June 24, 1969 N. C. BEESE 3,452,236

HIGH-PRESSURE ELECTRIC DISCHARGE LAMP HAVING MAGNETICALLY ACTUABLE ARC IGNITION MEANS, AND APPARATUS FOR STARTING SUCH A LAMP

Filed Dec. 6, 1966 Sheet 1 of 3

FIG. 1.

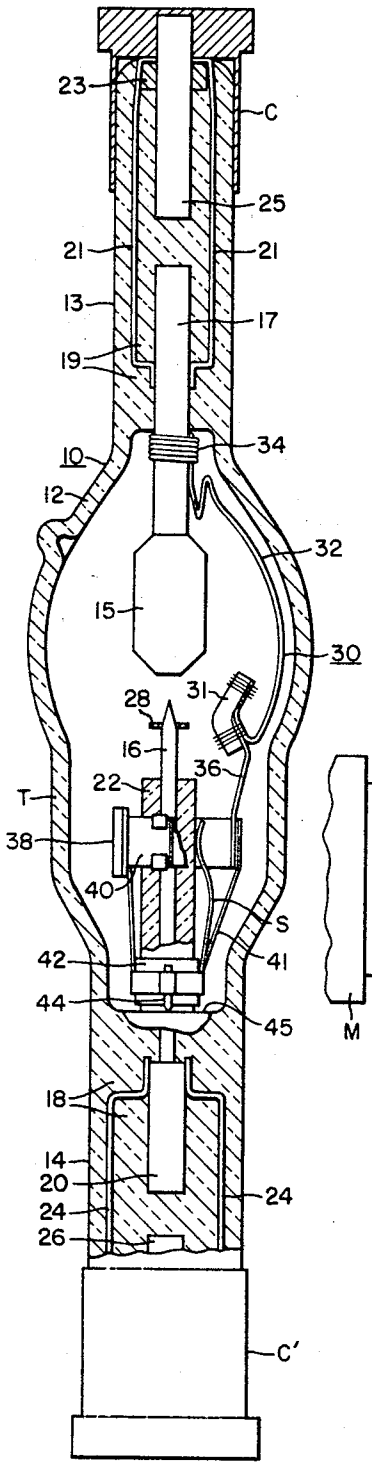
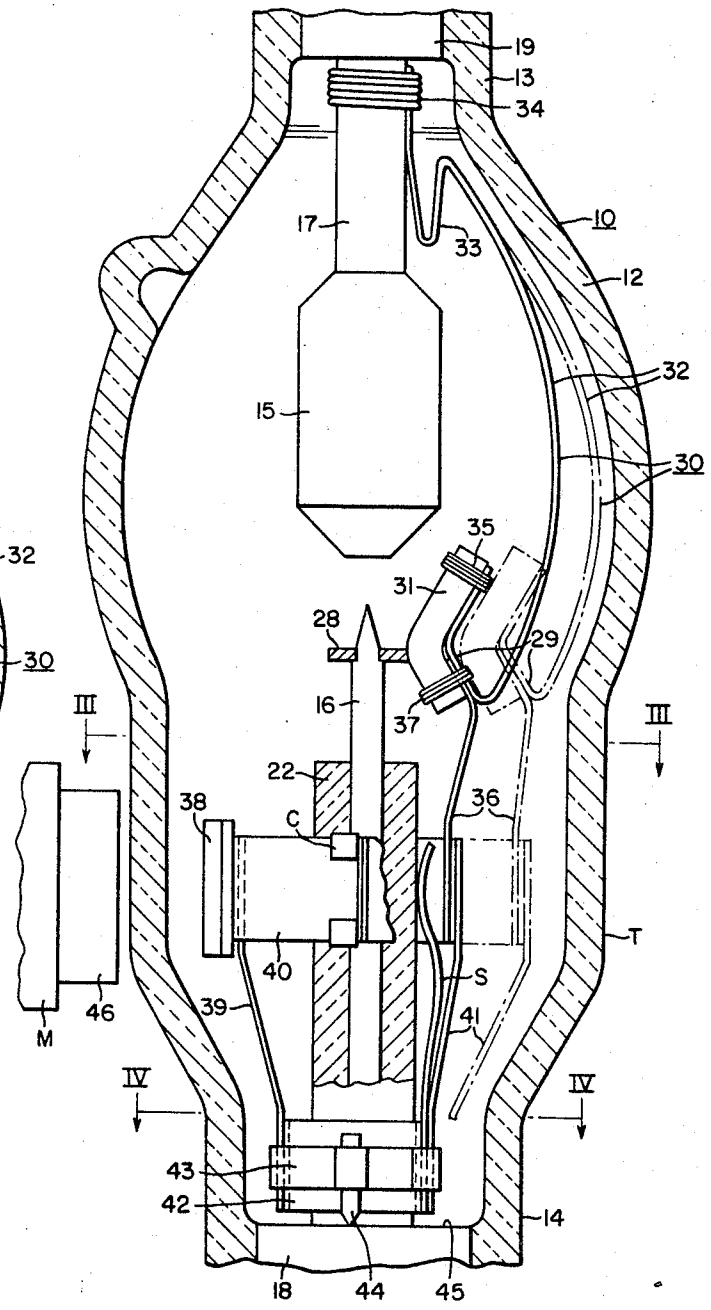


FIG. 2.



