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Bacon

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(54) **X-RAY TUBE DRIVER**

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(52) **U.S. Cl.** **378/101**; 714/57; 318/254
(58) **Field of Search** 378/101; 714/57; 318/254

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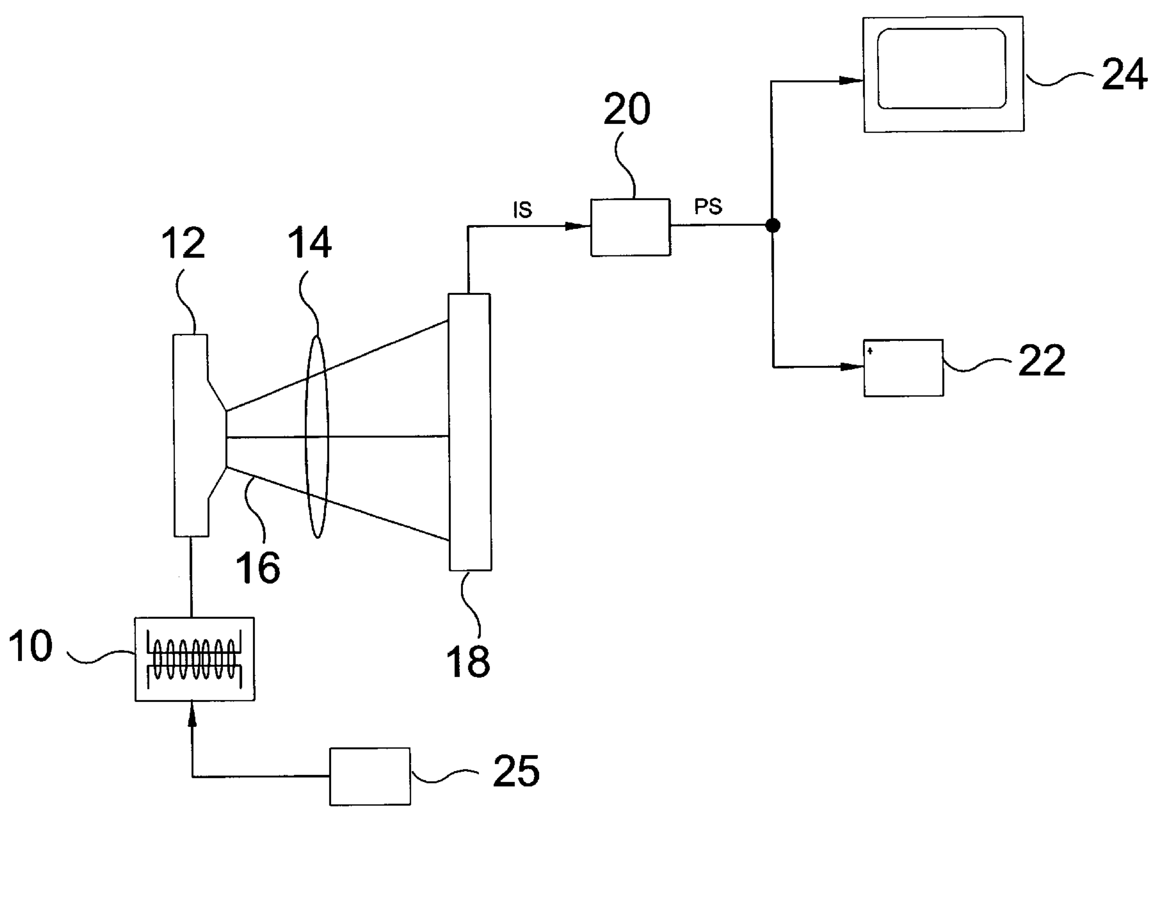
(57) **ABSTRACT**

A driver circuit for supplying power to an X-ray tube includes a filament supply, a first transformer connected to an anode of the X-ray tube and a first switch connected between the driver control and first transformer. The driver control controls the first switch to move between an open and closed position. The signal applied to the first transformer when the switch is closed is adjustable in both frequency and pulse width and is applied to the X-ray tube to generate an adjustable X-ray beam. The first transformer includes a primary winding connected to the first switch and a secondary winding connected to an anode of the X-ray tube, a voltage to be induced in the secondary winding is applied to the anode of the X-ray tube for generating the X-ray beam. The X-ray tube driver may further include a second switch, a second transformer connected between the second switch and driver control and a third transformer connected in parallel with the filament of the X-ray tube, the second transformer being connected to the cathode and in series with the parallel connection of the third transformer and ground. The second transformer applies a negative voltage to the cathode. The driver circuit is able to provide a high voltage pulse having a width within a range of 100–200 μsec. The high voltage pulse is adjustable to generate a voltage within a range of 0–40 k and a range of 0–80 kV when the second and third transformers are connected.

