows. The main window is the window 30 (Figure 3), located in the upper compartment at the forward end of the box. There are also two windows 32 in each side wall of the box, these windows preferably being located in the lower compartment, as is best shown in Figures 1 and 5. The absence of side windows in the upper compartment insures the passage of air all the way through the upper compartment around the entire length of the tube. The windows in the lower compartment cause some of the air to flow downwardly around the glass stems projecting through the partition. The bottom windows also afford convenient observation of the shorting bars of the cathode tuner. The windows are all screened with appropriate copper screening in order to complete the shielding of the apparatus.

In order to understand some of the features of

the present invention, it may be desirable to outline the arrangement of tube 18. This tube comprises tuned U-shaped circuits 34 (Figure 1) connected to the anodes, and additional tuned U-shaped circuits 36 therebeneath, connected to the grids. The grids project upwardly and are disposed within the anodes. Filamentary cathodes are disposed within the grids, there being four cathodes, grids and anodes, two at each side of the tube. The anode leads 38 project upwardly through glass stems 40. Grid-circuit support wires 42 project downwardly through glass stems 44. A pair of wires for each filament projects downwardly through each of four glass stems 46. The four filaments are connected in parallel for the heating current, but pairs of the filaments are at opposite phase in respect to radio frequency voltage.

Referring now to Figure 6, the four filaments are schematically represented at 48, 50, 52 and 54. The leads of filament 48 are connected as shown to bars or straps of metal 56, 58. In practice these are disposed face to face with a thin sheet of mica therebetween, thereby insulating the bars one from another with respect to the low voltage filament heating current, but not with respect to radio frequency energy. The leads of filament 50 also are connected to the bars of 56 and 58. The leads of filaments 52 and 54 are connected to another pair of bars or straps of metal 60, 62, which are similarly disposed face to face with a thin sheet of mica therebetween. The inner bars 58, 60 may be connected together at 64, while the outer bars 56, 62 are connected together at 66. It is thus possible to heat all four filaments in parallel by means of low voltage connections 68, 70.

The filaments 48, 50 operate in phase opposition or push-pull with respect to filaments 52, 54. The push-pull related filaments 50, 52 are tuned by means of a loop or trombone adjusted by a slidable U-shaped spring or "shorting bar" 72. Similarly the filaments 46, 54 are tuned by means of a slidable spring or shorting bar 74. These shorting bars 72 and 74 are preferably simultaneously equally moved in opposite directions, thus keeping the arrangement symmetrical with respect to the filaments.

The structure for this purpose may be seen in detail by referring to Figures 10 and 11 of the drawing. Figure 10 clearly shows the metal bars 56 and 58, separated by mica strip 76, and also the metal bars 60 and 62, separated by mica strip 78. Bars 56, 58 and mica film 76 are assembled by means of screws 80, which are screwed into bar 58 but which are insulated from bar 56 by appropriate washers. In the same way the bars 60, 62 and mica film 78 are assembled by means of screws 82. Two of these screws may be used to hold soldering lugs 84. The inner bars 58, 60 are fixedly secured to the metal block 64 by screws 86. The outer bars 56, 62 are fixedly secured to metal block 66 by screws 88. This provides a rigid tuning-bar structure devoid of R. F. insulators between opposite sides of the tuning loop. The use of metal spacing blocks 64 and 66 at both ends also facilitates sturdy support of the tuning loop within the shield box. In Figure 11 it will be seen that these blocks are secured to plates 90 which are fastened to the upper ends of insulators 92. The lower ends of the insulators are secured to the bottom 146 of the shield box. The insulators 92 may be moulded of ceramic material, and are designed to insulate the tuner for high voltage direct current, but are not subjected to a radio frequency load because they are located at R. F. potential nodes.

