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KLYSTRON APPARATUS

Filed Oct. 1, 1956 3 Sheets-Sheet 1

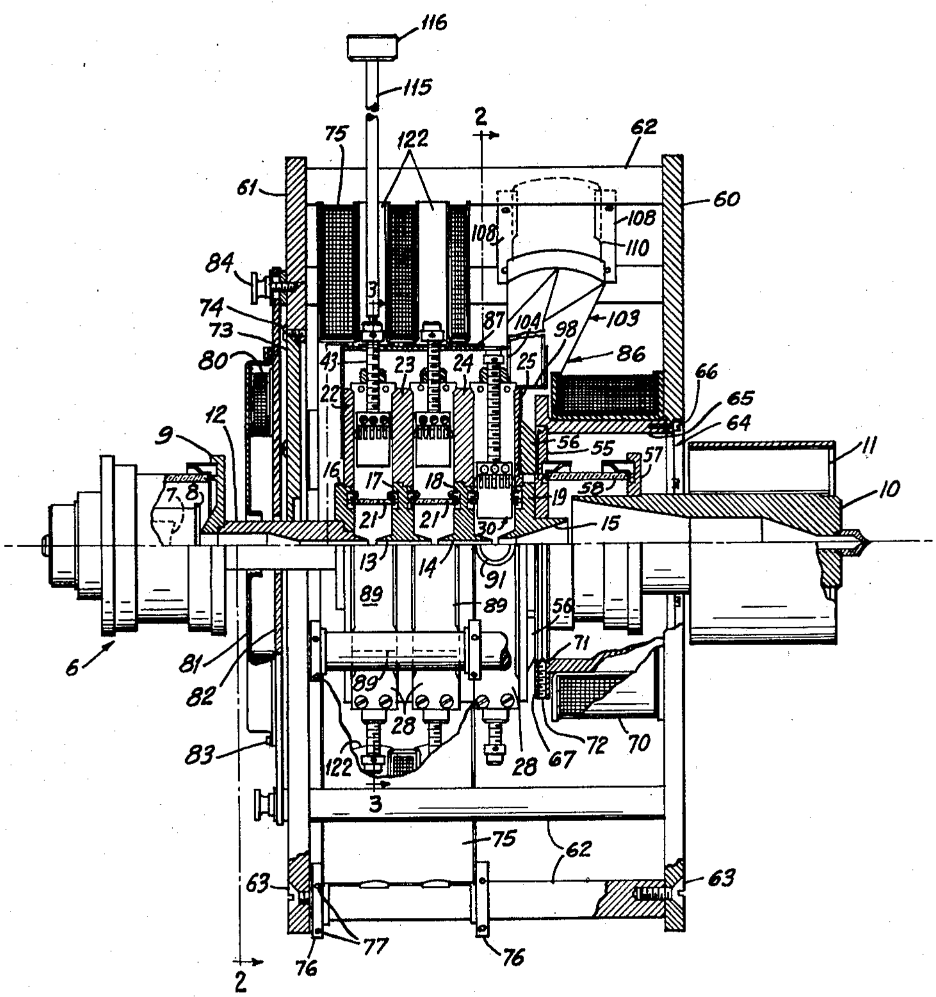

Fig.1

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