21 Claims, 5 Drawing Sheets



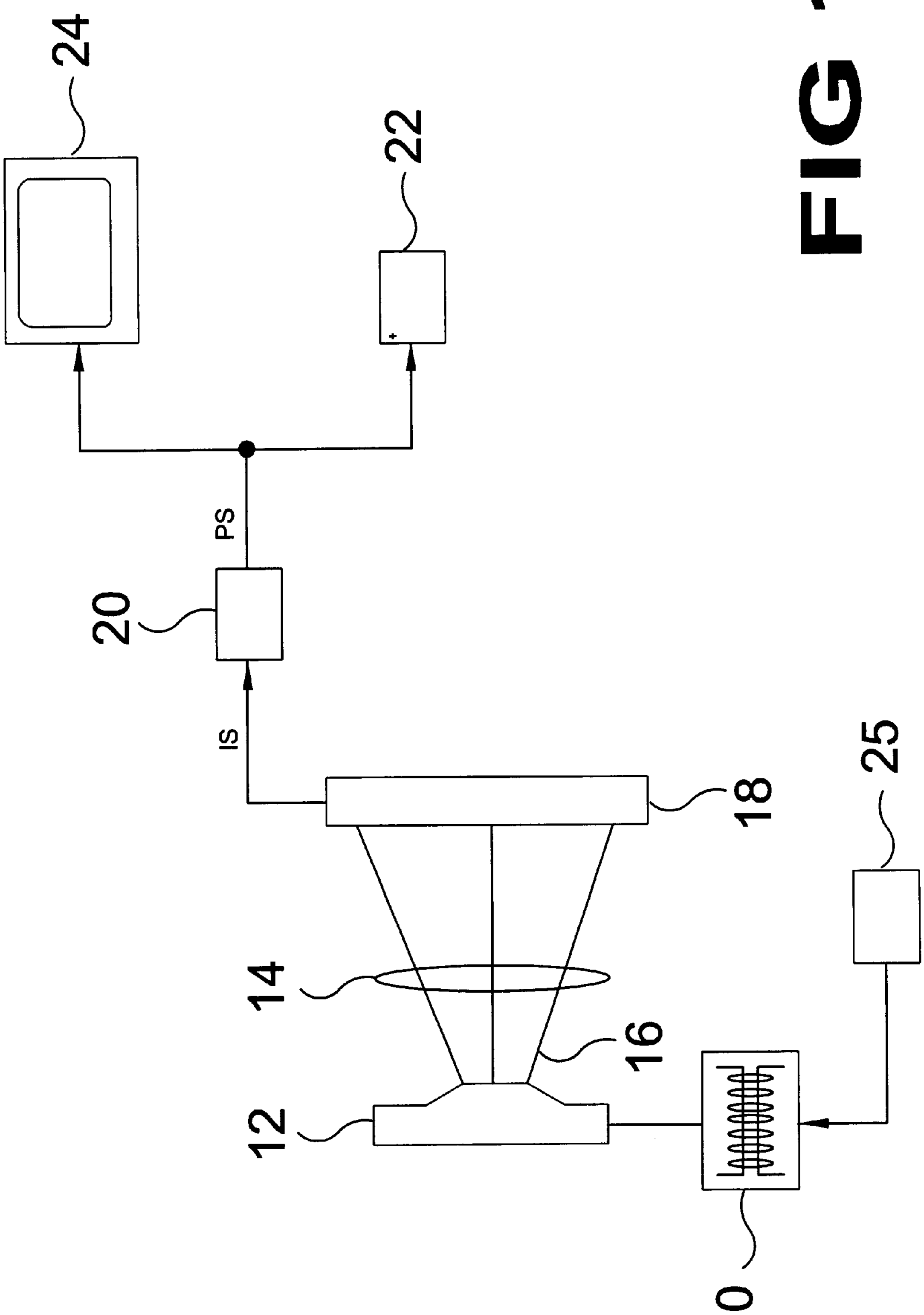


FIG 1

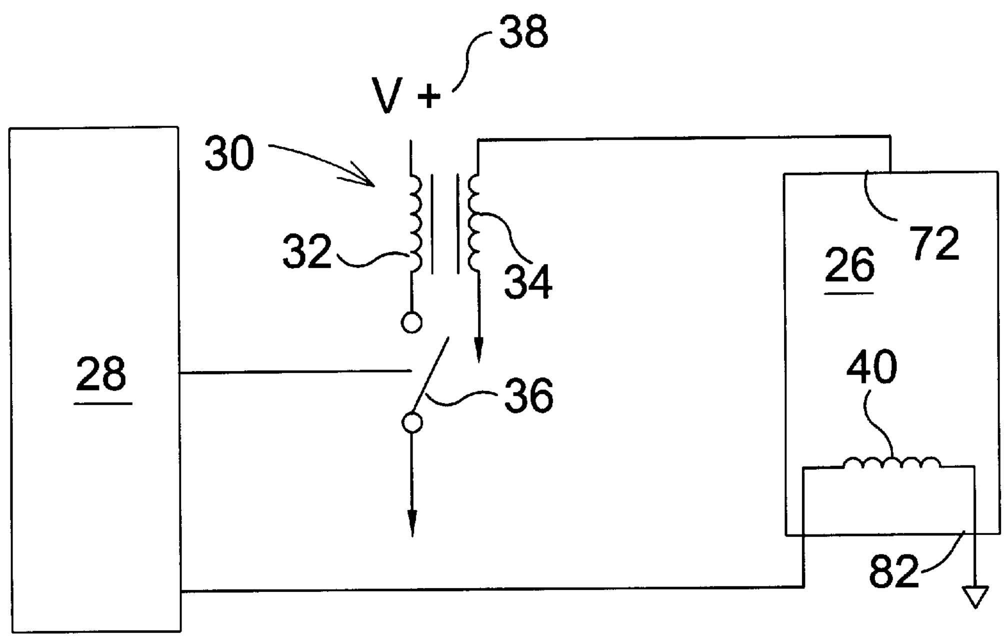

38
V +
30
32
34
28
36
26
72
40
82

FIG 2

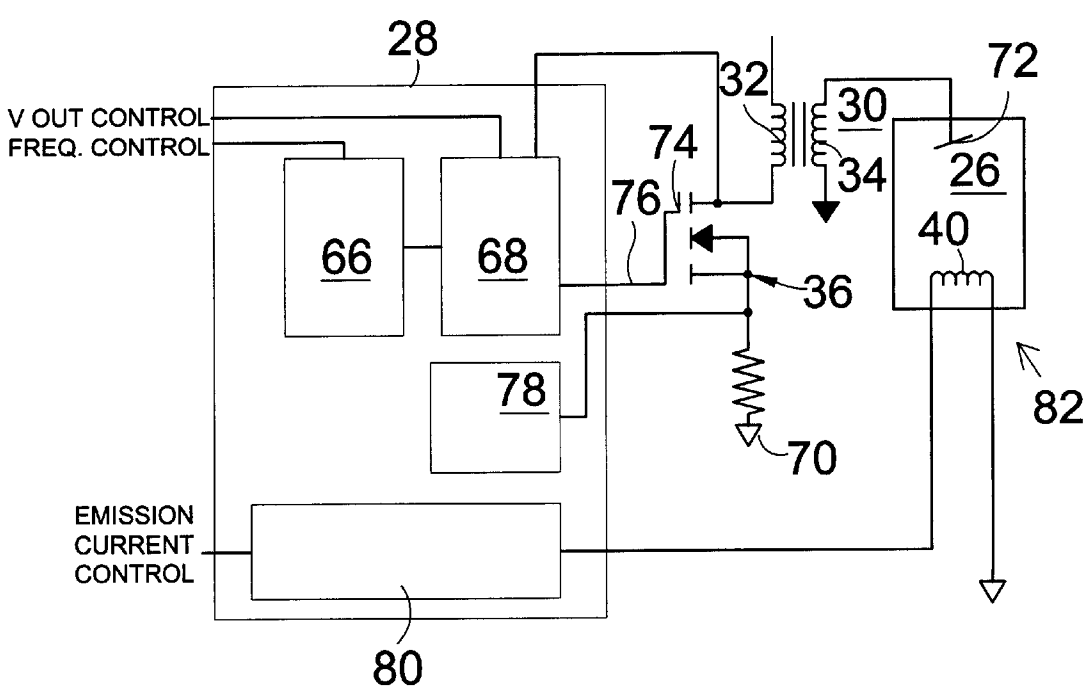

28
V OUT CONTROL
FREQ. CONTROL
66
68
78
32
30
34
74
76
36
70
72
26
40
82
EMISSION
CURRENT
CONTROL
80

FIG 2A

