

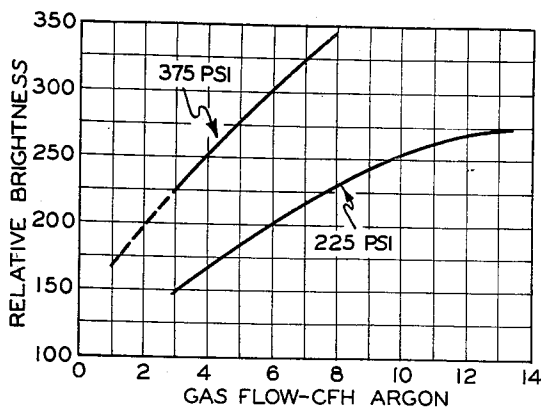
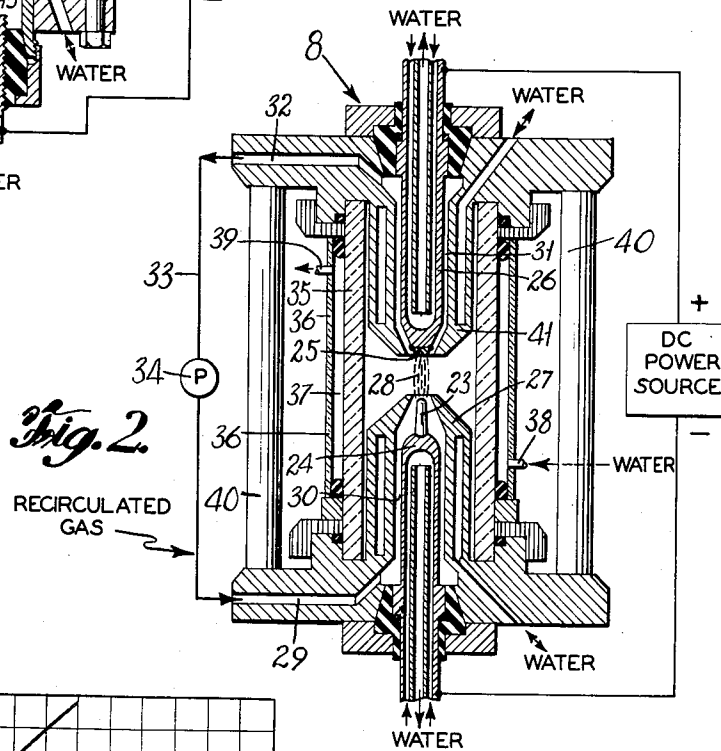
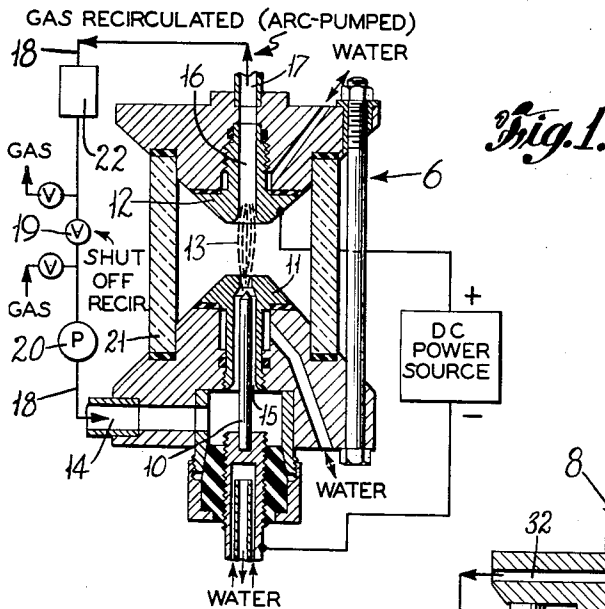
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HIGH INTENSITY LIGHT SOURCE

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HIGH INTENSITY LIGHT SOURCE

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This invention relates to high intensity electric arc light sources, and more particularly to high pressure collimated arc lamps.

According to this invention there is provided an improved arc lamp in which an intense light is generated between non-consumable electrodes by maintaining a wall-stabilized high pressure arc in a selected gas that is continuously circulated through a transparent chamber so as to laterally concentrate and stabilize such arc in such chamber.

