June 28, 1960 J. W. RABERN ET AL 2,942,547

GAS GENERATING ASSEMBLY

Filed June 24, 1958

FIG. 1

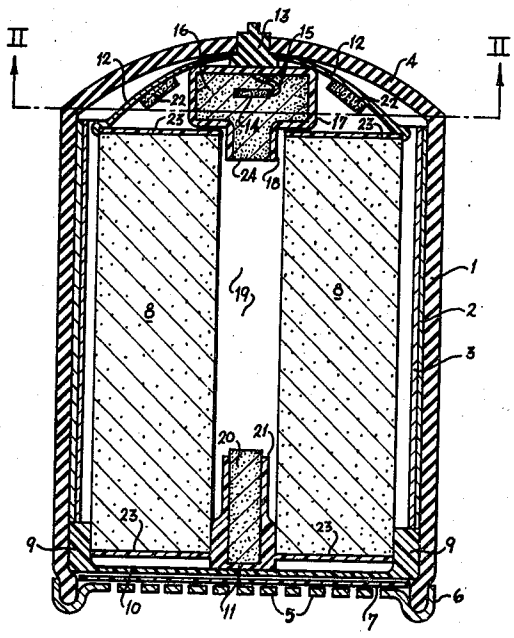
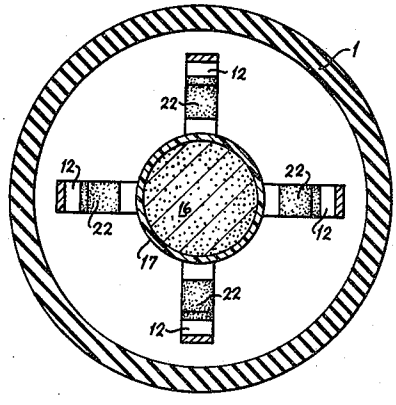


FIG. 2



INVENTORS.
JOSEPH W. RABERN
NORMAN J. WILKAITIS

BY

ATTORNEYS

United States Patent Office

2,942,547

Patented June 28, 1960

2,942,547

GAS GENERATING ASSEMBLY

Joseph William Rabern, Herrin, and Norman J. Wilkaitis, East Alton, Ill., assignors to Olin Mathieson Chemical Corporation, East Alton, Ill., a corporation of Virginia

Filed June 24, 1958, Ser. No. 744,253

3 Claims. (Cl. 102—39)

This invention relates to gas generating units and particularly to improved ignition assemblies therefor.

Solid gas generating charges are generally used as the source of power for the operation of prime movers such as internal combustion engines, motor starters, switch closers, jet engine starters, and the like. Ammonium nitrate with plastic binders has been regarded as the most suitable gas generating material in such charges because of its low cost, ease and safety in handling, and the predictability and control of gases generated upon ignition. However, ammonium nitrate consolidated charges are exceedingly difficult to ignite. Therefore, previous attempts to utilize ammonium nitrate in solid gas generating charges has not been completely satisfactory because no reliable means has heretofore been found for their ignition. Ideally, such solid gas generating charges develop gas and pressure in a more or less stepwise manner. Thus, the initial power generation must be sufficiently great to overcome the inertia of the driven mechanism but at the same time not so great as to destroy the mechanism or subject it to undue mechanical force before it is put in motion. After the initial inertia of the driven mechanism is overcome, the power demands from the gas generating charge are much greater. Prior art generating devices have been quite deficient in their capability of providing a relatively low pressure followed by a sustained substantially constant higher pressure, and this recognized desirable result could not be reproduceably obtained.

It is, therefore, an object of this invention to provide a gas generating cartridge and an ignition means therefor overcoming the disadvantages of the prior art. Another object of this invention is to provide an improved ignition assembly for solid gas generating charges. A more specific object of this invention is to provide a solid gas generating assembly capable of reliably igniting ammonium nitrate type gas generating charges as well as other types of gas generating charges in a stepwise manner. Other objects will be apparent when the following detailed description is read in connection with the accompanying drawing in which:

Figure 1 is a longitudinal sectional view of a gas generating cartridge illustrating a preferred embodiment of the present invention; and

Figure 2 is a transverse view partially in section taken along the lines II—II of Figure 1.