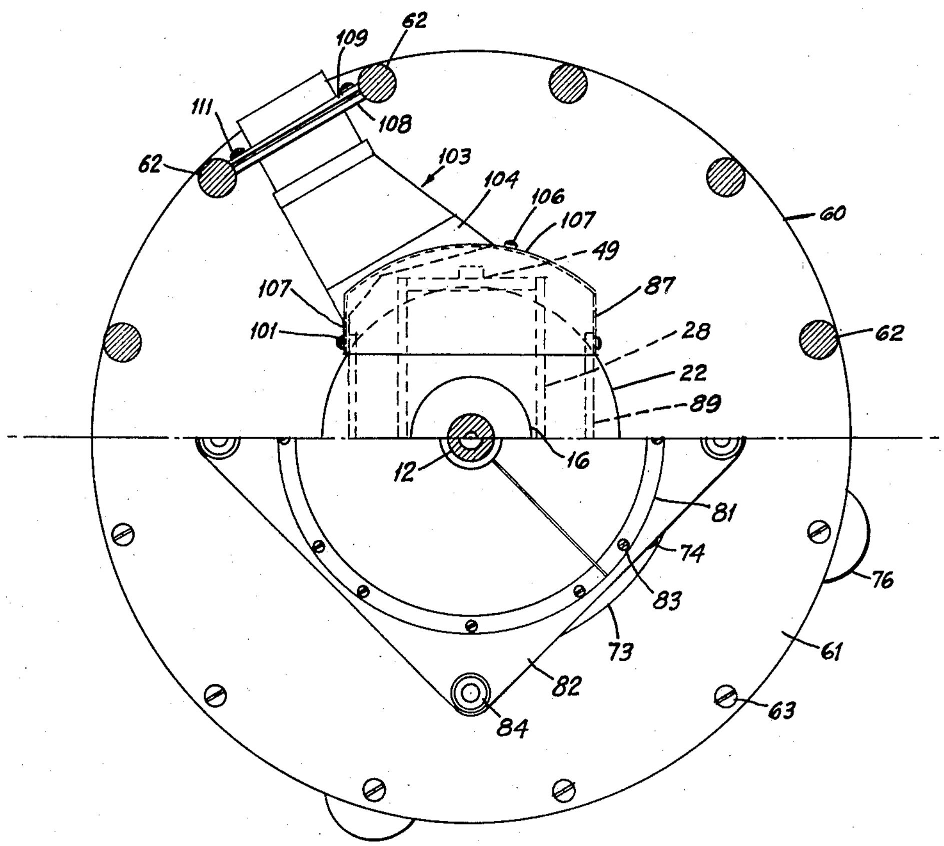

Fig. 2

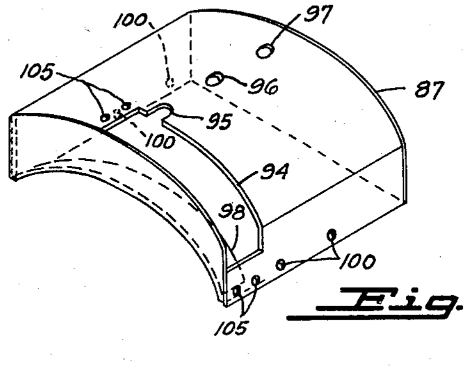

Fig. 5

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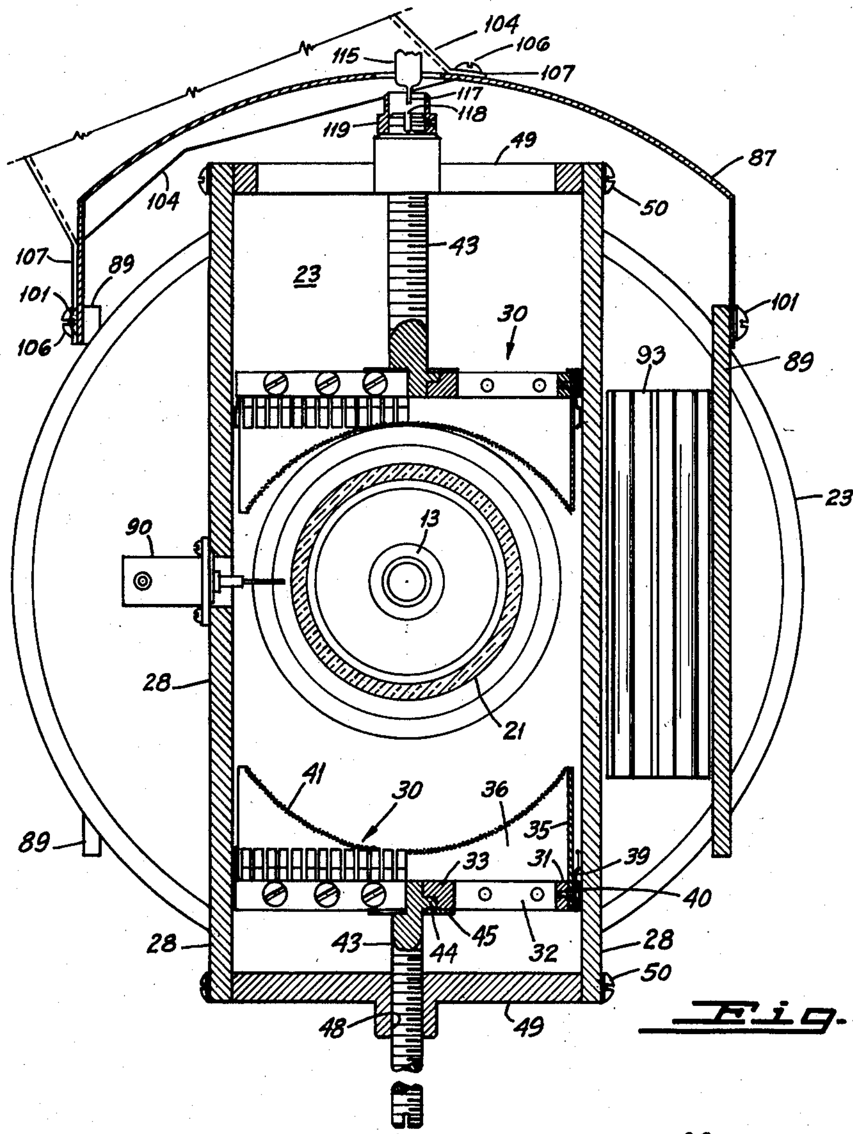