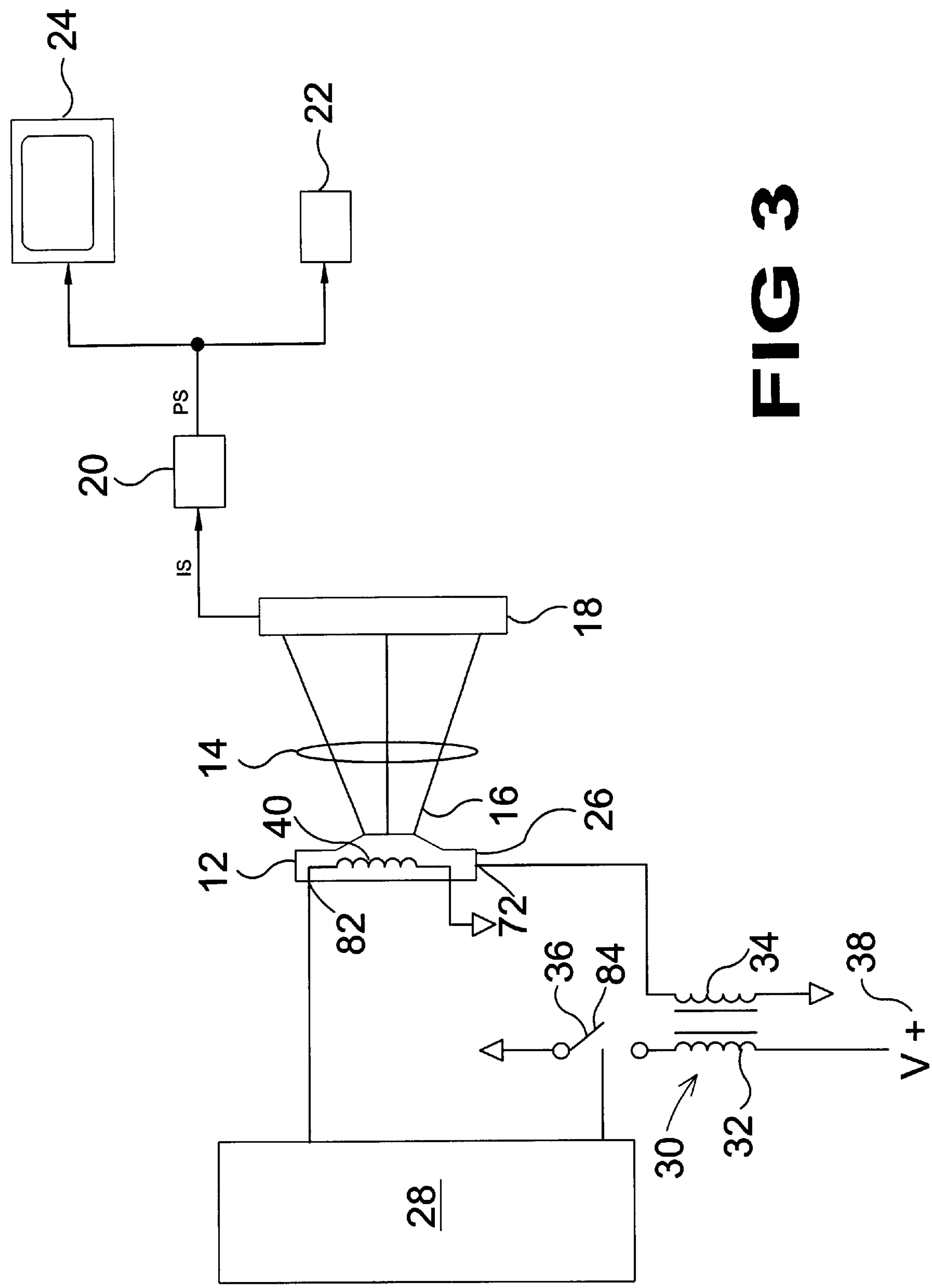


FIG 3

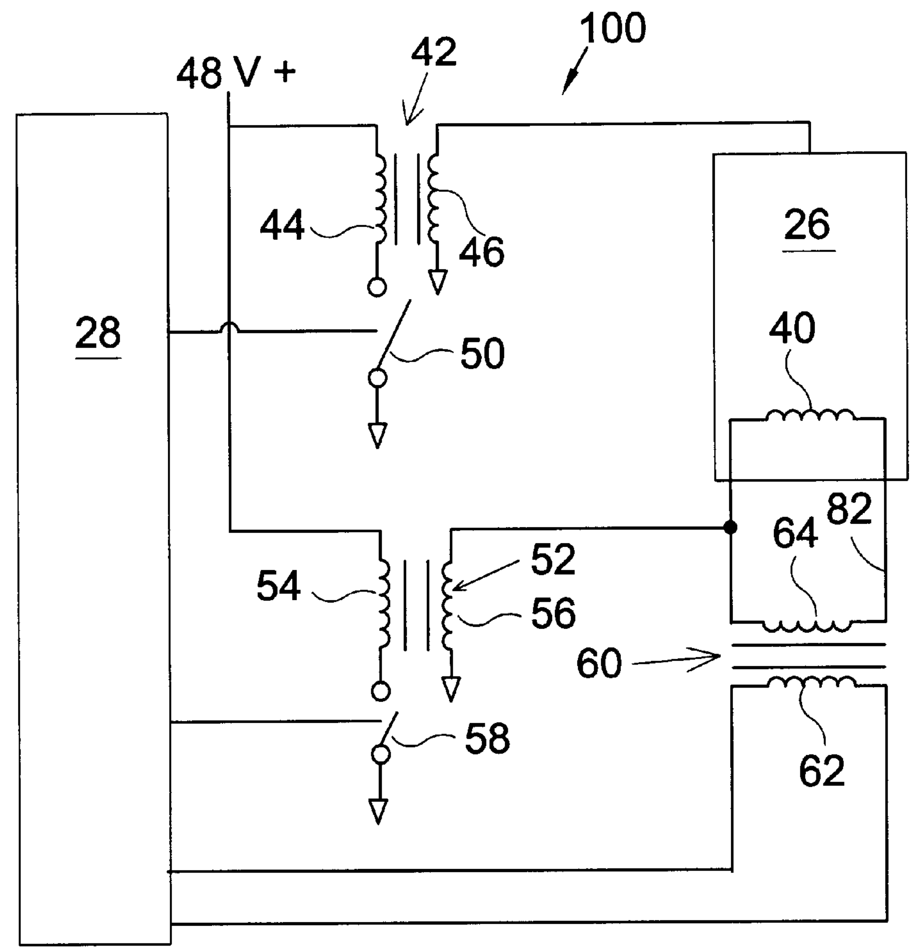

100
48 V +
42
44
46
26
28
50
40
82
64
54
52
56
60
58
62

FIG 4

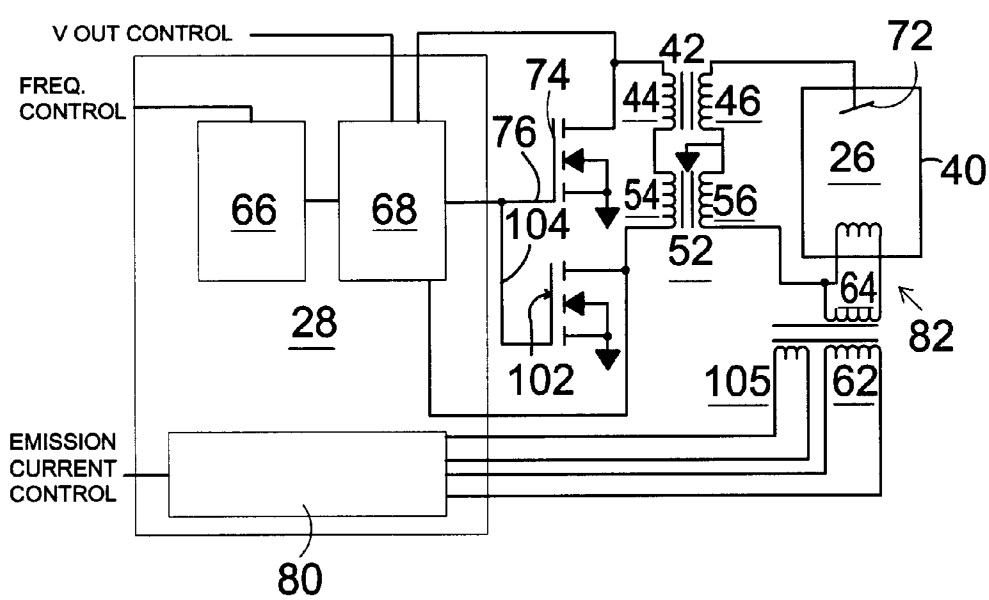

V OUT CONTROL
FREQ. CONTROL
42
72
74
44
46
26
40
76
66
68
54
56
104
52
28
64
82
102
105
62
EMISSION CURRENT CONTROL
80

FIG 4A

