Dec. 16, 1958 A. C. LOEDDING 2,864,311

FLARES

Filed Dec. 7, 1953

Fig. 1

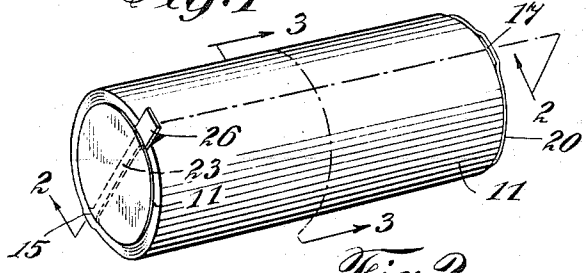


Fig. 2.

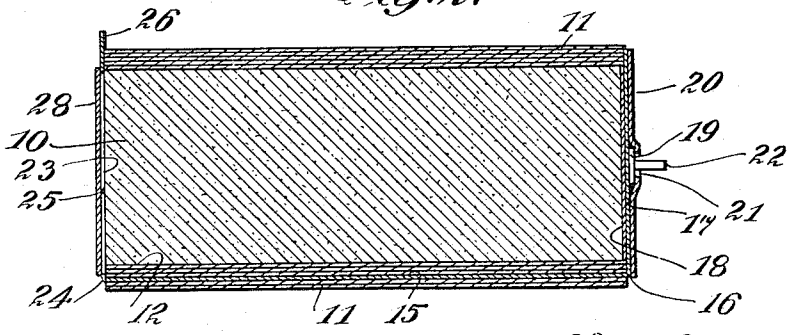


Fig. 3.

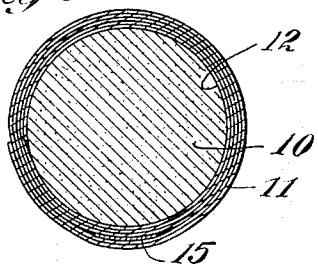


Fig. 4.

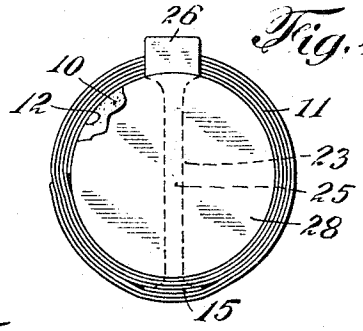


Fig. 5.

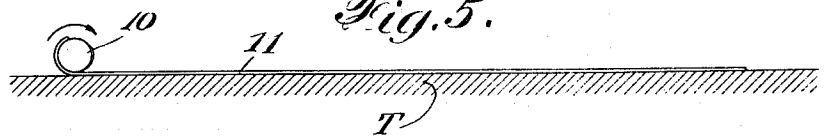


Fig. 6.

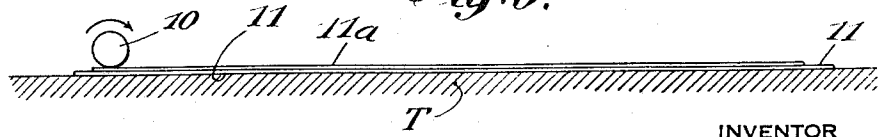
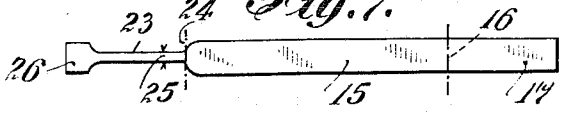


Fig. 7.



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FLARES

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Application December 7, 1953, Serial No. 396,375

1 Claim. (Cl. 102—37.8)

This invention relates to flares, and has for its object to provide a cheap, throw-away flare whose charge burns at a constant rate and is immediately responsive to ignition.

The flare of this invention consists of a cartridge shell containing one solid powder charge, or a series of charges arranged end-to-end, such charge or charges being wrapped in a spirally wound enveloping paper, in a very thin metal layer, or both, said envelope being of a width equal to the length of the charge, and at the same time enclosing part of an igniter which extends from the bottom of the charge to the top of the same, with its terminals connected to the positive and negative terminals of a source of electric current. The igniter at the top of the charge is specially arranged to give a definite and instantaneous current transfer to the ignition unit. Electric matches may be interposed when the charge is being ignited. The gases are expelled from the cylindrical envelope, and due to the slowness of combustion, a plurality of layers of paper or like material adjacent to the charge are provided to be destroyed slowly because of the poor heat transfer through the surface of each layer. This permits an inexpensive and safe (in the event of explosion) envelope or cartridge shell which is thrown away after use.

The improved flare is an inexpensive self-contained unit preventing excess heat transfer to the outer surface and housing even after relatively long burning times of 60 to 100 seconds.

The invention will be further described in more detail hereinafter, an embodiment thereof shown in the drawings, and the invention will be finally set forth in the claims.

