NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF:

October 15, 1970

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General
Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned
U.S. Patents in STAR

N71-12540

In accordance with the procedures contained in the Code GP to Code USI memorandum on this subject, dated June 8, 1970, the attached NASA-owned U.S. patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No.	:	3,271,620
Corporate Source	:	Calif. Institute of Technology
Supplementary Corporate Source	:	Jet Propulsion Laboratory
NASA Patent Case No.	:	XNP-01058

Please note that this patent covers an invention made by an employee of a NASA contractor. Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of. . . ."

Gayle Parker

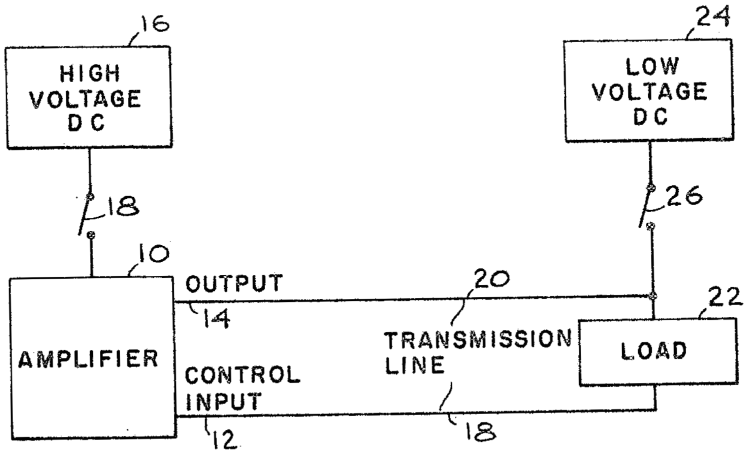
Gayle Parker

Enclosure:
Copy of Patent

N71-12540

Sept. 6, 1966 JAMES E. WEBB 3,271,620
ADMINISTRATOR OF THE NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION
STARTING CIRCUIT FOR VAPOR LAMPS AND THE LIKE
Filed Oct. 1, 1963

Fig. 1



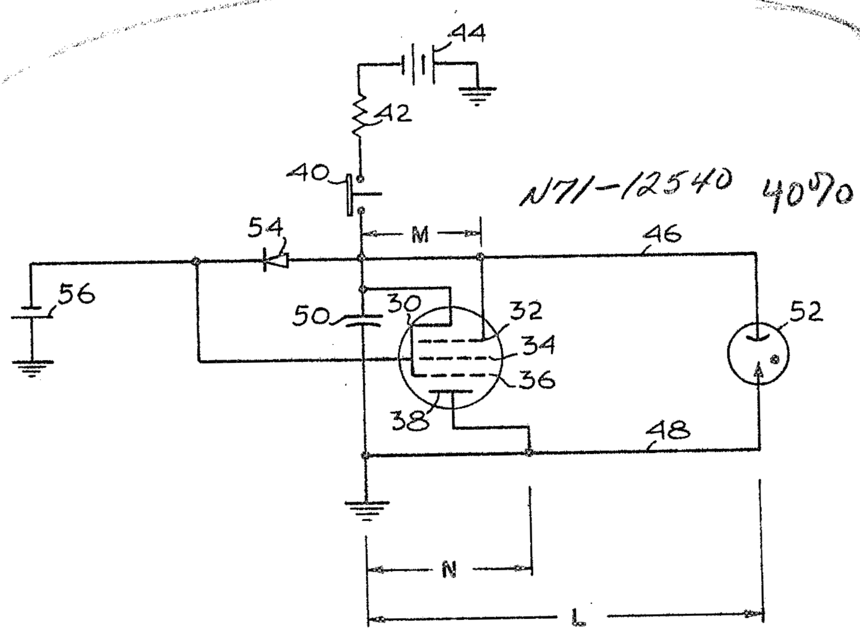


Fig. 2

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BY
[signatures]

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FACILITY FORM 602

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United States Patent Office

3,271,620

Patented Sept. 6, 1966

3,271,620
STARTING CIRCUIT FOR VAPOR LAMPS AND THE LIKE

James E. Webb, Administrator of the National Aeronautics and Space Administration with respect to an invention of John E. Guisinger

Filed Oct. 1, 1963, Ser. No. 313,136
8 Claims. (Cl. 315—160)

This invention relates generally to power supplies and more particularly to a power supply suitable for starting and maintaining a high intensity vapor lamp.