INVENTOR
Norman C. Beese

BY D. S. Bulega
AGENT

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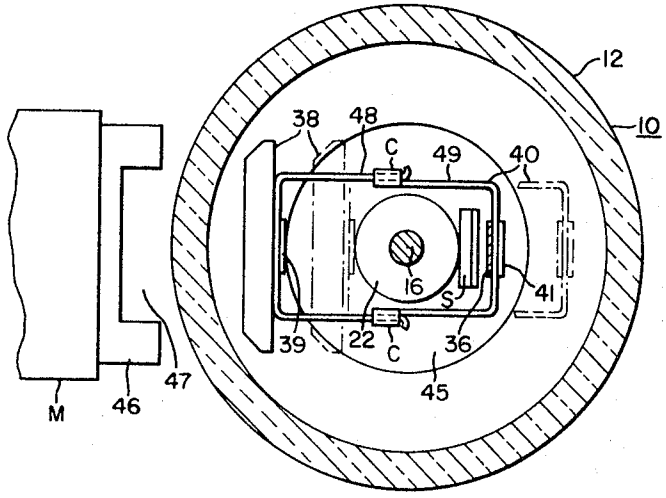


FIG.3.

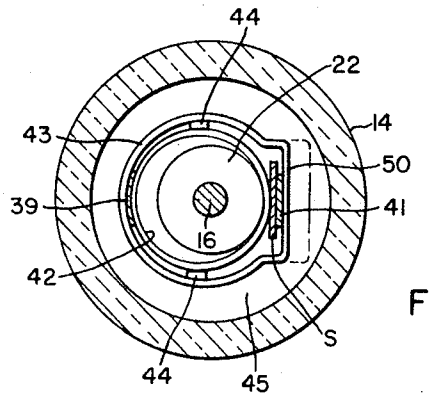


FIG.4.

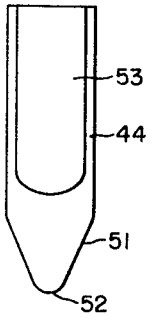


FIG.5.

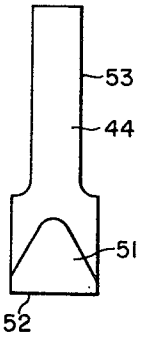


FIG.6.

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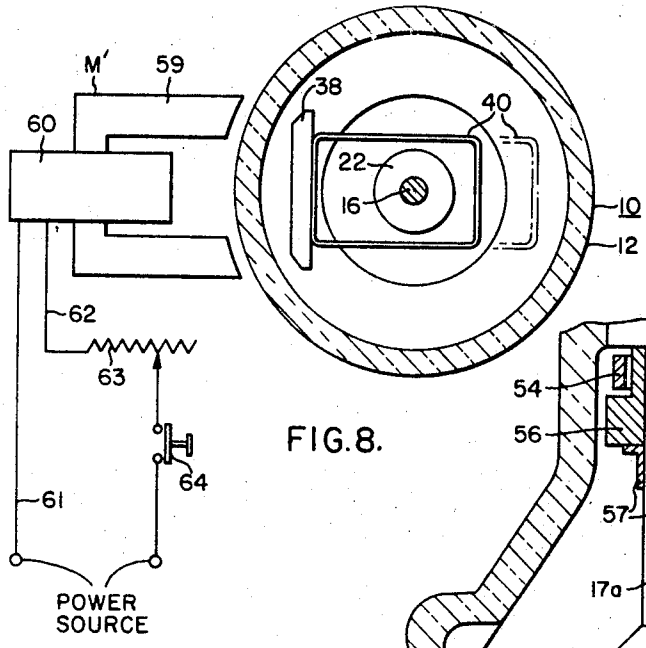


FIG. 8.

