Jan. 6, 1970 R. E. PAQUETTE 3,488,546

ARC LAMP WITH MOVABLE ELECTRODE FOR ARC STARTING

Filed Nov. 13, 1967 2 Sheets-Sheet 1

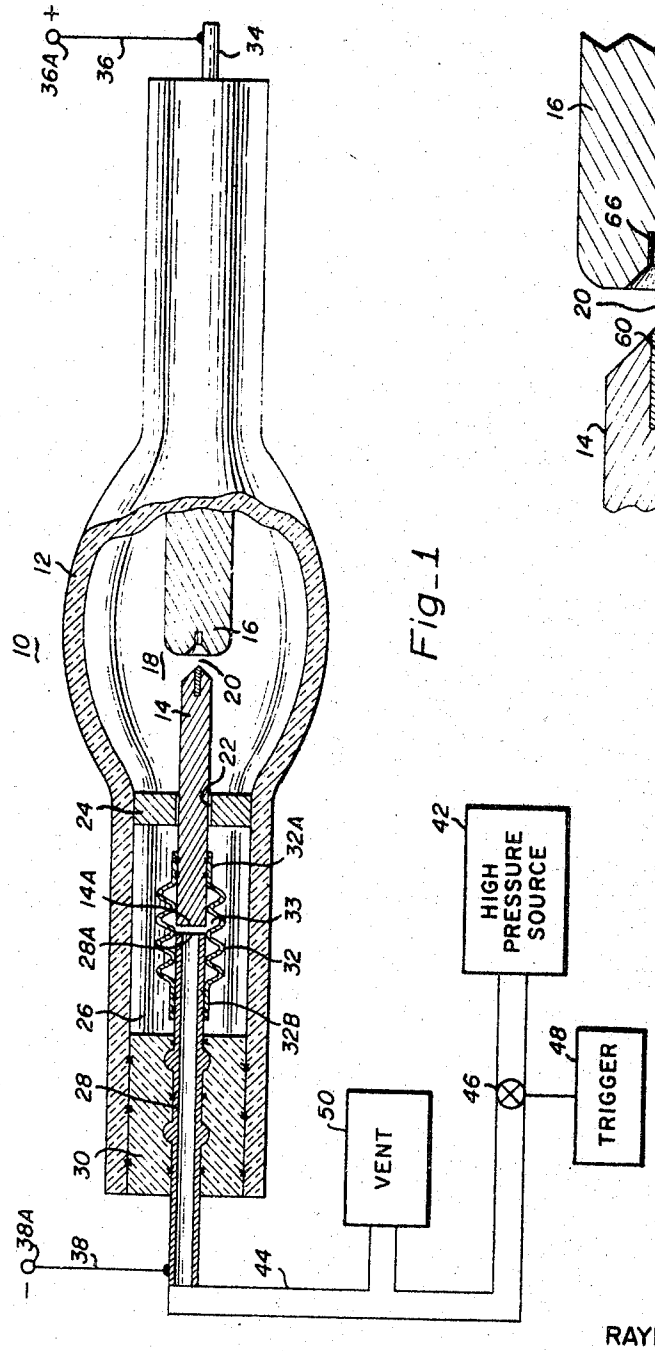


Fig-1

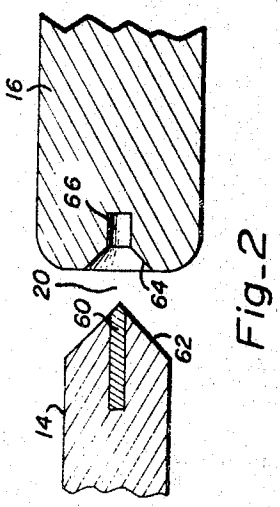


Fig-2

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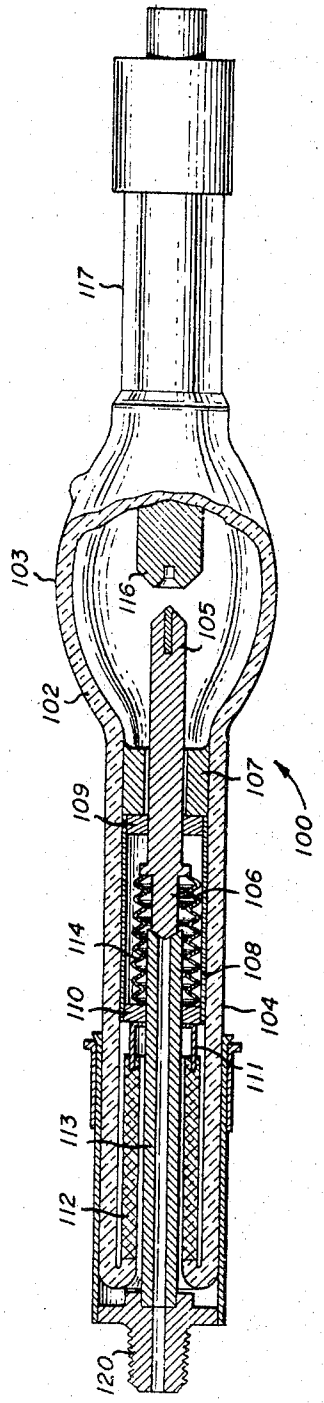


Fig_3

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ARC LAMP WITH MOVABLE ELECTRODE FOR ARC STARTING

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10 Claims

ABSTRACT OF THE DISCLOSURE

An arc lamp having one of its electrodes movably supported within a sealed envelope so that it can be moved into touching contact with the other electrode for subsequent withdrawal to form an arc across the arc gap. The movable electrode is moved towards the other electrodes by the application of high fluid pressure and is withdrawn by the application of low fluid pressure.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to arc light sources such as arc lamps and methods for starting the arc in such arc lamps and, more particularly, to an arc lamp in which the arc is started by moving one electrode against the other utilizing high fluid pressure while the electrodes are connected to a source of arc sustaining current.

Description of the prior art

Arc light sources are in relatively common use today in applications requiring intense sources of light. For example, such light sources find application for oscillographic photography, for solar simulation to determine deterioration due to sunlight, for searchlights to mention a very few.

To start such lamps ordinarily requires the initial application of a very high voltage starting pulse which is typically 15,000 volts and which is supplied by an arc starting or trigger pulse power supply. The starting pulse serves to partially ionize the gas between the electrodes to flash an arc thereacross. Once an arc is started, the power to maintain the same is at low voltage which is typically around 20 volts and which is normally provided by an arc sustaining or main power supply.

For many applications and in many environments, the requirement of having to provide a starting pulse power supply is often quite burdensome, both from the point of view of weight and complex circuitry. This is particularly true since the sole function of the starting pulse power supply is to start the arc. In many applications, where it is desirable to provide intense light sources, the weight, complexity, size and expense associated with the requirement of a starting pulse power supply has been found a serious limitation on the use of arc lamps, and many attempts have been made to find other means of starting such lamps, each of which has certain advantages and disadvantages.

