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[54] STABILIZED POWER SUPPLY
7 Claims, 5 Drawing Figs.

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315/230, 317/255, 328/227

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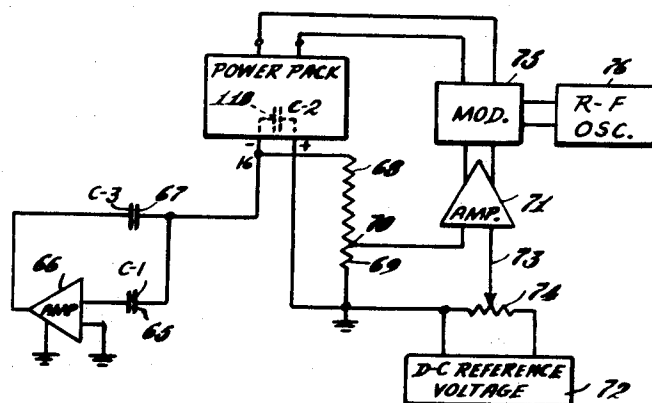
[50] **Field of Search**..... 323/93, 66;
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340/200; 321/8, 18

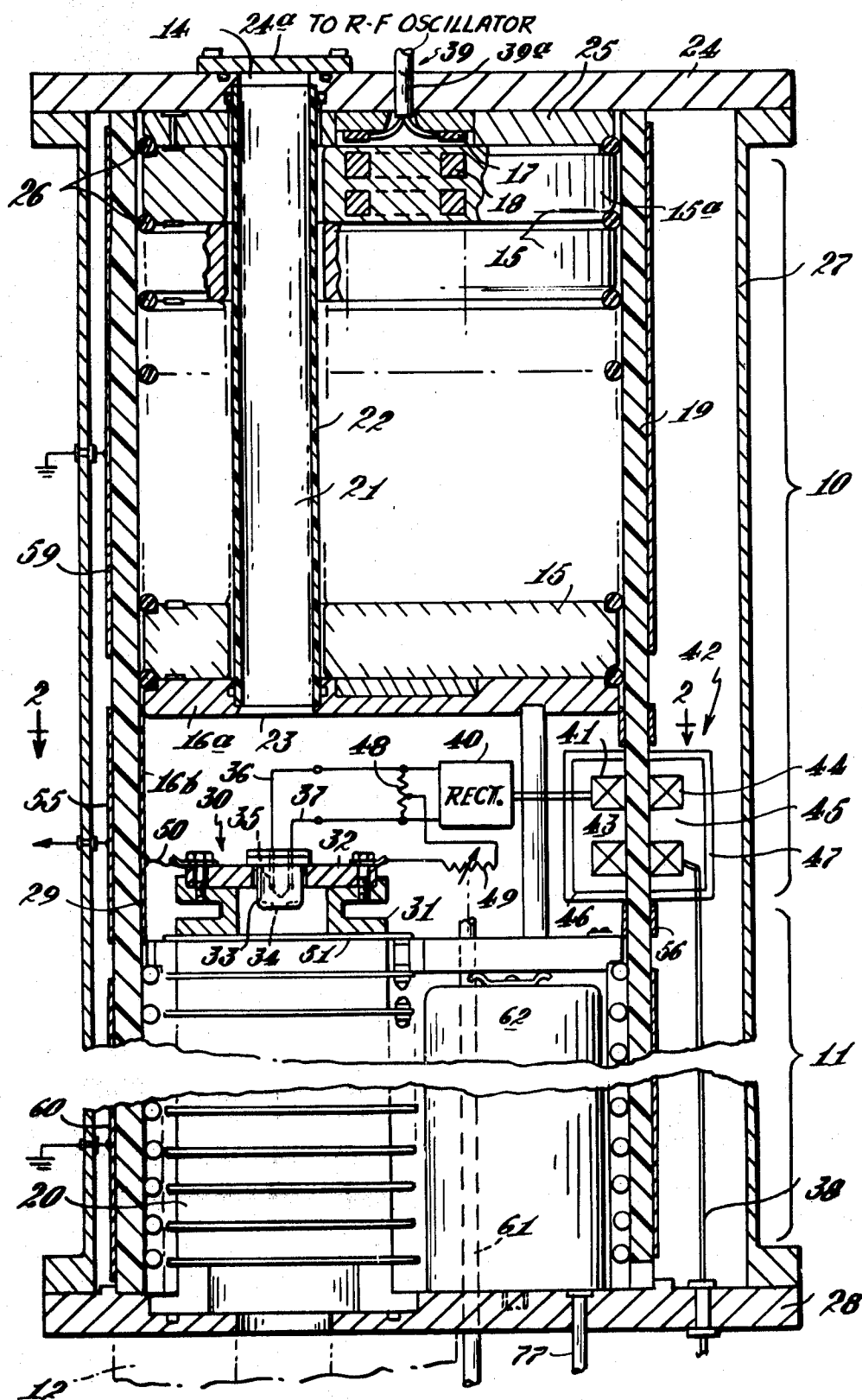
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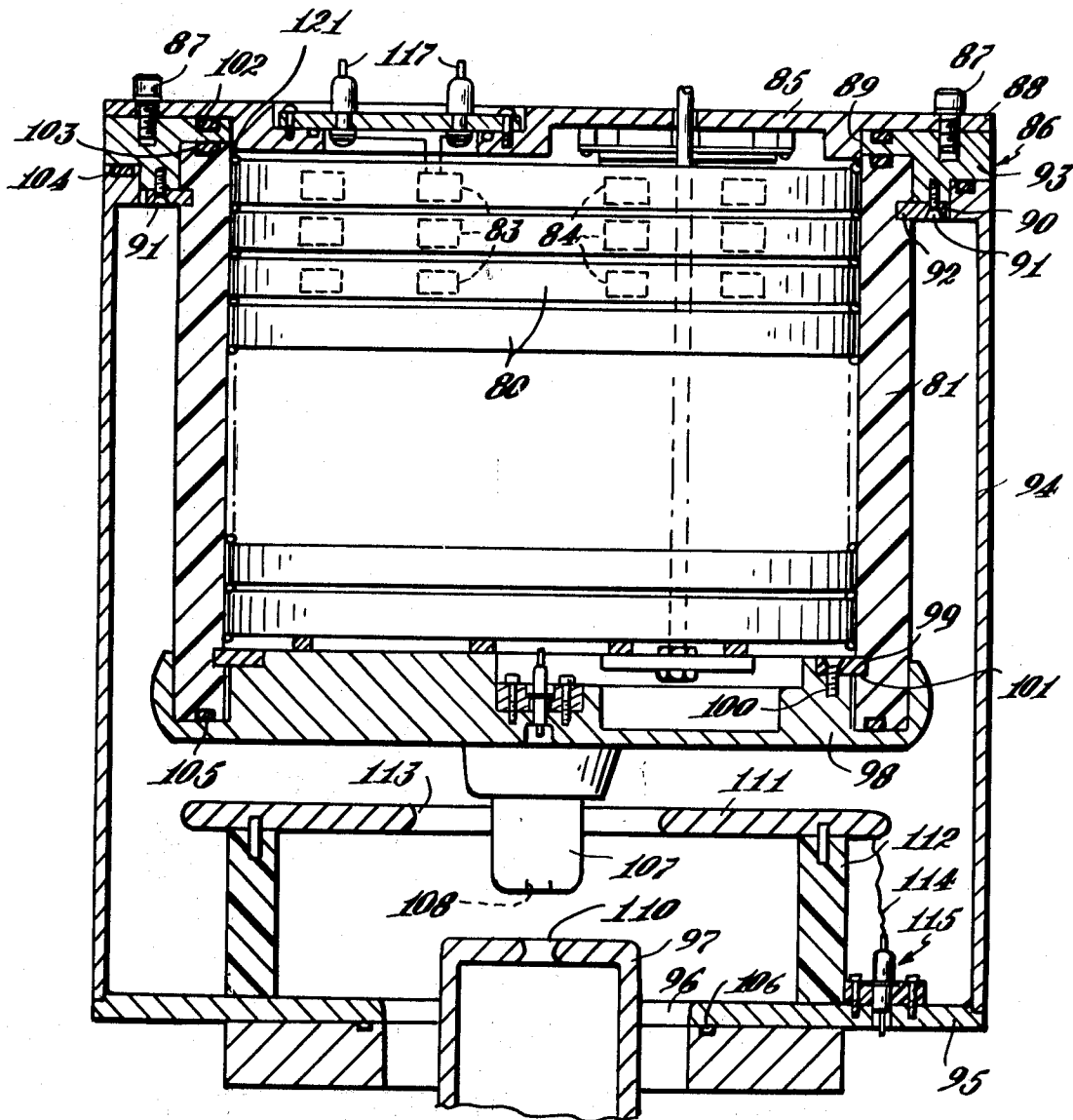
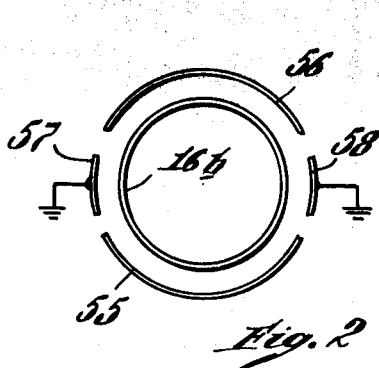
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ABSTRACT: A high voltage power supply for providing highly stabilized voltages of several hundred kilovolts or more which can be applied between the filament assembly and the grounded anode of the gun for an electron microscope, for example, and made as an integral unit with the microscope structure. A plurality of stacked power deck units are mounted within an insulative tube which may also enclose the filament assembly and an accelerator tube if one is used. A coupling capacitor for feeding the output voltage to a regulator system is fashioned as an integral part of the overall structure and arranged so as to couple solely to the output voltage terminal in order to provide accurate corrections of rapid fluctuations of the output voltage. Provision is also made for the regulation of slower fluctuations, such as slow voltage drifts.