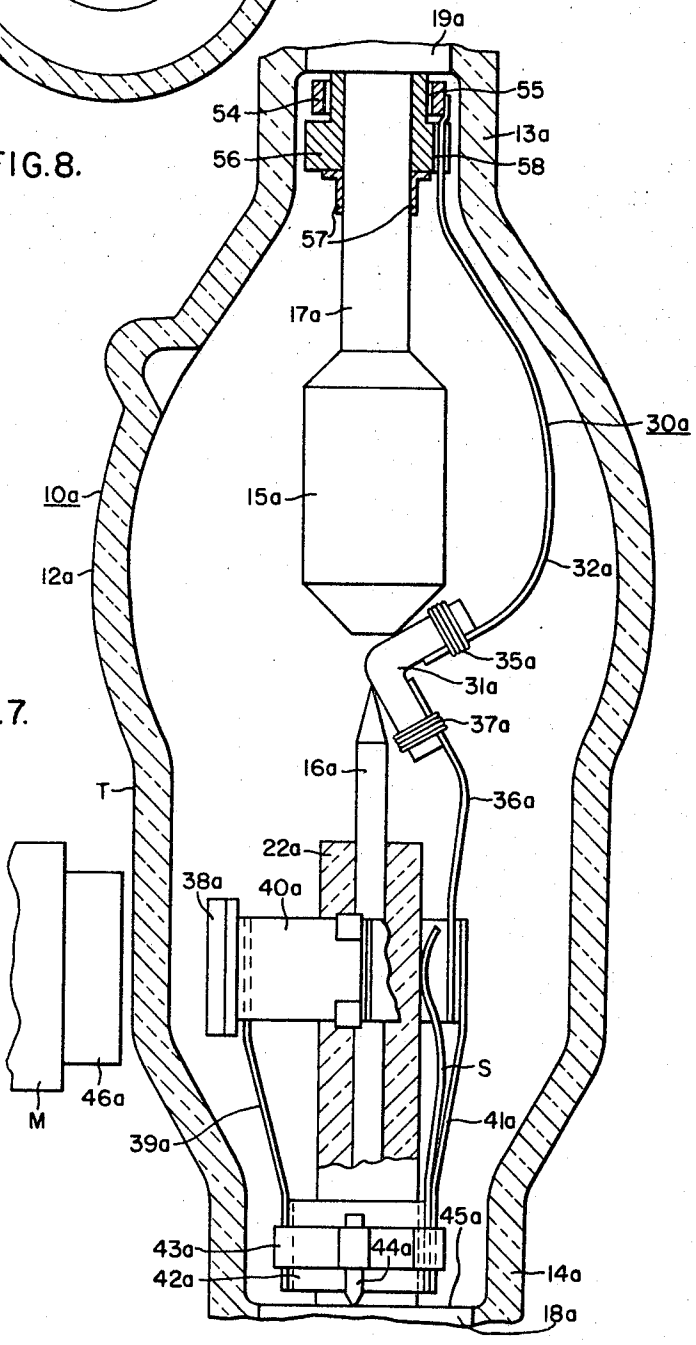


FIG. 7.

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3,452,236

HIGH-PRESSURE ELECTRIC DISCHARGE LAMP HAVING MAGNETICALLY ACTUABLE ARC IGNITION MEANS, AND APPARATUS FOR STARTING SUCH A LAMP

Norman C. Beese, Verona, N.J., assignor to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

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Int. Cl. H01j 1/50, 1/52, 21/22
U.S. Cl. 313—152 18 Claims

ABSTRACT OF THE DISCLOSURE

An elongated arc-initiating assembly is movably mounted within the lamp envelope and actuated by an exterior electromagnet so that a refractory metal member mounted on a flexible part of the assembly makes-and-breaks contact with one or both electrodes. The assembly, when actuated, momentarily completes the circuit between the energized electrodes and then, as it retracts, draws an arc from one electrode that is transferred to the other electrode to effect lamp ignition.

Background of the invention

This invention relates to electric discharge devices and has particular reference to a high-pressure short-arc lamp and an improved apparatus for starting such lamps. As is well known, high-pressure gaseous discharge lamps require a much higher starting voltage than operating voltage. In the case of short-arc lamps, starting is generally accomplished by applying a series of high-voltage pulses in the order of 20 to 50 kilovolts to the lamp electrodes to ionize the gas and strike the arc. A starting circuit of this type wherein the high-voltage pulses are produced by a spark-gap oscillating circuit is described in U.S. Patent No. 2,708,251 issued to C. M. Rively. Such pulse-type starting circuits are expensive, bulky, and critical in that they must be properly adjusted to avoid excessive power inputs which could destroy the fragile lead-in conductors or otherwise damage the lamp.

Discharge lamps and starting circuits utilizing magnetically-actuated auxiliary electrodes are also known. Lamps and circuits of this type are described in U.S. Patent Nos. 1,086,105 and 1,144,396. However, the prior art structures are inherently unsuited for use in high-intensity discharged amps insofar as the auxiliary electrode remains in the discharge path and requires a large or constantly energized electromagnet.

Summary of the invention

It is accordingly the general object of the present invention to provide an improved high-pressure electric discharge lamp which has a long useful life and can be reliably started with voltages of much lower magnitude than those heretofore required for lamps of this type.

Another object is the provision of an improved short-arc lamp that is practical from a manufacturing standpoint and can be repeatedly and reliably started without the use of high-voltage auxiliary equipment or impairing its performance.

Still another object is the provision of a compact and inexpensive apparatus which will quickly and reliably start such lamps on conventional power supplies without interfering with or impairing the normal operation of the lamp.

Briefly, the aforesaid objectives and other advantages are achieved in accordance with the present invention by mounting a flexible arc initiating assembly of conjoined refractory metal strips within the lamp in such a way that

the medial portion of the assembly is free to swing in pendulum-like fashion toward and away from the electrodes.

According to a preferred embodiment, one end of the starter assembly is hingedly attached to the anode of a short-arc lamp and the opposite end of the assembly is hingedly attached to but insulated from the cathode so that a metal striker bar carried by the assembly will make and break contact with a predetermined portion of the cathode. The lateral movement of the assembly and striker bar is achieved by means of an armature of magnetizable material that is fastened to the assembly and is actuated by an electromagnet located outside the lamp. The spacing between the striker bar and cathode and the other parameters are such that when the normal operating voltage is applied to the lamp electrodes and the striker bar is actuated and then returned to its normal break-contact position, it draws an arc of sufficient length from the cathode that the arc is transferred to the anode by convection currents generated by the heated filled gas—thus starting the lamp.

