Dec. 7, 1965 J. W. WINZELER ETAL 3,222,569

APPARATUS AND METHOD FOR GENERATING HIGH-INTENSITY LIGHT

Original Filed May 22, 1961

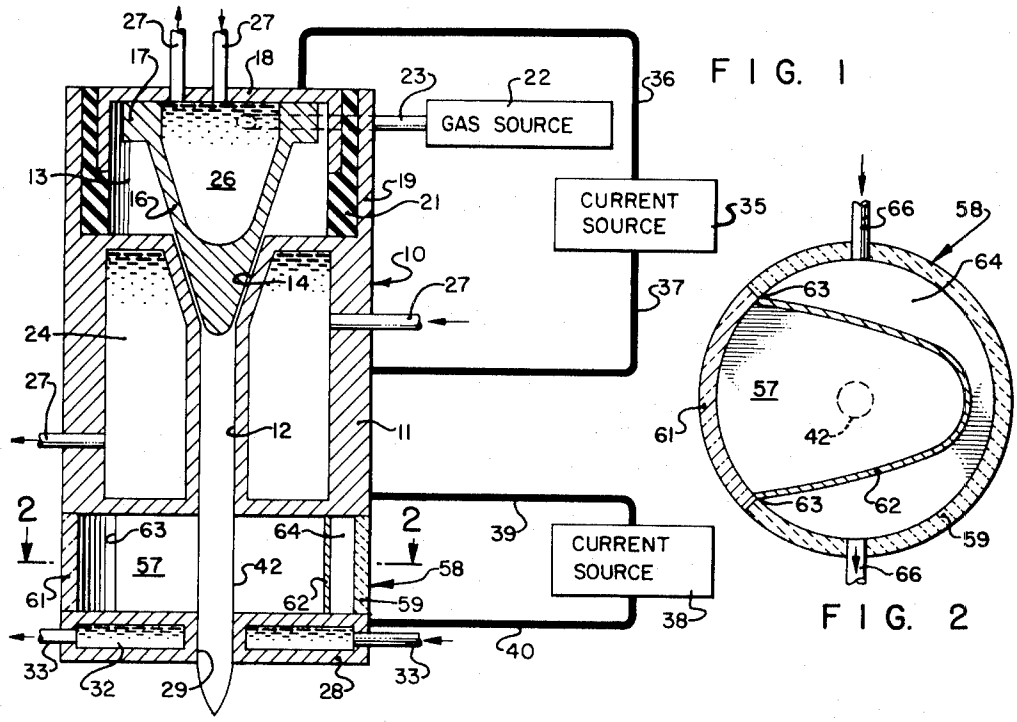



FIG. 1



FIG. 2

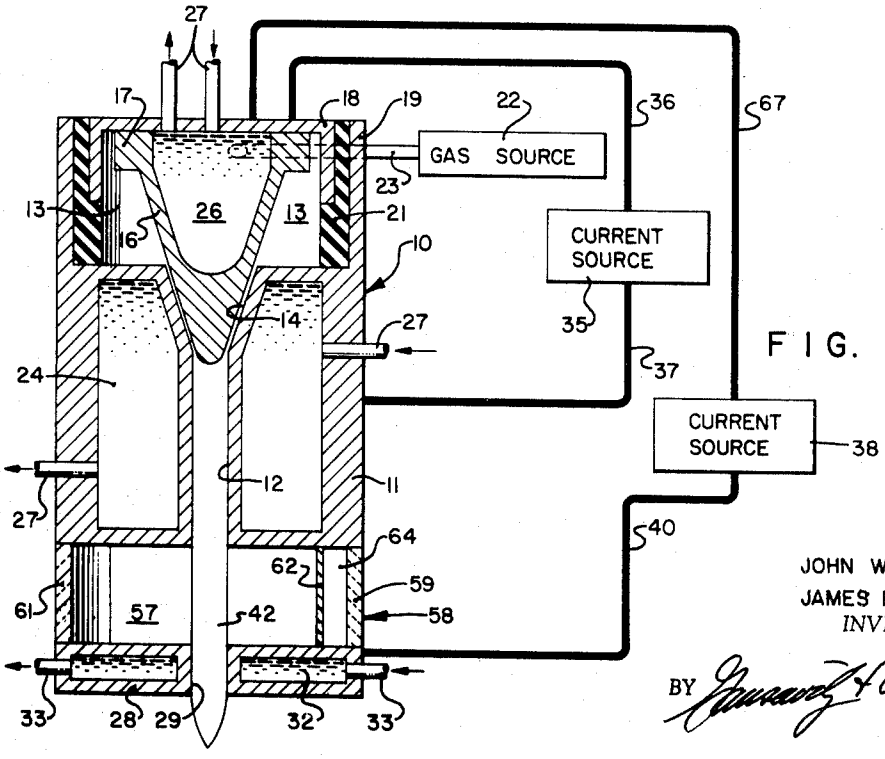



FIG. 3

JOHN W. WINZELER
JAMES F. TUCKER
INVENTORS

BY

ATTORNEY

United States Patent Office

3,222,569

Patented Dec. 7, 1965



3,222,569

# APPARATUS AND METHOD FOR GENERATING HIGH-INTENSITY LIGHT

John W. Winzeler and James F. Tucker, Santa Ana, Calif., assignors, by mesne assignments, to Giannini Scientific Corporation, Long Island, N.Y., a corporation of Delaware

Original application May 22, 1961, Ser. No. 111,763. Divided and this application Sept. 30, 1963, Ser. No. 312,573

11 Claims. (Cl. 315—111)

This invention relates to an apparatus and method for generating a very intense light. The present application is a division of our copending patent application Serial No. 111,763, filed May 22, 1961, for an Apparatus and Method for Generating Heat and Light.

An object of the invention is to provide an apparatus and method for generating an extremely intense light which may be employed as a light source for numerous purposes.

Another object is to provide a highly efficient light source and method characterized by the maintenance of an arc in a chamber through which gas is continuously circulated, in combination with special mirror means which at least partially defines said chamber and which reflects light from said arc to a window in the chamber wall.

These and other objects and advantages of the invention will be more fully set forth in the following specification and claims, considered in connection with the attached drawing to which they relate.

In the drawing:

FIGURE 1 is a schematic longitudinal sectional view illustrating one form of apparatus for generating an intense light;

FIGURE 2 is a transverse section taken on line 2—2 of FIGURE 1, showing the reflector and window for the light; and

FIGURE 3 is a schematic longitudinal central sectional view corresponding to FIGURE 1 but illustrating a different manner of supplying current to the various electrodes.

Referring first to the embodiment of FIGURES 1 and 2, an electrical plasma-jet torch is indicated generally at **10** and has a non-consumable metal nozzle electrode **11** formed with an elongated cylindrical passage or opening **12**. The upper end of passage **12** communicates with a cylindrical gas vortex chamber **13** having a frustoconical central portion or extension. The frustoconical wall **14** of such central portion or extension merges, at its narrow end, with the wall of passage **12**.

