

May 9, 1939.

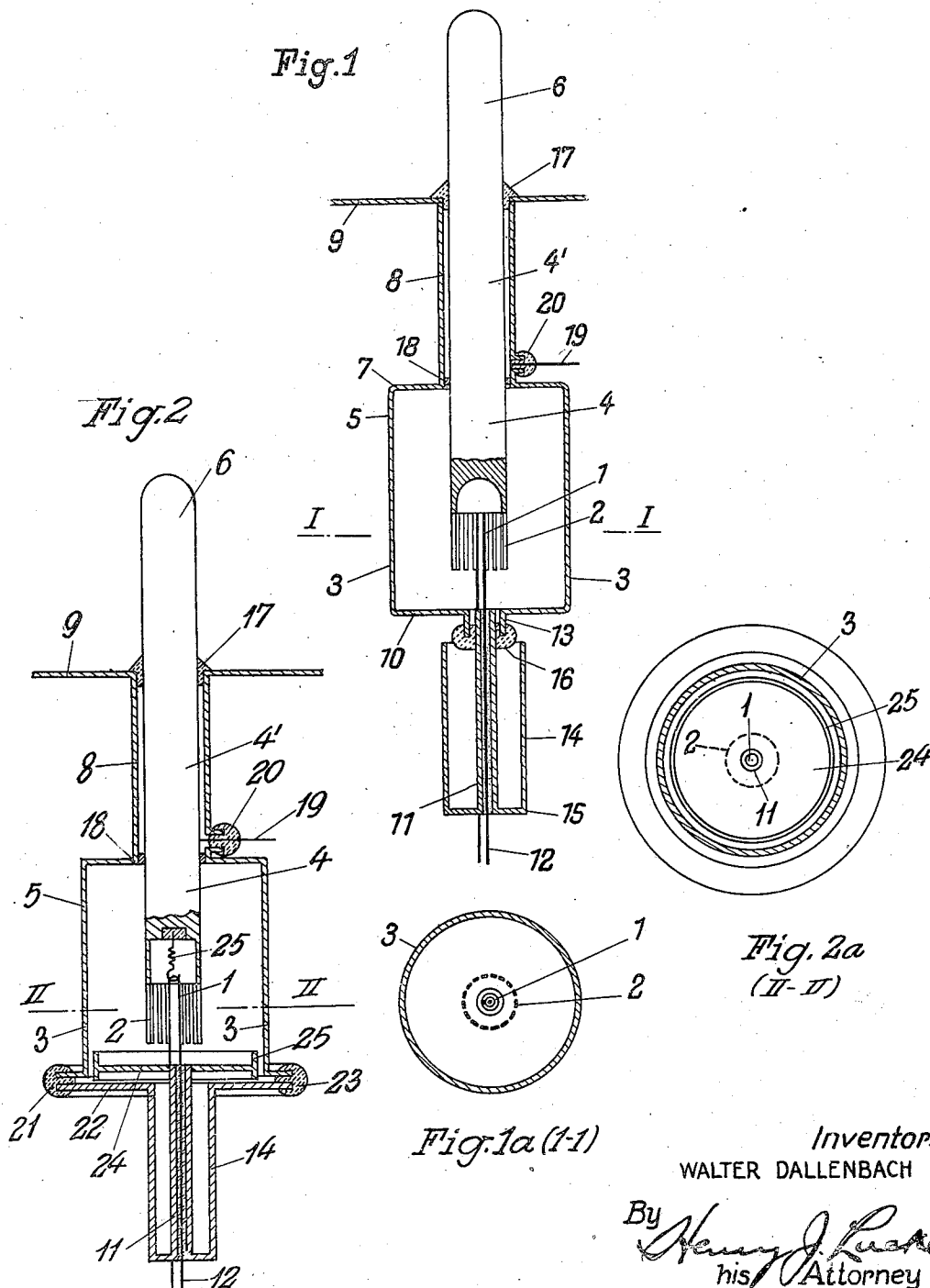
W. DÄLLENBACH

2,157,952

THERMIONIC VALVE

Filed April 16, 1936

5 Sheets-Sheet 1



Inventor:
WALTER DÄLLENBACH

By *Henry J. Luce*
his Attorney

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W. DÄLLENBACH

2,157,952

THERMIONIC VALVE

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5 Sheets-Sheet 2

Fig. 3

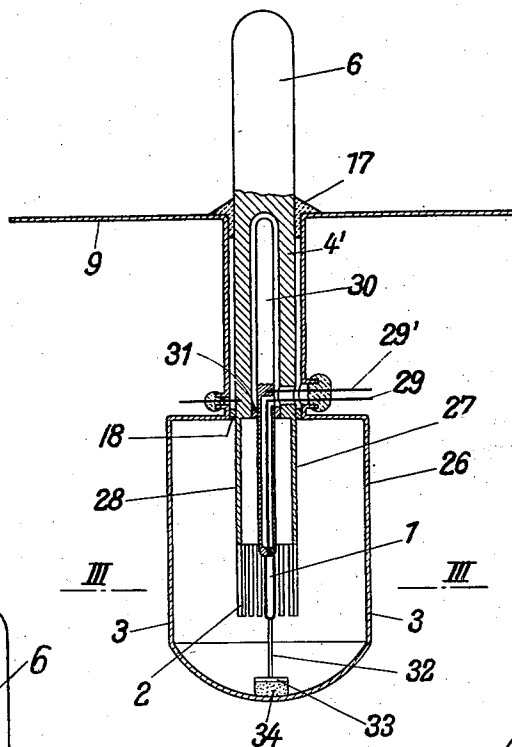


Fig. 4

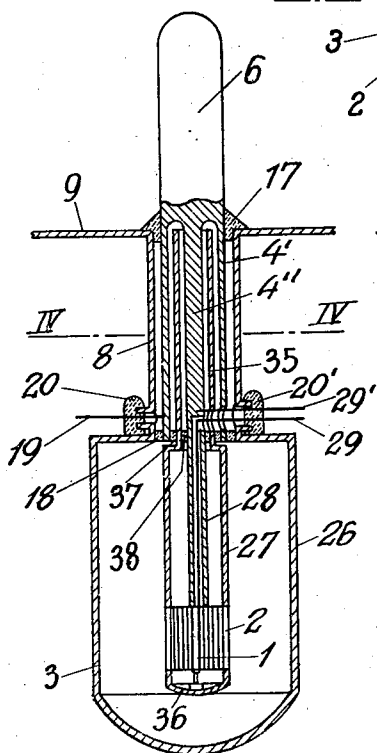


Fig. 3a (III-III)