Each of the adjustable shorting bars 72 and 74 comprises a metal block 94 carrying a pair of phosphor bronze or equivalent springy contact arms 96, which spring outwardly against the inner bars 58, 60. The ends of the springs preferably have small outwardly bent tabs 98 to hold the arms against vertical displacement. These tabs must not project far enough to touch the outer bars 56, 62. The blocks 94 are carried by a threaded rod 100 having right- and left-hand threads 102, 104. The rod 100 is made of a suitable insulation, such as Bakelite, and therefore does not short-circuit the filament heating supply at the end blocks 64, 66. The use of insulation for the rod 100 also protects the operator against D. C. voltage when using the control knob 106, the latter being secured to the forward end of the rod at a point outside of the shield box, as is best shown in Figures 1 and 2. In order to increase the insulation for this purpose, the rod is preferably extended at the forward end of the shield box and the projecting end is supported by a surrounding shielding can 108.

Reverting to Figures 10 and 11, the rod 100 is supported against axial movement by means of appropriate threaded collars 110 and lock nuts 112 screwed thereagainst. The collars 110 preferably have holes for a spanner wrench or capstan bar. Rotation of the control knob 106 causes simultaneous opposite movement of the threaded blocks 94, thereby equally lengthening or shortening the filament tuning loops.

Clamp plates 114, 116, 118, and 120 may be provided for detachable connection of the filament leads to the bars 56, 58, 60 and 62 respectively. These plates are L-shaped in section, as is best shown in Figure 11A, and are held in assembled relation by means of screws 122, which are threadedly received in the inner L-shaped plates, but which are insulated from the remainder of the structure, as will be clear from inspection of Figure 11A.

The clamp plates 114—120 are released by loosening the screws 122, whereupon one lead from filament 48 (Figure 6) is disposed between plate 114 (Figure 10) and bar 56 at the left end of plate 114. The other lead from filament 48 is disposed between bar 58 and plate 116 at the left end of the plate. The top flanges of the plates are preferably notched as shown at 124 to fix the position of the filament leads. The other filament leads are clamped in position in a similar fashion at the other notches. Proper location of the filament leads is important because it affects the overall length of the filament tuning loops. This is so because the tuning loop includes the vertical filament leads and also the horizontal portion of the tuning bars disposed between the point of attachment of the leads and the shorting bars 94.

The glass envelope of the tube 18 is generally cylindrical. It is supported or cradled in position by means of four blocks 126 (Figures 1, 5 and 16) which are fastened on top of partition 16. The upper ends of these blocks are properly sloped or concaved to mate with the cylindrical surface of the tube. The tube is additionally supported against upward movement by means of four spring pressed blocks 128 best shown in Figures 1 and 4. These blocks are carried on the inner ends of spring arms 130, the outer ends of which are held by blocks 132 fastened to the top of the shield box. The blocks 126—128 which come into direct contact with the heated tube envelope are

made of a suitable heat-resistant material. A good example is the refractory insulation known commercially as "Mycalex."

The top wall 134 is cut away to pass the upwardly directed stems 40 of the tube, and the resulting aperture or window is preferably finished by a rounded metal rod 136 (see Figure 2), thereby providing a smooth rounded finish to prevent high voltage breakdown to adjacent conductors connected to the anode leads 38.

The partition 16 beneath the tube is provided with three holes, best shown in Figure 16. The smaller outer holes 138 receive the downwardly directed stems 44 (Figure 1) of the grid circuit support leads, while the large center hole (Figure 16) receives four downwardly directed stems 46 (Figure 1) of the filament support leads.

The shield box is openable for tube replacement, and inasmuch as a change of tube may have to be made very rapidly as, for example, under field conditions in military use, the box is preferably made readily and rapidly openable and is so designed that when opened the tube and all of the internal connections are fully exposed. Referring to Figures 4 and 5, the top wall 134 and the side walls 142 are made of a single piece of sheet metal. The front and rear end walls 144 and the bottom wall 146 are also made of a single piece of sheet metal. When the box is changed from the closed condition shown in Figures 1, 2 and 3 to the open condition shown in Figures 4 and 5, the tube and the filament tuner and all of the internal connections are fully exposed. The top is shown adjacent the bottom to show the relation therebetween, but the top may be removed altogether.

