

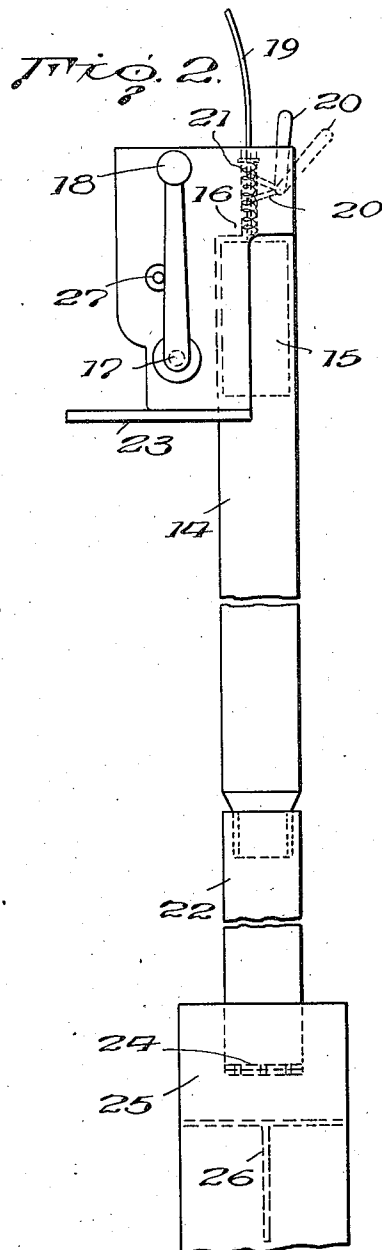
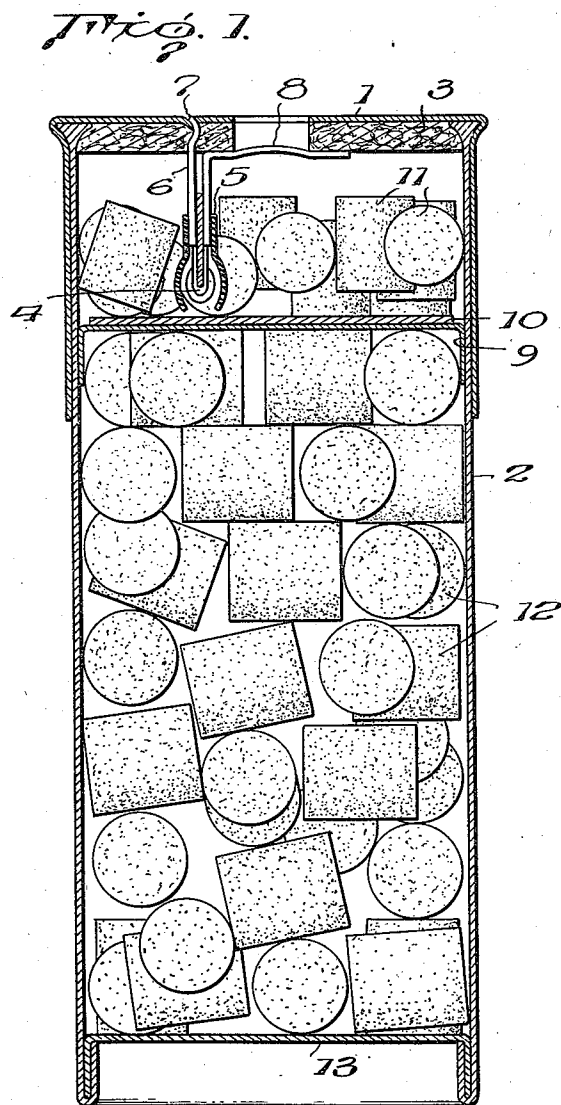
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CARTRIDGE FOR ACTUATING GAS PRESSURE OPERATED MECHANICAL DEVICES

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CARTRIDGE FOR ACTUATING GAS PRESSURE OPERATED MECHANICAL DEVICES

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The present invention relates to cartridges of the kind adapted to generate gas under pressure for the operation of mechanical devices, as distinct from the propulsion of projectiles. More particularly the invention relates to cartridges for use in operating gas pressure actuated internal combustion engine starters in which the movement of a piston or the like outside the engine is converted into rotational movement of the crank-shaft of the engine.

