March 12, 1957 J. A. KONKEL ET AL 2,785,336

REGULATED HIGH VOLTAGE SUPPLIES

Filed June 9, 1954

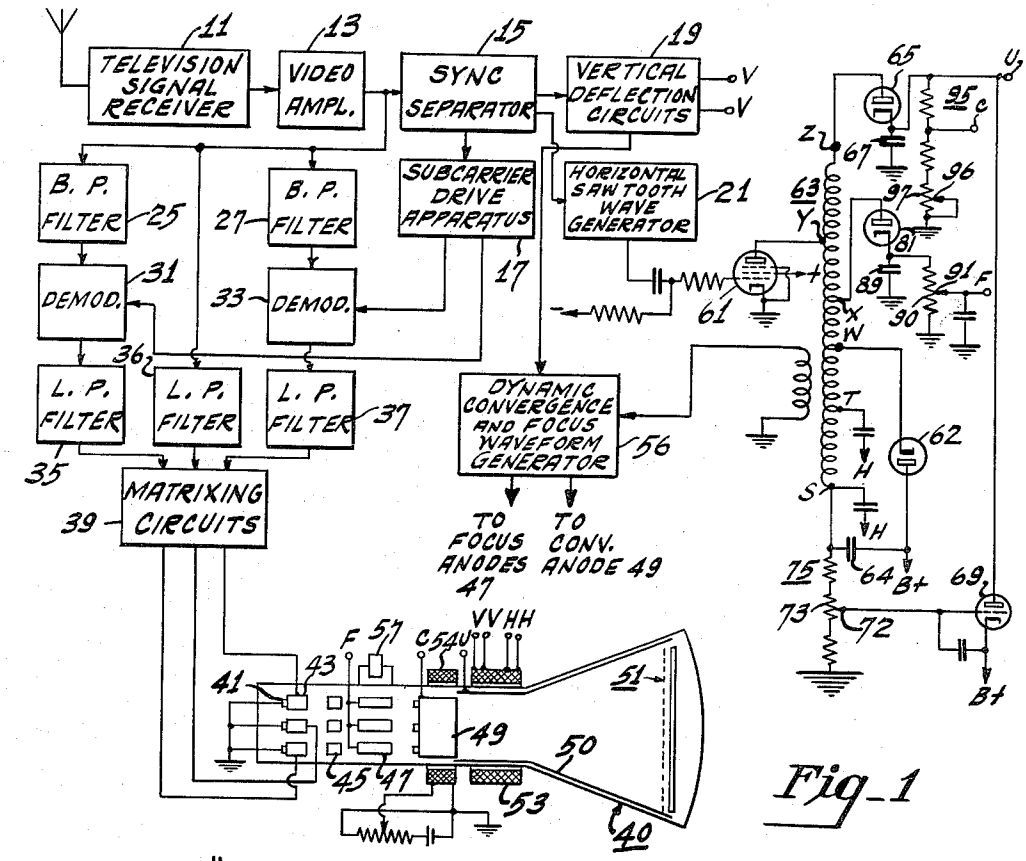



Fig_1

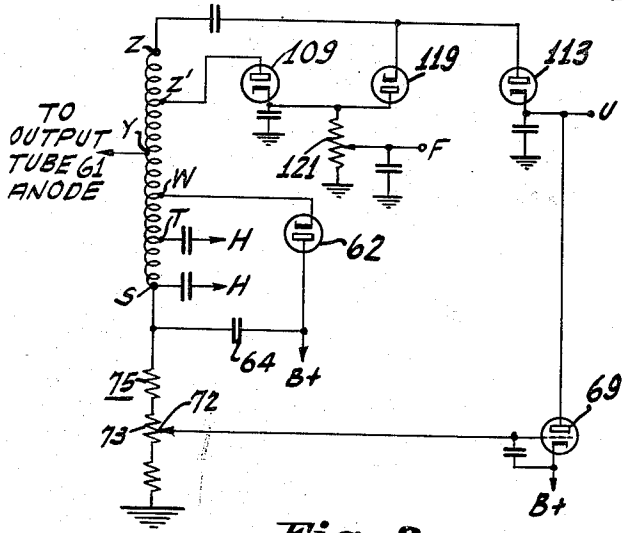



Fig_2

INVENTORS
JOHN A. KONKEL AND
JOHN STARK, JR.