The detailed construction of the particular shield box here illustrated may be further explained by reference to Figures 13 and 15 of the drawing. The end walls 144 and the bottom wall 146 are formed of a single piece of sheet metal, which is preliminarily bent to channel shape as shown in Figure 13. Mitre notches 148 (Figure 12) are cut in the side walls so that the channel may be bent to the shape shown in Figure 14. The resulting mitred corners are brazed or welded, etc., at 150. The ends of the side wall may be cut away as indicated at 152 in Figure 12, thereby providing projecting pieces of metal which may be bent over as indicated at 154 in Figure 14, and fastened by brazing, welding or the like.

The shelf 16 is itself made of a piece of sheet metal bent to channel shape,as indicated in Figure 15. The width of the shelf is slightly less than the width of the channel shown in Figures 12 and 13, so that the shelf will be received within the side flanges of the end walls 144. The ends of the shelf are turned downwardly as is indicated at 156, the side flanges of the shelf preferably being preliminarily notched as was explained at 152 in Figure 12. The down-turned ends of the shelf are preferably tapped to receive small screws 158 (Figures 1 and 3), which hold the shelf in position.

The upper part of the shield box fits slidably around the lower part shown in Figure 14. In order to clamp the same in position and to complete effective electrical shielding at the vertical edges, the lower part of the box is preferably provided with four vertical clamping strips 160. (See Figures 1 through 5.) These strips may be tightened or loosened by means of thumb screws 162. Referring to Figure 2, the thumb screw 162 is received in a nut 164 which is welded, brazed or otherwise secured to the inwardly flanged edge 166 of the shield box. The knurled knob is fixed to the screw and acts as its head, the inside head 163 of the screw serving merely to prevent complete removal and loss of the screw. The side walls 142 of the shield box are a little shorter than the top wall (see Figure 5), so that they will be received between the vertical rows of screws 162. With this arrangement the upper part of the shield box is readily slid upwardly when the thumb screws 162 (and vertical clamp plates 160) are loosened, but the parts are securely fastened together when the screws are tightened. The bottom edges also are preferably clamped against the bottom of the box. In Figure 5 it will be seen that the sides are notched at 168 to fit around the bottom thumb screws 170 within the knurled heads thereof.

As so far described the external shielding is complete, but the partition 16 may not adequately isolate the upper and lower compartments of the box. To help perfect the shielding between the upper and lower parts of the box, we provide spring strips 172 (see Figure 4) which extend horizontally (Figure 5) along the side walls 142 and are so disposed as to bear against the side flanges of the partition 16 when the box is closed. The spring strips 172 are preferably made of a highly-conductive resilient material, such as phosphor bronze. They do not interfere with the desired rapid opening or closing of the shield box.

Appropriate connections are provided to permit the oscillator tube to be connected for either cathode, anode or grid keying. Cathode keying is schematically illustrated in Figure 7. In this arrangement, the tuned anode leads 38 are grounded at 174 and a high minus D. C. potential is applied to the cathodes at 176. It will be understood that in practice the cathodes are not connected directly together but instead are connected to the filament tuning bars, as is shown in Figure 6. The plate and grid loops 178 and 180 are disposed within the sealed glass envelope of the tube . The lead 42 to the grid circuit 180 may be connected to a suitable bias resistor 182. The keying pulse is applied to the cathodes at the point 176.

Plate and grid keying arrangements are shown in Figures 8 and 9 respectively. In both cases the cathodes are grounded (through the cathode tuner), and a high positive plate potential is applied to the tuned anode leads, while a negative grid bias potential is applied to the grid circuit. In the case of Figure 8, however, the keying pulse is applied at the point 184, while in Figure 9 the keying pulse is applied at the point 186.