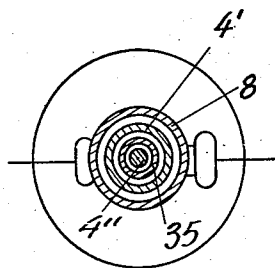
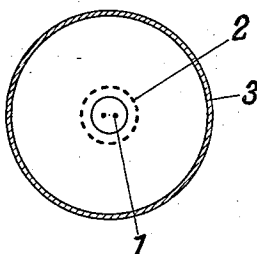


Fig. 4a
(IV-IV)

Inventor:
WALTER DÄLLENBACH

By *Henry J. Lucke*
his Attorney

May 9, 1939.

W. DÄLLENBACH

2,157,952

THERMIONIC VALVE

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5 Sheets-Sheet 3

Fig. 5

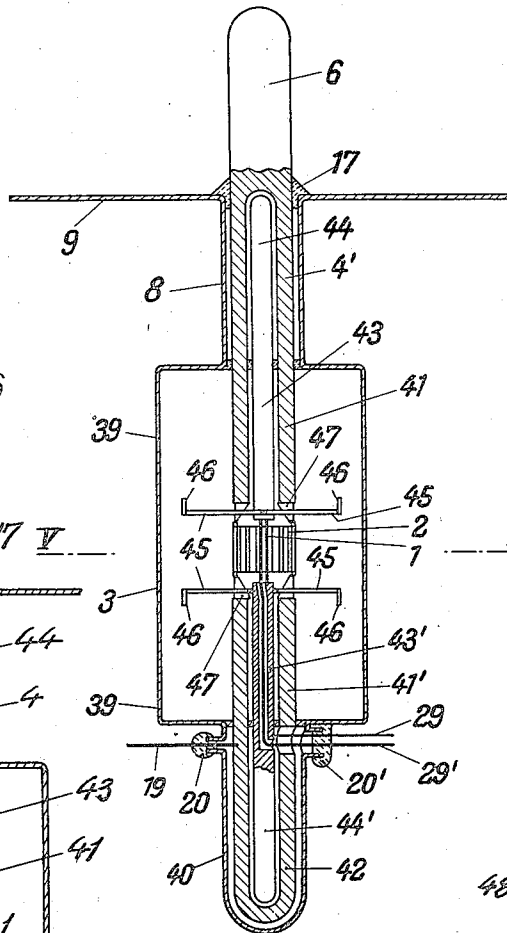


Fig. 6

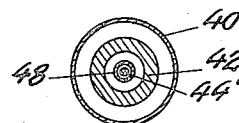
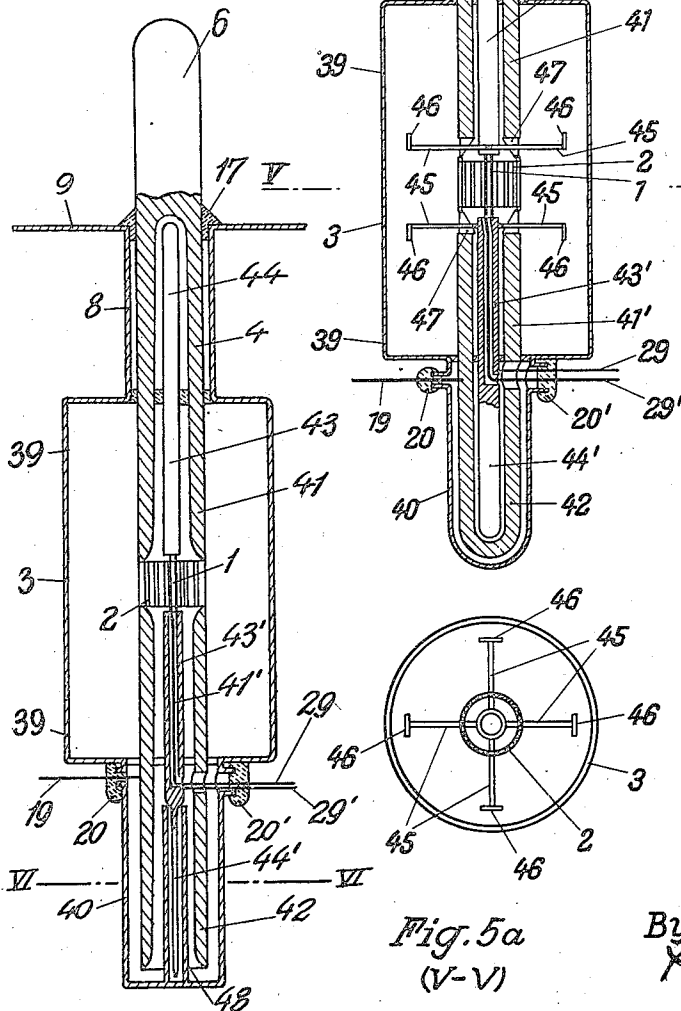


Fig. 6a.
(V-V)

Fig. 5a
(V-V)

Inventor:
WALTER DÄLLENBACH
By *Henry J. Lucke*
his Attorney

May 9, 1939.