The non-consumable metal back electrode **16** of the illustrated torch is conical in shape, the cone angle corresponding generally to that of wall **14**. The tip of the back electrode is disposed in the frustoconical extension of vortex chamber **13**, being spaced from wall **14** to form a frustoconical channel therebetween. The main body of the back electrode is disposed in the main or relatively large portion of vortex chamber **13**, and has a radial flange **17** the peripheral wall of which is cylindrical in shape.

Flange **17** seats sealingly against the bottom of an inverted metal cup **18**. The side wall of cup **18** is telescoped into a generally tubular end portion **19** of nozzle electrode **11**, there being an insulating sleeve **21** provided between the cup wall and the tubular portion **19** in order to maintain the nozzle and back electrodes insulated from each other.

The internal surface of the cup side wall, and the exposed interior surface of insulating sleeve **21**, are flush with each other and form the cylindrical wall of vortex chamber **13**. Such cylindrical wall has a diameter substantially greater than the cylindrical wall of flange **17**, in order to permit introduction of gas therebetween as will next be described.



Gas is introduced into chamber **13** from a suitable gas source which is represented schematically at **22**. The gas conduit **23** from source **22** communicates tangentially with chamber **13** at a point located radially outwardly from flange **17**. A suitable gas is thus introduced tangentially so that it will flow vortically around the back electrode **16**. The gas then flows vortically and helically through the channel around the tip of the back electrode, and then flows vortically and helically through nozzle passage **12**.

The nozzle electrode **11** is formed with an annular cooling chamber **24** around the nozzle passage and also around wall **14**. Water is passed through such chamber, and through a cooling chamber **26** in back electrode **16**, by means of various conduits which are indicated at **27**.

Mounted coaxially of nozzle electrode **11**, in spaced relationship from the lower end thereof, is an additional non-consumable electrode **28** of annular shape. Such electrode, which may be formed of copper, tungsten or the like, has an opening **29** the diameter of which corresponds generally to that of the nozzle passage **12** with which it is registered. The additional electrode **28**, which is insulated from the nozzle as will be described, is formed with an annular coolant chamber **32** through which water is passed by means of conduits **33**.