Referring now to Figure 1, a suitable large porcelain insulator 188 is secured to the back end wall of the shield box. A pair of concentric conductors (mutually insulated for low voltage) pass through the insulator 188. Filament heating current may be applied to the lugs 190 and 192. The inner lug may also be used for the keying pulse, etc. The conductors are terminated within the box by lugs 194 and 196, which in turn are connected by short direct leads to the lugs 84 and 85 on the filament tuner. (These connections correspond to the connections 68 and 70 shown in Figure 6.) Grid bias potential may be applied to soldering lug 198 of conical porcelain lead in 200. The lug 202 within the box is readily connected by a short direct lead to the downwardly projecting wire 42 of the tube. The anode connections are, of course, made to the

upwardly projecting terminals 38 of the tube. A ground connection to the shield box itself may be made at the wing nut 204. With the connections thus provided the tube may be wired for any of the keying methods shown in Figures 7, 8 and 9).

It is believed that the construction and operation of our improved shield box and filament tuner, as well as the many advantages thereof, will be apparent from the foregoing detailed description. The shield box is compact, relative to the size of the tube. It raises the efficiency of the tube and minimizes radiation therefrom. The particular tube illustrated oscillates at a frequency of, say 600 mc. At ultra high frequencies of this magnitude the problem of efficient shielding is critical, and the dimensions of the shield box should be properly selected to obtain reflection of the energy in correct phase.

The high frequency tube here considered generates a small but appreciable quantity of X-rays. The shield box, if made of reasonably heavy gauge sheet metal, say $\frac{1}{16}$-inch thick, protects the operator from injury from the relatively soft X-rays.

The filament tuner is a rigid structure which does not require radio frequency insulation between its sides. Two equal loops are provided, and are symmetrically aranged to provide identical tuning for the pairs of cathodes even though four cathodes are used. The desired equal length of loop would be readily obtainable by using a single loop disposed vertically, but in such case a cumbersome structure of substantial height would result. The present structure is made compact largely by reason of the horizontal disposition of the tuner. With a single loop disposed horizontally, however, the loop would be longer for one pair of cathodes than for the other. Moreover, a single tuning loop would require radio frequency insulation to support the open end of the loop. The present arrangement overcomes all of these difficulties and provides a sturdy structure which is both rigid and efficient and which may be solidly supported at both ends within the shield box. The shield box not only shields the tube and the tuning loop, but also shields them from one another. The shield box is readily opened, and when open exposes the tube and all of its connections, thus facilitating tube change.

It will be apparent that while we have shown and described our invention in a preferred form, many changes and modifications may be made in the structure disclosed without departing from the spirit of the invention, as sought to be defined in the following claims.

We claim:

1. A metal shield box for an ultra high frequency oscillator tube, said box being divided into two compartments by a horizontal partition, the top and sides of said box being made of sheet metal into a unitary structure, the ends, bottom and partition of said box being made of sheet metal into a second unitary structure, the top and sides being upwardly slidable to completely open the shield box and thereby expose the tube for replacement, the said sides of said box having horizontally disposed spring strips so positioned as to bear against the side edges of the aforesaid partition in order to effectively complete the shielding action of the partition, said box having spaced blocks to support the bottom portion of the tube, the removable top of said box having yieldable means to bear against the top portion of the tube when the box is closed.

2. A metal shield box for an ultra high frequency oscillator tube requiring an external cathode tuner, said box comprising an upper compartment enclosing and shielding the tube and a lower compartment enclosing and shielding the cathode tuner, the partition between said compartments being a metallic shield for shielding the tuner and tube from one another, the top and sides of said box being made of sheet metal into a unitary structure, the ends, bottom and partition of said box being made of sheet metal into a second unitary structure, the partition being secured between the ends, and the top and sides being upwardly slidable to completely open the shield box and thereby expose the tube for replacement.