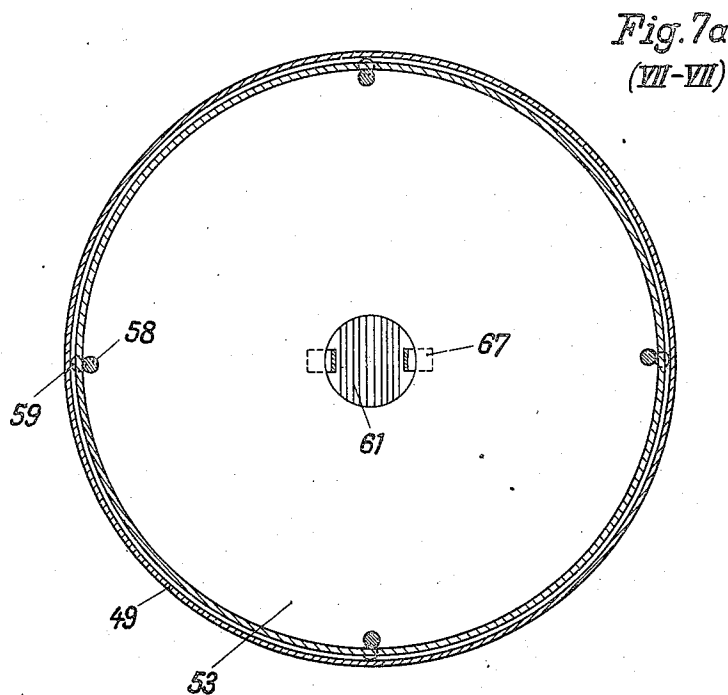
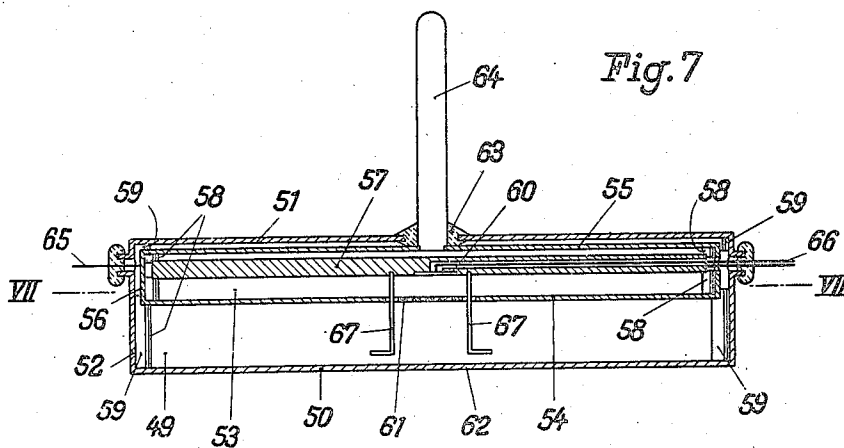
W. DÄLLENBACH

2,157,952

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5 Sheets-Sheet 4



Inventor:
WALTER DÄLLENBACH

By
Henry J. Rucke
his Attorney

May 9, 1939.

W. DÄLLENBACH

2,157,952

THERMIONIC VALVE

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5 Sheets-Sheet 5

Fig. 8

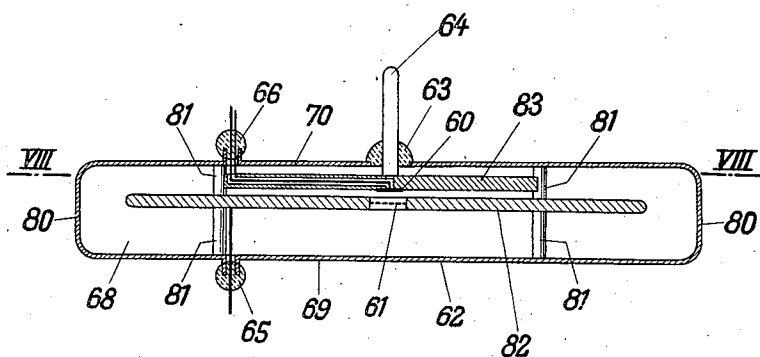
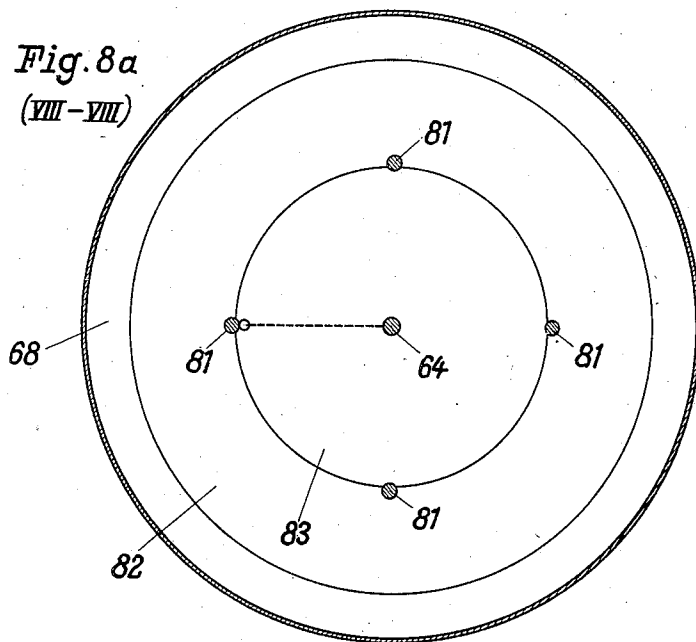


Fig. 8a
(VIII-VIII)



Inventor:

WALTER DÄLLENBACH

By *Henry J. Lucare*
his Attorney

UNITED STATES PATENT OFFICE

2,157,952

THERMIONIC VALVE

Walter Dällenbach, Berlin-Charlottenburg, Germany, assignor to Julius Pintsch Kommanditgesellschaft, Berlin, Germany

Application April 16, 1936, Serial No. 74,797
In Germany April 18, 1935

12 Claims. (Cl. 250—27.5)

The present invention concerns valves for exciting electromagnetic oscillations, and particularly for the production, amplification or reception of electromagnetic oscillations having wavelengths of from 10 metres down to a few centimetres.