The invention includes novel arrangements for swingably attaching the arc-initiating structure to the electrodes and making them integral parts of a subassembly that can be inserted into the envelope through one of its sealing arms. A preferred apparatus for starting a lamp having the aforementioned magnetically-responsive arc-initiating structure is also provided which minimizes the size of the electromagnet and isolates the lamp from magnetic fields during operation.

Brief description of the drawing

A better understanding of the invention will be obtained by referring to the accompanying drawing, wherein:

FIGURE 1 is a longitudinal sectional view of a high-intensity short-arc lamp embodying one form of starting assembly in accordance with the present invention;

FIG. 2 is an enlarged sectional view of the light-generating portion of the lamp shown in FIG. 1 and one form of exterior electromagnet for actuating the starting assembly;

FIGS. 3 and 4 are cross-sectional views along the lines III—III and IV—IV, respectively, of FIG. 2;

FIGS. 5 and 6 are side and front elevational views, respectively, of the pivot pins utilized in the lamp shown in FIGS. 1–4 to provide a freely movable lower anchorage for the starting assembly;

FIG. 7 is a fragmentary longitudinal sectional view of a short-arc lamp embodiment having a modified starting assembly; and,

FIG. 8 is a cross-sectional view of a short-arc lamp of the type shown in the preceding figures and a schematic diagram of a preferred form of actuating electromagnet and associated energizing circuit.

While the present invention can be used with advantage to start various types of gaseous discharge devices which require a higher starting than operating voltage, it is particularly adapted for use in conjunction with high-intensity short-arc lamps designed to be operated in a vertical position from a direct-current power source and it has accordingly been so illustrated and will be so described.

Embodiment I

In FIG. 1 there is shown a 1200 watt xenon short-arc lamp **10** having an envelope **12** of suitable light transmitting material, such as quartz, which is terminated by a pair of opposed sealed arms **13** and **14** that hold an enlarged anode **15** and a cathode **16** in spaced apart aligned relationship within the envelope. The anode **15** has a shank **17** which is anchored in a body of quartz **19** that is fused to and hermetically seals the envelope arm **13** in

the customary manner. The anode **15** is electrically connected to a terminal cap C by suitable lead-in conductor means such as a number of sealed-in refractory metal ribbons **21** that are attached to the anode shank **17** and to a metal collar **23** that is sealed into the end of the envelope arm **13**. The collar, in turn, is fastened to a support rod **25** that is attached to the terminal cap C and anchored in the arm **13**.

The cathode **16** comprises a pointed rod that is partly embedded in a fused quartz core **18** that closes the other envelope arm **14** and is connected by a metal sleeve **20** and a second group of sealed-in metal ribbons **24** to the support rod **26** of another terminal cap C'. The lamp **10** is designed to operate on a direct-current power source of approximately 40 or 50 volts in a substantially vertical position with the anode disposed above the cathode, as shown in FIGS. 1 and 2. The electrodes are fabricated from tungsten or other suitable refractory metal.

Ignition of the lamp **10** is accomplished in accordance with the present invention by a flexible elongated arc-initiating assembly **30** which, as is shown in FIGS. 1 and 2, is swingably mounted in pendulum-like fashion within the envelope **12** and disposed so that an intermediate portion of the assembly is movable toward and away from the tip of cathode **16** in a lateral direction when the lamp is disposed in its vertical burning position.

The starting assembly **30** is actuated by a magnetic field generated by an exterior electromagnet M (FIG. 2) that is located adjacent the lamp **10** and properly oriented with respect to a magnetically-responsive component that comprises an integral part of the assembly. In this embodiment, the aforesaid component comprises a flat generally rectangular armature **38** of highly permeable material, such as iron, that is attached to the lower end of the assembly **30** by a laterally extending support or yoke structure **40**. This support yoke is located within a cylindrical or tubular portion T of the envelope **12** and is so arranged that the armature **38** faces the envelope wall.

As is shown more particularly in FIG. 2, the upper portion of the starting assembly **30** comprises a thin arcuate strip **32** of suitable resilient refractory metal one end of which is attached to the anode shank **17**, as by welding and a few turns **34** of tungsten wire. The lower end of the metal strip **32** is fastened to one end of an angular striker bar **31** of electrically conductive material and to a second refractory metal strip **36** that is attached to the other end of the striker bar and extends downwardly therefrom. The ends of the metal strips **32** and **36** are welded to the striker bar **31** and a few turns **35** and **37** of tungsten wire are desirably wound around each end of the bar as insurance in case of a weld failure. The striker bar **31** is fabricated from a suitable refractory metal such as tungsten.

The lower end of the metal strip **36** is fastened to one end of the laterally extending support yoke **40** which, in turn, is held in such position by a pair of flexible metal support straps **39** and **41** attached to the diametrically opposite ends of the yoke. The lower ends of the straps **39** and **41** are fastened to a collar **42** that encircles a sleeve **22** of vitreous material, such as quartz that encases the shank portion of the cathode **16** and is fused to the quartz core **18**.