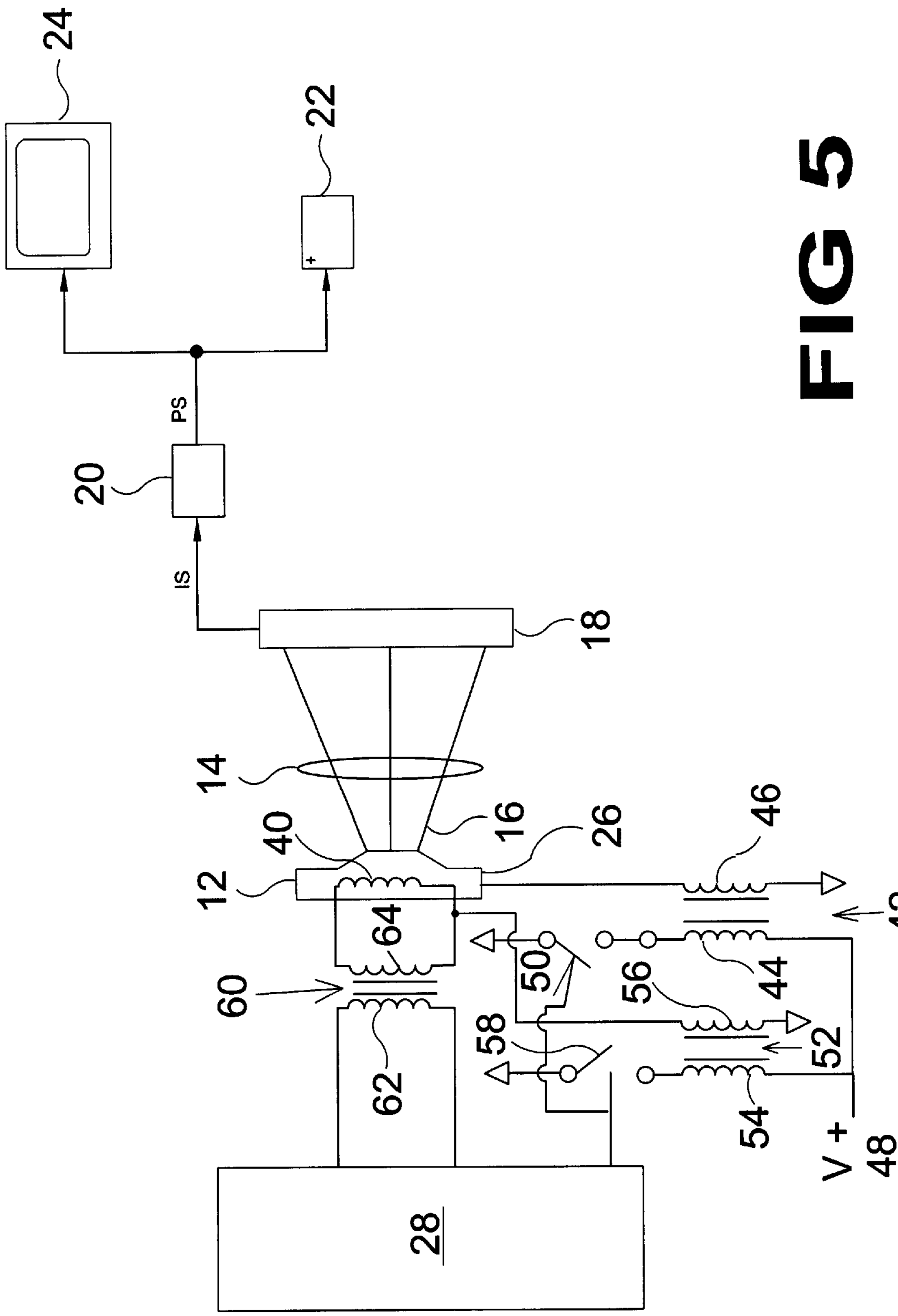


FIG 5

X-RAY TUBE DRIVER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to X-ray tubes and, more specifically, to a driver for powering an X-ray tube able to provide constant and adjustable power to the X-ray tube without significant thermal buildup from the creation of X-rays.