More particularly, according to the invention such chamber itself is kept cool by circulating a transparent cooling medium adjacent the wall of such chamber to overcome the intense heat generated by such arc.

Compending application, Serial No. 759,765, by L. I. Dana et al. filed September 8, 1958, now U.S. Patent No. 2,972,698, describes process and apparatus involving the use of a collimated electric arc as a light source wherein a desired gas is passed through a collimated wall-stabilized arc of an arc torch of the type disclosed in Gage Patent No. 2,806,124. The present invention is concerned with an improved apparatus and process for producing and using a transferred type collimated arc light source.

The transferred arc torch process produces an extremely stable high intensity arc column which has relatively even illumination along its arc length. This is apparently due to the collimated arc produced within this torch wherein the gases flowing through the torch nozzle tend to maintain the constricted nature of the arc column some distance from the end of the nozzle.

Prior art sealed-in-quartz arc light sources, as exemplified by lamps of the Osram type, were limited in power level due to the fact that all of the arc heat had to be dissipated through the surrounding transparent envelope. A major advantage of the present invention is achieved by recirculating the arc gas externally to the arc zone. The gas is cooled in a water-cooled anode passage, and by external heat exchangers, if desired. The heat transfer load which the transparent envelope, such as quartz, must accept is thus greatly diminished, increasing the power capacity of a given size envelope by an estimated factor of 3 as compared to that of prior art sealed-in-quartz lamps.

Any of the arc supporting inert gases can be used with the present invention, but the most useful gases with respect to light output are the heavier inert gases such as argon, krypton, and xenon. In particular, xenon is preferred because it produces the brightest and whitest light.

In the drawings:

FIGURE 1 is a view mainly in vertical cross section of improved arc light apparatus illustrating the present invention;

FIGURE 2 is a similar view of a modification; and

FIGURE 3 is a graph of relative brightness versus gas flow collinear with the arc for various arc zone pressures.

As shown in FIGURE 1, lamp 6 is provided with a stick cathode 10 composed preferably of thoriated tungsten positioned coaxially within a water-cooled copper nozzle 11. Anode 12 is hollow and is also composed of water-cooled copper. An arc 13 is struck between cathode 10 and anode 12, while selected inert gas is circulated collinearly with said arc. Such gas enters the lamp 6 through

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an inlet passage 14, passes up through an annular space 15 around cathode 10, passes with the arc 13 through the opening in nozzle 11, passes through a hollow space 16 in anode 12, and leaves the torch through an outlet passage 17. Inlet passage 14 and outlet passage 17 are connected through an external pipe line 18 and valve 19. Gas circulation can be maintained by arc-pumping and convection, but an external pump 20 in line 18 may be used for this purpose.

The arc zone is surrounded by a transparent sleeve 21 which serves to maintain a pressure chamber as well as to provide a viewing port for the arc light source. Such sleeve is preferably composed of quartz. A heat exchanger 22 may be used, if desired, in the external gas pipe line 18 to remove arc heat from the recirculating gas.

FIGURE 2 shows a modified device 8 of the present invention, including a cathode 23 preferably composed of thoriated tungsten, swaged to a water-cooled copper electrode holder 24 that is positioned within a water-cooled copper nozzle 27. The anode consists of a button 25 composed preferably of tungsten, welded to a water-cooled copper support 26. The anode is surrounded by water-cooled copper nozzle 41 which acts primarily as a shield to direct the gas flow around the anode 25 and also to somewhat constrict and stabilize the arc. An arc 28 is struck between cathode 23 and anode 25 while selected inert gas is circulated collinearly with said arc. Such gas enters the torch through inlet 29, passes up through an annulus 30 around electrode holder 24 and electrode 23, passes through an annular space 31 around electrode holder 26, then passes out through outlet 32. Inlet 29 and outlet 32 are connected through a pipe line 33, provided with a pump 34 for gas circulation.