The armature **38** is thus located on one side of the cathode **16** and the striker bar **31** and the main body portion of the assembly **30** on the other. This permits the pole piece **46** of the electromagnet M to be positioned close to and aligned with the armature **38**. Thus, when the magnet M is energized, it attracts the armature **38** and pulls the lower end of the assembly **30** to the left, as viewed and shown in FIG. 2, a sufficient distance to cause the striker bar **31** to contact the cathode **16**. When the electromagnet M is deenergized, the assembly **30** and striker bar **31** are returned to their original position (indicated by the phantom showing in FIG. 2) by the spring action of the upper metal strip **32** and a metal leaf spring S that is attached to the collar **42** and presses against the upper portion of the quartz sleeve **22**. The striker bar **31** is thus movable along a linear horizontal path into make-and-break contact with the cathode **16** by the electromagnet M and the restoring force exerted by the aforementioned springs.

Upper hinge assembly

In order to keep the size of the electromagnet M within practical limits, the restoring spring system and manner of mounting the starting assembly **30** within the lamp **10** must be such that the assembly can be readily shifted into its make-contact position. An important feature of the present invention is accordingly the manner in which the assembly **30** is swingably attached to the electrode structures. As will be noted in FIG. 2, the arcuate spring strip **32** is provided with an S-shaped retroverted segment **33** adjacent its upper end that provides a bellows-type hinging action. This not only increases the flexibility of the metal strip **32** but reduces the stress imparted to the metal as it flexes. This latter feature is important insofar as the metal strips **32** and **36** are heated to elevated temperatures during lamp fabrication and when the lamp is operated and thus tend to recrystallize and become brittle. The aforesaid bellows type juncture has been found advantageous in preventing the premature failure of the starter assembly due to metal fatigue.

The stress on the opposite end of the metal strip **32** is reduced in a similar fashion by forming a U-shaped retroverted segment **29** thereat instead of attaching it directly to the proximate end striker bar **31**.

Lower rocker-arm assembly

The lower end of the starting assembly **30** is swingably held in place by a rocker-arm type anchorage consisting of the metal collar **42** which loosely fits around the quartz sleeve **22** and has a pair of pivot pins **44** (see FIG. 4) attached to diametrically opposite sides of the collar by a ring clamp **43**. The clamp also overlies the end of the support strap **39** and has a flat portion **50** that accommodates the ends of the spring S and the other strap **41**. As will be noted in FIG. 4, the collar **42** is considerably larger in diameter than the quartz sleeve **22** and permits the lower end of the assembly **30** to move a predetermined distance laterally, as indicated by the broken lines.

The lower ends of the pins **44**, as shown in FIGS. 1 and 2, engage the flat upper surface **45** of the quartz core **18** and thus serve as pivot members that support the entire weight of the starter assembly **30**. The assembly is accordingly free to pivot on the pins **44** and move laterally a limited distance relative to the sleeve **22**.

The frictional forces and drag inhibiting such movement are minimized by providing the pins **44** with flattened tip portions **51** and smoothly rounded points **52**, as shown in FIGS. 5 and 6. The upper shank portions **53** of the pins are desirably flattened to facilitate the sandwiching thereof between the circular collar **42** and retaining ring **43** (see FIG. 4.)

Support yoke assembly

Another important feature is the construction of the support yoke **40**. As shown in FIG. 3, the yoke consists of a pair of conjoined U-shaped members **48** and **49** that provide a rectangular frame which straddles and is spaced from the quartz sleeve **22** and is thus free to move laterally without touching the sleeve or interfering with the action of the restoring spring S. The members **48** and **49** are held in telescopic relation by suitable locking means, such as friction clamps C, so that the yoke can be collapsed and reduced to approximately half its extended length during the lamp assembly operation. This is an important advantage since it permits the arc-initiating structure **30** and associated components to be attached to the electrode structures and the resulting subassembly inserted as a unit into the envelope **12**

through one of its sealing arms. When the subassembly is properly positioned within the envelope, the telescoped support yoke **40** is extended to its full length shown in FIG. 3 and is retained in such condition by the clamps C. The envelope arms **13** and **14** are then sealed to the quartz cores **18** and **19** in the usual manner.

Starting method and apparatus

The lamp **10** is started in accordance with the principles of this invention by applying the normal operating voltage across the anode **15** and cathode **16** and then momentarily energizing the electromagnet M. The resulting magnetic field attracts the armature **38** which pulls the medial portion of the starting assembly **30** toward the discharge path until the striker bar **31** contacts the cathode **16**, as shown in FIG. 2. Since the striker bar **31** is electrically connected to the anode **15** by the assembly **30** but is insulated by the vitreous sleeve **22** from the cathode **16**, it completes the circuit between the cathode and anode while it is in its make-contact position.

As soon as the electromagnet M is deenergized and the magnetic field is removed, the assembly **30** is returned to its original position by the restoring spring **32** and S thereby retracting the striker bar **31** from the cathode **16**. The striker bar **31** draws an arc from the cathode **16** and current temporarily flows through the metal spring strip **32** to the anode **15**. Gas convection currents generated in the hot atmosphere around the arc simultaneously pump ionized xenon gas into the discharge gap which quickly transfers the arc from the striker bar **31** to the tip of the anode **15**. This make-break contact and arc-shifting sequence occurs very rapidly and, since the striker bar **31** is automatically cut out of the circuit when in its normal break-contact position, the lamp **10** continues to operate in the normal fashion.