An object of the invention is an electronic valve comprising an air-evacuated vessel containing a cathode, a grid and an anode, conductive bodies being connected to the grid and anode and forming, with the electrodes, a hollow body which on its inner surface is entirely, or almost entirely, electrically conductive, and which acts as a resonator, conductors also being provided in the valve and coupling the exciting resonator with the control resonator located between the cathode and the grid.

With the valve according to the invention, self-regulation or self-excitation is for example, possible, the corresponding control field being made opposite in direction to the main field owing to the fact that the anode projects into the control space between the grid and cathode.

The electronic valve according to the invention is suited for operation with transmission times of the electrons between the cathode and the anode which are small in relation to the duration of the periods of the excited oscillation, or with electron transmission times that are of small order of magnitude or are larger than the duration of the periods of the oscillation.

The valve according to the invention has, compared with the known valves, the advantages of small losses, particularly small radiation and leakage-losses, and, in view of the screening of all the spaces concerned with the exciting of the oscillations, of certainty and constancy of operation.

In order that the invention may be clearly understood and readily carried into practice, reference will now be made to the accompanying drawings, in which various embodiments of the invention are illustrated by way of example and in which:—

Figures 1 to 4a show, in longitudinal and transverse sections, thermionic valves having cylindrical and concentric electrodes and an exciting resonator consisting of concentric conductors.

Figures 5 to 6a show, likewise in longitudinal and transverse sections, thermionic valves having cylindrical and concentric electrodes and with an exciting resonator symmetrically located with respect to the electrodes.

Figures 7 to 8a show valves having disc-shaped resonance spaces and electrodes located symmetrically around the axis.

In the example shown in Figures 1 and 1a, the electrode system used for excitation consists of the hairpin-like cathode 1, the cylindrical grid 2 concentrically surrounding the cathode, and the cylindrical anode 3 that is concentric relative to said cathode and anode. The grid and anode are extended in one direction by concentric conductors 4 and 5 to form a resonator. The upper end of this resonator is prolonged by a concentric energy conductor. There is connected to the inner conductor of the resonator the inner conductor 4' of the energy line 4', 8, which at the upper end passes into an aerial 6. The outer conductor 5 of the resonator is galvanically connected to the outer conductor 8 of the energy line by way of the flange-like part 7, and the upper end of the outer conductor 8 is joined to a metal plate 9 perpendicular to the axis of the valve. The lower end of the anode 3 is closed practically completely by a plate 10, through which are passed, in the axis of symmetry of the valve, the heating leads which are formed outside the valve as concentric conductors 11 and 12. The tubular outer conductor 11 is passed, insulated, through the metal plate 10 connected to the anode and forms with the cylindrical extension 13 a condenser of finite magnitude. The tubular heating supply conductor 11 is furthermore surrounded by a metal cylinder 14 of about the length $\lambda/4$ that is galvanically connected to the conductor 11 at the end remote from the valve by a disc-shaped wall 15. The interior of the valve is closed vacuum-tightly by the seal 16 at the place where the conductor 11 is passed into the valve, and by the seal 17 at the end of the energy line 4', 8. The space between the concentric heating leads 11 and 12 is filled with an insulating material which also seals the interior of the valve vacuum-tightly. An insulating ring 18 is provided at the place where the resonator and the energy line merge into one another for the purpose of attaching the inner conductor 4' or 4. To enable a suitable bias to be imparted to the grid electrode a conductor 19 passing through the outer conductor 8 is connected to the conductor 4' at the point where the resonator merges into the energy line, in the potential node. This conductor 19 passes through the outer conductor 8 by way of the vacuum-tight seal 20.

The manner in which this valve functions is as follows:—

Assuming that an alternating field exists between the grid 2 and the anode 3, it is found that with the described coupling a field is set up in the control space between the anode and the

cathode, which is directed oppositely to the field set up due to penetrance. This consequently gives rise to the conditions favourable for a correct-phase controlling potential with a transmission time of the electrons between cathode and anode that is short in comparison to the duration of the oscillations. As the conductor parts between the cathode 1 and the condenser 13 are short in comparison to the wave-length, the cathode receives an alternating tension that is of like phase to the anode. The amplitude of this alternating tension is determined by the magnitude of the condenser 13. Thus, if for example there exists between the anode and the grid a field directed inwards from without, the control field between the cathode and the grid is directed outwardly from within, that is to say oppositely, and it eradicates the harmful effect of penetrance, or produces on the cathode a superficial charge of suitable magnitude that controls the space charge. In this example the length of the control space is made short in comparison to the wave-length. The energy line 4', 8 connecting with the resonator in the potential node serves to couple loosely the aerial 6 and the plate 9 acting as counterpoise.

In order to prevent leakage of oscillation energy by way of the heating leads, the two heating leads are formed outside the valve as concentric conductors which mutually form a short-circuit condenser. Further, the outer conductor 11 forms with the hollow cylinder 14 a resonator of length $\lambda/4$ that acts as a choke element.

Figures 2 and 2a show quite a similar embodiment to that of Figures 1 and 1a, with the difference that the resonator 14, 11 acting as a choke element is directly connected to the valve. The lower end of the anode cylinder 3 is provided with a flange 21, opposite which is a metal plate 22 closing the valve. The hollow cylinder 14 adjoins the metal plate 22. Advantageously the choke element is tuned to a quarter of the wave-length. The concentric heating supply leads are again arranged in the interior of this hollow cylinder. The choke element is vacuum-tightly joined to the valve by the glass seal 23. The additional coupling between the control space and the exciting space is set up by the disc-shaped conductor 24 constituting an aperiodic conductor because not tuned to resonance with the operating wave length of the tube, which on the one side is galvanically connected to the tubular heating lead 11 and on the other hand is capacitively coupled to the anode through the intermediary of the annular conductor 25. In this case also the length of the actual control space is short in comparison with the length of the resonator, so that the latter cannot additionally excite itself. In addition the cathode is attached to a tension spring 25 inside the control space. In principle the manner in which this arrangement functions is the same as described in connection with Figure 1. The metallic surface 15 at the end of cylinder 14 forms a condenser which is cooperatively related to the conductor 24.