In the accompanying drawings:

Fig. 1 is a perspective view of the improved flare;

Fig. 2 is a longitudinal central section on line 2—2 of Fig. 1, enlarged to actual size;

Fig. 3 is transverse section taken on line 3—3 of Fig. 1;

Fig. 4 is an end view of the discharge end of the shell;

Fig. 5 is a diagrammatic view of the manner of winding the paper wrapping around the powder charge;

Fig. 6 is a view similar to that of Fig. 5, illustrating a sheet of thin metal, and a sheet of paper being simultaneously wound around the powder charge; and

Fig. 7 is a developed view, reduced size, of an electrical conductor for igniting the charge.

Similar characters of reference indicate corresponding parts throughout the various views.

Referring to the drawings, and more particularly to Figs. 5 and 6, a compacted powder charge **10** of cylindrical form is placed in horizontal position across a strip of manila or other suitable paper **11** about four feet in length to obtain the proper wall thickness (approx. ⅛ inch) of the hollow cylinder to be formed around said charge. The thickness of the paper or metal is between .008 and .0150 inch. The outer form of the charge may also be hexagonal with a filler for the flat surfaces

to make a cylindrical form, or the outer contour may have a multiplicity of small serrations. The powder charge **10** is then rolled along the strip **11** supported by a table T, so that the paper winds around the charge until the winding has been completed. An adhesive is applied to the inner side of the paper before wrapping, so that when wound a compact cylindrical container for the charge has been provided; such an adhesive may also be applied to the charge itself. Another form of envelope, where the internal pressure requires it, is one which results from winding a sheet of such paper and a very thin metal strip **11***a*, in faying relationship, around the charge **10**, with or without the aid of the adhesive. Also, an extruded cylindrical tube of aluminum or its alloys, with one end closed, can be provided around the paper layers. This makes a water proof container and supplies the necessary firmness and roundness, rendering the device especially suitable for operation at high pressures.

Instead of one charge of about 4 inches in axial length, two charges each two inches in length can be used, preferably joined end-to-end by an adhesive, that covers the abutting surfaces of said two charges. United charges to form a long multiple charge may be desirable to enable the completed cartridge to withstand severe handling loads, vibration, etc., for example, when the layers of paper and/or metallic foil are applied to its periphery. This is largely a matter of manufacturing the charges, and the dimensions just stated can be varied as to design conditions and as to certain requirements.

This manner of assembly as shown in Fig. 5 and Fig. 6, while preferable at this time, can be carried out by use of a cylindrical mandrel of the contour of the charge **10**, preferably of wood, and when the winding is complete, then the mandrel can be replaced by the powder charge, which is held frictionally in the bore **12**, or can be attached by an adhesive. In such an alternative case, the powder charge need not be entirely cylindrical, but can be serrated or the like, as long as peripheral surfaces are provided which closely hug the surface of the bore **12**, so as to be permanently attached thereto either by friction, or by an adhesive to prevent the charge from being separated from its enclosure.

An igniter forms part of the cartridge. A strip **15** which may be a fine single wire, a mesh of electrical conducting metal of high resistance, or a thin metal strip (approximately .002 inch) as shown in Fig. 7, is applied to the wound paper roll just before the winding is completed, so that the plies overlapping the metal conductor insulate the same. The strip resistance type igniter is preferred when current is 5 amperes or more. A standard squib or electric match that normally uses less than one ampere of current may be more desirable for aircraft, rocket, or missile use. The strip is then bent along the dot-dash line **16**, to form the base **17** of the igniter which is connected with one polarity of a source of electric energy. The base **17** is separated from the charge by a cardboard insulating disk **18** (see Fig. 2), previously applied to the cylindrical casing of wound strips either by friction, in which case the diameter of the disk **18** is slightly smaller than the internal diameter of the wound casing at its peripheral plies, or by a suitable adhesive.

A contact piece **19** is preferably applied to a second covering disk **20** of cardboard or other insulating material having a central hole **21**. An electrical conductor **22** passes through said hole **21** and its free end is secured by soldering, fusing or the like to the contact piece **19**. The conductor leads to one pole of the source of electricity (not shown). This conductor **22** may be replaced by any other suitable conduit connecting mem-

ber 17 with a source of electrical energy. Opening 21 should be less than the full width of the portion 17 of strip 15. The hole or opening 21 must be large enough for an electrical contact, if it be desired to use a contact piece supported by a thin disk such as 20, supporting a contact piece 19, at the base of the cartridge. The other end 23 of the igniter strip 15 is reduced in width as at 25, to incandesce promptly, and this reduced portion 25 passes over and is in contact with the discharge end of the powder core or charge. The reduced end is bent along the dot-dash lines 24 at right angles, so that it contacts the surface of the powder charge. The strip 15 again widens to its normal width and extends over to the side of the casing, as at 26 (Fig. 2) to be connected with the other polarity of a source of electrical energy (not shown). Tests are being made with more suitable materials to maintain practical dimensions of about 1/32 of an inch for part 25 but reduce the current flow to possibly one ampere. To enhance the certainty of operation, the reduced resistor strip 25 can be brought into intimate contact with a quick match or a specially prepared gauze or bag containing loose black powder or an equivalent substance for immediate ignition.