As such cartridges are discharged into a space that includes a cylinder fitted with a piston or the like, unless the ejected material is combustible and burns substantially without residue, deposits will be left in the cylinder which will necessitate the starter being taken down and cleaned with excessive frequency. For this reason, and on account of their high gas yield, colloidized nitrocellulose compositions of the general character employed in small arms and ordnance are desirably employed, and the closure of the cartridge at the end through which its contents are discharged is desirably made of celluloid or the like combustible ashless material.

In an engine starter of the kind described, however, the conditions under which the colloidized nitrocellulose composition is burned are quite different from those obtaining in firearms and ordnance. Whereas in firearms the gas pressure steadily decreases from a maximum attained when the projectile is near the breech to a negligible value in the very small fraction of a second occupied by the travel of the projectile up the barrel from breech to muzzle, in an engine starter of the kind described there must be maintained during the motion of the piston or the like a more or less steady pressure sufficient to keep it in motion at the required speed, over a period that may be of the order of one second but cannot be much less than that. Moreover, the pressures that it is permissible to generate in an engine starter never exceed about 3,000 lbs. per sq. in., and are thus much lower than those involved in the early stages of the travel of a projectile up a barrel of a weapon; and the ratio of maximum to mean pressure must be kept low in order to avoid damage to the starter mechanism.

For the preceding and other reasons the choice of a colloidized nitrocellulose propellant explosive composition is a matter of considerable difficulty. Thus many such compositions will not burn satisfactorily but yield excessive carbon deposits and nitrous fumes at the low pressures permissible, while many of those that are capable of burning satisfactorily at such pressures do so with excessive rapidity and result in an unsatisfactorily high ratio of maximum to mean pressure, or necessitate the employment of grain forms that

are inconvenient to manufacture or to load into the cartridges.

It is particularly desirable that the colloidized nitro-cellulose charge should consist of grains of decreasing burning surface characteristics, such as rods, pellets or the like solid grain forms of which a multiplicity can be run freely into the cartridge case. The decreasing burning surface characteristics of the grains together with the expansion of the space available for the gases after the piston or the like has commenced to move to some extent compensate for the fact that the surface rate of combustion of the colloidized nitro-cellulose is cumulatively increased by the increase in pressure of the gases generated in the enclosed space in the earlier stages of combustion. Usually it is necessary to employ for the main portion of the charge a colloidized nitrocellulose powder of such composition and grain size that it is not very easily ignited by the primary ignition means employed, and must be assisted by a more fiercely burning material which may comprise grains of a more rapidly burning colloidized nitrocellulose composition.

Thus there have been employed cartridges containing a main charge consisting of a multiplicity of pellets of a single base nitrocellulose propellant explosive powder, with which may be associated pellets of a nitroglycerine-nitrocellulose propellant explosive powder, and provided with an electric fuzehead or a resistance wire embedded in a readily ignitable deflagrating powder to ignite the charge. According to a proposal on similar lines for a power generating unit for engine starters, or more generally for performing work in which the pressure does not exceed 3,000 lbs. per sq. in., the charge includes intermingled nitroglycerine-containing pellets and nitrocellulose pellets, the primary igniting means being adapted for percussion or electrical operation. In both cases the double base powder, i. e. that containing nitroglycerine in addition to nitrocellulose, is the more easily ignited of the two and is the more rapidly burning of the two, so that it serves to convey the ignition to the single base nitrocellulose powder. Single base nitrocellulose powders must be made with the assistance of a volatile nitrocellulose solvent, and are troublesome to make in the required grain sizes since evaporation of the solvent from the shaped material or grains made therefrom by subdivision becomes progressively more difficult as it proceeds, and such powders must be dried for at least several weeks before they can be marketed, or loaded. Cartridges containing these charges are moreover unsatisfactory in their performance since the powder may fail to ignite, or if it does ignite the ratio of maximum to mean pressures is liable to an unde-

sirable or even dangerous variation from batch to batch, or as a result of storing the cartridges.