Additional structural features

Experience has shown that the arc will not transfer from the striker bar **31** to the anode **15** if the striker bar touches the cathode **16** too far from its tip. The arc will be initiated satisfactorily but the current will continue to flow through the striker bar **31** and spring strip **32** and will not transfer to the anode **15**. This difficulty is overcome by using an angular shaped striker bar **31** of the type shown in FIGS. 1 and 2 having a bend or sloped surface the apex of which faces the cathode **16** and is oriented to contact a laterally-protruding part of the cathode. The aforesaid protuberance is conveniently formed by fastening a tungsten washer **28** (as here shown) or a coil of tungsten wire to the cathode **16** at a controlled distance from its tip. The striker bar **31** thus engages a predetermined portion of the cathode **16** near its tip and the latter, due to its small mass, heats up rapidly and minimizes the blackening effect on the envelope during the starting cycle. For optimum results in the case of a 1200 watt xenon lamp of the type here shown, the spacing of the washer **28** from the cathode tip should be approximately 3 mm.

It has also been found that reliable starting will not occur if the striker bar **31** is spaced too close or too far from the cathode **16**. The spring portions of the assembly **30** are thus designed to produce a restoring force such that the striker bar, when in its normal break-contact position, is spaced approximately 2 to 4 mm. from the washer **28**, and preferably 3 to 4 mm.

Lamp tests have demonstrated that the presence of even relatively weak magnetic fields within the lamp, once it has been started, cannot be tolerated since they distort the arc and stretch it to such an extent that the lamp extinguishes itself. Thus, the electromagnet M is only energized momentarily to produce a pulse of magnetic power which actuates the starting assembly **30**. The magnet is then immediately deenergized. A steady magnetic field from a permanent magnet or a constantly energized electromagnet thus cannot be used to keep the starting assembly **30** in its break-contact position.

Optimum results are also achieved if the magnetic field is configured and oriented in such a way that it produces linear motion of the armature **38** (i.e. along a path that is substantially normal to the longitudinal axis of the lamp) with a minimum of rotational torque. To this end the pole piece **46** of the electromagnet M, as shown in FIGS. 2 and 3, is at least as large as the armature **38**, is disposed parallel thereto and preferably provided with a central longitudinal-extending slot or cavity **47** (FIG. 3) that divides the face of the pole piece into two spaced segments which are substantially aligned with the side edges of the armature.

In view of the foregoing restriction regarding the presence of magnetic fields within the lamp **10** during operation, the armature **38** is fabricated from magnetizable material which will quickly return to a demagnetized condition in the absence of magnetic field. While the armature can be fabricated from soft iron, iron has a Curie point of 770° C. which is too low to permit the lamp to be restarted while it is still hot. (The Curie point is the temperature at which the magnetic properties of a material disappear due to thermal agitation.) Hence, it is advantageous to fabricate the armature from a material which not only is highly permeable but retains its permeability at elevated temperatures. The armature is accordingly preferably fabricated from a material such as "Hiperco-27" alloy which contains 27% cobalt and 73% iron and has a Curie point of 925° C.

While the spring metal strip **32** and leaf spring S may be fabricated from molybdenum, tantalum or tungsten, these metals tend to lose their flexibility at elevated temperatures due to recrystallization or impurity gettering. The aforesaid components are accordingly preferably made from tungsten "K" metal which has a much higher recrystallization temperature than molybdenum and tungsten and will thus retain its resiliency for a longer period of time under the high temperature conditions which prevail within the lamp when it is operating. Tungsten "K" metal is an alloy of tungsten and a small percentage (e.g., 2% by weight) of thorium oxide. Since a strip of tungsten (and its alloys) is more rigid than a molybdenum strip of the same dimensions, the aforesaid spring elements if made from tungsten or a tungsten alloy are desirably made of thinner material, or from a pair of superimposed strips which are one-half the thickness of the single strip.

Test data

The aforesaid combination of a flexible magnetically-actuable starting assembly **30** and a pulse-energized exterior electromagnet M will rapidly and reliably start a short-arc lamp on the same power supply used to operate the lamp. Starting currents and times obtained on a 1200 watt short-arc lamp having an arc length of about 5 millimeters, a spacing of about 2.5 millimeters between the cathode tip and striking bar when the latter is in its normal break-contact position, and a filling of xenon at a pressure of 6 atmospheres, and operated on a 65 volt DC power supply are given in Table I below.

Table I

Starting current in amps.:	Starting time in seconds (approx.)
25	2
40	1
50	½
60	¼

As indicated, higher starting currents provide faster starting. The time required to start a particular lamp will vary since it is dependent upon the spacing between the cathode and the striking bar, the displacement of the initial arc below the cathode tip, the arc length, the gas

pressure, the gas purity, the arc current, and the voltage of the power supply and the orientation of the lamp.