BY Otis V. Mitchell
ATTORNEY

United States Patent Office 2,785,336
Patented Mar. 12, 1957



2,785,336

# REGULATED HIGH VOLTAGE SUPPLIES

John A. Konkel and John Stark, Jr., Woodbury, N. J., assignors to Radio Corporation of America, a corporation of Delaware

Application June 9, 1954, Serial No. 435,472

6 Claims. (Cl. 315—15)

This invention relates generally to regulated voltage supplies and more particularly to improvements in regulated voltage supplies of the type suitable for use in satisfying the high voltage requirements of a cathode ray tube.

It has become more or less a general practice in the monochrome television art to obtain the high voltage required for the final accelerating electrode of a receiver's kinescope (and the voltage for the focus electrode, where electrostatic focusing is employed) from a pulse type supply. In such pulse type supplies, the high voltages are usually developed through rectification of the high amplitude transient "flyback" voltage pulses appearing in the receiver's horizontal output transformer during retrace periods of the line scanning cycle, when cutoff of the horizontal output tube causes a sudden collapse of a magnetic field in the horizontal deflection yoke. In color television receivers employing color kinescopes of the types presently contemplated, the high voltage requirements are generally of greater magnitude, more critical as to regulation, and over all present a significantly more complex problem than do the monochrome kinescope high voltage requirements. It has been proposed to utilize a voltage regulator tube shunting the high voltage output of the supply applied to the kinescope's ultor electrode to insure the desired stability of the supplied voltages. A control voltage for such a regulator tube has usually been derived from a high voltage bleeder, also shunting the ultor voltage output of the supply. Such a high voltage bleeder is generally necessary, where the color kinescope employs electrostatic beam convergence apparatus, to provide a tapping point for the derivation of the required static D.-C. convergence voltage. However, where the electromagnetic type of beam convergence apparatus is employed, there is no need to obtain a D.-C. convergence voltage from the high voltage supply. Thus, the employment of a high voltage bleeder for the sole purpose of obtaining a regulator control voltage (which need be only a small fraction of the peak supply voltage) in color receivers not using the electrostatic form of beam convergence is wasteful of power. This has been recognized in several co-pending applications, namely, the application of Leonard Dietch, Ser. No. 407,921, filed February 3, 1954 now U. S. Patent No. 2,729,764, issued January 3, 1956, and entitled "High Voltage Supply," and the application of Bernard Vonderschmitt, Ser. No. 416,186, filed March 15, 1954, and entitled "High Voltage Supply." In embodiments of the inventions described therein the control voltage for the shunt regulator of the high voltage supply is derived from a bleeder which shunts a source of voltage of an order substantially less than the peak ultor voltage output of the supply, viz. a voltage of the order of the supplied focus voltage.

In accordance with an embodiment of the present invention a regulated high voltage supply of the type suitable for use with a color kinescope is provided in which the control voltage for the supply's shunt regulator is derived from the B-boost circuit conventionally associated



with the horizontal deflection wave output circuit of the television receiver. The high voltage regulation obtained by use of such a manner of controlling the regulator compares satisfactorily with the regulation obtained by more conventionally deriving the regulator control voltage through sampling the high voltage via a high voltage bleeder. By relegating the regulator sampling point to the relatively low voltage B-boost circuitry, the need for employing a high voltage bleeder in supplies for use with color kinescopes of the electromagnetic type is eliminated, thereby removing a source of significant power losses and improving the overall efficiency of the high voltage supply. Even where color kinescopes of the electrostatic convergence type are concerned, practice of the present invention is advantageous in that it simplifies the high voltage bleeder design, making it possible to vary D.-C. convergence with a potentiometer at a relatively low potential. A further advantage of practice in the present invention as compared with the more conventional derivation of regulator control voltage from a high voltage bleeder has been noted with respect to a lessening in raster width changes with line voltage variations.

Accordingly, it is a primary object of the present invention to provide a novel and improved regulated voltage supply.