The objects of the present invention are achieved, generally speaking, by providing a cylindrical resilient cartridge case having a closed end and a discharge port at the other end, and containing a consolidated gas generating charge having a longitudinal perforation together with means to insure positive and stepwise ignition of the gas generating charge over a wide temperature range. More specifically, the present invention contemplates a cylindrical consolidated gas generating charge or grain provided with a centrally located longitudinal perforation and an ignition system for the grain. One portion of the ignition system for the grain consists of a consolidated ignition or pyrotechnic charge located within the perforation of the grain and near the discharge port. In addition, an electric squib imbedded in an igniter assembly is centrally positioned at the other end of the perforation and a plurality of auxiliary ignition pellets are provided below the main fuel charge near the closed end of the cartridge.

The gas generating charge of the present invention is preferably contained in a resilient casing which is adapted upon ignition of the charge to expand so as to effectively seal the breech structure or other mechanism in which the cartridge is fired. Various types of synthetic rubber and elastomers can be used in this connection. When such an organic casing is used, it is preferably provided with an insulating lining such as asbestos or the like and also with a reinforcing lining of metal or other suitable material. Alternately, a metallic casing can be used. One end of the casing is closed and carries the necessary electrical contacts, while the opposite end constitutes the discharge port. The discharge end is spanned by a screen or a perforated metal plate to permit passage of the gases generated upon combustion of the fuel charge. This end of the cartridge is preferably provided with a sealing means that is readily destroyed when the cartridge is put into operation.

The gas generating charge utilized in accordance with this invention preferably consists predominantly of granular ammonium nitrate together with a resinous or plastic binder or matrix. Suitable binders for the ammonium nitrate include synthetic rubber, nitrocellulose, plastic resins, and the like.

The ammonium nitrate charge substantially fills the interior of the chamber but is of a slightly smaller diameter so as to provide an annular space about the periphery of the grain. This annular space, which is essential for the proper combustion of the grain, is maintained by any suitable spacing means. The end surfaces of the ammonium nitrate charge are inhibited by any conventional means to prevent end burning. Thus, a layer of a non-combustible material, such as rubber-asbestos, ammonium oxalate-synthetic rubber, epoxy resins, polyurethane, or the like, can be affixed to the end surfaces of the grain for this purpose.

The ignition stimulus for the system originates from an electric squib or similar deflagrating device embedded in a body of a vigorous ignition composition. This ignition composition in which the squib is embedded is preferably contained in a plastic cup which, upon ignition, disintegrates without forming any harmful residue. While polyethylene is particularly well suited for this purpose, any other suitably evanescent material can be used. The plastic cup is centrally located near the closed end of the cartridge and is aligned with the central perforation of the main fuel charge. The top of the cup is provided witht a closure that will readily yield upon ignition of the contents of the cup. The top portion of the cup is directed into the central perforation of the grain and preferably extends partially thereinto.

For convenience and clarity in describing the invention, the term "top" is applied to the discharge end of the cartridge and the term "bottom" is applied to the closed end. It will, of course, be readily apparent that this cartridge can be fired in any position.

Various types of ignition compositions capable of producing an intense flame with a moderate evolution of gaseous products can be utilized in this plastic cup. These charges are preferably provided with a binder. Compositions containing a metal, a plastic binder, and an oxidizer are particularly well suited for this purpose. Compositions containing polyvinyl acetate, boron, and potassium perchlorate have been found to be satisfactory but other

metals, including aluminum and the like, fuels and oxidizers can, of course, be used.