Fig. 3

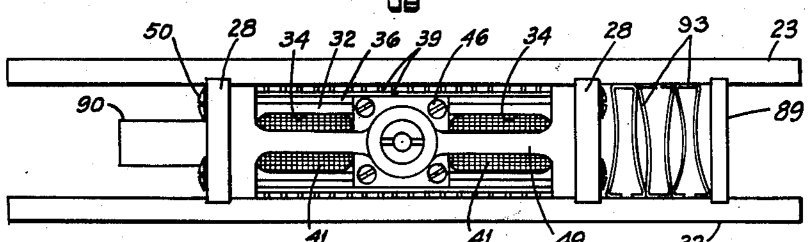

Fig. 4

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KLYSTRON APPARATUS

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Application October 1, 1956, Serial No. 612,995

14 Claims. (Cl. 315—5.46)

This invention relates to klystron apparatus and more particularly to apparatus including a klystron tube and magnetic circuitry therefor.

As is well known by those skilled in the art, klystrons normally comprise an elongated envelope forming a drift tube having an electron gun at one end and a collector electrode at the other end. The drift tube is made of a plurality of spaced tubular sections forming between them gaps which are surrounded by cavity resonators. It is also well known that the upper frequency level at which a klystron will operate depends to some extent on the distance between said gaps; the smaller the distance, the higher the frequency.

An object of this invention is to provide an improved construction for klystrons in which it is desirable to have relatively small spacing between adjacent gaps in the drift tube.

When the distance between adjacent drift tube gaps is decreased it naturally follows that the cavity resonators surrounding the gaps are also brought closer together. As a result of the crowded positioning of the resonators it is impossible to blow enough cooling air between them to accomplish the required heat dissipation.

Accordingly, a further object of the invention is to provide an improved construction for a cavity resonator which permits cooling air to be blown through the inside of the resonator.

Another object of the invention is to provide an improved construction for the tuning doors of the cavity resonator whereby cooling air can be blown through the doors and thus through the resonator.

An additional object of the invention is to provide an air duct arrangement associated with a klystron and its magnetic circuitry in such manner as to provide improved cooling and to facilitate insertion and removal of the klystron from the magnetic circuitry.

The compact arrangement of cavity resonators which results from closely spaced gaps causes, in addition to the heating problem, a problem of tuning the resonators. Normally cavity resonators have therein a tuning member which is movable radially of the drift tube axis and is operated by a radially extending tuning shaft. Klystrons of the type under consideration are surrounded by a magnetic circuit which includes magnet coils. When widely spaced resonators are used, the magnet coils can be spaced between them so that the tuning shafts can pass between the coils. However, when the resonators are close to each other there is insufficient space between the tuning shafts to accommodate coils of sufficient size.

Accordingly, a further object of the invention is to provide improved klystron apparatus wherein a magnet coil surrounds a plurality of compactly positioned cavity resonators and yet does not interfere with the shafts or other operating mechanisms for the tuning members in the resonators.

Another object of the invention is to provide improved

magnetic circuitry which permits insertion and removal of a klystron with minimum effort and delay.

A further object of the invention is to provide an extremely strong and compact klystron, and magnetic circuitry therefor having an improved arrangement for holding the klystron firmly in position.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the invention. It is to be understood that the invention is not limited to the disclosed species, as variant embodiments thereof are contemplated and may be adopted within the scope of the claims.

Referring to the drawings:

Figure 1 discloses an electron tube apparatus with the upper half essentially in cross section and the lower half essentially in side elevation with parts broken away.

Figure 2 is a view along line 2—2 of Figure 1.

Figure 3 is an enlarged view along line 3—3 of Figure 1, with the upper tuning door moved inwardly.

Figure 4 is a bottom view of Figure 3.

Figure 5 is a prospective view of the shroud shown in Figures 1, 2 and 3.