It is a further object of the present invention to provide a novel and improved regulated high voltage supply of a type suitable for use in satisfying the high voltage requirements of a color kinescope.

It is an additional object of the present invention to provide a color television receiver high voltage supply in which satisfactory regulation of the supplied voltages is achieved with a saving in power losses over prior art practices.

It is another object of the present invention to provide a color television receiver high voltage supply wherein the high voltage bleeder may be eliminated or simplified.

Other objects and advantages of the present invention will be apparent upon a reading of the following detailed description and an inspection of the accompanying drawing in which a high voltage supply regulated in accordance with an embodiment of the present invention is illustrated schematically in Figure 1 as supplying the high voltages required by a color kinescope in a typical color television receiver.

Figure 2 illustrates schematically application of the principles of the present invention to regulation of another form of high voltage supply suitable for supplying high voltages to a color kinescope in a color receiver of the type shown in Figure 1. The color television receiver illustrated essentially in block form in Figure 1 is generally representative of presently contemplated color receivers for a simultaneous subcarrier type color television system in accordance with the revised FCC color standards, and is in general accord with the principles and apparatus discussed in the article entitled "Principles and development of color television systems," by G. H. Brown and D. G. C. Luck appearing in the June 1953 issue of the RCA Review. Carrier waves modulated by a composite color picture signal are illustrated as being received by conventional signal receiving apparatus 11, which may include the usual R. F. tuner, converting apparatus, I. F. amplifier, signal detector, etc. The video frequency signals recovered from the modulated carrier in the receiving apparatus 11 are amplified in the video amplifier 13. Synchronizing information is derived from the recovered signals in the sync separator 15 and utilized to synchronously control the receiver's subcarrier drive apparatus 17, to control the generation of scanning waves in the vertical deflection circuits 19, and control the generation

of horizontal frequency sawtooth voltage waves in the horizontal sawtooth wave generator 21.

Respective color mixture signals (e. g. narrow band $E_Q$ signals and wider band $E_I$ signals, discussed in detail in the aforementioned article) are recovered from the video signal output of amplifier 13 in respective color demodulator channels which include bandpass filters 25 and 27 of respectively appropriate passbands, synchronous demodulators 31 and 33 receiving respectively appropriate phases of the output of the subcarrier drive apparatus 17, and low pass filters 35 and 37 having the respectively appropriate narrow and wider responses. The receiver is also provided with a brightness channel, including a low pass filter 36 having the desired wide band response, through which the broad band monochrome portion of the composite picture signal may pass. The outputs of the brightness channel and two color channels are suitably combined in the matrixing circuits 39 of the receiver to obtain the simultaneous color signals which may be applied to appropriate beam control elements of the color image reproducer 40.

The color image reproducer 40 is illustrated schematically as one of the three-gun, shadow-mask kinescope type. Color image reproducers of this general type are discussed in some detail in the article by H. B. Law entitled "A three-gun shadow-mask kinescope," appearing in the October 1951 issue of the Proceedings of the I. R. E. In a color image reproducer of this type, three electron beams are used, one for each primary color. The beams strike a phosphor screen composed of a regular array of red-, green-, and blue-emitting phosphor dots. Between the electron gun position and the phosphor screen there is placed a thin perforated metal sheet for the purpose of partially masking the electron beams. The phosphor dot array on the screen comprises a plurality of closely spaced phosphor dot trios, each trio consisting of a red-, green-, and blue-emitting phosphor dot with the centers of the dots lying at the corners of an equilateral triangle. The trios themselves lie at the corners of an equilateral triangle of larger size. Associated with each of the phosphor trios is a hole in the video mask, these holes also being located at the corners of an equilateral triangle. The three beams, disposed 120° apart about the tube axis, are converged to a point on the mask by suitable static and dynamic beam converging means. The electron beam which is to contribute the red portion of the picture is prevented, by the mask, from striking those areas on the screen containing blue and green emitting phosphors. Likewise the green and blue beams can strike only the green and blue emitting phosphor dots, respectively. The target structure 51 of the illustrative color kinescope 40 may be considered to be of the general shadow-mask type above described.