2. Description of the Prior Art

Numerous types of power supplies have been provided in the prior art. For example, U.S. Pat. Nos. 3,195,038; 3,711,747; 3,938,031 and 5,589,760 all are illustrative of such prior art. While these units may be suitable for the particular purpose to which they address, they would not be as suitable for the purposes of the present invention as heretofore described.

This invention relates to a voltage or current regulator apparatus, e.g. variable ratio transforming apparatus for the conversion of electrical energy from one voltage or current to another. The invention includes a plurality of transformer windings or sources of alternating current, a plurality of switch means associated with the windings. Each switch is changeable between a condition in which it connects the associated winding or source into a circuit and a condition in which the associated winding is by-passed in the circuit without being short circuited. A control device causes the switches to connect one or more of the windings in series.

A power supply for use with different AC line voltages, which includes a power transformer having a plurality of separate primary windings and a corresponding plurality of fuses connected thereto. The primary windings are connected to each other in several different ways to change the turns ratio of the power transformer depending upon the value of the voltage supplied thereto. Thus, a predetermined voltage is produced in the secondary winding of the transformer irrespective of the value of the supplied AC line voltage and the current flowing through each of the fuses is held substantially constant, during normal operating conditions, regardless of the manner in which the separate primary windings are connected.

An adjustable voltage alternating current power supply is provided which is especially suitable for supplying loads of variable resistance. The power supply consists of a transformer having two secondary windings with solid-state switches for alternatively connecting the secondary windings in either parallel or series, and with a firing control circuit for changing the connection of the windings from parallel to series at a predetermined point in each half-cycle of the voltage to adjust the effective output voltage so that constant output power can be maintained, or the output power can be varied in any desired manner.

A voltage converter for traveler's uses includes: a 50 watt (0–50 W) transformer for converting an input voltage of 220 VAC to an output voltage of 110 VAC for normally powering a load of 50 watts or less; a 1600 watts (50–1600 W) transformer for converting an input voltage of 220 VAC to and output voltage of 110 VAC for powering a load ranging from 50 watts to 1600 watt; and a sensing control circuit operatively sensing an output load having a power rating larger than 50 watts (50 W to 1600 W) for operatively actuating a relay for automatically switching an output terminal of the 50 watts transformer to the output terminal of the 1600 watts transformer for preventing burning or damaging of the output load connected with the voltage converter and for protecting the voltage converter itself.

SUMMARY OF THE PRESENT INVENTION

The present invention relates generally to X-ray tubes and, more specifically, to a driver for powering an X-ray tube able to provide constant and adjustable power to the X-ray tube without significant thermal buildup from the creation of X-rays.

A primary object of the present invention is to provide a X-ray tube driver that will overcome the shortcomings of prior art devices.

Another object of the present invention is to provide a X-ray tube driver which is able to drive an X-ray tube directly using a high voltage transformer.

A further object of the present invention is to provide a X-ray tube driver which is able to provide the constant pulse to the X-ray tube without significant thermal buildup from the creation of X-rays.

A yet further object of the present invention is to provide a X-ray tube driver which is able to provide an adjustable pulse of 0–40 kV or 0–80 kV to an X-ray tube but not limited by these boundaries.

A still further object of the present invention is to provide a X-ray tube driver which is small and light weight.

An even further object of the present invention is to provide a X-ray tube driver which is able to vary the frequency of pulses to thereby change the number of X-rays generated per second.

A still further object of the present invention is to provide a X-ray tube driver which is able to vary the voltage of pulses thereby changing the amount of X-ray penetration through a desired object being X-rayed.

A yet further object of the present invention is to provide a X-ray tube driver which is able to vary output pulses over a set time to get the best possible image of the object being X-rayed.

Another object of the present invention is to provide a X-ray tube driver wherein there is no significant heat build up in the X-ray tube due to X-ray generation.

A still further object of the present invention is to provide a X-ray tube driver which is able to control the current, through the x-ray tube, of the voltage pulses thereby changing the amount of X-ray beam power through an object being X-rayed.

An even further object of the present invention is to provide a X-ray tube driver which is able to pulse an X-ray tube with at least 70 watt pulses without heat sinking the tube and preventing voltage tracking across the tube, but not limited to 70 watt pulses.

A further object of the present invention is to provide a X-ray tube driver that is simple and easy to use.

A still further object of the present invention is to provide a X-ray tube driver that is economical in cost to manufacture.

Additional objects of the present invention will appear as the description proceeds.

A driver circuit for supplying power to an X-ray tube including a filament supply, a first transformer connected to an anode of the X-ray tube and a first switch connected between the driver control and first transformer is disclosed by the present invention. The driver control controls the first switch to move between an open and closed position. The signal applied to the first transformer when the switch is closed is adjustable in both frequency and pulse width and is applied to the X-ray tube to generate an adjustable voltage and frequency for producing an X-ray beam. The first transformer includes a primary winding connected to the first switch and a secondary winding connected to an anode of the X-ray tube, a current to be induced in the secondary winding is applied to the anode of the X-ray tube for generating the X-ray beam. The X-ray tube driver may further include a second switch; a second transformer connected between the second switch and a cathode of the X-ray tube; and a third transformer connected in parallel with the filament of the X-ray tube, the second transformer being connected in series with the parallel connection of the third transformer connected to the cathode and ground potential. The second transformer applies a negative voltage to the cathode. The driver circuit is able to provide a high voltage pulse having a width within a range of 100–200 μsec but not limited to that range. The high voltage pulse is able to generate a voltage within a range of 0–40 k and a range of 0–80 kV when the second and third transformers are connected, but not limited to those ranges.

To the accomplishment of the above and related objects, this invention may be embodied in the form illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and that changes may be made in the specific construction illustrated and described within the scope of the appended claims.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

Various other objects, features and attendant advantages of the present invention will become more fully appreciated as the same becomes better understood when considered in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the several views.