Figures 3 and 3a show an embodiment similar to those of Figures 1 to 2a, with the difference that the control space is prolonged to a tuned control resonator so that the latter can be used as a choke element for the heating leads. The heating leads are therefore passed in the neighbourhood of occurring potential nodes through the spaces passing oscillation energy, so that the difficulties of choking the heating leads are overcome in a still more simple way in this case. In this example the anode or the outer conductor of

the exciting resonator consists of a completely closed vessel-like metal body 26 containing in its interior the intermediate conductor 27 connected to the grid electrode. The leads to the hairpin-like cathode 1 likewise consist of concentric conductors 28 and 29 which run coaxially to the other conductors in the interior of the hollow cylinder 27. The cylindrical conductor 26 is prolonged to form a conductor that forms with the inner conductor 4' of the energy line a short circuit condenser. The conductor consisting of the two conductors 29 and 30 is insulatedly held in the potential node by an insulating ring 31. In the neighbourhood of the potential node the two heating supply leads 29 and 29' also traverse the spaces passing oscillation energy. The additional coupling between the control resonator and the exciting resonator is set up by a conductor 32 advantageously provided in the valve, which is connected at its upper end to the cathode and at its lower end to the condenser plate 33. The insulator 34 serves to secure the coupling element 32, 33 or also for securing the cathode.

The manner in which this arrangement functions is quite similar to that of the previously described valves. In addition, by using a separate control resonator attached to the cathode and the grid the advantage is obtained that the coupling between the exciting resonator and the control space can be made very loose. Furthermore the influence of the additional coupling elements on the wave length produced is slight.

In the examples hereinbefore described the additional coupling of the control space to the exciting resonator has been by means of aperiodic conductors by way of the electrical alternating field.

In contrast to this, Figures 4 and 4a show an exemplary embodiment in which the control space is coupled to the exciting resonator by way of conductors of resonance length. As in the example according to Figures 3 and 3a the exciting resonator consists of a vessel-like hollow metallic body 26 and a cylindrical inner conductor 27. As in the example of Figure 3, the control resonator is wholly located within the exciting resonator and is bounded by the concentric conductors 27 and 28. The lower ends of the conductors 27, 26 and 28 are again provided with anode 3, grid 2 and cathode 1. At the upper end and in the potential node of the exciting and control resonators there is attached a coupling conductor which connects the two resonators and which is advantageously tuned to half the wavelength. The two relatively concentric portions within the inner conductor 4' are connected together at their upper ends. Thus the entire coupling channel surrounds loop-wise the hollow cylinder 35 forming the prolongation of the conductor 27. If a potential loop occurs between the anode and the lower end of the exciting resonator, and a potential node at the upper end at the place of transition into the coupling channel, a potential loop also occurs at the upper end of the loop-like coupling channel, over which loop the control resonator is coupled to the exciting resonator. A potential node again occurs at the place of transition of the coupling channel into the control resonator, and a potential loop at the lower end of the control resonator between cathode 70 and grid. Thus the alternating field which forms between the grid and the cathode is directed oppositely to that occurring in the control space owing to penetrance. The flow of electrons can thus be controlled in correct phase by this con-

control field. It is possible to adjust the correct magnitude of the control amplitude in the control space by suitably selecting the surge impedance of the exciting and control resonators or of the coupling channel.

The energy line 4', 8 by which the aerial 6 or the counterpoise 9 is coupled to the exciting resonator runs concentrically about the coupling channel that connects with the exciting resonator in the potential node. Owing to the fact that the two conducting channels for coupling the control space and for coupling the aerial to the exciting resonator connect parallel thereto in the potential node, the oscillation energy flowing away over these two channels is divided. The distribution of the oscillation energy on to the two lines is brought about by the oscillating current flowing at the upper end of the exciting resonator on the surface of the two conductors 26 and 27 passing partly capacitively between the conductors 4', 8 or 4', 35 and flowing round the lower edge of the inner conductor 4'. It is possible, by suitably selecting the surge impedances of these conductors and the connected resonators, to arrange so that the optimum alternating amplitudes occur in the control space of the control resonator, and the aerial is optimally adapted or tuned to the exciting resonator.

In addition, in this example, the free end of the grid 2 is closed by a metal cap 36, to which the hairpin cathode 1 is insulatedly attached. One end of the heating filament is joined to the cylindrical conductor 28 which merges, without any variation in cross-section, in the potential node of the control resonator, into the conductor 4'', the upper end of which is galvanically connected to the conductor 4' in the interior of the latter. The second heating lead 29 is passed insulatedly in the interior of the conductor 28 as far as the potential node of the control resonator and then, together with the lead 29', is insulatedly passed through the concentric conductors 35, 4' and 8. The glass seal 28' serves to permit the vacuum-tight entry of the heating leads 29 and 29'. The grid electrode also has a voltage lead 19 in the potential node, this lead passing through the conductors 4' and 8 and being attached to the conductor 35. The glass seal 26 closes vacuum-tightly the place where the lead 19 passes out of the valve. Thus in this case likewise, by the arrangement of the current or voltage supply leads to the grid and cathode in the potential node of the resonator, the result is obtained that a maximum leakage losses occurs, and special choke elements are rendered superfluous.

Valves of greater symmetry and fly-wheel resistance are obtained with a resonator tuned to half the wave length. The valves illustrated in Figures 1 to 4a, and in particular Figures 1 to 3a, can for example be so constructed that the exciting and control resonators are symmetrically prolonged to a perpendicular plane through the valve in the potential node. The energy line for coupling an aerial could then connect, preferably perpendicularly to the conductors bounding the exciting resonator adjacent the potential node.