3. A metal shield box for an ultra high frequency oscillator tube requiring an external cathode tuner, said box comprising an upper compartment enclosing and shielding the tube and a lower compartment enclosing and shielding the cathode tuner, the partition between said compartments being a metallic shield for shielding the tuner and tube from one another, the top and sides of said box being a unitary structure made of sheet metal, the ends, bottom and partition of said box being a second unitary structure made of sheet metal, the partition being secured between the ends, the top and sides being upwardly slidable to completely open the shield box and thereby expose the tube in the upper compartment for replacement, said partition having spaced blocks to support the envelope of the tube, and the top of said box having a spring means to bear downwardly against the envelope of the tube when the box is closed.

4. A metal shield box for an ultra high frequency oscillator tube requiring an external cathode tuner, said box comprising an upper compartment adapted to enclose and shield the tube and a lower compartment adapted to enclose and shield the cathode tuner, a partition between said compartments being a metallic shield adapted to shield the tuner and tube from one another, the top and sides of said box being a unitary structure made of sheet metal, the ends, bottom and partition of said box being a second unitary structure made of sheet metal, the partition being secured between the ends, the top and sides being upwardly slidable to completely open the shield box and thereby expose the tube in the upper compartment for replacement, and the sides of said box having horizontally disposed spring strips so positioned as to bear against the side edges of the aforesaid partition in order to effectively complete the shielding action of the partition.

5. A metal shield box for an ultra high frequency oscillator tube, the top and sides of said box being a unitary structure made of sheet metal, the ends and bottom of said box being a second unitary structure made of sheet metal, and a blower connected to one end of the shield box, said box having one or more windows for free flow of cooling air, said windows being screened with fine mesh metal screening for shielding purposes, the top and sides being upwardly slidable to completely open the shield box and thereby allow a tube to be installed or removed.

6. A metal shield box for an ultra high frequency oscillator tube requiring an external cathode tuner, said box comprising an upper compartment adapted to enclose and shield said tube and a lower compartment adapted to enclose and shield said cathode tuner, a partition between

said compartments being a metallic shield adapted to shield the tuner and tube from one another, a blower connected to one end of the shield box at the tube compartment, said tube compartment having one or more windows for free flow of cooling air, said windows being screened with fine mesh metal screening for shielding purposes, the top and sides of said box being a unitary structure made of sheet metal, the ends, bottom and partition of said box being a second unitary structure made of sheet metal, the partition being secured between the ends, the top and sides being upwardly slidable to completely open the shield box and thereby allow a tube to be installed in or removed from said partition having spaced blocks to support the envelope of the tube, and the top of said box having spring means to bear yieldably downwardly against the envelope of the tube.

7. A metal shield box for an ultra high frequency oscillator tube requiring an external cathode tuner, said box comprising an upper compartment adapted to enclose and shield said tube and a lower compartment adapted to enclose and shield said cathode tuner, a partition between said compartments being a metallic shield adapted to shield the tuner and tube from one another, a blower connected to one end of the shield box at the tube compartment, said tube compartment having one or more windows for free flow of cooling air, said windows being screened with fine mesh metal screening for shielding purposes, the top and sides of said box being a unitary structure made of sheet metal, the ends, bottom and partition of said box being a second unitary structure made of sheet metal, the partition being secured between the ends, the top and sides being upwardly slidable to completely open the shield box and thereby allow a tube to be installed in or removed from the upper compartment, and the sides of said box having horizontally disposed spring strips so positioned as to bear against the side edges of the aforesaid partition in order to effectively complete the shielding action of the partition.

8. A tunable cathode loop for a push pull oscillator tube, said loop comprising two spaced parallel bars, each of said bars including two strips of metal insulated with respect to each other for direct currents but not, for radio frequency currents, whereby the heater leads of one cathode may be connected to the two strips respectively of one bar and the heater leads of the other cathode may be connected to the two strips respectively of the other bar, a shorting contact slidable along the bars, and means for adjusting the position of the shorting contact along the bars.