High intensity vapor lamps generally require a very high voltage at low current for starting, an intermediate voltage at intermediate current just after starting, and a low voltage at high current for maintaining the lamp energized after a plasma arc is established therein. Although arcs can be established in vapor lamps by the application thereacross of a sufficiently high direct current voltage, it has been found that a lower starting voltage can be tolerated if a high frequency alternating current voltage is utilized instead of a low frequency alternating current voltage or a direct current voltage.

Although various power supplies are disclosed in the prior art for starting and maintaining high intensity vapor lamps, none of them is entirely satisfactory. Most prior art power supplies utilized with vapor lamps employ transformers thereby making them somewhat heavy, slow acting, and expensive.

In view of the deficiencies in prior art vapor lamp power supplies, it is the principal object of the present invention to provide an improved power supply suitable for starting and maintaining an arc in a vapor lamp.

Briefly, the invention herein is based on the recognition that an oscillator can be formed by connecting a feedback path, comprised of a load, e.g. a vapor lamp, and an appropriate length of transmission line, between the output terminal and control input terminals of an amplifier so that oscillations will occur so long as the load comprises a substantially open circuit. By positioning the load in the transmission line at a point of maximum voltage and minimum current, ideal starting conditions for a vapor lamp are established. In response to a short circuit condition being developed across the load, appropriate switch means can be actuated to apply a low direct current voltage maintenance supply thereto to remove the higher direct current voltage supplied to the amplifier.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a block diagram of a power supply constructed in accordance with the present invention; and

FIGURE 2 is a schematic diagram of a preferred embodiment of a vapor lamp starting circuit constructed in accordance with the present invention.

Attention is initially called to FIGURE 1 of the drawings which illustrates an amplifier **10** having a control input terminal **12** and an output terminal **14**. A high voltage direct current source **16** is connected through a switch **18** to the amplifier **10**. As is well known, virtually any amplifier can be connected in a circuit arrangement so as to cause it to oscillate by coupling a portion of the output voltage derived from the amplifier back into the control input terminal of the amplifier. Generally, such oscillator feedback paths are comprised of resonant circuits including capacitors and inductive elements. In

accordance with the present invention, in lieu of providing such a feedback path, a transmission line comprised of parallel conductors **18** and **20**, respectively connected to the control input terminal **12** and output terminal **14**, are provided. The conductors **18** and **20** are terminated in a load **22**.

The load **22** can comprise, e.g. a vapor lamp, characteristically defining an open circuit condition prior to the ionization of the vapor therein. The vapor can be ionized by applying a high direct current voltage across the lamp electrodes or a not quite so high voltage alternating at a high frequency, preferably in the radio frequency range. Once the vapor is ionized, an arc is established thereby effectively creating a virtually no resistance or short circuit path between the electrodes. The arc, once established, can be maintained by a much lower direct current voltage than is required to initiate it. Consequently, a low voltage direct current source **24** is provided. A switch **26** couples the low voltage direct current source **24** to the load **22**. Means (not shown in FIGURE 1) responsive to the establishment of a short circuit in load **22**, can be provided for opening the switch **18** and closing the switch **26**. By appropriately determining the transmission line length, a high voltage low current condition can be established across the load **22** to thereby assure most rapid starting. The load **22** will be positioned at the point of maximum voltage and minimum current by placing it substantially one quarter wavelength from a point of maximum current and minimum voltage.

