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APPARATUS FOR GENERATING HIGH-INTENSITY LIGHT WITH HIGH TEMPERATURE PARTICULATE MATERIAL

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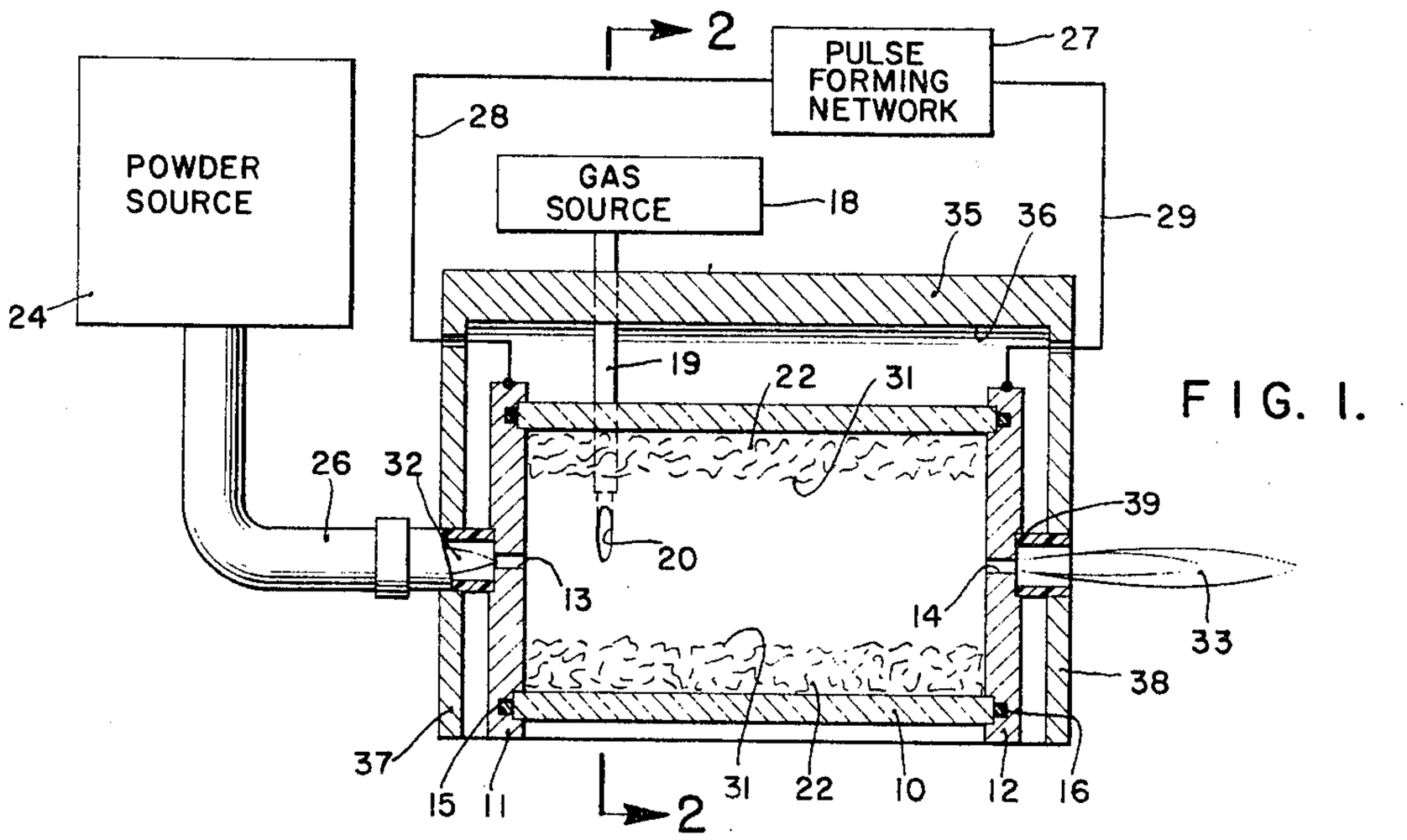


FIG. 1.