Likewise very symmetrical arrangements with resonators tuned to $\lambda/2$ but having only one electrode system are illustrated in Figures 5-5a. These figures illustrate an embodiment with an aperiodic and electric coupling between exciting resonator and control space. Figures 6 and 6a

show a valve similar to that of Figures 5-5a, but with a coupling channel of resonance length.

In the examples shown in Figures 5 and 5a the electrode system consists of a filamentary cathode 1, a concentric cylindrical grid 2 and a concentric cylindrical anode 3. All the three electrodes are prolonged in both directions by cylindrical conductors to form resonators or to energy lines or short-circuit condensers of resonance length connected thereto. The anode is prolonged to form the cylindrical metallic casing 39, to the lower end of which is attached a cylindrical tube 40 of smaller diameter than the outer conductor of the resonator, this tube 40 being closed at its end. The metal tubes 41 and 41' are connected to the two ends of the grid. The tube 41' merges, without changing its cross-section, into the tubular element 42 that is likewise closed at its end, while the tube 41 is prolonged at the end of the valve by the inner conductor 4' of the energy line. Conductors 43 and 43' connecting with the cathode are located concentrically within the tubes 4', 41, 41' and 42. The cylindrical conductor 43 is prolonged upwardly by the cylindrical conductor 44, whilst the likewise cylindrical conductor 43' is prolonged downwardly by the conductor 44'. Thus two resonance spaces are formed which are only coupled together through the gaps in the grid 2. The resonance space acting as exciting resonator is bounded by the grid, anode and conductors 39, 41 and 41', and the resonance space acting as the control resonator is bounded by the cathode, grid and conductors 41, 41', 43 and 43'. The conductors 40 and 42 or 42 and 44 form short-circuit condensers, tuned to a quarter of the wave length, for the exciting and control resonators respectively, so that potential nodes of the oscillations occur at the places where the resonators merge into the short-circuit condensers. The same function is fulfilled by the conductors 4', 44 for the control resonator at the upper end. The concentric conductors 4', 8 which connect to the exciting resonator at the upper end form the energy line for coupling the aerial 6 or the counterweight 9 to the exciting resonator. The voltage supply lead 19 to the grid and the leads 29, 29' to the cathode are passed vacuum-tightly into the interior of the valve in the lower potential node of the resonators, in the same way as in the example shown in Figure 3. Also rings of insulating material are provided in the potential nodes for supporting the concentric conductors.

Similarly to the example of Figure 2, the aperiodic coupling of the control space to the exciting resonator is effected by means of short conductor parts 45 connected to the conductors 43 and 43', which pass insulatedly through the conductors 41, 4' connected to the grid and which are capacitively coupled near the anode by means of plates 46. The openings 47 through which the conductors pass must be large enough to prevent additional false coupling between the conductors 45 and 41, 41'. Instead of the short conductor parts 45 with condenser plates 46 which are used for the additional coupling, it is possible to use a symmetrical structure similarly to the example of Figure 2. The manner in which the valve functions will be clearly understood from what has gone before.

The embodiment according to Figures 6 and 6a corresponds to that of Figures 5 and 5a except that the additional coupling between the exciting resonator and the control space is set up in a different manner. In the present embodi-

ment the coupling elements 45 and 46 are dispensed with, and instead the tubular conductor 42 is left open at the lower end of the resonator and the end of the conductor 40 is in addition provided with a tube 48 which, with the end of the conductor 44', forms a short-circuit condenser. The cylindrical and tubular conductors 40, 42 and 48 form a coupling channel between the exciting resonator and the control resonator which has the same effect as the coupling channel in the example according to Figure 4. The surge impedance of this coupling channel can again be so selected that the correct amplitude of the alternating tension occurs in the control space between cathode and grid.

As the conductors used in the preceding examples for forming the resonators or coupling elements are constructed as cylindrical tubes, they can be manufactured very accurately by turning, so that the calculated surge impedances can be kept within very exact limits in constructing the valve. In addition these valve constructions are distinguished by the fact that a wire or filamentary cathode can be used. Similar advantages arise with a flat construction of the electrodes and of the conductors connected to the electrodes for forming suitable resonance spaces. Closed resonance spaces protected from radiational losses can be obtained in particular by means of disc-shaped conductors closed at the edges.

Figures 7 and 7a illustrate a valve of this kind with flat electrodes and disc-shaped resonance spaces. The constructional elements of this valve are a box-like metallic casing 49, having a preferably flat bottom 50 and top 51 and a cylindrical jacket 52, a second metallic casing 53 entirely surrounded by the casing 49 and likewise having a preferably flat bottom 54 and top 55 and a jacket 56, and a flat metal plate 57 entirely enclosed by this casing 53. The diameter of the metal plate 57 is made only slightly smaller than the internal diameter of the casing 53. At its edge this metal plate is supported away from the casing 53 by insulators 58 in such a manner that a disc-shaped space is formed between the walls 54 and 57 of large surge impedance, and a disc-shaped space between the walls 55 and 57 of small surge impedance, which spaces are in communication with one another through the gap at the edge. Similarly, the diameter of the casing 53 is made only slightly smaller than that of the casing 49. The casing 53 is also supported away from the walls of the casing 49 at the edge by insulators 59, whereby a disc-shaped resonance space of great height and great surge impedance is formed between the walls 50 and 54, and another resonance space of small height and small surge impedance is formed between the walls 51 and 55. Around the axis of symmetry the lower face of the plate 57 carries a flat cathode 60 and the wall 54 carries a grid 61. In the adjacency of the axis the wall 50 serves as an anode 62. Consequently the disc-shaped resonance space between the walls 50 and 54 forms the exciting resonator, and the disc-shaped resonance space between the wall 54 and plate 57 forms the control resonator. In the middle of the upper wall 54 of the outer casing an opening 63 is provided through which an aerial attached to the wall 55 projects to the exterior. The supply leads 65 and 66 to the grid and anode respectively pass through the outer casing and both casings respectively at the edges. As in the previous examples the passages are

closed by glass seals, so that in this case also the outer casing can be used as a vacuum vessel. The conductors 67 connected to the plate 57 and capacitively coupled to the plate 50 serve to set up the additional coupling between the control resonator and exciting resonator.