Embodiment II

In FIG. 7 there is illustrated another lamp embodiment **10***a* having the same type of envelope **12***a*, anode **15***a* and cathode **16***a* as in the previously described Embodiment I. However, the protuberance on the cathode tip is omitted and the starting assembly **30***a* is quite different in that the angular striker bar **31***a* is shaped and oriented to span the discharge gap and contact the tips of both the cathode and anode when the stirker bar is in its make-contact position, as illustrated in the drawing. The striker bar thus momentarily short circuits the electrodes during the starting operation when the lamp **10***a* and electromagnet M are energized.

In addition, the upper spring metal strip **32***a* is insulated from the anode shank **17***a* so that the striker bar **31***a* is insulated from both the cathode and anode when in its break-contact position. The upper metal strip **32***a* thus does not carry any of the starting current. This is a distinct advantage since the tendency of the strip **32***a* to gradually recrystallize in use is greatly reduced. This embodiment is accordingly more practical from a life standpoint and is preferred.

The aforementioned insulation from the anode is achieved by attaching the upper end of the strip **32***a* to a bushing-like structure consisting of a loose fitting sleeve **54** of molybdenum or the like that rides within an annular recess **55** provided in a quartz collar **56** which is rigidly attached to the anode shank **17***a* by metal tabs **57**. The strip **32***a* passes through a slot **58** provided in the rim of the quartz collar **56** so that the assembly **30***a* is prevented from rotating. The loose fitting sleeve **54**, however, permits the end of the assembly **30***a* to move a predetermined distance (several millimeters) longitudinally—thus providing a "floating" suspension that allows the upper spring strip **32***a* to flex without being constrained at each end. Actuation of the assembly **30***a* can thus be effected with a weaker magnetic field.

The anchorage at the opposite end of the assembly **30***a* is identical to that of Embodiment I and shown in FIGS. 1–4.

Embodiment III

In FIG. 8 there is shown an alternative form of electromagnet and an associated pulse-energizing circuit for starting a short-arc lamp **10** of the type shown in FIGS. 1, 2 and 7. The pole piece **59** of the electromagnet M' is U-shaped and positioned so that its poles are aligned with the side edges of the rectangular armature **38**. The ends of the poles may be curved, as shown, to match the contour of the envelope **12** and reduce the intervening air gap to a minimum. The resulting centralization and concentration of the magnetic field permits the desired linear motion of the support yoke **40** to be achieved with a very compact magnet.

The solenoid **60** of the magnet M' is wound around the center of the U-shaped pole piece **59** and connected to one side of a suitable AC or DC power source by a conductor **61**. The other side of the circuit is completed by another conductor **62**, a variable resistor **63** and a push-button switch **64**.

It will be apparent from the foregoing that the objects of the invention have been achieved in that an improved starting assembly and apparatus have been provided which will reliably and repeatedly ignite a high-pressure gaseous discharge lamp on the same voltage source utilized to operate the lamp.

While several embodiments have been illustrated and described, it will be understood that various modifications can be made without departing from the scope of the invention. For example, the starting assembly can be actuated by a portable permanent magnet that is positioned adjacent the lamp during the starting operation and then removed. The bending stress on the upper spring support **32** can be further alleviated by inserting a movable element in the support strap **41** that connects the yoke **40** to the lower support collar **42**. This can be accomplished by making the strap in two sections and coupling the sections together so that one slides over the other.

If a soft iron armature is used, it can also be encased in a thin sheet of molybdenum (or wrapped with molydenum ribbon) to prevent the possibility of contaminating the lamp with vaporized iron during extended use at elevated temperatures.

I claim as my invention:

1. A high-pressure electric discharge lamp comprising, in combination;

a light-transmitting envelope containing an ionizable medium and a pair of fixed electrodes that define a discharge path,

separated lead-in conductor means sealed through said envelope and connected to the respective electrodes,

an elongated arc-initiating structure that is supported by each of its ends within said envelope at a location remote from and along said discharge path and has a flexible medial portion that is laterally movable into make-and-break contacting relationship with one of said electrodes, and

magnetically-responsive means carried by said structure and adapted, when actuated, to flex the medial portion of said arc-initiating structure and place it in make-contact relationship with said one electrode.

2. The lamp set forth in claim **1** wherein the part of said flexible medial portion that makes and breaks contact with said one electrode comprises a refractory metal member that completes an electrical circuit between said electrodes when said member is in make-contact position.

3. The lamp set forth in claim **1** wherein;

the part of said flexible medial portion that makes and breaks contact with said one electrode comprises a refractory metal member which, when in make-contact relationship with said one electrode, is spaced from the other of said electrodes, and

said member is connected to said other electrode by a flexible conductor.

4. The lamp set forth in claim **3** wherein said refractory metal member has a protruding portion that faces toward said one electrode and is so oriented that it engages a part of said one electrode that is spaced a predetermined distance from its tip.

5. The lamp set forth in claim **3** wherein said flexible conductor comprises an integral part of said elongated arc-initiating structure.

6. The lamp set forth in claim **2** wherein;

said refractory metal member is so dimensioned and oriented that, when in make-contact relationship with said one electrode, it spans the discharge path and also contacts the other electrode, and

said refractory metal member when in its break-contact position is electrically isolated from both of said electrodes.