Referring in more detail to the drawings, Figure 1 discloses a klystron comprising an electron gun **6**, having a cathode **7**, a focusing electrode **8** and an anode **9**; a collector electrode **10** having cooling fins **11**; and a drift tube structure comprising a plurality of spaced tubular sections **12**, **13**, **14** and **15** forming three gaps therebetween. Drift tube sections **12**, **13**, **14** and **15** are each provided with radially extending flanges **16**, **17**, **18** and **19**, respectively, which form end walls of cavity resonators that are provided around the three gaps. A cylinder **21** of insulating material such as ceramic surrounds each gap and is sealed between adjacent end walls **16**—**19** to form outer walls of the evacuated tube envelope.

Additional walls **22**, **23**, **24** and **25** are brazed respectively to walls **16**, **17**, **18** and **19** to form outward extensions thereof. The extension walls **22**—**25** have parallel grooves therein in which resonator side walls **28** are brazed.

The resonators are completed by the addition of tuning doors **30** as shown best in Figures 3 and 4. Each of the tuning doors comprises a hollow rectangular frame having short sides **31**, and long sides **32** joined by bridge **33** so as to form the two apertures **34**. Short walls **35** extend inwardly toward ceramic cylinder **21** from the frame sides **31**, and long walls **36** extend inwardly from the frame sides **32**. Resilient contact fingers **39** are positioned around the walls **35** and **36** and are held in place by screws **40**. In order to complete the tuning doors a metal screen wall **41** is brazed across the frame provided by the inner edges of walls **35** which are straight and the inner edges of walls **36** which are curved to fit around the ceramic cylinder when the tuning door is moved to its inner position as shown in the upper half of Figure 3. The use of a sieve-like end wall for the tuning door such as is formed by screen **41** forms an important feature of the invention as will be described hereinafter. It should be understood that during tube operation the tuning doors should be kept at equal distances away from cylinder **21** rather than with one door in and one door out as shown in Figure 3.

From the preceding discussion it will be understood that a cavity resonator surrounding each of the gaps has a portion which is internal of the evacuated envelope and a portion which is external of the evacuated envelope. Ceramic cylinder **21** separates these two portions and serves as a wall of the tube envelope. At the same time cylinder **21** serves as a window which permits transfer of radio frequency energy between the internal resonator portion and the external resonator portion.

The resilient contact fingers **39** on the tuning doors **30** are in sliding engagement with the resonator end walls **22—25** and the resonator side walls **28** so that the doors can be moved radially of the tube axis toward and away from cylinders **21**. Adjustment of the tuning doors is accomplished by means of threaded shafts **43**, each having an annular flange **44** rotatably received in a countersunk hole in the bridge portion **33** of each tuning door. The flange **44** is held in place by a cover plate **45** secured to the bridge by means of screws **46**. Shaft **43** is rotatably engaged in a threaded aperture **48** formed in a bracket **49** which is held between resonator walls **28** by means of screws **50**. It will be seen from Figures 3 and 4 that the ends of the cavity resonators are open because brackets **49** do not form closures for the resonators but serve merely as supports for the shafts **43**. Thus, cooling air can be blown into one end of the resonators, through the tuning doors via apertures **34** and screen walls **41**, and then out the other end of the resonators.

In Figure 1 it will be seen that drift tube section **15** has a radially extending flange **55** brazed thereto in addition to the flange **19** and its extension **25**. Flange **55** and the extension flange **25** have radially extending grooves therein in which reinforcing ribs **56** are brazed. The collector electrode **10** has brazed thereto a flange **57** which is insulatingly connected to flange **55** by means of a ceramic cylinder **58** which is sealed between the flanges.

It will be understood from consideration of Figure 1 that an integral metal structure is formed between drift tube sections **12** and **15** by virtue of the fact that resonator end walls **23** and **24** each serves two resonators and all of the end walls **22—25** are directly connected to each other by side walls **28**. Thus, stresses tending to deform the tube are taken by the strong metal walls of the resonators rather than by the four ceramic cylinders **21** or the sealing means joining them to the adjacent side walls **16—19**.