It is an object of the present invention to provide for an engine starter of the aforementioned kind a gas pressure generating cartridge containing a charge of a colloided nitrocellulose composition that is easily loaded, and of improved certainty of ignition and reliability in its performance. Another object is to provide for such engine starters a gas pressure generating cartridge of satisfactory reliability in its performance, containing a charge comprising colloided nitrocellulose that can be more advantageously manufactured or loaded than hitherto known or used colloided nitrocellulose charges for cartridges of that kind. Other objects will appear hereinafter.

We have found that these objects are attained if the gas pressure generating charge comprises a multiplicity of grains of decreasing burning surface characteristics of a double base colloided nitrocellulose composition having a calorific value between 700 and 1050 calories per gram (calculated on the basis that the water produced remains liquid) and made without the employment of a volatile solvent, in undelayed ignition contact with the primary ignition means.

The grains of the double base colloided nitrocellulose composition having a calorific value between 700 and 1050 calories per gram made without the employment of a volatile solvent and of decreasing burning surface characteristics will usually require to be of web thickness from about 0.25 to 0.4 inch and can conveniently be made by extrusion under heat and pressure and subsequent subdivision. They may take the form of rods of which a number can be loaded side by side into the cartridge case, or pellets, discs or polygonal forms, and for convenience in loading these into the cartridge case it is desirable that their longest dimension should not amount to as much as half the diameter of the cartridge case.

Double base propellant powders of the so-called nonsolvent type may be used for the purposes of our invention provided their calorific value and their grain form are as hereinbefore defined. In such compositions the gelatinisation of the nitrocellulose is brought about by nitroglycerine, usually with the aid of nonvolatile materials acting as assistants of gelatinisation, but without the use of any volatile solvent. It will be understood that propellant explosive powders made from other liquid nitric esters than nitroglycerine, for instance nitroglycol or other gelatinisable cellulose derivatives than nitrocellulose, for instance cellulose nitroacetate, would also fall within the description of nonsolvent double base powders. If assistants of gelatinisation are employed, they remain in the finished explosive, and the same is true of moderants or other materials included in the composition.

The primary ignition means may conveniently consist of an electric fuzehead or a percussion cap. To ensure ignition of the double base powder used according to our invention a length of quickmatch or a black powder-coated disc or the like may be placed at the base of the cartridge in proximity to the primary ignition means, and if desired there may also be provided a small proportion of grains of a more rapidly ignitable explosive than the said double base propellant powder in order to assist the ignition of the latter. A satisfactory ignition system consists of an electric fuzehead having a short length of rubber

tubing round it so as to direct the ignition flame against a coating of black powder on a Celluloid disc. This disc is placed across the cartridge near the base, and is just above the fuzehead, and the rapidly ignitable grains are packed below it or partly below and partly above it; the function of this Celluloid disc being to carry the ignition flame from the fuzehead to the rapidly ignitable grains. These may advantageously consist of a single or double base propellant powder of calorific value exceeding 1,050 calories per gram. As the proportion of these rapidly ignitable grains in the cartridge is small, and will not usually exceed $\frac{1}{2}$ of the whole, and as their dimensions are also relatively small it is not essential that these more rapidly ignitable grains should be of the non-solvent type.

The cartridge case may conveniently be made after the fashion of a shotgun cartridge case, and closed by turning the end of the wall over a Celluloid or like easily combustible disc, suitable insulating means being provided at the metal base in the case when the primary ignition means are electrically operated.

Compositions from which the double base powder grains used according to our invention may be fashioned include, for instance, nitrocellulose-nitroglycerine compositions that include a sufficient proportion of a non-volatile-non-explosive gelatiniser, e. g. diamyl phthalate, diethyl diphenyl urea or dinitrotoluene or any of the other common moderants, to bring the calorific value to the specified value.

It is also an advantage to have present a small percentage of potassium nitrate or some other agent that will ensure that any residue left after the charge has been fired is not acid and so will not corrode the metal of the engine starter.

The invention will be further understood by reference to the following examples, in which the parts are parts by weight.