9. A tunable cathode loop for a push pull oscillator tube, said loop comprising two spaced parallel bars, each of said bars including two strips of metal separated by thin insulation, whereby the heater leads of one cathode may be connected to the two strips respectively of one bar and the heater leads of the other cathode may be connected to the two strips respectively of the other bar, a slider disposed between the bars and slidable along the inner strips, and screw mechanism for adjusting the position of the slider along the bars.

10. A tunable cathode loop for a push pull oscillator tube, said loop comprising two spaced parallel bars, each of said bars including two strips of metal separated by thin insulation, whereby the heater leads of one cathode may be connected to the two strips respectively of one bar and the heater leads of the other cathode may be connected to the two strips respectively of the other bar, a U-shaped spring or slider disposed between the bars and slidable along the inner strips, a screw made of insulation and threadedly received by said slider for adjusting the position of the slider along the bars, and a metal block between the inner strips at one end of the strips.

11. A tunable cathode loop for an oscillator tube having two pairs of cathodes, said loop comprising two spaced bars, each of said bars including two strips of metal insulated from each other with respect to direct current but not radio frequency currents, the cathode leads of one pair of cathodes being connected to the two strips of one bar, the cathode leads of the other pair of cathodes being connected to the two strips of the other bar, a slider disposed between the bars and slidable along the inside strips near one end of the bars, a slider similarly slidable near the other end of the bars, and means to simultaneously equally move the sliders in opposite directions, so that the tuning loop remains symmetrical with respect to all of the cathodes.

12. A tunable cathode loop for an oscillator tube having two pairs of cathodes, said loop comprising two spaced bars, each of said bars including two strips of metal insulated from each other with respect to direct currents but not radio frequency currents, a metal block connecting the inner strips at one end of the bars, a second metal block connecting the outer strips at the other end of the bars, the cathode leads of one pair of cathodes being connected to the two strips of one bar, the cathode leads of the other pair of cathodes being connected to the two strips of the other bar, a slider disposed between the bars and slidable along the inside strips near one end of the bars, a slider similarly slidable near the other end of the bars, and insulated mechanism for simultaneously equally moving said sliders in opposite directions, so that the tuning loop remains symmetrical with respect to all of the cathodes.

13. A tunable cathode loop for an oscillator tube having four cathodes, said loop comprising two spaced parallel bars, each of said bars comprising including two strips of metal separated by thin insulation, a metal block connecting the inner strips at one end of the bars, a metal block connecting the outer strips at the other end of the bars, insulators supporting the blocks respectively, the cathode leads of one pair of cathodes being connected to the two strips of one bar, the cathode leads of the other pair of cathodes being connected to the two strips of the other bar, a U-shaped spring or slider disposed between the bars and slidable along the inside strips near one end of the bars, a second U-shaped spring or slider similarly slidable near the other end of the bars, and an insulation screw passing through the blocks and freely rotatable relative thereto and having right- and left-hand threads, one of said threads receiving one of said sliders and the other of said threads receiving the other of said sliders, whereby both sliders may be simultaneously equally moved in opposite directions, so that the tuning loop remains symmetrical with respect to all of the cathodes.

14. A shield box and tunable cathode loop for an oscillator tube including two cathodes, said loop including two spaced parallel bars, each of said bars including two strips of metal insulated

from each other with respect to direct currents but not radio frequency currents, the cathode leads of one cathode being connected to the two strips of one bar, the cathode leads of the other cathode being connected to the two strips of the other bar, a slider disposed between the bars and slidable along the bars, an insulation screw threadedly receiving the slider, and a metal shield box shielding the tube and the cathode tuning loop, said metal shield box having a partition disposed between the tube and the loop, one end of said threaded rod projecting out of one end of the shield box and having a control knob for rotation thereof, said end of the shield box having a shielding can projecting therefrom and surrounding the projecting end of the rod in order to space the knob a substantial distance from the loop so as to protect the operator from any high direct current potential on the loop.