A first current source **35** is connected through leads **36** and **37**, respectively, to the cup **18** and to nozzle electrode **11**. Since the current in cup **18** flows through the adjacent back electrode to the tip thereof, an electric arc may thus be maintained in passage **12** between the tip of back electrode **16** and the wall of the passage **12**. The current source **35** may be a source of either D.C. or A.C., preferably D.C. so that continuous ionization takes place, and should be adapted to deliver relatively large currents although not necessarily as large as those delivered by a second current source which is indicated at **38**.

The second source **38** is connected, through leads **39** and **40**, respectively, between the additional electrode **28** and the nozzle **11**. The second source **38** is adapted to deliver extremely large currents and may comprise a D.C. source or an A.C. source, either single or multi-phase. Furthermore, the second source may comprise a circuit (such as containing a capacitor or bank thereof) adapted to deliver a large pulse of current at predetermined time intervals.

A chamber **57** is defined between the electrodes **11** and **28**, by means of a tubular insulating element **58** which is fixedly connected between the peripheral portions of the electrodes. Element **58** may be formed entirely of quartz or other suitable light-transmissive material, or else it may comprise an opaque ceramic insulator **59** having a quartz window **61** through which light is beamed by a reflector **62** next to be described.

Element **62** is illustrated as comprising a parabolic reflector the focal axis of which is coincident with the jet **42** of plasma or hot gas which emanates from passage **12**. Element **62** is so constructed and mounted, for example by means of suitable electrical insulators, that it will not create a short circuit between electrodes **11** and **28**. The end edges of the parabola are sealingly associated at **63** with the ends of window **61**, thereby defining a sub-chamber **64** around the reflector **62** and which is sealed from the portion of chamber **57** through which the jet **42** passes. A suitable coolant may be passed through sub-chamber **64** around the reflector **62** and which is sealed from the portion of chamber **57** through which the jet **42** passes. A suitable coolant may be passed through sub-chamber **64** by means of conduits indicated at **66** in FIGURE 2.

In performing the method with the embodiment of FIGURES 1 and 2, the electrical plasma-jet torch **10** is employed to generate the jet **42** which passes through the chamber **57** and through the opening **29** in electrode **28**. The current source **38** is then applied to maintain an extremely high-current electric arc through the jet **42** between electrodes **11** and **28**. The resulting combination arc and jet **42** is an intense light source, so that the beam reflected from the parabolic reflector **62** and transmitted through window **61** is exceedingly powerful.

The light may be employed for a wide variety of purposes, for example as a search light, spectroscopic light, etc. The gas employed may be varied in accordance with the type of light which is desired. Such gas may comprise argon or xenon, for example. Nitrogen may also be employed.

*Embodiment of FIGURE 3*

In the embodiment of FIGURE 3, the current source **38** is connected between the additional electrode **28** and the back electrode **16**, there being no connection between electrode **28** and electrode **11**. Thus, the lead **39** of the previous embodiments is omitted and is replaced by the lead **67** from the current source to the back electrode **16**. Alternatively, the current source connected between elements **16** and **28** may be additional to the current sources shown in FIGURE 1.

In the operation of the embodiment of FIGURE 3, the current source **35** is first applied (after application of the gas and water sources) to maintain an arc in passage **12** between electrode **16** and electrode **11**. The second current source **38** is then applied to maintain an arc between back electrode **16** and additional electrode **28**, such arc passing through the passage **12** and also through chamber **57**. The portion of the arc in chamber **57** is employed as a light source, as previously described.

The current source **38** may be a multi-phase A.C. source or a pulse source such as one employing a capacitor discharge. It may also, as indicated, be a D.C. source.

Various embodiments of the present invention, in addition to what has been illustrated and described in detail, may be employed without departing from the scope of the accompanying claims.

We claim:

**1.** A source of high-intensity light, which comprises
means to define a chamber having an outlet opening therefrom,
window means to transmit light out of said chamber,
means including a first electric arc to introduce ionized gas into said chamber for discharge out said outlet opening, and
means to maintain a second and separate electric arc through said ionized gas in said chamber to thereby create an intense light.

**2.** The invention as claimed in claim **1**, in which reflector means are disposed in said chamber to collect light from said second arc and transmit the same through said window means.