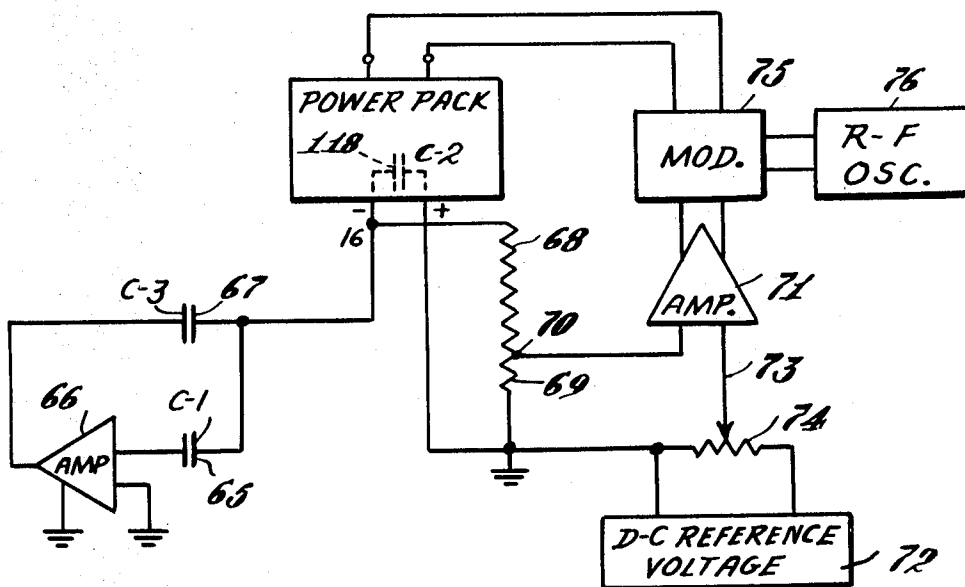


Fig. 4

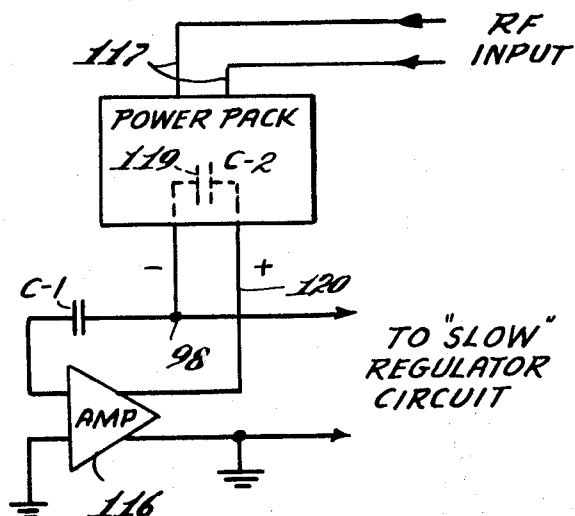


Fig. 5

STABILIZED POWER SUPPLY

This invention relates generally to high voltage power supplies and, more particularly, to structures for providing highly stabilized DC voltages, particularly having values in the order of several hundred thousand volts and even up to ranges of 1,000,000 volts or higher.

In many applications using such relatively high voltage power supplies, fluctuations of the output voltage must be kept to minimum levels. In supplying the high voltage for an electron gun which is used, for example, in producing an electron beam for an electron microscope, undue fluctuations of the supply voltage will not permit proper operation of the overall device.

Further, high voltage power supplies used in such applications have normally been fabricated as separate units requiring one or more interconnecting cables or transmission lines between the supply itself and the filament assembly of the electron gun system. Power supplies of the conventional Van de Graaff type or of the insulating core transformer type have not been found readily adaptable to the fabrication of an integrally packaged system in which the desired voltage stabilization is easily achieved.

Some SOME power supplies have been successfully used in integrally formed packages to provide high voltages in the order of magnitudes discussed above. Such supplies can be found, for example, in electron processing operations in which certain materials are bombarded by high-intensity electron beams. In such applications, however, stabilization of the voltages involved is relatively unimportant and little or no effort has been made to reduce the high voltage output fluctuations which result.

This invention, however, provides a high voltage power supply which can be integrally fabricated with the device to which the voltage is to be applied so that separate interconnecting cables, or other transmission line devices, are not required, the structure of such power supply also being suitably arranged to provide a high degree of stabilization of the output voltage. While the power supply of the invention is described below as used in particular embodiments for supplying high voltages to an electron gun of an electron microscope system, it is clear that such power supplies may have many other uses and can be readily adapted for other applications.