For example, arc lamps used as modulatable light sources for the optical tracking of airborne vehicles make use of an exploding bridgewire which bridges the gap and which, when subjected to arc sustaining power, is consumed to start the arc. The bridgewire is described in U.S. Letters Patent No. 3,256,459 and U.S. Letters

Patent No. 3,274,427 and, while eminently suitable to start the lamp, has the disadvantage of a single use which is of no consequence in missile applications, and would not normally be economically feasible for applications requiring many starts during its useful life.

Another arc starting feature that has been proposed particularly for searchlights is a construction making use of a movable electrode which is electromagnetically moved against the other electrode and then withdrawn. The disadvantage of this type of system is that a large electromagnet and current therefor is required to generate an intense field to move the electrode. This particular starting feature, however, has a number of disadvantages which include the extremely large weight and bulk of the required magnetic structure, the large current required to energize the magnet, the danger of the electrode losing its magnetic properties as its temperature increases, and, finally, the danger of sticking electrodes unless one electrode is retracted immediately upon application of arc sustaining power.

SUMMARY OF THE INVENTION

It is, therefore, a primary object of the present invention to provide an arc lamp construction in which the arc is started, after applying arc sustaining power, by utilizing fluid pressure.

It is another object of the present invention to provide an improved arc lamp construction which is started without the use of a high voltage starting pulse, and without the use of an exploding bridgewire.

It is still another object of the present invention to provide a new and novel method of starting and constructing an arc lamp which offers great advantages where repeated uses, small size, low weight, and high reliability are important factors.

It is still another object of the present invention to provide an arc lamp construction in which one electrode is moved against the other by the application of fluid pressure, and returned to its spaced apart position through pressure within the arc lamp.