Attention is now called to the preferred embodiment of the invention illustrated in FIGURE 2. The amplifier in FIGURE 2 comprises a pentode including a cathode **30**, a control grid **32**, a screen grid **34**, a suppressor grid **36**, and an anode **38**. The cathode **30** is connected through a push button switch **40** and a resistive impedance **42** to the negative terminal of a high voltage direct current source **44**. The source **44** is referenced to ground. The first end of a first conductor **46**, of a pair of parallel conductors comprising a transmission line is connected to the junction between cathode **30** and the push button switch **40**. The control grid **32** is connected to an intermediate point on the first conductor **46** spaced from the first end thereof by a distance M. The anode **38** is connected to an intermediate point on the second conductor **48** spaced a distance N from the first end thereof which is referenced to ground. A capacitor **50** is connected between the first ends of the conductors **46** and **48**. A vapor lamp **52** is connected between the second ends of the conductors **46** and **48**. The length of each of the conductors **46** and **48** is represented by the distance L. As is usual practice, the suppressor grid **36** is connected to the cathode **30**. The screen grid **34** is connected to the cathode of a diode **54** whose anode is connected to the first end of the conductor **46**. The cathode of the diode **54** is in addition connected to a negative terminal of a low voltage direct current source **56** which is referenced to ground.

The transmission line conductors **46** and **48** together with the lamp **52** act as a tank circuit for the pentode. The length L of each of the conductors **46** and **48** is equal to substantially one quarter wavelength of the oscillations provided by the oscillator comprised of the pentode and the quarter wave line, the frequency of oscillations being determined primarily by the quarter wave line. In response to the actuation of the push button switch **40**, the high voltage direct current source **44** is applied across the cathode **30** and anode **38** of the pentode. The open circuit of the lamp **52** appears as a very high impedance load with some capacity between conductors **46** and **48**. The impedance however is not so great as to prevent

oscillation buildup in the quarter wave line during a short initial period, e.g. a few microseconds, or until the high frequency oscillations are of sufficient magnitude to ionize the lamp vapor. The distance M along conductor 46, provides sufficient alternating current feedback voltage to maintain oscillations. The distance N along conductor 48 is provided to match the impedance of the pentode to the impedance of the transmission line.

Inasmuch as the oscillations occur at a high frequency, preferably in the radio frequency range, the capacitor 50 will serve to effectively short circuit the high frequency voltage variations across the first ends of the conductors 46 and 48 and thereby establish a low voltage high current condition across these first ends. Since the length of the conductors 46 and 48 is equal to substantially one quarter wavelength of the oscillations, an opposite condition, i.e. a high voltage low current condition will be established at the second ends of the conductors 46 and 48, adjacent the lamp 52. This condition adjacent the lamp 52 is, of course, an ideal condition to initiate ionization of the vapor in the lamp 52. As the ionization increases, the impedance of the lamp 52, of course, drops, finally becoming so low that oscillations in the pentode stop because the tank circuit is effectively short circuited. As the impedance of the lamp 52 drops, direct current from the source 44 flows through the lamp 52, and this direct current increases until a plasma arc is formed within the lamp 52 at which time the lamp substantially appears as a short circuit.

Prior to the establishment of the plasma arc within the lamp 52, the direct current flow through the impedance 42 was small and consequently the voltage on the anode of the diode 54 was substantially at the high negative voltage established at the negative terminal of source 44. Consequently, the diode 54 was back biased. In response however to the increased direct current flow through the impedance 42 resulting in a greater voltage drop thereacross, the voltage on the anode of the diode 54 changes significantly to thereby forward bias the diode 54. Consequently, a maintaining current path is established from ground, through the conductor 48, through the lamp 52, through the conductor 46, through the diode 54, through the low voltage direct current source 56, to ground.

In normal operation, an operator would maintain the push button switch 40 closed until he notices a sudden increase in lamp brightness which indicates to the operator that a plasma arc has been established in the lamp 52 and that the lamp 52 can thereafter be maintained by the low voltage source 56. In response to this sudden increase in lamp brightness, the operator can then release the push button switch 40. The low voltage source 56 can be made to provide a humming sound when it is supplying current to thereby advise the operator that the push button switch 40 can be released. Alternatively, a current monitoring device e.g. an ammeter may be provided in the low voltage source 56 to indicate when it is supplying current to thereby advise the operator that the push button switch 40 can be released. Further, in a more expensive circuit arrangement, the push button switch 40 can be automatically opened by some relay arrangement or through the utilization of a diode switching circuit similar to that utilized for diode 54.