In accordance with the invention, the rapid fluctuations of output voltage which may occur in such power supplies are effectively cancelled by using a capacitor sensing means appropriately arranged in the power supply package which capacitor senses such fluctuations and applies them to a suitable amplifier which may be externally mounted and the output of which is then fed back either in series with, or by capacitive coupling to the high voltage terminal, in parallel with the power supply in such a way as to cancel the original fluctuations. Accordingly, it is necessary that the sensing capacitor maintain a stable capacitance value in the face of mechanical vibrations of the system and environmental temperature changes thereof. Such a rapid stabilization system, sometimes hereinafter referred to as the "fast feedback" correction system, formerly has not been possible in previously used integrally packaged configurations because of the great difficulty in providing a suitable capacitor sensing means which couples solely to the high voltage output terminal without simultaneously being subjected to undesirable coupling to other points in the power supply which latter coupling produces spurious signals tending to degrade the fluctuation cancellation process. The configuration of this invention avoids such difficulties while providing highly efficient rapid stabilization.

The power supply of the invention can also be provided with means to eliminate relatively slow fluctuations, such as drifts of the output voltage. Such means, sometimes hereinafter referred to as a "slow feedback" correction system, is effectively separate from the fast feedback correction system discussed above and can be used in addition thereto to further enhance the overall stability of the power supply.

The structure and operation of the invention for providing a compact and highly stabilized power supply package which

corrects for both rapid and less rapid fluctuations of the voltage output is described more easily with the assistance of the accompanying drawings wherein:

FIG. 1 shows a longitudinal view in cross section of one particular embodiment of the power supply of the invention;

FIG. 2 shows a diagrammatic plan view along lines 2—2 of FIG. 1 showing certain capacitor elements formed therein;

FIG. 3 shows a longitudinal view in cross section of an alternative embodiment of the power supply of the invention;

FIG. 4 shows a circuit diagram showing means for providing corrections of both rapid and slow output voltage fluctuations, which circuit can be used with either of the embodiments of the invention shown in FIGS. 1 or 3; and

FIG. 5 shows an alternative embodiment of the circuit diagram of FIG. 4 which circuit also can be used with either of the embodiments of the invention shown in FIGS. 1 or 3.

FIG. 1 depicts a power supply apparatus in accordance with the invention which apparatus includes an upper portion 10 housing the power supply and an electron gun assembly for producing a beam of charged particles and a center portion 11 housing an acceleration tube for accelerating such beam of charged particles. A lower portion 12, only the top of which is shown in phantom, houses an electron microscope device, the structure and operation of which is known to those in the art and, therefore, is not described in further detail. In upper portion 10, the power supply comprises a plurality of stacked power deck units 15 each of which produces a DC voltage, the voltages from all of such decks being added in series to produce the overall output voltage at a terminal 16.

Although not limited thereto, one form in which such power deck units can be constructed is shown in my previously filed application, Ser. No. 850,051, filed Aug. 14, 1969, which application depicts a plurality of power decks which are formed as cascaded units containing secondary and primary coils using magnetic or nonmagnetic cores which coils are capacitively coupled under appropriate resonant conditions. Appropriate rectifier circuitry is connected thereto to produce a rectified voltage from each such unit, such rectified voltages being suitably added in series to produce a high DC voltage output. An input primary coil unit, such as coil unit 17 (shown in FIG. 1), is coupled to the secondary coil 18 of the uppermost cascaded unit 15a and is in turn fed from an appropriate external RF oscillator voltage source (not shown in the figure) via cable 39 through an appropriate gastight feed through insulator 39a in a cover member 24.

The structure and operation of such power deck units is more completely described in my previous application, incorporated herein by reference, and, thus, is not described in further detail here. The use of the particular units described therein, while preferred in some applications, is not necessary, however, to the use of this invention. Any suitable power pack, subdivided as here or not, which produces a high DC voltage output may be utilized in the upper portion 10 in accordance with the invention and the type described in my previously filed application is deemed to be exemplary only.

In using such a power supply for providing a voltage of 300 kv., for example, each power deck can be suitably arranged to produce a voltage of approximately 37.5 kv. and eight of such decks can be utilized to produce the overall DC output voltage required.