The manner in which this valve functions is quite similar to that of the examples described with reference to Figures 1, 2 and 3. A potential loop forms near the axis of symmetry in the exciting resonator, and a potential nodal line forms at the edge, owing to the fact that the plate-like energy line between the conductors 51 and 55 practically capacitively short-circuits the exciting resonator at the edge. Likewise the control resonator is short-circuited at the edge by the resonance space between 57 and 55, so that this also can only oscillate in its fundamental oscillation with a potential loop adjacent the axis of symmetry and with a nodal line of the potential at the edge. For the additional coupling, in the same way as in the preceding examples with aperiodic coupling, an alternating field is set up in the control space which is opposite in direction to the alternating field in the exciting space. In this example also the coupling of the control resonator by way of the conductor 67 can be made loose, since the control resonator has only a small damping and thus rises to high amplitudes even with a weak coupling.

Finally, Figures 8 and 8a show an embodiment similar to that of Figures 7 and 7a, but with the difference that the coupling between the exciting resonator and control space takes place over a coupling channel of resonance length. The constructional elements of this valve consist essentially of the disc-shaped metal casing 68 comprising a bottom 69 and top 70 and a jacket 80. In the interior of the casing 68 a metal plate 82 of somewhat smaller diameter than the internal diameter of the casing is supported by insulators 81. Between the plate 82 and the top 70 of the casing an insulatedly supported metal plate 83 is located, the diameter of which is approximately only half of that of the casing or the plate 82. Around the axis of symmetry the plate 83 carries a flat cathode 60 and the plate 82 carries a grid 61. Around the axis of symmetry the lower wall 69 of the casing again acts as an anode 62. The wall 70 of the casing is provided with an opening 63 through which an aerial connected to the plate 83 projects to the exterior. The voltage and heating leads 65 and 66 to the grid and cathode respectively pass at the same distance from the axis perpendicularly through the resonance spaces and, insulated, through the casing 68.

The manner in which this valve functions is as follows:

The space between the casing wall 69 and the plate 82 forms an exciting resonator which oscillates in its fundamental oscillation in such a manner that a potential loop occurs adjacent the axis of symmetry at the place where the electrodes are arranged, a nodal line occurs at the place where the insulators or leads are arranged, and a further potential loop occurs at the edge between the disc 82 and the cylindrical part 80. The correct distance of the nodal line from the axis, and thus the most favourable position of the insulators and leads can be readily determined by calculation. The disc-shaped space situated above the plate 82 of suitably smaller surge impedance is coupled over the potential loop at the edge of the disc-shaped exciting resonator. As

the two resonance spaces separated by the disc 32 have the same diameter, they have exactly the same natural frequency. The natural frequency of the space above the disc 32 is not altered even by the metal plate 33 that is introduced, but this plate divides the part of the upper resonance space between the nodal line and the potential loop in the axis of symmetry into two spaces. The interspace between the plates 32 and 33 acts as control resonator, while the upper space between 33 and 70 acts as energy line for coupling the aerial 64 to the exciting resonator. By suitably selecting the distances apart the various interconnected resonance spaces can be given such a surge impedance that optimum control amplitudes occur between cathode and grid, that is to say the aerial is optimally adapted or tuned to the exciting resonator.

The valves illustrated in Figures 7 to 8a are remarkable in particular for their high flywheel resistance and their low ohmic losses. The ohmic losses are especially very small when the surfaces bordering on the resonance spaces are made of good conducting metal and are highly polished. The advantage of low radiational losses and ease in conducting away the anode loss power is common to all the valves which are herein described.

In the embodiments illustrated in the drawings the resonance spaces have approximately the same surge impedance over their entire length. Resonators of even greater flywheel resistance can be obtained if the resonators are built up of sections of different surge impedances in such a way that the section bordering on a potential loop has a relatively small surge impedance and the section bordering on a potential node has a relatively great surge impedance. In such a resonator the losses are especially low.

The thermionic valves in accordance with the present invention are adapted for the production, amplification and reception both of meter-waves, and also of decimeter and centimeter waves. According to the anode potential which is chosen the valves can be so operated that the transmission time of the electrons in the exciting space is short or of the same order as the duration of the oscillations. With a short transmission time the requirement of correct-phase excitation of the fields in the control and exciting space is fulfilled. If the transmission time of the electrons in the exciting space is comparable with the duration of the oscillations, care must be taken that the electrons are of correct phase when entering this space. This may for example be effected by passing the electrons through a further space after they leave the control space, and only enter the exciting space after they have passed through a second grid. The valve may also be operated in what is known as a higher oscillation range, in which case the transmission time of the electrons in the exciting space is approximately an integral multiple of the duration of the oscillations, so that it is possible to work with substantially smaller anode potentials. The exact value of the most favourable transmission time is best determined experimentally.

The principle of the present invention may also be used in connection with the decimeter and centimeter range in brake-field valves having a positive grid and an anode which is only slightly positive or negative. In such cases a negative control grid bounding the control space is suitably inserted between the positive grid and the cathode. Particularly advantageous construc-

tions are obtained if a special and, in particular an aperiodic, acceleration space is provided between the control and exciting space. Furthermore, special space charge or screening grids may be embodied in the valve, especially in the case of amplifying and receiving systems.

What I claim is:—

1. A valve, comprising an anode, a vacuum container and a control electrode, a first conductor connected with said anode, a second conductor connected with said control electrode, said conductors forming a hollow body, the inner surface of which is substantially wholly electrically conductive and which surrounds an exciting resonator space, and a condenser coupling said exciting resonator space to the control space situated between said cathode and control electrode.