Example 1

A cartridge case of the shotgun type, of which the internal diameter is 0.970 inch, is provided with a fibre washer fitting tightly in the bottom of the case. The fibre washer carried an electric fuzehead, of which one leading wire is connected to the brass base of the cartridge case, and the other passes across a central hole in the base through which contact is made to complete an electric current for firing. The fuzehead is wrapped in a piece of sulphurless quickmatch. The nonsolvent double base powder charge comprises 21.2 gm. of haphazardly positioned pellets, each approximately 0.33 inch in diameter and 0.30 inch in length, the composition of the powder being nitroglycerine 36 parts, nitrocellulose 52 parts, diethyl-diphenylurea 4.75 parts, mineral jelly 0.25 part, diamyl phthalate 7 parts, potassium nitrate 1 part. The powder is prepared by wet-mixing the ingredients with the exception of the mineral jelly and potassium nitrate, incorporating these latter into the wet paste in a machine of the Werner Pfleiderer type, hot rolling the paste, extruding the gelatinised sheet so produced under elevated temperatures and pressures into rod form, and cutting the extruded rods. The calorific value of the powder is approximately 850 calories per gram, calculated on the assumption that the water remains liquid.

A Celluloid disc is placed over the powder charge and secured by the usual turnover.

When the cartridge is fired into the aeroplane engine starter for which it is designed, it develops

a mean maximum pressure of 1,770 lb./in.², a mean maximum torque of 988 lb.-ft., imparts a maximum velocity of 183 revs. per minute and gives 1.63 revolutions to a flywheel of moment of inertia 300 lb.-ft.² braked to a static torque of 300 lb.-ft., which conditions simulate the resistance encountered in an aeroplane engine.

Example 2

A cartridge is constructed as described in Example 1, except that the powder charge of weight 34 gm. is in the form of rods of diameter approximately 0.32 inch and length 3 inches.

When this cartridge is fired into the aeroplane engine starter, it develops a mean maximum pressure of 1860 lb./in.², a mean maximum torque of 1026 lb.-ft., and imparts a maximum velocity of 218 revolutions per minute and gives 2.03 revolutions to the braked flywheel loaded as described in Example 1.

Example 3

A cartridge is constructed as in Example 1, except that, in place of the fibre washer carrying an electric fuzehead, the base of the cartridge is fitted with a percussion cap after the usual manner of a shotgun cartridge. A piece of sulphurless quickmatch is laid across the flash holes of the cap chamber. This cartridge gives a performance similar to that given by the cartridge described in Example 1.

Example 4

A cartridge is constructed as in Example 6, except that, in place of the fibre washer carrying an electric fuzehead, the base of the cartridge is fitted with a percussion cap after the usual manner of a shotgun cartridge. A piece of sulphurless quickmatch is laid across the flash holes of the cap chamber. This cartridge gives a performance similar to that given by the cartridge described in Example 2.

Example 5

A cartridge is constructed as in Example 1. In this case, however, the fuzehead is wrapped in a piece of sulphurless quickmatch and is surrounded by 11 pellets, each 0.25 inch long by 0.23 inch diameter, of an easily ignited nitroglycerine containing propellant powder made without the aid of volatile solvent having a calorific value about 1,200. This powder consists of nitroglycerine 45 parts, nitrocellulose 52 parts, and diethyldiphenylurea 3 parts, and approximately 3 gm. of it are used. The combination of fuzehead, quickmatch and powder makes up the igniting system of the cartridge.

The main charge, placed on top of the igniting system, comprises 18.5 gm. of the pellets described in Example 1, haphazardly disposed.

When this cartridge is fired under similar conditions to those described in Example 1, it develops a mean maximum pressure of 2242 lb./in.² and a mean maximum torque of 1,224 lb.-ft., imparts a maximum velocity of 216 revs. per min. and gives 1.97 revolutions to the braked flywheel.

Example 6

A cartridge is constructed as in Example 5, except that, in place of the fibre washer carrying an electric fuzehead, the base of the cartridge is fitted with a percussion cap after the usual manner of a shotgun cartridge. A piece of sulphurless quickmatch is laid across the flash holes of the cap chamber. The 3 gm. of igniting powder are loaded in around the quickmatch and the

main powder charge on top thereof. This cartridge gives a similar performance to that given by the cartridge described in Example 5.