The power decks, of whatever type may be used, are enclosed in an appropriate insulator tube 19 which extends along the length of such decks and further downward to the lower end of accelerator tube 20. A tubular opening 21 is provided through power deck units 15 to provide access to an electron gun filament assembly, for example, as explained in more detail below. Opening 21 is formed by an insulator tube 22 which extends from an access opening 14 in cover 24 of the apparatus to a lower opening 23 just below the power deck assembly in upper portion 10. An additional cover member 24a may be used to cover opening 14 when in use. Insulator tubes 19 and 22 are made of suitable nonconducting materials which may be, for example, acrylic or appropriate epoxy resin

materials. An elastic cushion 25, in which primary coil 17 is insulatively enclosed, is positioned at the upper end of the power deck units and provides the pressure to firmly hold the power deck units in place at their upper end. A plurality of equipotential ring elements 26 are mounted between each deck unit 15 and between the first deck unit 15a and the elastic cushion 25, the latter equipotential ring being at ground potential. The remaining equipotential rings are at progressively higher potentials as is conventional in high voltage power supplies of this general type. The cover member 24 covers the top of the overall apparatus and is appropriately attached to a metallic case 27 which encloses both the power supply and accelerator tube portions of the apparatus, case 27 being suitably attached at its lower end to a lower metallic cover member 28.

The high voltage output terminal 16 is formed from a lower metal plate 16a in contact with the output terminal of the lowest power deck unit and from a band 16b of conductive coating material positioned around the inner surface 29 of insulator tube 19, such band extending longitudinally from a point just below power decks 15 in contact with terminal plate 16a to a point just above accelerator tube 20. An electron gun assembly 30 is mounted between accelerator tube 20 and power decks 15, below and in line with tubular opening 23 and with opening 51 of accelerator tube 20. The electron gun assembly includes a base member 31 mounted at the top of accelerator tube 20 and a plate 32 on which a filament cup 33 is mounted, filament cup 33 having an opening 34 through which electrons from a filament element 35 are directed toward accelerator tube 20. Filament 35 is connected via leads 36 and 37 extending from the top of filament cup 33 to a rectifier circuit 40 which can be appropriately mounted and is shown diagrammatically in the figure.

The input leads of rectifier 40 are connected to the secondary coil 41 of a filament transformer 42 mounted at the wall of insulator tube 19. Secondary coil 41 is wound on a ferrite core 43, such core being suitably affixed to the inner wall of tube 19. The primary coil 44 of filament transformer 42 is wound upon a ferrite core 45 suitably affixed to the external wall of insulator tube 19, ferrite cores 43 and 45 being shielded by aluminum cases 46 and 47, respectively, each of which is suitably affixed to tube 19. Primary coil 44 is appropriately connected to a source of RF energy oscillations (not shown in this figure) via leads 38. A fixed resistor 48 connected across the output leads of rectifier 40 has its midpoint connected to one end of a variable resistor 49, the other end of which is connected to mounting plate 32 and, hence, to filament cup 33. Filament cup 33 is connected to terminal 16 via an appropriate lead 50 to connect mounting plate 32 to terminal 16.

The accelerator tube 20 is of conventional construction and is suitably mounted directly below electron gun assembly 30 so that the opening 51 therethrough is aligned with the opening 34 of such assembly. During operation electrons emitted from filament 35 are directed through the opening 34 of filament cup 33, which cup is maintained at the output potential of the high voltage power supply, and, thence, through accelerator tube 20 so that such accelerated electron beams can then be appropriately utilized in the electron microscope in a manner well known to those in the art. In order to provide for correct operation in such an application, it is necessary that the value of the high voltage at terminal 16 and, hence, at filament cup 33 be maintained constant with substantially little or no rapid or slow variations thereof.

In order to prevent rapid fluctuations, it is desirable to use an appropriate circuit of the type shown in FIG. 4, for example. In such figure a sensing, or pickup, capacitor 65, identified as C-1, is directly coupled to high voltage terminal 16 and thereby causes rapid fluctuations of the voltage at such terminal to be coupled to the input of an externally located amplifier 66. The output of amplifier 66 is thereupon fed to a feedback, or driver, capacitor 67, identified as C-3, which is in turn coupled directly back to high voltage terminal 16 so

that such rapid variations, which are phase inverted at amplifier 66, cancel the rapid fluctuations originating from the high voltage supply at such terminal.

Capacitor elements 65 and 67 are appropriately formed in the structure of FIG. 1 as follows. One plate of each capacitor comprises an appropriate portion of the conductive coating band which forms terminal portion 16b. Such band effectively extending completely around the inner surface of insulator tube 19, except for that portion of the tube at which the secondary assembly of transformer 42 is mounted. The other plate of capacitor 65 is formed by a first conductive coating segment 55 which extends partially around the outer surface of insulator tube 19 opposite a corresponding portion of inner conductive coating 16b, as shown most clearly with reference to FIG. 2. The other plate of capacitor 67 is similarly formed by a second conductive coating segment 56 which also extends partially around the outer surface of insulator tube 19 adjacent segment 55, except for that portion of the tube at which the primary assembly of transformer 42 is mounted, and, thus, opposite a corresponding portion of inner conductive coating 16b. In each case the corresponding portions of tube 19 between such coatings form the dielectric material between the plates of each of capacitors 65 and 67.