The structure thus far described forms a unitary klystron assembly although some parts such as the tuning doors **30** are external to the envelope of the tube per se. The klystron assembly is surrounded by a magnetic circuit including a frame of magnetic material comprising end plates **60** and **61** connected by spaced rods **62** which are fixed to the plates by means of screws **63**. End plate **60** is apertured at **64** to accommodate passage of cooling fin structure **11**. A cylinder **65** extends inwardly from plate **60** adjacent to aperture **64** and is held in place by screws **66**. The inner end of cylinder **65** is provided with a flange **67** which serves to hold in place a magnet coil **70**. The inner end of cylinder **65** is recessed to provide a shoulder **71** against which is seated the flange **55**. Flange **55** has around its periphery a V-notch which is engaged by a plurality of screws **72** to hold the klystron secured within the magnetic frame. The end plate **61** is provided with a large central aperture in which a smaller plate **73** is secured by screws **74**. Plate **73** has a small central aperture surrounding drift tube section **12** and is made in two halves in order that it may be assembled after the tube has been inserted through plate **61**.

In addition to the magnet coil **70** the magnetic circuit includes a second magnet coil **75** which is adjustably supported for movement longitudinally of the axis of the klystron. Supporting means for coil **75** are provided in the form of collars **76** which are slidably received on several of the rods **62** where they are held in the desired position by means of set screws **77**. The magnetic circuit is completed by a focusing coil **80** which is surrounded by centrally apertured plates **81** and **82** of magnetic material. Plate **81** is attached to plate **82** by means of screws **83**, and plate **82** it attached to the main magnetic plate **61** by means of screws **84**. Plates **81** and **82** are made in two halves so they can be assembled around drift tube section **12**.

In order to provide a flow of cooling air through the inside and along the outside of the resonators an air duct is provided as indicated generally at **86**. Air duct **86** comprises a shroud **87** which forms a cover over one end of the cavity resonators and opens onto the resonators in registry with the open ends of the resonators. Referring to Figures 1 through 4, it will be seen that plates **89** are placed parallel to the resonator side walls **28** and brazed between the adjacent end wall flanges **22—25** to form an additional wall which cooperates with the side and end walls to make air channels extending parallel with the resonators. As shown in Figure 3, plate **89** is omitted adjacent to side resonator wall **28** to which the input coupling **90** is connected. Similarly, the plate **89** is omitted on the side of the output resonator which receives the output coupling **91** as shown in Figure 1. Accordingly, there are a total of four of the plates **89**, two on the middle resonator, and one each on the input and output resonators. As shown in Figures 3 and 4, cooling fins **93** are positioned between resonator walls **28** and plates **89** and are brazed to the adjacent plates **22—25**.

As shown best by Figure 5, the shroud **87** has an elongated inlet slot **94** adjacent one end thereof and three apertures **95**, **96** and **97** located along the center line of the shroud. Beneath slot **94** the shroud is provided with a band **98** which rests upon resonator end wall **25** as shown in Figure 1. The sides of the shroud are each provided with two holes **100** in which screws **101** are received for attaching the shroud to the plates **89**.

In addition to shroud **87** the air duct **86** includes a tubular inlet portion **103** which is flattened to form a rectangular inner end **104** which is received within the elongated slot **94** in the shroud. As shown best in Figure 3, the tubular portion **103** is secured to the shroud by means of screws **106** extending through tabs **107** and received within threaded apertures **105** provided in the shroud. It should be noted that the inlet slot **94** in the shroud is positioned adjacent the output resonator, that is, the resonator nearest the collector **10**, so that this resonator will receive the greatest cooling flow since it is the one in which the greatest heat is developed.

In order to provide additional support for tubular portion **103**, a pair of brackets **108** and a pair of brackets **109** are utilized. Each of the brackets has a curved portion **110** which fits around tubular portion **103**. Each of the brackets is slightly longer than the shortest distance between adjacent rods **62**. Accordingly, when the brackets are clamped together by the screws **111** as shown in Figure 2 they are firmly wedged between the rods **62** to form a tight support for tubular portion **103**.

Referring to Figure 1 it will be seen that shafts **43** on the tuning doors **30** do not extend radially beyond the circle formed by the rods **62**. Accordingly, it is necessary to provide removable extensions **115**. Only one such extension has been shown in Figure 1 but it should be understood that an extension is provided for each of the shafts **43**. Each extension **115** is provided at its outer end with a knob **116** by which it may be easily rotated. The inner end of each extension is provided with means for transferring torque to its associated shaft **43**. A convenient means for detachably connecting the extensions and shafts for torque transfer is to provide a screw-driver blade **117** on the inner end of each extension **115** and a cooperating slot **118** on the outer end of each shaft **43**. Preferably a collar **119** is attached to the outer end of each shaft **43** and serves both as a guide for extension **115** and a stop which determines the inner limit to which the associated door **30** can be moved. Since the resonant cavities are so closely spaced, there is not sufficient room between adjacent tuning shafts **43** in which efficiently to place separate magnet coils. In order to use the single coil **75**, radially extending bores **122** are provided therein to provide passageway for the tuning means comprising shafts **43** and their extensions **115**.