The arc zone is surrounded by transparent quartz sleeve 35 which serves to provide a pressure chamber as well as a viewing port for the arc light source. Transparent sleeve 35 should be thick enough to withstand the internal operating pressures. For example, a $\frac{3}{16}$ -inch thick quartz sleeve ($1\frac{1}{2}$ inch O.D.) has been used up to about 50 atmospheres. The quartz sleeve is protected from devitrification caused by arc heat and radiation by surrounding it with protective transparent sleeve 36 to provide an annular space 37 through which water is circulated from inlet 38 to outlet 39. Sleeve 36 may be constructed of any material having the desired transmission characteristics for the light desired, such as fused silica, quartz, or normal window glass. The entire arc device 8 is held together by supports 40.

As an example of operation of the device 8 shown in FIGURE 2, an arc of 125 amperes and about 65 volts (DCSP) was struck between a $\frac{3}{32}$ -inch diameter thoriated tungsten cathode positioned coaxially within a $\frac{1}{8}$ -inch diameter water-cooled copper nozzle and a $\frac{3}{16}$ -inch diameter tungsten anode positioned within a $\frac{5}{16}$ -inch diameter water-cooled copper nozzle. The cathode tip was set back about $\frac{1}{32}$ - to $\frac{1}{16}$ -inch. Greater setback increases the relative evenness of the brightness along the exposed arc length and also results in lower efficiency due to partial shielding. Argon gas at 100 c.f.h. (measured at standard temperature and pressure conditions) was passed collinearly with the arc, and the arc chamber was maintained at 375 p.s.i.g. (25 atmospheres). The arc brightness measured by a photometer directed at the outlet of the cathode nozzle was 128,000 candles/cm.². The arc was extremely stable and approximately cylindrical in shape.

The relative brightness of the arc is increased, ac-

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cording to the present invention, principally by three methods: increasing the current, increasing the gas flow through the torch, and increasing the arc chamber pressure. The effects of the latter two variables are shown in FIGURE 3. The gas flow shown is the flow under the indicated pressure conditions. Any chamber pressure above atmospheric can be used, but it preferably is operated at 225 to 750 p.s.i. (15 to 50 atmospheres).

What is claimed is:

1. High intensity light source apparatus comprising a pressure vessel having a transparent viewing port; a stick cathode, a cooled nozzle, and a cooled anode, said electrodes and nozzle being positioned coaxially within said pressure vessel; means for establishing an electric arc between said cathode and anode whereby a portion of said arc is surrounded and wall-stabilized by said cooled nozzle; and means for passing an inert gas stream at a pressure above atmospheric through said pressure vessel collinear with said wall-stabilized arc.

2. High intensity light source apparatus comprising a pressure vessel having a transparent viewing port; a stick cathode, a cooled nozzle, and a cooled hollow nozzle anode, said electrodes and nozzles being positioned coaxially within said pressure vessel; means for establishing an electric arc between said stick cathode and said cooled hollow anode whereby a portion of said arc is surrounded and wall-stabilized by said cooled nozzle, means for passing an inert gas stream at a pressure above atmospheric through said pressure vessel collinear with said stabilized arc; and means for recirculating said inert gas externally of said pressure vessel.

3. High intensity light source apparatus comprising a pressure vessel having a transparent viewing port; a stick cathode, a first cooled nozzle positioned near said cathode, a cooled anode, a second cooled nozzle, positioned near said anode, said electrodes and nozzles being positioned coaxially within said pressure vessel; means for establishing an electric arc between said cathode and anode whereby a portion of said arc is surrounded and stabilized by said first nozzle; means for passing an inert gas stream at a pressure above atmospheric through said pressure vessel collinear with said stabilized arc; and means for recirculating said inert gas externally of said pressure vessel.

4. High intensity light source apparatus comprising a pressure vessel having a transparent inner wall of sufficient dimensions to withstand internal operating pressures, and an outer transparent wall forming a cooling annulus in between said walls; means for passing transparent cooling medium through said annulus; a stick cathode, a first cooled nozzle positioned near such cathode, a cooled anode and a second cooled nozzle positioned near said anode, said electrodes and nozzles being positioned coaxially within said pressure vessel; means for establishing an electric arc between said cathode and anode whereby a portion of said arc is surrounded and stabilized by said first nozzle; means for passing an inert gas stream at a pressure above atmospheric through said pressure vessel collinear with said stabilized arc; and means for recirculating said inert gas externally of said pressure vessel.