Example 7

A cartridge is constructed as in Example 5, except that the main powder charge of 30 gm. is in the form of rods of diameter 0.32 inch and length 2.7 inches loaded symmetrically into the cartridge. The performance of the cartridge is similar to that of Example 2.

Example 8

A cartridge is constructed as in Example 6, except that the main powder charge of 30 gm. is in the form of rods of diameter 0.32 inch and length 2.7 inches. The performance of the cartridge is similar to that of Example 4.

Example 9

A cartridge is constructed as in Example 1, but in this case the electric fuzehead is sleeved with a piece of valve tubing, leaving only the tip of the fuzehead exposed. 11 pellets, each 0.25 inch long by 0.23 inch diameter, of an easily ignited nitroglycerine containing propellant powder made without the aid of volatile solvent and having a calorific value of about 1,200 calories per gram are placed at the base of the cartridge around the fuzehead. This powder consists of nitroglycerine 45 parts, nitrocellulose 52 parts, and diethyldiphenylurea 3 parts, and approximately 3 gm. of it are used. A Celluloid disc, which is a sliding fit in the cartridge case and which is coated in its underside with approximately 2 grains of fine grain black powder, rests on top of the fuzehead and the igniting charge.

The main charge placed on top of the Celluloid disc, comprises 17.7 gm. of the pellets described in Example 1, haphazardly disposed.

When this cartridge is fired into the aeroplane engine starter for which it is designed, it develops a mean maximum pressure of 1,890 lb./in.², a mean maximum torque of 950 lb.-ft., imparts a maximum velocity of 196 revolutions per minute and gives 1.67 revolutions to a flywheel of moment of inertia 300 lb.-ft.² braked to a static torque of 300 lb.-ft., which conditions simulate the resistance encountered in an aeroplane engine. The ratio of maximum to mean pressure is about 1.35.

Example 10

A cartridge is constructed as in Example 9. In this case, however, 5 gm. of igniting powder pellets are used, 3 gm. being placed below the blackpowder-coated Celluloid disc and 2 gm. above. The main charge, comprising 20.5 gm. of the pellets described in Example 1, is placed haphazardly on top of the igniting powder pellets lying on top of the Celluloid disc.

When this cartridge is fired into the aeroplane engine starter for which it is designed, it develops a mean maximum pressure of 1,800 lb./in.², a mean maximum torque of 1,630 lb.-ft., imparts a maximum velocity of 258 revolutions per minute and gives 2.66 revolutions to a flywheel of moment of inertia 382 lb.-ft.² braked to a static torque of 350 lb.-ft.

Example 11

A cartridge is constructed as in Example 9, but in this case the main powder charge of 30 gm. is in the form of rods of diameter 0.32 inch and length 2.7 inches loaded symmetrically into the cartridge. The performance of the cartridge is similar to that of Example 2.

The cartridges produced according to the method of our invention maintain their burning characteristics well on storage and cannot only be marketed when freshly assembled, but also the gas generating charge with which they are loaded may itself be freshly made or not, as desired, without sensibly affecting the performance of the cartridges.

Our invention is further illustrated in the drawing attached hereto, in which Fig. 1 is an axial section of one form of cartridge made in accordance with our invention, and Fig. 2 is a side view of a combustion chamber with breech and barrel connected to the cylinder of a piston-operated internal combustion engine starter, showing the position of the cartridge and of the piston in shadow section.

In Fig. 1, 1 is a centrally perforated brass cartridge base, 2 a paper cartridge wall and 3 an annular base wad of soft insulating material. 4 is an electric fuzehead shielded with a rubber sheath 5. The strip of metal 6 leading to one of the pole pieces of the fuzehead 4, passes through the insulating wad 3 and is soldered to the cartridge base 1 at 7, forming the earth connection of the fuzehead. The other metal strip 8 leading from the opposite pole piece of the fuzehead 4 passes over the opening of the wad 3 and the central perforation of the cartridge base 1. 9 is a Celluloid cup having cemented to it a layer 10 of black powder. 11 are grains of colloided nitrocellulose powder having a calorific value exceeding 1050 calories per gram, and 12 are grains of a colloided nitrocellulose powder made without the use of volatile solvents and consisting of a composition having a calorific value between 700 and 1050. 13 is a Celluloid closure cup over which the wall 2 is turned to close the cartridge.