Coming now to a description of a procedure for assembling the apparatus, the assembly of the magnetic circuit will be considered first, and throughout the description it will be assumed that the apparatus shown in Figure 1 is located in a vertical position with collector 10 at the bottom and gun 6 at the top. Starting with end plate 60, it is preferable first to attach the coil 70 by means of the cylinder 65. Next, the rods 62 are connected to plate 60. Then the brackets 108 and 109 carrying tubular portion 103 are slid downwardly between two of the rods 62. Next, several collars 76 are slid downwardly on rods 62 and tightened in place to form supports for the lower edge of coil 75 which is next lowered into contact with these collars. Then additional collars 76 are slid down against the upper edge of coil 75 and tightened in place so that the coil is clamped between the upper and lower collars 76. Finally, the end plate 61 minus its inner plate 73 is attached to the upper end of rods 62 by means of screws 63.

The circuit assembly thus far described forms a permanent socket structure which need not be disassembled in order to remove an existing klystron and insert a new one.

The klystron is inserted downwardly, collector end first, in the assembled circuit structure previously described. Flange 55 on the tube comes to rest against shoulder 71 on the cylinder 65 and is fixed in place by tightening screws 72. It should be understood at the time the klystron is inserted it carries shroud 87 and that the inner diameter of coil 75 is sufficient to receive the shroud. In addition it should be understood at the time the klystron is inserted the tubular portion 103 of the air duct is withdrawn outwardly so as not to prevent downward movement of the shroud. In addition, the tuning shafts 43 are screwed inwardly far enough that their collars 119 will not strike coil 75. After the klystron is in place, tubular portion 103 is moved inwardly until its rectangular end 104 is received within slot 94 and is then secured in place by the screws 106. Then the brackets 108 and 109 are clamped together around the tubular portion by means of screws 111. Next the split plate 73 is positioned as shown in Figure 1 and secured in place by screws 74. Then, the split plate 82 is positioned in place by means of screws 84, and the coil 80 and split plate 81 are attached to plate 82 by means of screws 83. In order to adjust the tuning doors 30 the extensions 115 are inserted through the bores 122 in coil 75 and are engaged with the outer ends of shafts 43.

It should be understood that all metal parts of the klystron are made of non-magnetic material so as not to interfere with the field provided by the magnetic circuit. In the entire apparatus the only parts which are made of magnetic material are the main parts of the magnetic circuit; namely, plates 60, 61, 73, 81 and 82, the rods 62, and the cylinder 65.

After a klystron has been inserted in the magnetic circuitry as shown in the drawings, a blower (not shown) is connected to the outer end of the tubular inlet portion 103 of the air duct 86. Air from the blower passes through inlet portion 103 and then into the shroud 87 which directs the air into each cavity resonator where it passes through the sieve-like screens 41 of the tuning doors. In addition the shroud directs the air through the channels containing cooling fins 93. Likewise the shroud directs air across the input coupling 90, the output coupling 91 and the resonator walls 28 in which these couplings are mounted After performing its cooling function the air is free to escape relatively unrestricted from the magnetic circuit because rods 62 are relatively narrow and are widely spaced.

Thus, it will be understood that cooling air flows into one end of each cavity resonator, through one of the tuning doors, around the ceramic cylinder 21, and out the other tuning door. This cooling feature is of course made possible by the sieve-like screen wall 41 on the tuning doors 30. The sieve-like wall 41 prevents the passage of any appreciable radio-frequency energy while permitting the passage of air. The basic criterion in designing the sieve-like wall 41 is to make each aperture and its metal boundary form such a high capacitance that the wall 41 appears to the radio-frequency current as a solid member. As a practical matter it has been found that the maximum permissible area of the apertures in wall 41 is in general dependent upon the frequency of the current in the resonator. More specifically, the apertures must be of smaller area for klystrons designed for a higher frequency range than for klystrons designed for a lower frequency range. In addition, the shape of each aperture and its depth help determine whether or not radio frequency will leak through the sieve-like wall 41. For example, increasing the depth of the aperture helps prevent leakage. Thus, a honeycomb structure would be electrically better than the thin screen shown in the drawing, but it would be substantially worse from the standpoint of air flow.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. Electron tube apparatus comprising a klystron having an air-tight envelope with an electron gun at one end and a collector electrode at the other end, a plurality of cavity resonator portions surrounding said envelope intermediate said gun and collector and having open ends, each two adjacent resonator portions having a common wall whereby all of the resonator portions are grouped compactly along said envelope, two tuning doors movably mounted in each resonator portion, each of said doors having a sieve-like wall forming a part of the inner surface of its respective resonator portion, a shroud opening onto said resonator portions in registry with the open ends of said resonator portions, said shroud having an inlett aperture therein adjacent the resonator portion nearest said collector, a magnetic circuit surrounding said envelope and comprising a frame including end plates spaced along the klystron axis and extending transversely of said axis, spaced rods interconnecting said end plates and arranged around the klystron axis substantially parallel to said axis, an annular magnet coil encircling said resonator portions, adjustment means for moving said tuning doors, said coil having bores extending therethrough for receiving the adjustment means for the tuning doors in said resonator portions, and means adjustably supporting said coil on said rods for movement longitudinally of the tube.