The ignition composition contained in the plastic cup is augmented by an ignition pellet located in the central perforation of the grain remote from the squib and a plurality of cakes of fast burning propellent located about the plastic cup at the closed end of the cartridge. These auxiliary ignition cake charges are preferably a composition made with a rubber type binder, similar to a fast burning rocket propellent. The pellet ignition charge positioned within the perforation of the grain is preferably contained in a plastic holder and is provided with an inhibitor to restrict burning on the cylindrical surface of the pellet except for a portion near the open end of the plastic holder.

In order to more fully explain and clarify the invention, reference is made to the drawing for a preferred embodiment thereof. Unless otherwise specified, compositions of the various formulations are expressed in parts by weight.

In this embodiment, the body of the cartridge consists of a synthetic rubber casing **1**, the sidewalls of which are provided with a liner **2** of asbestos and a metallic reinforcing liner **3**. The closed end of the cartridge is dome shaped, as indicated generally at **4** and the opposing discharge end is closed by a perforated plate or screen **5**, which is crimped about the lower end of the cartridge as shown at **6**. A thin layer **7** of polyester plastic tape or other evanescent plastic material is positioned over screen **5** to provide a weather seal for the cartridge. The main fuel charge is a consolidated grain **8** of granular ammonium nitrate in a binder of polybutadiene acrylic acid type synthetic rubber. This grain is provided with a layer of inhibitor **23** at each end to insure lateral burning. The grain is maintained in position within the cartridge by plastic spacers **9** which are integral with lateral extensions **10** of centrally located support **11**. Metallic supports **12** cooperate with plastic members **9** to maintain the grain in alignment. These members extend from the central portion of the closed end of the cartridge to the top of the gas generating grain. The electrical contacts for initiation of the squib pass through the closed end of the cartridge and are shown generally at **13**. Squib **14** is provided with lead wires **15** and is embedded in a black powder-pyrotechnic mixture **16** having the following approximate composition:

8.5% powdered boron
78.5% potassium perchlorate
8.0% graphite
5.0% polyvinyl acetate

This pyrotechnic mixture is contained in polyethylene cup **17**. In this preferred embodiment, the cup is provided with a portion **18** of reduced diameter closed with a thin polyethylene seal **24** and adapted to project into the central perforation **19** of the main grain.

Ignition charge **16** is complemented by ignition pellet **20** which is preferably provided with a lateral plastic inhibitor **21**. Composition **20**, in this embodiment, has substantially the following composition:

8.5% boron
13.0% aluminum
64.5% potassium perchlorate
10.0% graphite
4.2% polyvinyl acetate

In addition, the assembly is also provided with four cast propellent charges or cakes **22** which are bonded to supporting members **12** and positioned radially to plastic cup **17** between the main grain and the closed end of the cartridge. Two of these four pressed charges were composed of a mixture of about 75.0% ammonium perchlorate, 12.5% polyvinyl chloride, and 12.5% dioctyl phthalate, while the remaining two charges were composed of a mixture of about 57.5% potassium perchlorate, 12.5% aluminum powder, 5% boron, 12.5% dioctyl phthalate, and 12.5% polyvinyl chloride. In those instances where it is desired that these charges be aluminum free, the remaining two cast propellent cakes can be composed of a mixture of about 12.5% dioctyl phthalate, 12.5% polyvinyl chloride, 1% boron, and 74% potassium perchlorate.

Upon firing the cartridge, squib **14** ignites ignition charge **16** whose flame is directed through the central perforation of the gas generating charge so as to impinge upon the exposed surface of igniter pellet **20**. Charge **20** then ignites vigorously and together with the action of charge **16** initiates combustion of the gas generating charge **8** on its surface on the central perforation **19**. Auxiliary ignition charges **22** are then ignited and assist in carrying the flame and hot gases to the peripheral surfaces of the ammonium nitrate grain. In operation, the elastomeric case **1** is readily expanded so as to avoid any gas leakage or blow-back in the breech mechanism or cartridge holder which is not shown and does not form a part of the present invention. The plastic covering **7** for the foraminous closure plate **5** ruptures or burns so as to provide ready egress for the gaseous combustion products.