Briefly, the arc lamp construction of this invention utilizes a pair of normally spaced apart electrodes, disposed within a sealed envelope, containing a gas under pressure greater than atmospheric pressure. One of the electrodes is supported to be axially movable between a retracted position and a position where it touches the other electrode. The end portion of the movable electrode, opposite the arc end, is normally exposed to atmospheric pressure while the arc end is exposed to the internal lamp pressure. The pressure differential across the end portion of the electrode first moves and thereafter maintains the electrode in its retracted position.

To start the arc, the end portion of the movable electrode, normally exposed to atmospheric pressure, is exposed to a high fluid pressure which is in excess to the internal lamp pressure. This causes the movable electrode to move into the touching position until the fluid pressure is relieved. Application of normal arc lamp sustaining power, coupled with the subsequent retraction of the movable electrode, causes the arc to bridge the gap.

Further objects and advantages of the present invention will become apparent to those skilled in the art to which the invention pertains as the ensuing description proceeds.

The features of novelty that are considered characteristic of this invention are set forth with particularity in the appended claims. The organization and method of opera-

tion of the invention itself will best be understood from the following description when read in connection with the accompanying drawing in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view, partly in elevation and partly in cross section, of an arc lamp embodying the present invention;

FIG. 2 is a cross-sectional view of the arc end configuration of a pair of electrodes in accordance with the present invention; and

FIG. 3 is a view, partly in elevation and partly in cross section, of another arc lamp embodying the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and particularly to FIG. 1, there is shown an arc lamp **10** constructed in accordance with this invention comprising an envelope **12** which is typically made out of quartz for well-understood reasons and which defines an interior space **18** which is sealed and which contains a gas under pressure in excess of atmospheric pressure. Also disposed in space **18** are a pair of electrodes **14** and **16** which are spaced apart to define an arc gap **20** therebetween. Electrode **14** may form the cathode and electrode **16** may form the anode of the arc lamp, and both electrodes are normally constructed of a refractory metal such as molybdenum or tungsten. As will be explained in greater detail in connection with the description of FIG. 2, in the preferred embodiment of the present invention, the electrodes are constructed of different refractory metals to avoid sticking together.

Electrode **14** is slidingly supported within envelope **12**, for displacement along its axis, by a bearing bore **22** in an electrode support member **24**. Electrode support member **24** may be formed of quartz or the like, and is rigidly supported by the neck of envelope **12**. As will be understood hereinafter, support member **24** does not require to form a seal with envelope **12** since bearing bore **22** is not sealed to electrode **14**. As a consequence thereof, the space **26**, lying on the opposite side of support member **24** than space **18**, is generally at the same pressure as space **18**.

There is also provided a tubular member **28** which may, but does not necessarily need, be constructed of a refractory metal. Tubular member **28** is sealingly supported within the neck of envelope **12** by a sealing member **30**, which may be constructed of quartz, having its outer peripheral surface sealed to the interior surface of envelope **12**, and its inner peripheral surface sealed to the outer surface of tubular member **28**. Finally, there is provided a bellows **32** which has its end portion **32A** sealed to electrode **14** and its end portion **32B** sealed to the outer surface of tubular member **28**.

Electrode **16** is conventionally sealed into the other neck of envelope **12** as shown, and the particular type of seal forms no part of the present invention. One end of electrode **16** is conventionally connected to a rod **34** with which envelope **12** normally forms a rod seal. An electrical power lead **36** may be connected to rod **34**, as shown, to which the positive terminal **36A** of the arc lamp current source (not shown) is applied. Similarly, an electrical power lead **38** may be connected to tubular member **28** to which the negative terminal **38A** of the arc lamp current source is connected.

The interior space of tubular member **28** is connected to a high pressure fluid source **42** through a fluid line **44** which includes a valve means **46** actuatable by a trigger **48**. Some venting means **50** may be connected to line **44** to bleed off the high fluid pressure at a predetermined rate and to protect the system against damage.

In operation, a source of arc power is connected across terminals **36A** and **38A** which is typically the power necessary to sustain a once established arc. Either simultaneous with or any time after the application of arc sustaining power, trigger **48** is activated to cause high pressure fluid from source **42** to enter the interior space of tubular member **28** and pressurize the interior space **33** within bellows **32** with a pressure which exceeds the pressure within space **18**. As a consequence of pressurizing space **33**, a pressure differential exists across electrode **14** urging the same to move axially in the direction of electrode **16** until the displacement is stopped by touching contact.