2. A klystron comprising an envelope having an electron gun at one end and a collector electrode at the other end, a drift tube interposed between said gun and said collector, said drift tube comprising spaced tubular sections forming a gap, a cavity resonator portion formed internally of said envelope and comprising end walls extending radially from said tubular sections and a cylinder of insulating material surrounding said gap and sealed between said end walls to form the outside wall of said internal resonator portion, a cavity resonator portion external to said envelope and comprising a first pair of walls forming external extensions of said end walls, a second pair of walls connected between said first pair of walls, said second walls being spaced externally of said cylinder and positioned on opposite sides of the cylinder, tuning doors positioned within said first and second walls on opposite sides of said cylinder and forming the outer walls of said external resonator portion, and means for moving said tuning doors toward and away from said cylinder, said outer walls formed by said tuning doors being made of metal screen, whereby cooling air can be forced into said external cavity portion through one of said doors, around said cylinder and out through the other of said doors.

3. An electron tube comprising a vacuum-tight envelope with an electron gun at one end and a collector electrode at the other end, a cavity resonator portion sur-

rounding said tube externally of said envelope and intermediate said gun and said collector, and a tuning door movably mounted in said resonator portion, said tuning door comprising a sieve-like portion forming part of the inner surface of said resonator portion.

4. Electron tube apparatus comprising a klystron having a vacuum-tight envelope with an electron gun at one end and a collector electrode at the other end, a cavity resonator portion surrounding said klystron externally of said envelope and intermediate said gun and collector, said resonator portion being open at opposite ends, two tuning doors movably mounted in said resonator portion and each having a sieve-like portion forming part of the inner surface of said resonator portion, and an air duct having one end opening onto said resonator portion in registry with one of said open ends.

5. Electron tube apparatus comprising a beam-type electron tube comprising an envelope having an electron gun at one end and a collector electrode at the other end, a drift tube interposed between said gun and said collector, said drift tube comprising spaced tubular sections forming a gap, a cavity resonator portion formed internally of said envelope and comprising end walls extending radially from said tubular sections and a cylinder of insulating material surrounding said gap and sealed between said end walls to form the outside wall of said internal resonator portion, a cavity resonator portion external to said envelope and comprising a first pair of walls forming external extensions of said end walls and a second pair of walls connected between said first pair of walls, said second walls being spaced externally of said cylinder and positioned on opposite sides of the cylinder, an additional wall connected between said first pair of walls and spaced outwardly from one of said second walls to form an air channel in cooperation with said one second wall and said first pair of walls, tuning doors movably positioned within said first and second walls on opposite sides of said cylinder, said tuning doors each having a sieve-like portion forming part of the inner surface of said external resonator portion, the external resonator portion formed by said first and second walls being opened at its ends, and a shroud attached to said tube and opening onto one of said open ends of the external resonator portion and the adjacent end of said channel.

6. Electron tube apparatus comprising a beam type electron tube having a vacuum-tight envelope with an electron gun at one end and a collector electrode at the other end, a cavity resonator portion surrounding said envelope intermediate said gun and collector, a tuning door movably mounted in said resonator portion and having a sieve-like portion forming part of the inner surface of said resonator portion, adjustment means for moving said tuning door toward and away from said envelope, a magnetic circuit surrounding said tube comprising a magnet coil encircling said resonator portion, said coil being provided with a radially extending bore for the reception of said tuning means, and a shroud opening on to said resonator portion in substantial registry with said tuning door, said shroud having an aperture therein in substantial alignment with the bore in said coil.