15. A shield box and tunable cathode loop for an oscillator tube having four cathodes, said loop including two spaced parallel bars, each of said bars including two strips of metal insulated from each other with respect to direct currents but not radio frequency currents, a metal block connecting the inner strips at one end of the bars, a second metal block connecting the outer strips at the other end of the bars, the cathode leads of one pair of cathodes being connected to the two strips of one bar, the cathode leads of the other pair of cathodes being connected to the two strips of the other bar, a slider disposed between the bars and slidable along the inside strips near one end of the bars, a second slider similarly slidable near the other end of the bars, and an insulation screw having right and left hand threads, one of said threads receiving one of said sliders and the other of said threads receiving the other of said sliders, whereby both sliders may be simultaneously equally moved in opposite directions, so that the tuning loop remains symmetrical with respect to all of the cathodes, and a metal shield box shielding the tube and the cathode tuning loop, said metal shield box having a partition disposed between the tube and the loop, and one end of said threaded rod projecting out of one end of the shield box to allow rotation of the rod.

16. A shield box and tunable cathode loop for an oscillator tube having four cathodes, said loop including two spaced parallel bars, each of said bars including two strips of metal separated by thin insulation, a metal block connecting the inner strips at one end of the bars, a metal block connecting the outer strips at the other end of the bars, insulators supporting the blocks respectively within the box, the cathode leads of one pair of cathodes being connected to the two strips of one bar, the cathode leads of the other pair of cathodes being connected to the two strips of the other bar, a U-shaped spring or slider disposed between the bars and slidable along the inside strips near one end of the bars, a second U-shaped spring or slider similarly slidable near the other end of the bars, an insulation screw passing through said blocks and having right and left hand threads, one of said threads receiving one of said sliders and the other of said threads receiving the other of said sliders, whereby both sliders may be simultaneously equally moved in opposite directions, so that the tuning loop remains symmetrical with respect to all of the cathodes, and a metal shield box shielding the tube and the cathode tuning loop, said metal shield box having a shielding partition disposed between the tube and the loop, one end of said threaded rod projecting out of one end of the shield box and having a control knob for rotation thereof, said end of the shield box having a shielding can projecting therefrom and surrounding the projecting end of the rod in order to space the knob a substantial distance from the loop so as to protect the operator from any high direct current potential on the loop.

FRED H. McCALL.
PETER DEVREOTES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,382,914	Hoxie	June 28, 1921
1,737,824	Brower	Dec. 3, 1929
1,895,902	Snow	Jan. 31, 1933
1,928,408	Clavier	Sept. 26, 1933
2,130,243	Mitchell	Sept. 13, 1938
2,166,685	Henderson	July 18, 1939
2,215,200	Usselman	Sept. 17, 1940
2,298,075	Tinus	Oct. 6, 1942

FOREIGN PATENTS

Number	Country	Date
324,889	Great Britain	Feb. 6, 1930

Certificate of Correction

Patent No. 2,453,148. November 9, 1948.

FRED H. McCALL ET AL.

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 7, line 6, after the numeral "9" strike out the parenthesis; line 15, for "mc." read *Mc.*; column 9, line 15, claim 6, after the word "from" insert the words *the upper compartment*; column 10, line 15, claim 11, for "current" read *currents*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 12th day of April, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

Certificate of Correction

Patent No. 2,453,148. November 9, 1948.

FRED H. McCALL ET AL.

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 7, line 6, after the numeral "9" strike out the parenthesis; line 15, for "mc." read *Mc.*; column 9, line 15, claim 6, after the word "from" insert the words *the upper compartment*; column 10, line 15, claim 11, for "current" read *currents*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 12th day of April, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.