**3.** Apparatus for generating a high-intensity light, comprising
an electrical plasma-jet torch having a back electrode and a nozzle electrode,
means to maintain a first arc between said back electrode and said nozzle electrode,
wall means to define a chamber communicating with the nozzle opening in said nozzle electrode,
said chamber having an outlet opening therefrom,
means to pass gas through said torch and said nozzle opening for ionization by said first arc,
said gas passing through said chamber and out said outlet opening,
means to maintain a second and high-current arc in said chamber through said ionized gas and between said nozzle electrode and an additional electrode having at least a portion disposed in said chamber, and
window means to transmit light from said second arc through said wall means defining said chamber.



**4.** A source of light, comprising
an electrical plasma-jet torch having a back electrode and a nozzle electrode,
wall means to define a chamber communicating with the nozzle opening in said nozzle electrode and having a discharge opening therefrom,
said wall means including a window adapted to transmit light out of said chamber,
means including a first power source to maintain an arc between said nozzle electrode and back electrode,
means to pass gas between said back electrode and nozzle electrode and into said chamber,
said gas being ionized by said arc, and
means including a second and separate power source connected between said nozzle electrode and an electrically-conductive portion of said wall means to maintain a high-current electric arc in said chamber and thus generate light for transmission through said window,
said electrically-conductive portion of said wall means being spaced and insulated from said nozzle electrode and encompassing said discharge opening.

**5.** Means to generate a high-intensity light, which comprises
an electrical plasma-jet torch having a back electrode and a nozzle electrode,
means to introduce gas tangentially into said torch for vortical flow around the axis of said back electrode and thence through the nozzle opening in said nozzle electrode,
means including a first current source to maintain an electric arc between said back electrode and said nozzle electrode to thereby effect ionization of said gas,
wall means to define a chamber communicating with said nozzle opening and having a discharge opening therefrom,
said wall means including a light-transmissive window, and
means including a second current source independent of said first current source to generate an additional arc between said back electrode and an electrically-conductive portion of said wall means,
said electrically-conductive portion of said wall means being spaced and insulated from said nozzle electrode,
a portion of said additional arc passing through said chamber to generate light for transmission out said window.

**6.** A method of providing a high-intensity light, which comprises
employing an electrical plasma-jet torch to direct a stream of plasma to the vicinity of an additional electrode,
maintaining a high-current arc through said plasma and externally of said torch between said additional electrode and an electrode other than the back electrode of said torch, and
transmitting the light generated by said high-current arc to a desired area of utilization.

**7.** Apparatus for generating a high-intensity light, which comprises
wall means to define a chamber,
said wall means having formed therethrough an inlet opening into said chamber and an outlet opening from said chamber,
a portion of said wall means being transparent whereby to transmit light out of said chamber,

another portion of said wall means having on the interior thereof a reflector surface,

said reflector surface being shaped to reflect through said transparent portion of said wall means light received from a predetermined region of said chamber,

electrode means to maintain a high-current electric arc in said chamber at said predetermined region thereof,

means to supply a high current to said electrode means to maintain an arc therebetween,

means to introduce a gas continuously through said inlet opening into said chamber, and

means to discharge said gas continuously through said outlet opening from said chamber.

**8.** The invention as claimed in claim **7**, in which said arc extends between said inlet opening and said outlet opening.

**9.** The invention as claimed in claim **7**, in which said gas is selected from a group consisting of xenon, argon and nitrogen.

**10.** The invention as claimed in claim **7**, in which said reflector surface is parabolic in shape, and in which said predetermined region of said chamber is at the focal region of said reflector surface.

**11.** A high-intensity light source, which comprises

a reflector element which is curved in such manner that one side thereof is generally convex and the other side thereof is generally concave,



said concave side of said reflector element being reflective,

first wall means cooperating with said concave side of said reflector element to define an arc chamber,

at least a portion of said first wall means being transparent whereby to transmit light out of said arc chamber,

second wall means cooperating with said convex side of said reflector element to define a coolant chamber,

means to pass a coolant continuously through said coolant chamber,

means to pass a gas continuously through said arc chamber, and

means to maintain in said arc chamber at a predetermined region thereof a high current electric arc,

said predetermined region being so located that light generated by said arc will be reflected by said reflector element to and through said transparent portion of said first wall means.

**References Cited by the Examiner**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,856,532 | 10/1958 | Martoma | 313—230 X |
| 3,172,000 | 3/1965 | Rosener et al. | 313—231 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 646,015 | 6/1960 | Canada. |

GEORGE N. WESTBY, *Primary Examiner.*