A disk 28 of cardboard or other suitable insulating material is applied over the reduced portion 25 of igniter 15.

The manner of connecting the ends of the strip 15 with the two polarities of a source of electrical energy may be varied.

The essential function of the igniter is to bring about an instantaneous ignition of the discharge end of the powder charge, so that the entire charge may be consumed in a controlled manner.

It is also essential that the solid powder charge have the ability to burn at low pressures (even below standard atmospheric conditions such as at high altitudes), and low ambient temperatures in arctic regions. A suitable powder charge has been disclosed and claimed by me in an application for Letters Patent of the United States, filed on January 18, 1954 under Serial No. 404,717. Tests have shown that the combustion of this charge is uniform and smooth from minus 75° F. to plus 180° F. Actual tests also proved the high reproducibility from cartridge to cartridge and therefore immediate applicability as the main element in the ignition system of a ramjet type power plant.

The adhesive referred to is of a special kind, namely:

The material I prefer to use is a silicon base made by Dow-Corning put in liquid or paste form, and which was subsequently vulcanized at room or slightly raised temperatures. The adhesive used is pressure sensitive material at all ambient temperatures (minus 75 to plus 200° F.), such as XC–271 Adhesive, described in a publication entitled Silicone Notes of September 1953, distributed by the Dow Corning Corporation, of Midland, Michigan. For self-vulcanizing at room temperature Silastic 123, described in a publication entitled Silastic Facts of January 1952, distributed by said Dow Corning Corporation, is recommended, which also maintains its elastic characteristics at said extreme ambient temperature ranges. It is essential to first cover the charge with an inhibiting coat, which is essentially a synthetic rubber base material that will remain elastic at all ambient temperatures. Alternate materials are made by the Minnesota Mining Company, which they designate as EC–853 3–M Coating, as described in their publication entitled Technical Data Sheet of February 25, 1952. Either can be used. Also, Dow-Corning Silastic No. 125 (see their publication entitled Silastic Facts of March 1952) can be used as the preferred material since, it being a white paste without a migrating plasticizer or solvent, it maintains its paste form at all ambient temperatures, and therefore provides the greatest assurance of inhibiting the porous surface of the propellent charge to achieve controlled burning. The whiteness is obtained by the use of Titanium dioxide, TiO_2. This white substance reflects the radiant heat and renders the coating an excellent inhibitor to achieve controlled burning. On top of this layer a thick coating can be applied to this paste to build up an insulating covering, and an adhesive (Dow-Corning XC–271 Adhesive with 50 percent mica powder admixed thereto) may be used; or where only a sealer is required, Dow-Corning Silastic No. 123 or a product of the Minnesota Mining Company, known as EX–612 3–M Sealer (described in their publication entitled Technical Data Sheet of March 8, 1949) can also be used both as a sealer against flame flash and moisture, and as an adhesive. This final covering is also a sealer.

Epoxy type resins, such as "Epon" (trademark) of the Shell Chemical Corporation, can be satisfactorily used as the bonding agent, to build up charges from unit segments, in case segments are used instead of the single charge as in the drawings. The basic fact disclosed here is to free the charge from dust and apply a paste as Dow-Corning Silastic 125, and one preferable way is to mix it with a solvent (perchloroethylene preferred), so that it can be readily brushed or sprayed on. It has been found that combustible solvents such as benzine, xylene, toluol, etc., must not be used because they may not completely evaporate from the powder and will cause erratic and dangerous burning of the charge. Therefore, only non-combustible solvents must be used. Perchloroethylene is selected because it is relatively non-toxic. This having been done, a covering layer of XC–271 may be applied, which has the advantage of acting as an adhesive for building of segments, or to secure the charge to the paper wrapping. Instead of XC–271, resins that cure, due to catalytic action, may be used, such as an epoxy cement ("Epon" trademark) for bonding purposes. Thus a charge coated with such an adhesive is a new entity. Such a coating may be applied by brush, spray or by dipping when thinned with perchloroethylene, C_2Cl_4 or the like, which solvent then evaporates and leaves the coating in basic paste form that is fire-resistant. The surfaces will be inhibited against flash or flame propagation along the surfaces as the paste fills the pores. This paste which will not evaporate remains in paste form, with the same viscosity, without creeping.

The solid fuel cartridge of this invention is a cheap, throwaway unit because of the ability of the propellant to ignite easily and burn with good stability at low pressures (15 p. s. i. and up and throughout the temperature range of minus 75° F. to plus 170° F.).