As soon as the arc tip of electrode **14** touches the arc tip of electrode **16**, current flow starts and an arc is formed as the electrodes are separated. Application of high fluid pressure is only momentary to move electrode **14** into touching position with electrode **16**. After the electrodes touch, the high pressure source is disconnected from line **44**, and the fluid pressure in space **33** is allowed to bleed off thereby reversing the pressure differential across electrode **14** allowing the same to move to its retracted position in which end face **14A** of electrode **14** contacts end face **28A** of tubular member **28** or some other convenient stop.

It should be noted at this point that the time necessary for returning electrode **14** to its normal retracted position depends on a number of factors including the friction between bearing bore **22** and electrode **14** and the pressure differential across the electrode. Since the speed of retraction should be selected for best arc drawing across the gap, means are provided to control the speed of retraction in the form of vent means **50** which controls the pressure differential across electrode **14**. Vent means **50** initially must allow the rapid build-up of pressure so that electrode **14** is firmly and positively moved into touching position, and thereafter must dissipate the pressure at a rate such that the speed of retraction is optimum for arc drawing. One vent means **50** may take the form of a small opening in line **44** having a diameter such that a certain finite time is required for the pressure within space **33** to return to atmospheric pressure after the application of high pressure. In addition to, or instead of, a vent means in the form of a small opening, a relief valve may be provided which includes a delay to permit maintaining pressure long enough to assure that electrode **14** is moved in the touching position, and thereafter provide venting at a rate commensurate with a described rate of retraction.

Referring now to FIG. 2, there is shown a preferred embodiment of the arc ends of cathode **14** and anode **16** which are particularly suitable for arc lamps which are started by moving one electrode into contact with the other. Cathode **14** is constructed of molybdenum and anode **16** of tungsten. It is generally recognized that placing two electrodes into conductive contact with one another, and applying arc power thereto, will cause a certain amount of sticking if the electrodes are allowed to get very hot and are not rapidly enough withdrawn. This effect is similar to the one used for welding and is extremely undesirable in starting arc lamps. Utilization of dissimilar metals, such as molybdenum for one electrode and tungsten for another electrode, discourages electrode fusion to some extent. Since molybdenum normally has a much shorter lifetime as an arc electrode than tungsten, a tungsten insert is provided in the form of a rod **60** in cathode **14**. Further, the end of electrode **14** is shaped in the form of a conoid **62**, and a corresponding or mating conical opening **64** is provided in anode **16**. Finally, a cylindrical counter-sink **66** is provided at the apex of opening **64** to clear the tip of insert **60** from touching any part of tungsten anode **16**. As cathode **14** and anode **16** come together, conical surface **62** will engage conical surface **64** without sticking because of the dissimilar material, and the actual arc end of tungsten rod **60** remains out of contact with tungsten anode **16**.

It is to be understood that a number of modifications can be made within the spirit of this invention. For example, tubular member **28** is herein utilized not only for the purpose of providing a means for applying high fluid pressure to space **33** to move electrode **14**, but also to provide a current path to electrode **14** via bellows **32**. If desired, arc current carrying ribbons can be attached to

bellows **32** or may otherwise be sealed into the stem of envelope **12** if desired. Further, while ordinarily electrode **16**, and particularly the configuration shown in FIG. 2, provides a positive and convenient stop for moving electrode **14**, it is likewise within the contemplation of this invention to provide some stopping means such as the end face of bellows portion **32A** contacting support member **24**.

Referring now to FIG. 3, there is shown an alternate embodiment of the arc lamp embodying the present invention which includes a number of features found desirable, from practical considerations, to effect proper seals. Even though the arc lamp of FIG. 1 illustrates the basic concept of the present invention, the seals there shown are essentially in schematic form to allow for greater clarity in the description of the invention.

Referring now to FIG. 3, there is shown an arc lamp **100** comprising a quartz envelope **102** forming a bulb portion **103**, a cathode stem portion **104** and an anode stem portion **117**. Cathode stem portion **104** supports a lengthwise movable cathode **105** having one end welded or otherwise affixed to an alignment and backstop pin **106**. At the mouth of stem portion **104** there is supported a quartz alignment washer **107** whose inner bore is dimensioned to allow cathode **105** to freely slide lengthwise. Also supported within stem portion **104** is a molybdenum sleeve **108** which has sealed to its end portions a pair of molybdenum rings **109** and **110**. Ring **109** has an inner bore allowing freely sliding motion of cathode **105**.