7. Electron tube apparatus comprising a beam type electron tube having a vacuum-tight envelope with an electron gun at one end and a collector electrode at the other end, a cavity resonator portion surrounding said envelope intermediate said gun and collector, a tuning door movably positioned in said resonator portion for movement toward and away from said envelope, means forming a threaded opening at one end of said resonator portion, a threaded adjustment shaft received within said threaded bore and rotatably secured to said tuning door, a magnetic circuit surrounding said tube comprising a magnet coil encircling said resonator portion, said coil having a bore extending radially therethrough in substantial alignment with said shaft, and an adjustment shaft extension receivable in said bore in the magnet coil, said shaft and said extension being easily separated one from the other and having inter-engaging means for transmitting torque therebetween.

8. Magnetic circuitry for a klystron, said circuitry comprising a frame having two end plates of magnetic material, means connected to said plates and holding them spaced one from the other, said connecting means being of magnetic material and being positioned to surround a substantial open space, a magnet coil supported on said frame and positioned between said plates within the space surrounded by said connecting means, said coil being in substantial parallelism with said plates, a bore extending through said coil from its inner periphery to its outer periphery, and an air duct extending into said space surrounded by said connecting means, and adjustable clamping means supporting said duct on said magnetic frame for movement toward and away from the center of said open space in a plane substantially parallel to said plates.

9. Magnetic circuitry for a klystron, said circuitry comprising a frame having two end plates of magnetic material, a plurality of rods interconnecting said plates and arranged in a circular array, collars adjustably positioned on some of said rods, a magnet coil positioned within the circle formed by said rods and held in place by engagement between the collars on said rods, an air duct extending into the circle formed by said rods, and means adjustably supporting said duct between two of said rods for adjustment inwardly and outwardly of said circle.

10. Magnetic circuitry for a klystron, said circuitry comprising a magnetic frame including two centrally apertured end plates, means interconnecting said plates and holding the plates in spaced parallel relation, a cylinder of magnetic material attached to one of said plates and extending toward the other plate, said cylinder having a recess forming an annular shoulder therein, a threaded aperture in said cylinder opening inwardly to said recess and a screw in said aperture, a first magnet coil surrounding said cylinder, and a second magnet coil positioned within the boundary formed by said connecting means and spaced from said first coil toward said other end plate, said second coil having a bore extending therethrough from its inner periphery to its outer periphery.

11. A klystron comprising an envelope having an electron gun at one end and a collector electrode at the other end, a drift tube interposed between said gun and said collector, said drift tube comprising spaced tubular sections forming gaps therebetween, a cavity resonator portion for each of said gaps formed internally of said envelope and comprising end walls extending radially from said tubular section and a cylinder of insulating material surrounding each of said gaps and sealed between two of said end walls to form a vacuum-tight wall for the respective resonator portion, cavity resonator portions external to said envelope and each comprising a first pair of walls forming integral extensions of said end walls, each of said external portions further comprising a second pair of walls rigidly connected between said first pair of walls, said second walls being spaced externally of their respective insulating cylinder and positioned on opposite sides of the cylinder, and a mounting plate rigidly joined to said extension wall which is closest to said collector.

12. A klystron as claimed in claim 11, in combination with magnetic circuitry comprising a frame of magnetic material including two centrally apertured end plates, means interconnecting said plates and holding the plates in spaced parallel relation, a cylinder attached to one of said plates and extending toward the other plate, said cylinder having a recess forming an annular shoulder therein, a threaded aperture in said cylinder opening inwardly to said recess, and a screw in said aperture, said klystron being received within said magnetic circuitry and said mounting plate on the klystron having a V-groove therearound into which said screw projects.

13. A klystron comprising an envelope having an electron gun at one end and a collector electrode at the other end, a drift tube interposed between said gun and said collector, said drift tube comprising spaced sections forming gaps therebetween, a cavity resonator portion for each of such gaps formed internally of said envelope and comprising end walls extending radially from said tubular section and a cylinder of insulating material surrounding each of said gaps and sealed between two of said end walls forming a vacuum tight wall for the respective resonator portions, cavity resonator portions external to said envelope and each comprising a first pair of walls forming integral extensions of said end walls, each of said external portions further comprising a second pair of walls rigidly connected between said first pair of walls, said second pair of walls being spaced externally of their respective insulating cylinder and positioned on opposite sides of said cylinder, another wall positioned externally of one of said second pair of walls and between said first pair of walls to form a channel, and means for blowing air through said channel.

14. A klystron as claimed in claim 13 wherein a cooling fin is positioned within and attached to the inner surface of said channel formed by said first pair of walls, said one of said second pair of walls, and said third wall.

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