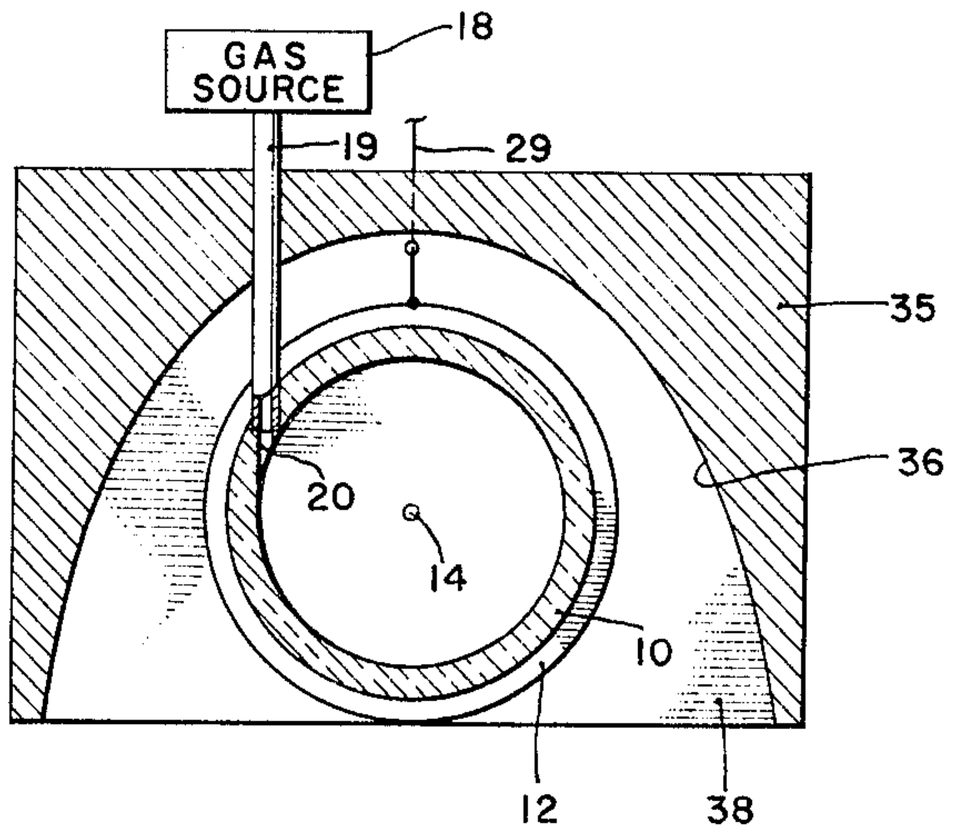


FIG. 2.

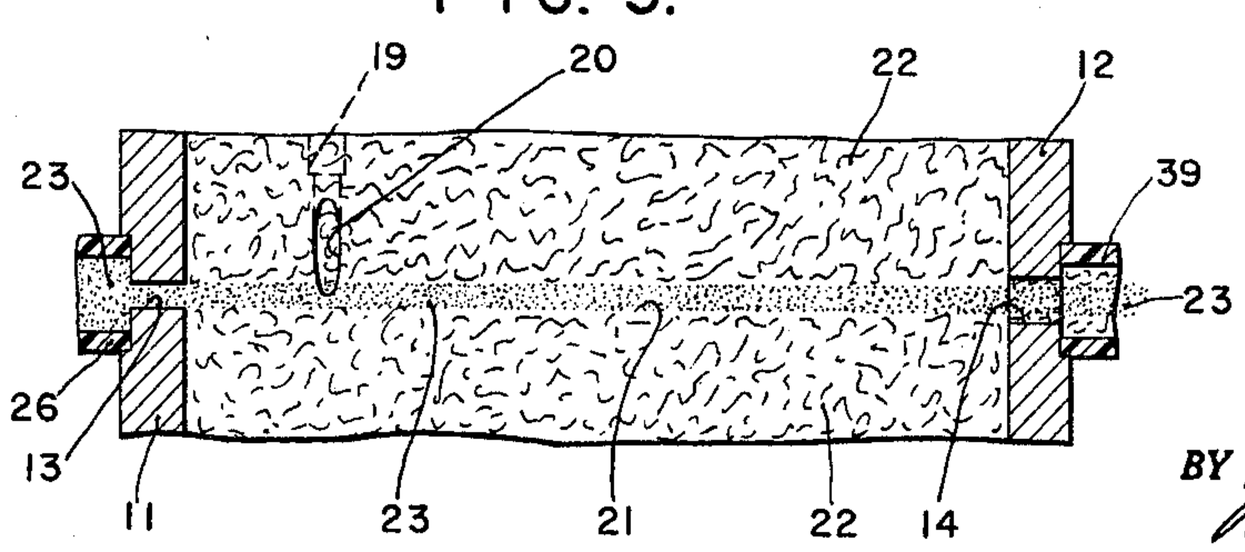


FIG. 3.