A pair of relatively short conductive coating segments 57 and 58 (shown in FIG. 2) are spaced between adjacent ends of segments 55 and 56, segments 57 and 58 being each in turn connected to ground potential in order to provide a pair of capacitances formed by segments 55 and 56 and correspondingly oppositely disposed segments of interior coating 16b effectively to shield conductive exterior coating segments 55 and 56 and hence capacitors 65 and 67, from each other. The remaining portions of the outer surface of insulator tube 19 extending longitudinally above and below capacitors 65 and 67 are also covered with conductive coatings 59 and 60, respectively, each of which is appropriately connected to ground potential as shown schematically in FIG. 1. It can further be seen that in the particular embodiment shown in FIG. 1 insulator tube 19 provides the only radial insulation for the power supply deck units, a progressively increasing voltage potential difference existing across the inner and outer surfaces of tube 19 in the longitudinal direction from cover member 24 to terminal plate 16a.

The value of resistor 49 in the filament assembly can be effectively varied by the use of a rod 61 extending through the lower section 11 of the apparatus, one end of said rod being thereby accessible externally to the apparatus and the other end being mechanically linked in a manner well known to those in the art with the movable wiper arm of resistor 49 in a well-known manner.

A housing structure 62 is used to house the resistors used in the regulator circuitry which corrects for "slow" fluctuations in the voltage at terminal 16, as explained more fully below, which circuitry is used in addition to the voltage regulation provided by the fast feedback circuit of FIG. 4. Such voltage regulation circuit is shown in FIG. 4 and, thus is also included in the structure of the invention to correct for relatively slow fluctuations of the output voltage. In such case a plurality of series resistors identified diagrammatically in FIG. 4 as overall resistor arrangement 68 is connected from high voltage terminal 16 to ground potential. A portion of the voltage across resistance 68 is monitored as, for example, across a resistor portion 69 of resistance 68 between the high voltage terminal 16 and a selected voltage point 70. In the embodiment shown the ratio of the resistance across resistor portion 69 to the total resistance 68 from the high voltage terminal to ground is set at approximately 1 to 30,000.

The voltage across resistor portion 69 is fed to the input of an externally located amplifier 71, via a suitable cable 77, which amplifier is also fed from a DC reference voltage source 72 via the variable center tap 73 of a variable resistance 74. Reference voltage source 72 is a conventional source of low DC voltage in the order of magnitude of 10 volts, for example.

The output of amplifier 71 thereby provides a correction signal which is fed to a modulator 75 which is used to provide a modulating voltage for RF oscillator source 76 used to drive the primary deck coil 17 of the cascade power supply configuration. If the high voltage output at terminal 16 varies in what may be termed a long term fashion, such as by a slow drifting or other relatively slow variation, an appropriate correction in the RF input signal fed to the input of the power deck units is accordingly made so as to compensate for such slow fluctuation.

The interior of case 27 is suitably filled with an appropriate insulating gas, such as Freon or sulfur hexafluoride, and he external amplifier, reference source, oscillator source, and modulator, as well as their associated power supplies can be each externally rack mounted for use with the apparatus.

An alternative embodiment of the invention may also be used for providing a high voltage in applications which do not require the use of an accelerator tube. Such voltage may be in the order of magnitude, for example, of 100 kv. to 200 kv. and may be used for the same purpose as discussed above, i.e., for supplying voltage to an electron gun of an electron microscope. In such an alternate configuration the radial insulation at the power units is arranged so as to be provided, not by the insulator tube which encloses the stacked power deck units, but rather by a vacuum system within which such tube, deck units, and filament assembly are placed, as discussed more fully below. Such a construction is shown in FIG. 3 wherein a plurality of power deck units 80 are enclosed within an insulator tube 81 which is essentially cylindrical in shape. Tube 81 houses a first plurality of DC power deck elements 83 for supplying the high voltage DC output and a second plurality of AC power deck elements 84 for supplying AC filament power as discussed in more detail below. The power deck coil elements, and other resistor and capacitor elements needed to complete the power deck circuitry can be encased in epoxy or other suitable plastic material and such deck units, each including such power deck elements, can be stacked one on the other as shown and discussed in more detail in my previously mentioned application. The insulator tube 81 also is used to house a resistor assembly which comprises the resistance element required for correction of slow variations in the output voltage, also as discussed in more detail below. Such resistance element can be separately encased in epoxy in a manner such as shown by housing structure 62 in FIG. 1, which structure may be located in a cylindrical cavity formed by holes (not shown in FIG. 3) suitably placed in deck units 80. The DC power deck units 83 can be essentially of the same type discussed above with reference to the configuration of FIG. 1 and their structure, therefore, is not shown in any further detail herein. In a preferred embodiment, for example, each deck unit can be arranged to supply 40 kv., such units being connected in series to produce an overall output voltage of 200 kv., for example. The AC filament power unit is formed from appropriately coupled coil elements in a known manner and are not shown in further detail.