FIG. **1** is a perspective view of an X-ray examination apparatus being driven by the X-ray tube driver of the present invention;

FIG. **2** is a block diagram of the X-ray tube driver of the present invention for generating power in a range of 0–40 kV;

FIG. **2**A is a schematic diagram of the X-ray tube driver of the present invention shown in FIG. **2**;

FIG. **3** is a perspective view of the X-ray tube driver shown in FIG. **2** connected to an X-ray examination apparatus for generating an X-ray;

FIG. **4** is a block diagram of the X-ray tube driver of the present invention for generating power in a range of 0–80 kV;

FIG. **4**A is a schematic diagram of the X-ray tube driver of the present invention shown in FIG. **4**; and

FIG. **5** is a perspective view of the X-ray tube driver shown in FIG. **4** connected to an X-ray examination apparatus for generating an X-ray.

DESCRIPTION OF THE REFERENCED NUMERALS

Turning now descriptively to the drawings, in which similar reference characters denote similar elements throughout the several views, the Figures illustrate the X-ray tube driver of the present invention. With regard to the reference numerals used, the following numbering is used throughout the various drawing figures.

10 X-ray tube driver of the present invention
12 X-ray source
24 object being X-rayed
16 X-ray beam
18 X-ray detector
20 post processing unit
22 buffer unit
24 monitor
25 control device
26 tube
28 control section of X-ray tube driver
30 high voltage transformer
32 primary coil of transformer
34 secondary coil of transformer
36 switch
38 voltage supply
40 filament of X-ray tube
42 first transformer
44 primary coil of first transformer
46 secondary coil of first transformer
48 voltage supply
50 first switch
52 second transformer
54 primary coil of second transformer
56 secondary coil of second transformer
58 second switch
60 third transformer
62 primary coil of third transformer
64 secondary coil of third transformer
66 first timer
68 second timer
70 ground potential
72 anode of X-ray tube
74 transistor forming switch
76 gate of transistor
78 over current protection circuit
80 filament control and feedback circuit
82 cathode of X-ray tube
84 wiper of switch
100 X-ray driver circuit including two transformers
102 second transistor forming second switch
104 gate of second transistor
105 control winding

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now descriptively to the drawings, in which similar reference characters denote similar elements throughout the several views, FIGS. **1** through **5** illustrate the X-ray tube driver of the present invention indicated generally by the numeral **10**.

The X-ray tube driver **10** of the present invention is shown in FIG. **1** connected to a system for taking an X-ray of an image. As can be seen from this figure, the X-ray tube driver **10** is connected to control a supply of power to an X-ray source **12**. An object to be X-rayed is positioned between the X-ray source **12** and a screen **18**. When power is supplied to the X-ray source **12** via the X-ray tube driver **10**, the X-ray source **12** will generate an X-ray beam **16**. The X-ray beam **16** will be directed towards the object **14** and the screen **18**. An X-ray image of the object **14** will be generated on the screen **18** by the X-ray beam **16** passing through the object **14**. The portions of the X-ray beam **16** able to pass through the object **14** will create the image on the screen **18**. The screen **18** is connected to provide a signal representative of the image generated to a post processing unit **20**. The post processing unit **20** will process the received signal and provide a processed signal to both a buffer unit **22** and a monitor **24**. The monitor **24** is able to display the image on a screen for viewing. The buffer unit **22** is able to connect with a peripheral device for outputting a signal representative of the image signal thereto. If the peripheral device is a printer, the printer will then generate a hard copy output of the image or even a photographic image for viewing. A control device **25** is connected to the X-ray tube driver **10** for controlling the voltage, current and frequency of the electrical pulses supplied to drive the X-ray source **12**.

FIGS. **2** and **2A** illustrate schematic diagrams of the X-ray tube driver **10** of the present invention connected to a X-ray tube **26**. As can be seen from these figures, the X-ray tube driver **10** includes a filament supply **28**. The X-ray driver supply receives a voltage control signal and a frequency control signal from the control device **25**. The frequency control signal is connected to a first timer circuit **66** (see FIG. **4A**). The first timer circuit **66** is preferably an astable free running oscillator. Control of the frequency is provided by an external voltage or by adjusting a potentiometer connected to the first timer. The voltage control signal is connected to a second timer circuit **68**. The second timer circuit is preferably a monostable oscillator. The frequency control signal is passed through the first timer circuit **66** and to the second timer circuit **68**. The second timer circuit **68** is connected to control the wiper arm of a switch **36**. Control of the pulse width is provided by an external voltage or by adjusting a potentiometer connected to the second timer **68**. The longer the pulse width the higher the voltage of the output pulse. The switch **36** is connected between a ground potential **70** and a primary winding **32** of a first transformer **30**. Thus, when the signal from the second timer circuit **68** causes the wiper arm of the switch **36** to close, the circuit containing the first transformer **30** is closed and a current is caused to flow through the primary winding **32** of the first transformer **30**. The flow of current through the primary winding **32** of the first transformer **30** stores energy in the transformer through the primary inductance, then when the first transistor shuts off this induces a current to flow in the secondary winding **34** of the first transformer **30**. The secondary winding **34** is connected between a ground potential and the anode **72** of the X-ray tube **26**. The current induced in the secondary winding **34** flows to the anode of the X-ray tube **26** causing the X-ray beam **16** to be generated. The primary and secondary windings **32** and **34**, respectively, of the first transformer **30** preferably have a turns ratio of 1:77. The filament supply is also controlled by an external voltage or potentiometer and induces a current that flows through the cathode connected filament **40** and controls the amount of high voltage or emission current that flows from the anode **72** to the cathode **82** and to ground.

The switch **36** is preferably a transistor **74** with the second timer **68** connected to the gate **76** of the transistor **74** (see FIG. **4A**). An over current control circuit **78** is connected to the switch **36** to prevent the current from destroying the switch **36**. A filament control and feedback circuit **80** is also contained within the X-ray driver **28** and is connected to the filament **82** of the X-ray tube **26** to provide a regulated DC current that can be controlled from 0 to 2 amps or more if necessary. The frequency control signal adjusts the first timer **68** to change the frequency of the pulses applied to the X-ray tube **26** through the secondary winding **34**. Thus, the duty cycle of the X-ray beam **16** is controlled. The frequency can be controlled to be between a single shot to 400 Hz., and beyond in duration. By controlling the frequency, the number of pulses generated per second can be controlled. The voltage control signal is adjusted using an external voltage or a potentiometer connected to the second timer **66** to change the pulse width in the primary winding and thus the magnitude of the voltage induced in the secondary winding. Thus the magnitude of the voltage applied to the anode of the X-ray tube **26** and the intensity of the X-ray beam generated is also adjusted. The voltage of the pulse in this circuit can be adjusted to a value within the range of but not limited to 0–40 kV. The cathode **82** and filament of the X-ray tube **26** is referenced to ground in this embodiment.