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APPARATUS FOR GENERATING HIGH-INTENSITY LIGHT WITH HIGH TEMPERATURE PARTICULATE MATERIAL

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Continuation of application Ser. No. 186,587, Mar. 30, 1962, which is a continuation of application Ser. No. 35,940, June 14, 1960. This application Apr. 21, 1964, Ser. No. 363,332

4 Claims. (Cl. 315—111)

This invention relates to an apparatus and method for generating an extremely bright light, such light being adapted to be employed in such fields as light radar, communications, search lights, and photochemistry. This is a continuation of my copending patent application Serial No. 186,587, filed March 30, 1962, now abandoned, for "Apparatus and Method for Generating High-Intensity Light." Said application is a continuation of application Serial No. 35,940, filed June 14, 1960, for "Apparatus and Method for Generating High-Intensity Light," now abandoned.

An object of the invention is to provide an apparatus and method for generating a very high-intensity light, either in brief pulses or continuously, and without effecting clouding of the window in the wall of the chamber in which the light is generated.

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 view, primarily in longitudinal central section, illustrating the condition of the apparatus during generation of a pulse of light;

FIGURE 2 is a transverse section taken on line 2—2 of FIGURE 1; and

FIGURE 3 is an enlarged fragmentary section corresponding to the central portion of FIGURE 1 but illustrating the condition of the apparatus prior to generation of a light pulse.

Referring to the drawing, the apparatus is illustrated to comprise a tube **10** formed of quartz or other light-transmissive material. Mounted coaxially at the ends of tube **10** are electrode discs **11** and **12**, preferably formed of a metal such as copper, and having openings **13** and **14** formed therein on the axis of the tube. The ends of the tube are illustrated as being inserted in annular grooves in the discs **11** and **12**, there being suitable sealing rings **15** and **16** provided to prevent leakage of material from the chamber formed by the tube and by the electrode discs.

A gas source **18**, adapted to deliver an inert gas such as argon at a suitable pressure such as ten p.s.i. gauge, communicates with the tube **10** through a conduit **19**. The inlet **20** from conduit **19** is tangential to the chamber within the tube. The diameter of the inlet opening **20** is so correlated to that of the axial outlet opening **14** that introduction of gas rapidly from source **18** will result in the formation of a gas vortex defining a canal which is indicated at **21** in FIGURE 3. The vortically-flowing gas, which is indicated at **22**, discharges through the opening **14** and (to some extent, during an explosion) through opening **13**.

Means are provided to introduce a finely-divided powder or particulate substance **23** into the opening **13** for flow through the canal **21** and out the opening **14**. Such means is schematically illustrated to comprise a suitable powder source **24** which is connected through a conduit **26** with the opening **13**. It is to be understood that a carrier gas may be provided for the powder, in accordance with principles well known to the art.

The powder is formed of a substance adapted to explode and emit a brilliant light upon sudden passage of a high-current spark or discharge through canal **21**, and preferably comprises a metal or compound thereof. Metals such as powdered aluminum and powdered tungsten have been employed with success. Powdered sodium chloride and aluminum oxide have also been found satisfactory.

The light-emitter substance introduced into canal **21** may also be in liquid form. For example, a concentrated aqueous solution of sodium chloride may be introduced through opening **13** in the form of a fine spray.

The particle size of the powder or liquid is caused to be sufficiently small that the particles will remain in canal **21** as shown at **23** in FIGURE 3. When the particle size is sufficiently small, the radially-inwardly directed component of the vortically-flowing gas is greater than the centrifugal forces tending to effect outward movement of the particles.

Means are provided for passing a high-current spark through the canal **21**, such means being indicated schematically as comprising a suitable pulse-forming network **27** which is connected respectively through leads **28** and **29** with electrodes **11** and **12**. The pulse-forming network may comprise a low-inductance capacitor, or bank thereof, adapted to deliver a high voltage to the electrodes. This results in a high-current spark which is confined, by the gas **22**, to canal **21**. The resulting sudden and extreme elevation of the temperature of the powder or liquid may be termed an explosion, and results in generation of a pulse of intense light.

It is a feature of the invention that current flow is terminated substantially before the shock front (indicated at **31** in FIGURE 1) created by the explosion reaches the wall of the envelope or window **10**. This prevents clouding of the window, as will be described subsequently. The pressure created by the explosion not only results in the formation of the shock front **31**, with consequent momentary increase in the size of the canal through the vortically flowing gas, but also results in discharge of jets of plasma **32** and **33** through openings **13** and **14**.

Means are provided to reflect the light, after it passes through the window **10**, in a desired direction. Such means may comprise a reflector apparatus **35** having a parabolic polished reflector surface **36** the focal axis of which is coincident with the axis of tube **10**. It is to be understood that the surface **36** is normally much larger than is indicated in the drawing, so that the light-generating tube **10** and electrodes **11** and **12** only occupy a relatively small region at the axis of the reflector. Reflector apparatus **35** is indicated as having end walls **37** and **38** which may serve as supports for the mounting means (not shown) which maintain the electrodes **11** and **12** in position. The conduit **26** passes through the end wall **37**, and a short conduit **39** is provided through the wall **38** so that the discharging plasma will not remain within the reflector. Both conduits **26** and **39** are formed of insulating material.