Ring **110** has sealed thereto a Kovar cup **111** which in turn is sealed to envelope **102** via a graded seal **112**. The inner bore of ring **110** is also sealed to a tubular member **113** which extends out of stem portion **104** and terminates in a fitting **120**. Bellows **114** have opposite ends sealed respectively to ring **110** and the inner shoulder of stop pin **106** thereby completing the sealed structure. There is also provided an anode **116** which is supported in anode stem portion **117** of arc lamp **100** in the usual manner.

The operation of the arc lamp of FIG. 3 is the same as the one described in connection with the arc lamp of FIG. 1, when a source of high pressure is connected to connector fitting **120**.

There has been described an arc lamp construction in which the cathode is moved under pressure against the anode, and then allowed to return to its retracted position, thereby carrying the arc across the arc gap. The arc lamp is simple to operate, inexpensive to construct and very reliable, there being no particular requirements imposed on making the electrode movable which would deleteriously affect either performance, operation or reliability.

What is claimed is:

1. An arc lamp comprising:

a sealed envelope;

a pair of electrodes having arc ends disposed within said envelope, at least one of said electrodes being movable with respect to the other between a normally retracted position in which said ends are spaced apart to define a normal arc gap therebetween and a touching position in which said arc ends are in conductive contact;

connecting means for connecting said electrodes to the terminals for a power supply disposed outside said envelope; and

a fluid pressure system including a tubular member sealed to and passing into said envelope and a bellows means sealingly connecting the end of said tubular member to said movable electrode, said bellows means being pressurized through said tubular member to move said movable electrode, said fluid pressure system being operable between a first state for urging said movable electrode into said touching position and a second state for urging said electrodes into said retracted position.

2. An arc lamp in accordance with claim **1** in which said bellows means and said tubular member are conductive and in which said connecting means includes said bellows means and said tubular member.

3. An arc lamp in accordance with claim **2** in which at least the portions of said electrodes which are in contact when said electrodes are in said touching position are constructed of different metals to minimize sticking during arc lamp starting.

4. An arc lamp in accordance with claim **3** in which one of said electrodes is constructed of tungsten and the other electrode is constructed of a refractory metal other than tungsten, and in which the arc end of the other-than-tungsten electrode is shaped to have a conical end portion and the arc end of the tungsten electrode is shaped to provide a seat mating with said conical end portion, the center of said seat being recessed to prevent the apex of said conical end portion from making direct contact with the tungsten electrode.

5. An arc lamp in accordance with claim **4** in which said other-than-tungsten electrode is provided with an axial bore at said conical arc end portion, and in which a tungsten pin having a conical end is disposed within said axial bore to form the operating arc end of said other-than-tungsten electrode, said pin being dimensioned and positioned such that it will not make direct contact with said tungsten electrode when said electrodes are in said touching position.

6. An arc lamp comprising:

a sealed envelope;

a pair of electrodes having arc ends disposed within said envelope at least one of which is movable with respect to the other between a normally retracted position in which said arc ends are spaced apart to define a normal arc gap therebetween and a touching position in which said arc ends are in conductive contact, one of said electrodes being constructed of a first refractory metal and the other electrode being constructed of a different refractory metal, the arc end of said one electrode being shaped to have a generally conical end portion and the arc end of said other electrode being shaped to provide a seat for mating with the conical end portion of said one electrode, the center of said seat being recessed to prevent the apex of said conical end portion from making direct contact with said other electrode;

connecting means for connecting said electrodes to the terminals of a power supply disposed outside said envelope; and

a fluid pressure system operatively coupled to said lamp for moving said one electrode relative to the other, said fluid pressure system being operable between a first state for urging said one electrode into said touching position and a second state for urging said one electrode into said retracted position.

7. An arc lamp in accordance with claim **6** in which said one electrode is provided with an axial bore at said conical arc end portion and in which a pin formed of a metal other than said first refractory metal and having a conically shaped end is disposed within said axial bore to form the operating arc end of said one electrode, said pin being dimensioned and positioned such that it will not make direct contact with said other electrode when said electrodes are in said touching position.

8. An arc lamp in accordance with claim **7** which further includes a tubular member sealed to and passing into said envelope, said member forming a communicating passage between said fluid pressure system and said movable electrode.

9. An arc lamp in accordance with claim **8** which further includes bellows means sealingly connecting said tubular member to said movable electrode.

10. An arc lamp in accordance with claim **9** in which said bellows means and said tubular member are conduc-

tive and in which said connecting means includes said bellows means and said tubular member.

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U.S. Cl. X.R.

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