FIG. **3** illustrates the X-ray tube driver **10** connected to the X-ray system of FIG. **1**. As can be seen from this figure, the switch **36** is controlled by a signal from the driver control **28**. The driver circuit **28** is also directly connected to the cathode **82**. The control signal from the driver **28** controls the wiper blade **84** of the switch **36** to move between the open and closed positions. When in the open position, the primary winding **32** of the first transformer **30** is open circuited and disconnected from the driver **28** such that no current is supplied to the X-ray tube **26**. When in the closed position, the primary winding **32** forms a closed circuit thereby allowing current to flow thereby causing energy to be stored in the transformer **30** when switch is opened the transformer flys back which induces a current to flow in the secondary winding **34** thereby supplying a current to the anode **72** of the X-ray tube **26**. The current flowing through the X-ray tube **26** causes the X-ray beam **16** to be generated. Current flowing through the tube is indirectly controlled by the current flowing through the filament which is controlled by the filament supply.

The X-ray beam is directed at the screen **18** and produces an image thereon representative of the amount of the beam **16** able to pass through the object **14** positioned between the filament tube **26** and the screen **18**. The screen **18** provides a signal representative of the image generated to the post processing unit **20**. The post processing unit **20** processes the received signal and provides a processed signal to the buffer unit **22** and the monitor **24**. The monitor **24** is able to display the image on a screen for viewing. The buffer unit **22** is able to connect with a peripheral device for outputting a signal representative of the image signal thereto.

The driver circuit **100** provides an additional transformer connected to the cathode **82**. The cathode **82** in this instance is referenced to a negative 40 kV pulse thereby increasing the range for the high voltage pulse applied to the X-ray tube **26**. The driver circuit **100** includes three high voltage transformers and is illustrated in FIGS. **4**, **4A** and **5**. This circuit is able to generate a high voltage pulse within the range of but not limited to 0–80 kV, twice the range generated using a single high voltage transformer. This circuit **100** includes a first transformer **42**, a second transformer **52** and a third transformer **60**.

The first transformer **42**, as also illustrated in FIGS. **1–3**, includes the primary winding **44** coupled between the source of positive voltage **48** and the wiper arm of the first switch **50**. The secondary winding **46** of the first transformer **42** is connected between the ground potential and the anode **72** of the X-ray tube **26**. The first switch **50** is controlled by the driver control **28** to open and close thereby controlling the flow of current through the primary winding **44**. The flow of current through the primary winding **44** causes a current to be induced in the secondary winding **46** which is applied to the anode **72** of the X-ray tube **26**. The application of voltage to the X-ray tube **26** causes an X-ray beam to be generated.

A primary winding **54** of the second transformer **52** is also coupled to the voltage supply **48**. A second terminal of the primary winding **54** is coupled to a terminal of a second switch **58**. The second switch **58** is also controlled by a control signal received from the driver control **28** to open and close thereby controlling the flow of current through the primary winding **54**. The second switch **58** is preferably a transistor **102** with the control signal received at its gate **104** from the second timer **68**. The flow of current through the primary winding **54** causes a current change to be induced in the secondary winding **56** of the second transformer **52** which is applied to the cathode **82** of the X-ray tube **26**. The current applied to the cathode **82** is a negative current and thus application of the current to the negative lead, i.e. The cathode **82**, increases the range of voltages for the high voltage pulse and thus the voltage of the generated X-ray beam.

A secondary winding **64** of a third transformer **60** is connected in parallel with filament **40** connected to the cathode **82**. The secondary winding **56** of the second transformer **52** is connected in series with this parallel connection and ground. The primary winding **62** of the third transformer **60** is controlled by the filament control and feedback circuit **80** of the driver **28**. The filament supply **28** controls the application of a current to the third transformer and thus controls the inducement of current in the secondary winding **64** which applies the induced current to the filament **40** of the cathode **82** causing the X-ray tube **26** to develop an emission or high voltage current to flow and thus to generate the X-ray beam. The induced current in the secondary winding **64** of the third transformer **60** controls current in the X-ray tube **26**. An auxiliary winding **105** on the third transformer serves as a feedback output control winding.

The X-ray tube driver circuit shown in FIGS. **4** and **4A** is shown connected to a system for generating an X-ray image in FIG. **5**. As can be seen from this figure, the first and second switches **50** and **58**, respectively, are controlled to open and close by a signal received from the driver control **28**. The third transformer **60** is connected directly to and controlled by a second signal from the filament circuit and is connected to supply a control current directly to the filament. The first transformer **42** receives a signal having a controllable frequency and pulse width from the driver control **28** when the first switch **50** is caused to close. The primary winding **44** of the first transformer **42** induces a current, as described previously, to flow in the secondary winding **46** thereof which is applied to the X-ray tube **26** for generating an X-ray beam **16**. The intensity and pulse frequency of the X-ray beam **16** is controlled by the voltage induced in the secondary winding **46** which is directly related to the frequency and pulse width of the control signal from the driver control **28**.

The second transistor **52** also receives a signal having a controllable voltage and pulse width from the driver control **28** when the second switch **58** is caused to close. The primary winding **54** of the second transformer **52** induces a current, as previously described, to flow in the secondary winding **56** thereof which is applied to the cathode **82** of the X-ray tube **26**. The voltage applied by the secondary winding **56** of the second transformer **52** to the cathode **82** is a negative voltage and thus increases the potential difference between the anode **72** and cathode **82**. The increase in the potential difference increases the apparent voltage applied to the anode **72** by the secondary winding **46** of the first transformer **52** and thus increases the intensity of the X-ray beam **16** generated thereby.

The third transformer **60** is connected in parallel configuration with the filament connected cathode **82**. The parallel combination of the cathode and third transformer **60** is connected in series configuration with the secondary winding of the second transformer **52**. The third transformer **60** is controlled by the filament control and feedback circuit **80** of the driver control **28** thus controlling the current applied to the filament **40**.