It is to be understood that a plurality (for example, four) of the devices illustrated in the drawing may be provided in adjacent relationship and all directed in the same direction. The pulse-forming networks **27** for such devices may then all be so correlated or gated that each generates light during one-quarter of a full cycle of operation, so that a continuous light source is simulated. Each pulse-forming network may be adapted to deliver a square pulse continuing for one-quarter cycle, with each pulse terminating at approximately the same instant that the pulse for the next light source commences.

Description of the method and summary of operation

Stated generally, the method comprises creating a canal by means of vortically-flowing gas, introducing a light-emitter substance into the canal, and passing an electric spark discharge through the canal in order to effect explosion of the light-emitter and consequent generation of intense light.

With particular relation to the apparatus illustrated in the drawing, the method comprises employing the gas source **18** to introduce gas rapidly and tangentially into the cylindrical chamber defined by tube **10**, so that the gas flows vortically in the chamber and results in formation of the canal indicated at **21** in FIGURE 3. Powder source **24** is then employed to introduce powder **23** (or liquid) through opening **13** into the canal **21**. This powder remains in the canal **21**, being confined thereto by the circulating gas **22** as previously described. The pulse-forming network **27** is then employed to impress a high voltage between electrodes **11** and **12**, with consequent passage of an electric spark between the electrodes and through the canal **21**.

The electric spark effects sudden heating (explosion) of the powder **23**, with consequent generation not only of an intense light but also of the shock front **31** (FIGURE 1) which moves radially outwardly toward the wall of the light-transmissive envelope **10**. Substantially before the shock front **31** reaches the envelope wall, current flow is terminated so that cooling of the gas (and dissipation of shock front **31**) immediately results. The vortically-flowing gas then results in re-formation of the small-diameter canal **21** (FIGURE 3), and in purging of the chamber of the products of the explosion. The majority of such products discharge through the opening **14** and short conduit **39**, but certain of the products pass out through the opening **13** into tube **26**. Because of the fact that the chamber is purged of the products of the explosion, and because of the fact that the shock front **31** dissipates (as stated above) before reaching the interior wall of the envelope, such wall does not become clouded.

The explosion products which enter tube or conduit **26** (immediately following the explosion) provide a compressor or pulsation action, similar to a piston, which has the beneficial effect of agitating the powder within the conduit **26** and aiding in the feeding action.

After the small-diameter canal **21** has been re-established, additional powder **23** is introduced into the canal, and the pulse-forming network **27** is operated to repeat the process. If desired, the flow of powder from source **24** to opening **13** may be stopped and started, in timed relation to the application of voltage pulses, to conserve the supply of powder **23** (or of liquid).

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.

I claim:

1. Apparatus for generating high-intensity light, comprising wall means to define a chamber and having a light-transmissive portion, means to introduce gas continuously into said chamber and to effect vortical flow of gas therein about a central axis and consequent formation of a canal along said axis, means to drain gas continuously from said chamber, means to introduce a particulate light-emitter substance directly into said canal, first and second electrode means disposed at spaced points along said canal, and means to effect passage of an electrical discharge between said electrode means along said canal, said last-named means effecting said electrical discharge at a power level sufficiently high to explode said particulate substance and thus generate high-intensity light.

2. The invention as claimed in claim **1** in which at least part of said wall means lies in a surface of revolution about said central axis, in which said electrical discharge is a spark discharge, in which said last-named means is adapted to maintain said discharge for an interval of time shorter than the time required for the shock front resulting from said explosion to reach said surface of revolution, and in which said light-transmissive portion of said wall means is in said surface of revolution.

3. The invention as claimed in claim **1**, in which said means to introduce said light-emitter substance into said canal comprises a passage formed in one of said electrode means at said axis.

4. A vortex light source, comprising light-transmissive wall means to define a generally cylindrical chamber, first and second spaced electrodes each having an opening adjacent the axis of said chamber, means to introduce particulate substance through the opening in said first electrode into the axis of said chamber, said particulate substance being adapted when heated to explode and emit intense light, means to introduce gas tangentially into said chamber for vortical flow therein and subsequent draining through the opening in said second electrode, and means to apply sufficient voltage to said electrodes to effect generation of a high-current electric discharge therebetween, said discharge passing along the canal in said vortically-flowing gas and having a power level sufficiently great to explode said particulate substance and thereby generate intense light.

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