As schematically illustrated the three electron beams are developed and shaped in respective electron gun structures, each including a thermionic cathode 41, a control 43, a first anode or accelerating electrode 45, and a focusing electrode 47. The electron gun structures may be of the general type disclosed in the co-pending application of Hannah C. Moodey, Ser. No. 295,225, filed June 24, 1952, and disposed symmetrically about the tube axis such as to produce three substantially parallel beams as in said Moodey application, or may be inclined at respective angles to the tube axis so as to provide three beams substantially converging at a common point on the target, as in the co-pending application of Albert M. Morrell, Ser. No. 364,041, filed on June 25, 1953, now U. S. Patent No. 2,752,520, issued January 26, 1956.

A common convergence anode 49 is illustrated, which when energized by suitable dynamic convergence waveforms developed by the generator 56 along with an appropriate (static convergence) D.-C. component, serves to converge the three beams to a common point in the plane of the shadow-mask of target structure 51 throughout the scanning of the raster. The principles of multi-beam convergence, and a description of typical circuits for developing dynamic convergence waveforms from sawtooth waves of field and line frequency may be found in an article by Albert W. Friend appearing in the October 1951 issue of the Proceedings of the I. R. E. and entitled "Deflection and convergence in color kinescopes." As illustrated, the dynamic convergence waveform generator 56 may derive the respective sawtooth information from the vertical deflection circuits 19 and the horizontal output transformer 63, and convert these sawtooth waves into essentially parabolic waveforms, as disclosed in the aforementioned Friend article, for combined application with a D.-C. component as a suitable convergence waveform to the common convergence electrode 49. Also, as indicated on the drawings, the dynamic convergence waveforms, generated for application to convergence anode 49 by generator 56, may also be applied (suitably modified in amplitude) to the focus electrodes 47 to maintain essentially optimum focus throughout the entire raster, as suggested in the aforementioned Friend article.

While the use of electrostatic convergence apparatus has thus been illustrated, the alternative use of electromagnetic convergence apparatus such as disclosed in the co-pending application of Hunter C. Goodrich, entitled "Electromagnetic beam convergence systems for tri-color kinescopes," Ser. No. 322,653, filed November 26, 1952, now U. S. Patent No. 2,707,248, issued April 26, 1955, in the aforesaid Morrell patent and in another co-pending application of the aforesaid Morrell, Ser. No. 383,340, filed September 30, 1953, and entitled "Tri-Color Kinescope," may be followed. In the latter the aforesaid patents and application, the incorporation of internal pole pieces in such electromagnetic convergence apparatus is disclosed.

Three beam alignment magnets 57, one associated with each of the three electron beams may be employed to provide individual correction of beam misalignment, as disclosed in the aforementioned Friend article. However, where electromagnetic convergence apparatus is employed of the nature providing individual control of the three beams in respective radial directions relative to the tube axis, as in the aforementioned Goodrich and Morrell patents, a single beam alignment magnet providing control of a selected one of the beams in a direction perpendicular to the radial convergence control direction associated with that beam is sufficient, again as indicated in the aforementioned Goodrich and Morrell patents. In such a case the single beam alignment magnet may take the form of an adjustably insertable magnet associated with cooperating external and internal pole pieces, as disclosed in the co-pending application of Max Obert, Ser. No. 405,445, filed January 21, 1954, and entitled "Electron Beam Control Means."

In addition to the beam controlling apparatus already described, the illustrated color kinescope 40 is also provided, as is generally customary, with a "color purity" yoke 54, applying a uniform transverse magnetic field to all the electron beams to orient the system of beams as desired. The yoke may comprise either a rotatable single pair of coils, or two fixed pairs of coils at right angles, fed from an adjustable source of D. C. (as indicated on the drawing). The use of such a "purity coil" to deflect the three beams equally so that they may be adjusted to pass through their respective color centers is explained in greater detail in the aforesaid Friend article, and in the co-pending application of Friend, Ser. No. 202,185, filed December 22, 1950, now U. S. Patent No. 2,719,249, issued September 27, 1955, and entitled "Beam Alignment Device."