When the diode 54 is back biased, the negative voltage at the cathode 30 of the pentode is far below that of the screen 34 and considerable current thereby flows through the pentode. However, once the diode 54 is forward biased the only voltage drop between the screen 34 and the cathode 30 is the forward voltage drop across the diode 54, which of course is very small thereby permitting only a negligible current flow through the pentode. Since almost all of the current from the low voltage source 56 thereby flows through the lamp and since there is no impedance connected in series with the source 56, except for the forward resistance of the diode 54, extremely efficient use is made of the energy provided by the source 56.

Although the invention has been illustrated in its preferred embodiment comprising a vapor lamp starting circuit, it is specifically pointed out that loads other than a vapor lamp, which have substantially the same starting and maintaining characteristics, can be utilized in lieu of the lamp and other amplifiers can of course be substituted for the pentode. It is also suggested that the invention finds utility in situations where it is unnecessary to maintain a current through the load, as for example in photo flash units where it is merely desired to excite, but not maintain, the load. In such a situation, the diode 54 and source 56 can be deleted and as a consequence in response to the actuation of the push button 40, oscillations will be initiated in the pentode which will in turn ionize the vapor within the lamp 54 which in turn will quench the oscillations. The temporary ionization however can be utilized for, e.g., photo flash applications.

It is further pointed out that an embodiment of the invention is particularly useful for starting devices that are to be maintained in operation by low voltage transistor regulated power supplies where it is very necessary to prevent any high voltage from appearing across the power supply output terminals.

What is claimed is:

1. In combination with a load defining a substantially open circuit condition prior to the application of a high voltage high frequency signal thereacross and a substantially short circuit condition subsequent to the application of said high voltage high frequency signal thereacross, an oscillator for generating said high voltage high frequency signal, said oscillator comprising an amplifier having an output terminal, a control input terminal; and a transmission line terminated by said load connected between said output terminal and said control input terminal, and means responsive to the establishment of said substantially short circuit condition for maintaining said load in that condition.

2. The combination of claim 1 including a high voltage direct current source; a low voltage direct current source; first switch means connecting said high voltage direct current source to said amplifier; second switch means connecting said low voltage direct current source across said load; and means for opening said first switch means and closing said second switch means in response to said short circuit condition being defined.

3. The combination of claim 1 wherein the length of said transmission line is equal to one quarter wavelength of said high voltage high frequency signal.

4. The combination of claim 3 including means for establishing a low voltage high current condition at a first end of said transmission line remote from said load and a high voltage low current condition at a second end of said transmission line adjacent said load.

5. A circuit for establishing an arc in a vapor lamp comprising an amplifier including an output terminal and a control input terminal; a high voltage direct current source; first switch means coupling said high voltage direct current source to said amplifier; first and second parallel conductors; means connecting said vapor lamp between first ends of said first and second conductors for generating an oscillating signal in said conductors; means respectively connecting said output and control input terminals to said first and second conductors; means connecting a capacitor between said first and second conductors spaced from said lamp by a distance substantially equal to one quarter of the wavelength of said oscillating signal whereby a low voltage high current condition will be established across said capacitor and a high voltage low current condition will be established across said lamp for thereby establishing an arc in said lamp.

6. The circuit of claim 5 wherein said amplifier comprises a vacuum tube having a cathode, a control grid, and anode; means connecting said high voltage direct current

source in series with an impedance and said first switch means across said anode and cathode; and means connecting said lamp between said anode and said control grid.

7. The circuit of claim 5 including a low voltage direct current source; second switch means coupling said low voltage direct current source across said lamp, and means responsive to the establishment of said arc for closing said second switch means.

8. The circuit of claim 7 wherein said amplifier comprises a vacuum tube having a cathode, a control grid, and an anode; means connecting said high voltage direct current source in series with an impedance and said first switch means across said anode and cathode; means connecting said lamp between said anode and said control grid; and wherein said second switch means comprises a diode connected between said low voltage direct current source and said impedance.

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