A metallic cover 85 is attached to a first ring member 86 via a plurality of screw elements 87 inserted through an outer flange portion 88 of cover 85 into the main body of ring member 86. An inner flange portion 89 of ring member 86 rests on the upper surface of insulator tube 81 as shown. A flat split ring member 90 is attached to the bottom portion of ring member 86 via a plurality of screw elements 91, ring member 90 being adapted to fit into a matching slot, or notch, 92 at the exterior surface of the upper portion of tube 81. An outer flange portion 93 of ring member 86 buttresses against the upper portion of a metallic case 94 which encloses the power deck units 80, the insulator tube 81 and the filament assembly described in more detail below. A metallic bottom plate 95 is welded to the lower end of case 94, plate 95 having a substantially centrally located opening 96 in which an anode element 97 is mounted, as described in more detail below.

A lower terminal plate 98 which may be fabricated of aluminum, for example, is attached to the lower end of insulator

tube 81 via an arrangement similar to that utilized with reference to the cover at the upper end of such tube. Thus, a flat split ring member 99 is attached to terminal plate 98 via a plurality of screw elements 100, said ring member being adapted to fit into a matching slot, or notch, 101 at the interior surface of the lower portion of tube 81. Appropriate O-rings 102, 103, 104, 105 and 106 are used as shown so as to maintain a vacuum in the interior regions of case 94 and an insulating gas in the interior region of tube 81, as discussed more fully below.

The filament assembly for the structural embodiment shown in FIG. 3 comprises an aluminum filament cup 107 which is fixedly attached to terminal plate 98 and has an appropriate opening 108 at the lower end thereof in a manner substantially similar to that discussed with reference to the filament cup assembly shown in the embodiment of FIG. 1. The remainder of the filament assembly is also effectively the same as that previously shown and includes a suitable filament element, a rectifier, a center-tapped resistor and a variable resistor together with associated leads to furnish power to the filament. The appropriate connections needed for that purpose and for connection to the lowest AC power deck unit can be made through a terminal board mounted below terminal plate 98 as shown.

Anode element 97 is appropriately mounted below the filament assembly by being suitably attached to the upper portion of the electron microscope section. Anode element 97 has an appropriate opening 110 through which the electron beam furnished from the filament passes so that it is accelerated accordingly toward the electron microscope mounted therebelow for use therein.

The structure of the apparatus of FIG. 3 is in contrast to that discussed with reference to that shown in FIG. 1 in that no accelerator tube is required. For the voltage operating levels desired in this a particular embodiment (i.e., in order of magnitude of 100 to 200 kilovolts), further acceleration of the electron beam via an accelerator tube is not necessary and a single anode element appropriately mounted with reference to the filament assembly and operating at a suitably selected potential with reference thereto provides sufficient acceleration capability for the purpose desired in many applications. The correct voltage relation may be obtained, for example, by adapting the DC power deck stack to provide a negative voltage (i.e., -100 kv. to -200 kv.) and adapting the anode for connection to ground potential.

The capacitor sensing means required to couple the DC output voltage from the power deck supply to an external circuit for regulating rapid voltage fluctuations (i.e., the capacitance effectively corresponding to capacitor means 65 of FIG. 1), must be arranged so as to be effectively coupled solely to the output voltage at terminal plate 98 so that coupling to other voltage points is substantially negligible. In the embodiment of FIG. 3, one plate of such capacitor is formed by the terminal plate 98, itself, as attached at the lower end of insulator tube 81, and the other plate thereof is formed by a pickup electrode ring 111 positioned in the region between terminal plate 98 and the lower cover plate 95 of metallic outer case 94, such ring being mounted on a plurality of appropriate insulator stand-offs 112 attached to lower cover plate 95. Pickup electrode 111 has a centrally located opening 113 appropriately arranged so that aluminum filament cup 107 extends downwardly therethrough, as shown. The interior of metallic case 94 is appropriately evacuated so that the evacuated region between terminal plate 98 and pickup electrode ring 111 acts as an effective dielectric, thereby forming the overall capacitor. Electrode ring 111 is then appropriately connected via lead 114 to a conventional output coaxial terminal 115 which is in turn adapted for connection to appropriate external circuit elements.

Since the interior region of case 94 is appropriately evacuated, a suitable vacuum insulation is thereby formed for the complete power supply unit. Thus, unlike the structure of FIG. 1, radial insulation is achieved in the embodiment of FIG. 3 by

such evacuated space rather than by the use of the insulative characteristics of tube 81.