7. The lamp set forth in claim **1** wherein said magnetically-responsive means comprises a magnetizable member that is attached to the flexible unsupported medial portion of said arc-initiating structure.

8. The lamp set forth in claim **1** wherein;

said elongated arc-initiating structure is so supported that the flexible medial portion thereof laterally moves toward and away from said one electrode along a linear path, and

said magnetically responsive means comprises a magnetizable member that is disposed adjacent a wall of said envelope and is supported in such position by a laterally extending yoke that is attached to the flexible medial portion of said structure.

9. The lamp set forth in claim **1** wherein;

said lamp has a longitudinal axis and is adapted to be operated on a direct-current power source,

said electrodes comprise a cathode and an anode,

said lamp is further adapted to be operated in a position such that the anode is disposed above the cathode,

said elongated arc-initiating structure comprises a flexible assembly of conjoined refractory metal strips that is suspended in longitudinal pendulum-like fashion within the envelope in a position such that its medial portion is swingable toward and away from the discharge path in a lateral direction,

the electrode-contactor portion of said flexible assembly comprises a striker bar of refractory metal that is fastened to the swingable medial portion of said assembly and is oriented to contact the cathode, and

said magnetically-responsive means comprises a body of magnetically permeable material that returns to substantially demagnetized condition in the absence of a magnetic field.

10. The lamp set forth in claim **9** wherein one of said conjoined metal strips constitutes a spring that maintains the striker bar in break-contact position in the absence of a magnetic field.

11. The lamp set forth in claim **9** wherein;

said flexible assembly is swingably supported at each end, and

said body of permeable material is located proximate a wall of said envelope and is supported in such position by a horizontally extending yoke that is attached to a medial part of said assembly and straddles and is spaced from the cathode.

12. The lamp set forth in claim **9** wherein:

the portion of said envelope that contains said body of permeable material is of tubular configuration, and

said body of permeable material has a substantially planar face that is disposed toward a wall of the tubular portion of said envelope.

13. The lamp set forth in claim **9** wherein;

said lamp comprises a short-arc lamp,

said envelope is terminated at each end by opposed seal arms in which the cathode and anode are respectively anchored,

the portion of said cathode adjacent the arm in which it is anchored is encased in a vitreous sleeve,

one end of said flexible refractory metal assembly is hingedly fastened to said vitreous sleeve and is thus insulated from said cathode, and

the opposite end of said assembly is hingedly fastened to a part of said anode remote from the arc-sustaining tip thereof and is thus electrically connected to said anode.

14. The short-arc lamp set forth in claim **13** wherein;

the end of said flexible metal assembly is fastened to said vitreous sleeve by a loose-fitting collar,

the inner end of the seal arm proximate said collar defines a substantially flat laterally-extending surface, and

a pair of spaced pins depend from said collar and contact said surface thereby permitting the attached end of said flexible assembly to pivot and also move laterally a predetermined distance with a minimum of friction.

15. The short-arc lamp set forth in claim **13** wherein;

said cathode has a pointed tip and a laterally-protruding portion that is spaced a predetermined distance axially from said tip,

said striker bar is of angular configuration and disposed so that its apex contacts the laterally-protruding portion of said cathode, and

the end of said refractory metal assembly that is fastened to said anode has a retroverted segment that provides a bellows-like hinge action.

16. The lamp set forth in claim **9** wherein:

said lamp comprises a short-arc lamp,

one end of said flexible assembly is hingedly attached to and is insulated from said cathode,

the opposite end of said assembly is coupled to and insulated from the anode by a bushing-like structure that allows the said end of the assembly to move a limited distance axially but prevents it from rotating, and

said striker bar is of angular configuration and so dimensioned and oriented that it bridges the gap between said electrodes and contacts both of them when in the make-contact position.

17. Apparatus for starting an electric discharge lamp that requires a higher starting than operating voltage has an envelope that contains a pair of fixed electrodes, which apparatus comprises:

an armature of magnetizable material carried by an elongated arc-initiating structure that is hingedly mounted within said envelope and has a flexible electrically-conductive medial portion which is adapted to make and break contact with one of said electrodes when said structure is actuated, said armature being secured to said flexible medial portion at a location adjacent the wall of said envelope,

an exterior electromagnet disposed adjacent said lamp and oriented so that the pole piece of the magnet is located directly opposite said armature,

the pole piece of said electromagnet being of such size and configuration that the side edges thereof are substantially aligned with the side edges of said armature,

circuit means for applying an operating voltage across said electrodes, and

means for momentarily energizing said electromagnet and thereby producing a magnetic field that attracts said armature and pulls the flexible medial portion of said arc-initiating structure along a linear path such that it makes and then breaks contact with said one electrode while said electrodes are energized.

18. The apparatus set forth in claim **17** wherein;

said armature is of planar configuration and composed of material which is highly permeable,

the pole piece of said electromagnet comprises two spaced pole segments that are substantially aligned with the side edges of said armature, and

the portions of said pole segments that face the lamp envelope are curved to match the contour thereof.

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JAMES W. LAWRENCE, *Primary Examiner.*

R. F. HOSSFELD, *Assistant Examiner.*