In Fig. 2, 14 is the barrel of a combustion chamber containing a cartridge 15 made in accordance with our invention. 16 is a breech closure capable of being swivelled with respect to the base 23 about the pin 17, and 18 is a locking arm operating mechanism not shown for locking the breech in closed position and for unloading the breech. 27 is a lever arm stop. 19 is a leading wire attached to a spring 21 which when the contact lever 20 is pulled advances the leading wire against the action of the spring so as to cause it to enter the central perforation of the cartridge base 1 and contact the strip 8 shown in Fig. 1 and thus when an electric current is switched on ignite the fuzehead. 22 is a communicating tube terminating in a grid 24 leading into the cylinder 25 containing the piston 26.

Since it is obvious that various advantages and modifications may be made in the above description without departing from the nature or spirit thereof, this invention is not limited thereto except as set forth in the appended claims.

We claim:

1. A gas pressure producing cartridge for the actuation of an internal combustion engine starter, having a basally situated primary ignition means and a closure at the ejection end made of Celluloid, loaded with a relatively small basal charge consisting of grains of an easily ignitable colloided nitrocellulose composition having a calorific value exceeding 1050 calories per gram, a relatively large main ejectable charge of substantially ashless material consist-

ing essentially of grains of decreasing burning surface characteristics, each of said named grains being of uniform composition throughout its volume and being formed of a less easily ignitable colloided double base nitrocellulose composition completely free from volatile solvents and of calorific value between 700 and 1050 calories per gram (calculated on the basis that the water produced remains liquid), and interposed between said charges in proximity to the primary ignition means a septum of combustible material coated on its basally directed surface with blackpowder.

2. A gas pressure producing cartridge as claimed in claim 1 wherein the basal charge of colloided nitrocellulose composition having a calorific value exceeding 1050 calories per gram does not exceed one fifth of the total charge.

3. A gas pressure producing cartridge as claimed in claim 1 wherein the basal charge of colloided nitrocellulose composition having a calorific value exceeding 1050 calories per gram is made from a double base colloided nitrocellulose composition.

4. A gas pressure producing cartridge for actuation of an internal combustion engine starter including a piston comprising a cartridge case having a primary ignition means mounted thereon, a black powder coated disk disposed in proximity to said primary ignition means and having a charge disposed within said case in undelayed ignition contact with the primary ignition means, said charge comprising essentially a plurality of ejectable grains of substantially ashless, non-solvent, double base, colloided and gelatinized nitrocellulose propellant composition, each grain being of uniform composition throughout and having decreasing burning surface characteristics, and said composition having a calorific value between 700 and 1050 calories per gram, calculated on the basis that the water produced remains liquid, the web thickness of said ejectable grains being not in excess of about 0.4 inch, said charge when ignited maintaining a steady pressure sufficient to keep the piston at the required speed for a period of the order of about one second.

5. A gas pressure producing cartridge for actuation of an internal combustion engine starter including a piston comprising a cartridge case having a primary ignition means mounted thereon, and having a charge disposed within said case in undelayed ignition contact with the primary ignition means, said charge comprising essentially a plurality of ejectable grains of substantially ashless, non-solvent, double-base, colloided and gelatinized nitrocellulose propellant composition, comprising an extruded admixture of nitrocellulose, nitroglycerine and diamyl phthalate, each grain being of uniform composition throughout and having decreasing burning surface characteristics, and said composition having a calorific value between 700 and 1050 calories per gram, calculated on the basis that the water produced remains liquid, the web thickness of said ejectable grains being not in excess of about 0.4 inch, said charge when ignited maintaining a steady pressure sufficient to keep the piston at the required speed for a period of the order of about one second.

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