2. A valve comprising an anode in the form of a vacuum container, a cathode within the anode, a grid between said cathode and anode, a first conductor connected to said anode, a second conductor connected to said grid, said conductors forming a hollow body the inner surface of which is substantially wholly electrically conductive and which surrounds an exciting resonator space, conductors connected to said cathode and grid and forming a second hollow body the inner surface of which is substantially wholly electrically conductive, and condenser means coupling said exciting resonator space to the control space situated between said grid and cathode.

3. A valve, comprising an anode, a vacuum container and a control electrode, a first conductor connected with said anode, a second conductor connected with said control electrode, said conductors forming a hollow body the inner surface of which is substantially wholly electrically conductive and which surrounds an exciting resonator space a third conductor connected with said cathode, said third conductor together with the conductor connected to the control electrode and the conductor connected with the cathode forming a second hollow body, the inner surface of which is electrically conducted said second hollow body being detuned relative to the natural frequency of the exciting resonator, and condenser means coupling said exciting resonator to the control space situated between said cathode and control electrode.

4. A valve, comprising an anode, a vacuum container and a control electrode, a first conductor connected with said anode, a second conductor connected with said control electrode, said conductors forming a hollow body the inner surface of which is substantially wholly electrically conductive and which surrounds an exciting resonator space, a third conductor connected with said cathode, said third conductor together with the conductor connected to the control electrode and the conductor connected with the cathode forming a second hollow body, the inner surface of which is electrically-conducted said second hollow body being tuned relative to the natural frequency of the exciting resonator space and forming a control resonator, and condenser means coupling said exciting resonator to the control space situated between said cathode and control electrode.

5. A valve comprising an anode in the form of a vacuum container, a cathode within the anode, a grid between said cathode and anode, a first conductor connected to said anode, a sec-

ond conductor connected to said grid, said conductors forming a hollow body the inner surface of which is substantially wholly electrically conductive and which surrounds an exciting resonator space, and aperiodic conductors, including a condenser, coupling said exciting resonator space to the control space situated between said cathode and grid.

6. A valve comprising an anode in the form of a vacuum container, a cathode within the anode, a grid between said cathode and anode, a first conductor connected to said anode, a second conductor connected to said grid, said conductors forming a hollow body the inner surface of which is substantially wholly electrically conductive and which surrounds an exciting resonator space, and aperiodic conductors, comprising a condenser, coupling said exciting resonator to the control space situated between said cathode and grid, said last-named conductors being short in comparison with the wave-length of the exciting resonator.

7. A valve comprising an anode in the form of a vacuum container, a cathode within the anode, a grid between said cathode and anode, a first conductor connected to said anode, a second conductor connected to said grid, said conductors forming a hollow body the inner surface of which is substantially wholly electrically conductive and which surrounds an exciting resonator, and aperiodic conductors, including a condenser, coupling said exciting resonator to the control space situated between said cathode and grid, said last-named conductors being short in comparison with the wave-length of the exciting resonator and being coupled to the electric alternating field of said exciting resonator.

8. A valve comprising an anode in the form of a vacuum container, a cathode, a grid within the anode and arranged coaxially therewith, concentric conductors connecting with said grid and anode and forming with the latter an exciting resonator space, an aperiodic conductor, including a condenser, coupling said anode to said cathode, supply leads connecting to said cathode, and a choke element on said supply leads, the conductors defining the said exciting resonator forming a hollow body the inner surface of which is substantially wholly electrically conductive.

9. A valve comprising an anode in the form of a vacuum container, a cathode, a grid within the anode and arranged coaxially therewith, concentric conductors connecting with said grid and anode and forming with the latter an exciting resonator space, an aperiodic conductor, including a condenser, coupling said anode to said cathode, supply leads connecting to said cathode, and a choke element on said supply leads, the conductors defining the said exciting

resonator forming a hollow body the inner surface of which is substantially wholly electrically conductive, and a concentric high frequency line of relatively low surge impedance connecting to said exciting resonator in the potential node.

10. A valve comprising an anode in the form of a vacuum container, a cathode, a grid within the anode and arranged coaxially therewith, concentric conductors connecting with said grid and anode and forming with the latter an exciting resonator space, an aperiodic conductor, including condenser means, coupling said anode to said cathode, supply leads connecting to said cathode, and a choke element on said supply leads, the conductors defining the said exciting resonator forming a hollow body the inner surface of which is substantially wholly electrically conductive, said choke element comprising an outer conductor and an inner conductor, the outer conductor being capacitively connected to said anode and the inner conductor being galvanically connected to a cathode supply lead.

11. A valve comprising an anode in the form of a vacuum container, an inner, an intermediate and an outer conductor, said conductors being arranged concentrically with said anode a cathode at the end of said inner conductor, a grid at the corresponding end of said intermediate conductor, and the anode at the corresponding end of said outer conductor, a conductor closing the open end of said anode, said grid, anode, outer and intermediate conductors defining an exciting resonator space, and said cathode, grid, intermediate and inner conductors defining a control resonator space, and a conductor galvanically connected to said cathode and coupled to the anode by means of a condenser.

12. A valve comprising an anode in the form of a vacuum container, an inner, an intermediate and an outer conductor, said conductors being arranged concentrically with said anode a cathode at the end of said inner conductor, a grid at the corresponding end of said intermediate conductor, and the anode at the corresponding end of said outer conductor, a conductor closing the open end of said anode, a concentric high-frequency energy line of relatively low surge impedance connecting to the outer and intermediate conductors at the ends remote from the electrodes, said grid, anode, outer and intermediate conductors defining an exciting resonator space, and said cathode, grid, intermediate and inner conductors defining a control resonator space, and a conductor, short in comparison to the wave-length, galvanically connected to said cathode and coupled to said anode in the neighbourhood of the anode by means of a condenser.

WALTER DÄLLENBACH.