The kinescope is provided, as is conventional, with a final accelerating electrode, the ultor 50, which may take the usual form of a conductive coating on the inner surface of the kinescope 40 extending from the vicinity

fied doubler type described above, including diode **109** as the aforementioned first diode, diode **113** as the aforementioned second diode, and diode **119** as the unidirectional coupling device connected between the output of diode **109** and the input of diode **113**. As in the embodiment of Figure 1, the space discharge path of the regulator tube **69** shunts the ultor voltage output. Again, in accordance with the present invention, the control voltage for regulator **69** is obtained by adjustably coupling the control grid of regulator **69** to the low voltage bleeder **75**, latter being tied between "S," a point of B-boost potential, and ground.

Where the supply of Figure 2 is used with a color kinescope of the type employing electromagnetic beam convergence apparatus, as specifically considered in the aforementioned Dietch application, the high voltage supply is not required to supply a static convergence voltage. Thus, there is no need for a high voltage bleeder shunting the ultor voltage output of a supply. Relegation to a B-boost bleeder of the derivation of the regulator control voltage may also obviate the need for the bleeder **121** illustrated in Figure 2 as shunted across the output of the first diode **109**, if focus voltage is rather derived from a potentiometer in the D.-C. coupling path, as disclosed in the aforementioned Dietch applications. However, even where such an output-shunting bleeder **121** is employed for focus voltage derivation as illustrated, derivation of the regulator control voltage from a B-boost bleeder rather than the focus bleeder **121** possesses certain advantages apart from elimination of the high voltage bleeder which may be noted. Where the focus bleeder **121** serves only focus voltage derivation purposes, the bleeder value may be selected on a basis of having an optimum source impedance under design center conditions for the focus supply. Also, separation of the regulator sampling operation from the focus bleeder circuit asssures avoidance of the rather wide variations in ultor voltage which may occur in the dual-function use of the focus bleeder circuit when focus current is appreciable.

What is claimed is:

1. In a cathode ray tube system including a cathode ray tube having an ultor electrode, a deflection circuit including a transformer and a deflection wave output tube having an electrode coupled to said transformer, and a damper circuit including means for applying a boosted supply voltage to said output tube electrode via at least a portion of said transformer, a high voltage supply for developing an operating potential for said ultor electrode, said high voltage supply comprising in combination rectifying means having an input circuit and an output circuit, means for coupling said input circuit to said transformer, means for deriving said ultor operating potential from said output circuit, an electron discharge device including an anode, a cathode and a control grid, means for shunting the anode-cathode current path of said electron discharge device across said rectifying means output circuit, a low voltage bleeder connected between a point of said boosted supply potential and a point of reference potential, and means for coupling said control grid to said low voltage bleeder.

2. In combination with a cathode ray beam deflection circuit including a deflection wave output transformer, a deflection wave output tube coupled to said transformer, and additional means coupled to said transformer for applying a boosted supply potential to said output tube, a high voltage supply comprising a high voltage rectifier coupled to a high potential terminal of said transformer and having an output circuit, voltage regulating means shunting said output circuit, and means for controlling the operation of said voltage regulating means in accordance with variations of said boosted supply potential, said controlling means including a voltage divider connected between a point of said boosted supply potential and a point of reference potential, means for deriving a control voltage from said voltage divider, and means for applying said control voltage to said voltage regulating means to vary the impedance presented by said voltage regulating means to said rectifier output circuit in accordance with the variations of said boosted supply potential.



3. In combination with a cathode ray beam deflection circuit including a deflection wave output transformer, a deflection wave output tube coupled to said transformer, and additional means coupled to said transformer for applying a boosted supply potential to said output tube, a high voltage supply comprising a high voltage rectifier coupled to a high potential terminal of said transformer and having an output circuit, voltage regulating means shunting said output circuit, and means for controlling the operation of said voltage regulating means in accordance with variations of said boosted supply potential, said boosted supply potential applying means including a damper tube circuit shunting a portion of said transformer, said damper tube circuit including a storage capacitor in series with said damper tube and said transformer portion, and means for effectively adding the supply potential to the charge stored by said capacitor, said voltage regulating means comprising an electron discharge device including a grid electrode, and said controlling means including a voltage divider connected between the high potential terminal of said storage capacitor and a point of reference potential, and means for coupling said control grid to a point on said voltage divider.