The ignition of the main gas generating charge in its central perforation by substantially non-gaseous ignition charges followed by ignition of the outer surface of the grain provides a system wherein the initial pressure generated by the cartridge is relatively low and is followed by a sustained period of substantially high pressure generation.

While the above embodiment was directed specifically to an ammonium nitrate type gas generating charge, it will be readily appreciated that this ignition system can be utilized with advantage in connection with other gas generating compositions based on nitroguanidine, guanidine nitrate, perchlorates, and the like. It is also evident that various other modifications may be made without departing from the scope of the present invention. For example, various types of ignition compositions can be used. Also, the ignition pellet contained within the central perforation can be uninhibited and a larger or smaller number of auxiliary ignition charges can be positioned between the gas generating charge and the closed end of the cartridge. Also, the ignition assembly can be housed and positioned by any suitable means.

Since variations in the specific embodiment may be made within the spirit and scope of this invention, the detailed description is not to be considered as limitative except in the light of the appended claims.

What is claimed is:

1. A gas generating cartridge for an engine starter and the like comprising a substantially cylindrical resilient casing having a permanently closed end and an oppositely disposed discharge end, a centrally perforated substantially cylindrical end-inhibited ammonium nitrate gas generating charge disposed in and spaced from the casing as the main charge, the longitudinal axes of the cylindrical casing and of the cylindrical gas generating charge being substantially parallel, a laterally and basally inhibited cylindrical pyrotechnic charge positioned in and substantially filling that portion of the central perforation proximate the discharge end of the cartridge, the base of the pyrotechinc charge being proximate the discharge end of the cartridge, an electric squib embedded in an ignition mixture, said ignition mixture being contained in an evanescent plastic cup positioned at the closed end of the cartridge and having a portion extending into and substantially closing that portion of the central perforation proximate the closed end of the cartridge, and a plurality of ignition charges positioned radially about the plastic cup and between the closed end of the cartridge and the proximate end of the ammonium nitrate grain.

2. A gas generating cartridge for an engine starter and

the like comprising a substantially cylindrical resilient casing having a permanently closed end and an oppositely disposed discharge end, an end inhibited gas generating centrally perforated grain contained in the casing and spaced therefrom, an evanescent cup positioned at one end of the perforation with a cylindrical portion of the cup extending into and closing that end of the perforation, the evanescent cup containing an ignition mixture having an electric squib embedded therein, the opposite end of the perforation being closed by a pyrotechnic charge free to burn only on that surface facing the evanescent cup, and a plurality of ignition charges positioned radially about the plastic cup and between the closed end of the cartridge and the gas generating grain.

3. A fuel charge for a gas generating device comprising as the main fuel a cylindrical end-inhibited grain of a gas generating composition having at least one longitudinal perforation, a laterally and basally inhibited cylindrical pyrotechnic charge substantially filling one end of the perforation in the gas generating charge, the top of the pyrotechnic charge extending into the perforation, an ignition assembly closing the other end of the perforation

and containing an electric squib embedded in an ignitor mixture contained in an evanescent plastic cup, a plurality of ignition charges positioned radially about the ignition assembly and between the perforation and the external wall of the cylindrical grain, and means supporting said grain and charges.

References Cited in the file of this patent

UNITED STATES PATENTS

2,518,958	Thompson et al.	Aug. 15, 1950
2,685,837	Sage et al.	Aug. 10, 1954
2,688,920	Jarvis	Sept. 14, 1954
2,743,580	Loeb	May 1, 1956
2,771,035	Clark	Nov. 20, 1956
2,865,456	Dennis	Dec. 23, 1958

FOREIGN PATENTS

502,757	Germany	Aug. 5, 1930

OTHER REFERENCES

Jet Propulsion magazine article, Feb. 1956, pp. 102 and 103 required.