The generated X-ray beam **16** is directed at the screen **18** and produces an image thereon representative of the amount of the beam **16** able to pass through the object **14** positioned between the X-ray tube **26** and the screen **18**. Adjustment of the voltage control signal and frequency control signal control the voltage and pulse width of the current applied to the first and second switches **50** and **58**, respectively and thus controls opening and closing of the switches. The current allowed to pass through the first and second switches **50** and **58**, respectively, determine the amount of voltage induced in the secondary windings **46** and **56** of the first and second transformers **42** and **52**. The induced voltage along with the current flowing in the filament then determines the intensity of the generated X-ray beam **16**. The pulse width of the control signal provided to the first and second switches **50** and **58** determines the opening and closing of the switches **50** and **58** and thus the voltage and frequency of the pulses of the generated X-ray beam **16**.

The screen **18** provides a signal representative of the image generated to the post processing unit **20**. The post processing unit **20** processes the received signal and provides a processed signal to the buffer unit **22** and the monitor **24**. The monitor **24** is able to display the image on a screen for viewing. The buffer unit **22** is able to connect with a peripheral device for outputting a signal representative of the image signal thereto.

The first transformer **42** is connected to the anode **72** using a spark plug cable or automotive ignition cable. Such cable is more resistive than inductive and the insulation of this cable has very little capacitance. This type of cable provides virtually no voltage drop across lengths of at least 15 feet and provides a very dampened ringing effect. Furthermore, running the X-ray tube with the X-ray tube driver of the present invention eliminates the need to submerge the X-ray tube in high voltage oil or encapsulation for high voltage isolation across the tube or heat sinking to dissipate heat created from the generation of the X-ray beam.

From the above description it can be seen that the X-ray tube driver of the present invention is able to overcome the shortcomings of prior art devices by providing a X-ray tube driver which is able to drive an X-ray tube directly using a high voltage transformer, providing a constant pulse to the X-ray tube without significant thermal buildup from the creation of X-rays. The X-ray tube driver provides an adjustable pulse of preferably but not limited to 0–40 kV or 0–80 kV to an X-ray tube. The X-ray tube driver which is also able to vary the frequency of pulses to thereby change the number of X-rays generated per second and vary the voltage of pulses and vary the current of the pulses thereby changing the amount of X-ray power and penetration through a desired object being X-rayed, the pulses may be varied over a set time to get the best possible image of the object being X-rayed. The X-ray tube driver can also pulse an X-ray tube with at least 70 watt pulses without heat sinking the tube and preventing voltage tracking across the tube. Furthermore, the X-ray tube driver of the present invention is simple and easy to use and economical in cost to manufacture.

It will be understood that each of the elements described above, or two or more together may also find a useful application in other types of methods differing from the type described above.

While certain novel features of this invention have been shown and described and are pointed out in the annexed claims, it is not intended to be limited to the details above, since it will be understood that various omissions, modifications, substitutions and changes in the forms and details of the device illustrated and in its operation can be made by those skilled in the art without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention.

What is claimed is new and desired to be protected by Letters Patent is set forth in the appended claims:

1. A driver circuit for supplying power to an X-ray tube, said driver circuit comprising:

a) a driver control;

b) a first transformer connected to an anode of the X-ray tube; and

c) a first switch connected between said driver control and said first transformer, wherein said driver control provides a control signal to said first switch for moving said switch between an open and closed position, said signal being adjustable in both frequency and pulse width whereby said control signal is applied to the X-ray tube via said first transformer after said first switch has closed and opened to generate an X-ray beam which is adjustable in both intensity and frequency.

2. The X-ray tube driver as recited in claim **1**, wherein said first switch is a transistor.

3. The X-ray tube driver as recited in claim **1**, wherein said first transformer includes a primary winding connected to receive said control signal from said first switch and a secondary winding connected to an anode of the X-ray tube, wherein said first signal being applied to said primary winding causes a current to be induced in said secondary winding, said induced current being applied to the anode of the X-ray tube for generating an X-ray beam.

4. The X-ray tube driver as recited in claim **3**, wherein the primary and secondary windings preferably have a turns ratio of 1:77.

5. The X-ray tube driver as recited in claim **2**, wherein said driver control includes a first timer and a second timer, said second timer being connected to provide said control signal to a gate terminal of said transistor.

6. The X-ray tube driver as recited in claim **5**, wherein said first timer is an astable free running oscillator and control of frequency is provided by adjusting an external voltage or a potentiometer connected to said astable free running oscillator.

7. The X-ray tube driver as recited in claim **6**, wherein said second timer is a monostable oscillator and control of pulse width and thus voltage is provided by adjusting an external voltage or a potentiometer connected to said monostable oscillator.

8. The X-ray tube driver as recited in claim **1**, wherein said first transformer is connected to the anode of the X-ray tube via a cable which is more resistive than inductive and has minimal capacitance.

9. The X-ray tube driver as recited in claim **1**, wherein said driver circuit is able to provide a high voltage pulse having a width within a range of 100–200 μsec.

10. The X-ray tube driver as recited in claim **2**, further comprising an overcurrent control circuit coupled to a source of said first transistor for protecting said first transistor.

11. The X-ray tube driver as recited in claim **1**, further comprising a second switch and a second transformer connected between said second switch and a cathode of the X-ray tube.

12. The X-ray tube driver as recited in claim **11**, wherein said second switch is a transistor, a gate of said transistor being connected to receive said control signal from said driver control.

13. The X-ray tube driver as recited in claim **12**, further comprising a third transformer connected in parallel with the filament of the X-ray tube.

14. The X-ray tube driver as recited in claim **13**, wherein said second transformer is connected in series with the parallel connection of said third transformer, cathode and ground potential.

15. The X-ray tube driver as recited in claim **13**, wherein said third transformer is controlled by a signal from a filament control and feedback circuit.

16. The X-ray tube driver as recited in claim **11**, wherein said high voltage pulse is adjustable to generate a voltage within a range of 0–40 kV.

17. The X-ray tube driver as recited in claim **11**, wherein said driver circuit is able to provide a high voltage pulse having a width within a range of 100–200 μsec.

18. The X-ray tube driver as recited in claim **17**, wherein said high voltage pulse is adjustable to generate a voltage within a range of 0–80 kV.

19. The X-ray tube driver as recited in claim **11**, wherein said first transformer is connected to the anode of the X-ray tube via a cable which is more resistive than inductive and has minimal capacitance.

20. The X-ray tube driver as recited in claim **11**, wherein said second transformer is connected to the cathode of the X-ray tube via a cable which is more resistive than inductive and has minimal capacitance.

21. The X-ray tube driver as recited in claim **20**, wherein said second transformer is connected to the cathode of the X-ray tube via a cable which is more resistive than inductive and has minimal capacitance.

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