4. In a cathode ray tube system, a high voltage supply comprising in combination a transformer having a high potential terminal and a low potential terminal, rectifying means coupled to said high potential terminal and having an output circuit, an electron discharge device including an anode, a cathode, and a control grid, means for shunting the anode-cathode current path of said electron discharge device across said rectifying means output circuit, a bleeder resistance connected between said low potential terminal and a point of reference potential, and means for adjustably coupling said control grid to said bleeder resistance.

5. In a color television receiver including a color kinescope comprising an ultor electrode, and including a deflection circuit comprising a deflection wave output transformer, said transformer having a high potential terminal and a low potential terminal, said low potential terminal being connected to a source of boosted B+ potential, a high voltage supply for developing an ultor voltage including a high voltage rectifier coupled to said high potential terminal and having an output circuit, means for deriving said ultor voltage from said output circuit, a grid-controlled voltage regulator shunting said output circuit, a bleeder resistance connected between said low potential terminal and a point of reference potential, and means for coupling said grid to said bleeder resistance.

6. In a color television receiver including a color kinescope comprising an ultor electrode and a convergence electrode and including a deflection circuit comprising a deflection wave output transformer, said transformer having a high potential terminal and a low potential terminal, said low potential terminal being connected to a source of boosted B+ potential, a high voltage supply for developing an ultor voltage including a high voltage rectifier coupled to said high potential terminal and having an output circuit, means for deriving said ultor voltage from said output circuit, a grid-controlled voltage regulator shunting said output circuit, a bleeder resistance connected between said low potential terminal and a point of reference potential, and means for coupling said grid to said bleeder resistance, and wherein said high voltage supply also develops a static convergence voltage for said

of the convergence electrode 49 to the beam target structure 52. Where the flared portion of the kinescope envelope is itself a conducting metal, the conductive coating need only extend forward sufficiently to make electrical contact with the metal flared portion.

To effect deflection of the three beams to trace a scanning raster on the target structure 51, a deflection yoke 53 is provided with appropriately disposed horizontal and vertical deflection windings. The yoke 53 is illustrated as having vertical yoke terminals V—V, to which field frequency scanning waves developed in the vertical deflection circuits 19 are applied. The horizontal yoke terminals H—H derive line frequency scanning waves from the horizontal output transformer 63, energized by a current developed in the horizontal output tube 61 to provide the desired scanning sawtooth in the horizontal yoke. The illustrated horizontal output transformer 63 is of the autotransformer type, the output of the horizontal output tube 61 being applied across a selected portion of the total series of windings, and the horizontal yoke being effectively coupled across a smaller segment of this portion. The driving connection of output tube 61 to the transformer 63 is illustrated as being at an intermediate point "Y," while the yoke connections are illustrated at the low potential terminal "S" and an intermediate point "T" on the transformer 63. Details of components and circuitry conventionally associated with yoke circuits, such as width and linearity controls, centering circuits, etc. have not been illustrated for the sake of simplifying the drawing.

As a conventional damper tube, of well-known purpose, diode 62 is illustrated, the cathode of diode 62 being connected to an intermediate point "W" on the windings of transformer 63, and the anode of diode 62 being connected by suitable means to a source of B+ potential (not shown). In accordance with well-known power conservation principles, a capacitor 64 is coupled between the anode of damper tube 62 and the low potential terminal "S" of the transformer 63, the charge built up on capacitor 64 in response to the periodic flow of current through damper 62 effectively adding to the B+ supply potential to provide a boosted supply potential (i. e. a so-called B-boost potential) for the anode of the horizontal output tube 61 (which is D.-C. coupled via windings of transformer 63 to terminal "S").

In the illustrated high voltage supply which is regulated in accordance with an embodiment of the present invention, the anode of a first rectifier, diode 65, is connected to the high potential terminal "Z" of the output transformer 63. The high amplitude transient flyback pulses appearing at terminal "Z" are rectified by diode 65 and provide a high amplitude D.-C. potential at the diode 65's cathode, appearing across a capacitor 67 connected between the cathode and a point of reference potential (i. e. ground in the illustrative embodiment). The output terminal "U," to which the kinescope's ultor electrode is coupled, is directly connected to the cathode of diode 65.