Since the voltage at terminal 98 will tend to have both rapid and relatively slow fluctuations, suitable corrections of the type discussed above with reference to the embodiment of FIG. 1 are required for the power supply of FIG. 3. A circuit for this purpose is shown in FIG. 5 which includes a capacitor, again represented as C-1, which capacitor in this case is formed by pickup electrode 111 and terminal 98. The rapid fluctuations of the output voltage at terminal 98, as coupled by such capacitor, are fed to an external amplifier 116. The phase-inverted output of amplifier 116 is fed back directly to the positive terminal 120 of the rectifier. For clarity, such terminal is not specifically shown in FIG. 3 but it is made available in a manner similar to that shown with reference to terminals 117 and connected to the positive terminal of the uppermost deck 80 and makes contact with equipotential ring 121. In such a configuration the need for a capacitor element C-3, which was utilized, for example, in the regulator circuitry of FIG. 4 and shown in FIG. 1, is eliminated and the output of the amplifier 116, rather than being fed back to the high voltage output terminal to cancel rapid fluctuations at that point, is instead connected in series with the power supply to introduce the cancelling fluctuations in this manner. Correction for slow fluctuations can be made in the same manner as shown and discussed with reference to FIG. 4.

In the configurations of FIG. 1 or of FIG. 3, it may be appropriate to apply the feedback voltage in series with the power supply (as in FIG. 5) or in parallel (as in FIG. 4) depending on the inherent effective internal capacitance of the overall DC power deck stack itself. Thus, in FIG. 4, such internal capacitance is diagrammatically represented by the dashed line capacitor 118, identified as C-2 and in FIG. 5 by dashed line capacitor 119, as shown. If the internal capacitance C-2 is relatively large compared to the capacitance value of C-1 (sometimes referred to as a "hard" power supply), it is generally preferable to utilize the configuration of FIG. 5 wherein the output of the feedback amplifier is applied in series, rather than in parallel, with capacitor C-3 being omitted. If, on the other hand, the internal capacitance C-2 is relatively small compared to that of C-1 (sometimes referred to as a "soft" power supply), it is generally preferable to utilize the configuration of FIG. 4 in which the output of the amplifier is applied through capacitor C-3 to the output terminal of the stacked DC power deck units.

What is claimed is:

1. A voltage regulation system comprising, in combination, power supply means for producing a DC output voltage; insulator means within which said power supply means is mounted; terminal means supported so as to be connected to said DC output voltage; a capacitance means having a first plate formed by at least a portion of said terminal means; conducting electrode means mounted adjacent said first plate and forming a second plate of said capacitance means, said first and second plates being positioned so that said conducting electrode means directly senses voltage changes at said terminal means; circuit means mounted external to said power supply means; and means for connecting said capacitance means to said exter-

nal circuit means, said capacitance means being adapted for use with said circuit means to regulate the value of said DC output voltage.

2. A voltage regulation system in accordance with claim 1 and further including a case substantially enclosing said insulator means, said terminal means being supported with said case and said circuit means being mounted external to said case.
3. A voltage regulation system in accordance with claim 1 wherein said power supply means includes a plurality of stacked power decks the outputs of which are serially connected to produce said DC output voltage; said insulator means comprises a tubular structure extending from a region at one end of said stacked power decks to a region beyond the other end thereof; said first plate of said capacitance means comprises a first inner conductive coating portion placed on the inner surface of said insulator means; and said second plate of said capacitance means comprises a first outer conductive coating placed on a corresponding first portion of the outer surface of said insulator means opposite said first inner conductive coating portion.
4. A voltage regulation system in accordance with claim 3 and further including a second capacitance means comprising a first plate formed from a second inner conductive coating portion placed on said inner surface of said insulator means; and a second plate formed by a second outer conductive coating placed on a corresponding second portion of the outer surface of said insulator means opposite said second inner conductive coating portion; and means for connecting said second capacitance means to said external circuit means.
5. A voltage regulation system in accordance with claim 4 wherein said external circuit comprises a feedback amplifier having its input connected to said first capacitance means whereby substantially rapid fluctuations of said DC output voltage are supplied to the input of said feedback amplifier to produce an output feedback signal representative of said rapid fluctuations and out of phase therewith; and means for connecting said output feedback signal to said second capacitance means whereby said out of phase fluctuations are caused to cancel said input fluctuations so as to substantially eliminate said rapid fluctuations of said DC output voltage.
6. A voltage regulation system in accordance with claim 4 and further including a first grounded conductive coating placed on a third portion of the outer surface of said insulator means above said first and second outer conductive coatings; and a second grounded conductive coating placed on a fourth portion of the outer surface of said insulator means below said first and second outer conductive coatings.
7. A voltage regulation system in accordance with claim 1 wherein said terminal means comprises a terminal plate mounted at the lower end of said insulator means; and said metallic means comprises a metal ring electrode insulatively mounted to said case at a position adjacent said terminal plate.