5. Apparatus of claim 4 wherein said cathode is composed of thoriated tungsten and said anode is composed of tungsten.

6. A high intensity arc lamp comprising, in combination, a transparent chamber, spaced electrodes mounted within said chamber, means for energizing a high pressure arc between said electrodes, means associated with one of said electrodes for circulating an annular stream of protective inert gas around such electrode to stabilize such arc, said other electrode having a central outlet for receiving such gas, and means for supplying and recirculating such gas so that the gas pressure within such chamber is higher than that of the atmosphere.

7. High intensity light source apparatus comprising a

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vessel having a transparent viewing port; a stick cathode; a cooled nozzle and a cooled anode, said electrodes and nozzle being positioned coaxially within said pressure vessel; means for establishing an electric arc between said cathode and anode whereby a portion of said arc is surrounded and wall-stabilized by said cooled nozzle; and means for passing an inert gas stream through said vessel collinear with said wall-stabilized arc.

8. A method of producing light which comprises striking an electric arc between a stick cathode and an anode inside of a vessel having a transparent viewing port; wall-stabilizing and collimating said arc by passing it through a cooled non-consumable nozzle; passing an inert gas stream along said stick cathode and through said arc stabilizing nozzle so that said gas stream becomes collinear with said arc; and recirculating said gas externally to the vessel; said collimated arc light source being highly stable and having relatively even brightness along its exposed arc length.

9. A method of producing light which comprises striking an electric arc between a stick cathode and an anode inside of a pressure vessel having a transparent viewing port; wall-stabilizing and collimating said arc by passing it through a cooled non-consumable nozzle; passing an inert gas stream at a pressure above atmospheric along said stick cathode and through said arc stabilizing nozzle so that said gas stream becomes collinear with said arc; and recirculating said gas externally to the pressure vessel; said collimated arc light source being highly stable and having relatively even brightness along its exposed arc length.

10. Method of claim 9 in which said gas is at 15 to 50 atmospheres gas pressure within said pressure vessel.

11. A method of producing light which comprises striking an electric arc between a stick cathode and an anode inside of a pressure vessel having a transparent viewing port; wall-stabilizing and collimating said arc by passing it through a cooled non-consumable nozzle; passing an inert gas stream selected from the class consisting of argon, krypton and xenon at a pressure above atmospheric along said stick cathode and through said arc stabilizing nozzle so that said gas stream becomes collinear with said arc; and recirculating said gas externally to the pressure vessel; said collimated arc light source being highly stable and having relatively even brightness along its exposed arc length.

12. Method of claim 11 wherein said gas is at 15 to 50 atmospheres gas pressure within said pressure vessel.

13. Method of producing high intensity light which includes striking an elongated electrical arc between two electrodes; maintaining such arc by a continuous flow of ionized inert gas at between 15-50 atmospheres pressure; substantially constricting the arc diametrically by exerting lateral compressive forces thereagainst; recirculating the such inert gas externally of the arc zone; and water cooling such gas while so recirculating it.

14. An electric lamp, which comprises means to define a first chamber having at least one light-transmissive wall portion, an electrical plasma-jet torch having a nozzle opening communicating with said chamber, said torch having a second chamber therein communicating with said nozzle opening, and means to effect recirculation of gas between said first chamber and said second chamber and thence through said nozzle opening in the form of high-temperature plasma having substantial light-radiating characteristics.

15. A high-intensity electric lamp, which comprises means to define a sealed chamber having at least one transparent or translucent wall portion, a nozzle element having a nozzle opening communicating with said chamber, and means to maintain an electric arc in the region of said nozzle opening and to effect continuous recirculation of gas through said nozzle opening solely as the result of said electric arc and in the absence of auxiliary pumping means.

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16. A self-recirculating plasma device, which comprises a nozzle element and a back electrode mounted in spaced relationship, means to define a sealed chamber communicating with said nozzle element on both sides of the nozzle opening therein, and means including said back electrode to maintain an electric arc in the vicinity of said nozzle opening and to effect recirculation of gas through said nozzle opening solely as the result of the presence of said arc and in the absence of auxiliary pumping means.

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