One function of this cartridge is to perform as a flare. Flares must produce a smokeless flame 12 to 18 inches long with considerable heat to cause combustion of large volume of gas at low pressure such as in the case of a ramjet engine before it attains high speed and high pressure necessary to cause spontaneous and continuous combustion. Existing flares fail because:

(*a*) Those using ordinary black powder burn too fast (rate must be less than .1 inch per second—requirement was 60 seconds for length of 4").

(*b*) Further, black powder gives off too much smoke, and hence undesirable solids and not enough heat although it will burn at low pressure.

(*c*) Known smokeless powder compounds (double base and synthetic rubber base propellants) will not burn satisfactorily at low pressures from 0 to 100 p. s. i., nor satisfactorily at low ambient temperatures. Hence such charges must be enclosed in strong cylinders and use a nozzle or orifice to raise the pressure to 500 p. s. i. or above to obtain uniform and certain combustion.

The present improved cartridge can also be used for compact heater work for emergency or in Arctic regions or as a major element in an instantaneous steam generating plant. It could also be used as the heating ele-

ment of a compact heating plant—or other places to create steam. It could serve as a firebox for a special locomotive.

The invention may be applied to uses in industries where certain fluids, chemicals or otherwise, must be discharged from storage vessels under pressure. The exhaust from such a solid gas generator must be suitable, that is, the products of combustion must not contain large quantities of solids nor excess oxygen that would support combustion of the fluid being discharged. For instance, when black powder is burned, undesirable solids, such as potassium sulphate (K_2SO_4), sodium sulphate ($NaSO_4$), potassium carbonate (K_2CO_3), etc., may cause undesirable effects.

When the well known smokeless powders, such as double-base (nitroglycerine and nitrocellulose) or the single base (nitrocellulose) are used, they require high pressure of 500 p. s. i. or over for uniform combustion, and produce slight excess oxygen which could cause combustion, or some other undesirable effect of the fluid being discharged.

In my charge, practically no solids are present in the exhaust gases and the chemical composition can be readily varied so that no excess oxygen results. Rods of aluminum, magnesium and zirconium, or of their alloys, may be embedded in the powder charge, preferably at its center core, which the fabrication technique of my previous invention permits. The burning of these rods will insure the absorption of any excess oxygen during the combustion of the charge and provide enormous heat release, not possible by the charges heretofore proposed.

The composition of this charge which may also be used as a propellant consists largely of three elements: (*a*) charcoal, (*b*) sulphur, and (*c*) non-smoke producing oxidizing agents, such as ammonium perchlorate (NH_4ClO_4) and other similar oxidizing agents. Ammonium nitrate (NH_4NO_3) (specially treated) may also be used as an ingredient in the composition. Ammonium nitrate (NH_4NO_3) is especailly useful in getting a slower burning rate and desirable products of combustion (non-toxic and non-corrosive). A preferred percentage of ammonium nitrate is approximately 10%, but it may be added in the amounts of up to 20% by weight. Other ingredients which are particularly useful in slowing the burning rate are quanidine nitrate, ester gum, or gum arabic, etc. More complete disclosure of the preferred charge of powder has been made by me in a separate application identified above.

In place of the specific igniter shown in Fig. 7, a conducting strip may be used from end to end or an envelope of aluminum foil may be used as an electric conductor, as it does not corrode. Also, a steel sheet or a sheet of any other suitable metal may be included in the envelope to act as an electric conductor, or merely as a strengthener against bursting forces. The steel which may or may not be stainless can be used as it is completely enclosed and therefore protected from the elements. It has the advantage that it facilitates the attachment of suitable closures to withstand high internal pressure. The previously mentioned extruded aluminum tube, closed at one end, will withstand high internal pressures and will enclose a substantially round charge from end to end, together with the electrical conductor that connects the two ends of the igniter which are connected with a source of electrical energy.

I have described several forms of my invention, but obviously various changes and modifications may be made in the details disclosed without departing from the spirit and scope of the invention as set out in the appended claim.

I claim:

In a flare, in combination: a solid substantially cylindrical powder charge having a longitudinal axis, a tubular envelope tightly receiving said charge for controlled end burning thereof, said envelope comprising a plurality of relatively thin layers of heat transfer reducing material and having a first and a second open end, an insulating member in the first end of said envelope adjacent to said charge, a flat metallic member having a first portion which constitutes an igniter and is in contact with said charge in the second end of said envelope, a second portion embedded in the layers of said envelope in substantial parallelism with the longitudinal axis of said charge, and a third portion separated from the charge in said first open end of the envelope by said insulating member, said first portion having a cross sectional area less than the cross sectional areas of said second and said third portion, and electrical conductor means connected with said first and said third portion for incandescing said first portion when connected with a source of electrical energy.

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