The anode of a second rectifier, diode 81, is connected to an intermediate point "X" on the windings of the output transformer 63. The medium amplitude flyback pulses appearing at terminal "X" are rectified by diode 81 and provide an intermediate amplitude D.-C. potential at the diode 81's cathode, appearing across a capacitor 89, connected between the cathode and ground. The output terminal "F," to which the kinescope focus electrodes are coupled is adjustably connected via tap 91 to a bleeder resistance 90 which is connected between the cathode of diode 81 and ground.

The static convergence voltage required by the convergence anode 49 of the kinescope 40 (beam convergence being effected electrostatically in the embodiment illustrated in Figure 1) is obtained from a high voltage bleeder 95, which is connected between terminal "U" and ground, and which in accordance with the invention is of simplified form in comparison with the high voltage bleeder form required in previously discussed supplies which use such a bleeder for regulator control voltage derivation purposes also. As illustrated, the convergence output terminal "C," to which the convergence anode 49 is coupled, is connected to a fixed tap on the high voltage bleeder 95. Convergence voltage control is effected at a low potential, as by adjusting the variable tap 96 of potentiometer 97 to selectively short out a predetermined segment of the potentiometer 97, which comprises the low potential series resistance portion of the high voltage bleeder 95. The maximum potential to which the convergence control potentiometer is subjected thus need only correspond to the width of the desired adjustment range. Such a system of convergence voltage control (i. e. wherein the high voltage bleeder current is varied to adjust the voltage derived from the fixed convergence tap) is made possible through practice of the present invention, since such bleeder current variations can be made without upsetting regulation, control of the regulator tube being effected apart from the high voltage bleeder 95, as explained in more detail in the subsequent paragraph.

To render the supplied voltages less sensitive to variations in loading, source voltage changes, and other such departures from normal operating conditions, a shunt regulator tube, triode 69, is provided. The space discharge path of the triode 69 is shunted across the ultor voltage output of the supply, its anode being connected to output terminal "U" and its cathode being returned to ground via a B+ supply. In accordance with the illustrated embodiment of the present invention, control of the regulator 69 is obtained by connecting the control grid of regulator 69 to an adjustable point on a relatively low voltage bleeder 75 connected between the transformer's low potential terminal "S" (a point of boosted B+ potential) and ground. The connection of the control grid of regulator 69 to the low voltage bleeder 75 is made by means of an adjustable tap 72 on the potentiometer 73, which serves as one of the series resistance portions of bleeder 75. Since a change in the ultor output voltage due to variations in loading or the like will be accompanied by a corresponding change in B-boost potential in the same direction, the control grid of regulator 69 will swing in a direction such as to appropriately alter the regulator space current to oppose such an ultor voltage change.

Figure 2 illustrates application of the principles of the present invention to another form of high voltage supply suitable for serving color kinescope requirements, and being of the type generally disclosed in the aforementioned Dietch patent. The Dietch supply may be briefly described as utilizing a modified voltage doubler circuit to obtain the required ultor output voltage, the modification providing what may be effectively termed a "one-and-a-half" voltage multiplier in which less-than-peak amplitude flyback pulses are rectified by a first diode and added to peak amplitude flyback pulses for rectification by a second ultor-supplying diode. In the aforesaid Dietch patent, focus voltage is derived from a potentiometer situated in the unidirectional coupling path between the first diode output and the second diode's input. Control voltage for the regulator tube shunting the ultor voltage output is derived from a bleeder connected alternatively between either end of the focus potentiometer and ground. In the aforementioned Vonderschmitt application, a high voltage supply of the general modified doubler type described above is disclosed, in which, however, the focus voltage is derived as well as the regulator control voltage from such a bleeder connected between a point in the D.-C. coupler path and ground, rather than from a resistance in that path.

The high voltage supply illustrated in association with output transformer 63 in Figure 2 is of the general modi-

convergence electrode, said high voltage supply also including a high voltage bleeder shunting said output circuit, means for deriving said convergence voltage from a fixed point on said high voltage bleeder, and means for varying the derived convergence voltage said latter means comprising means for varying the current drawn by said bleeder from said output circuit.



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