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SHEET PROPELLANT

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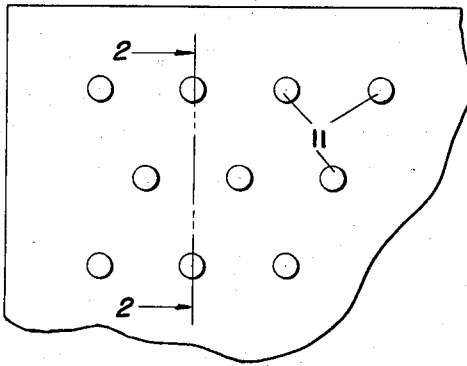


Fig. 1

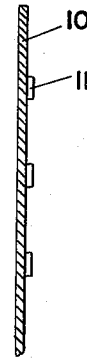


Fig. 2

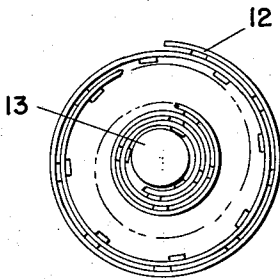


Fig. 3

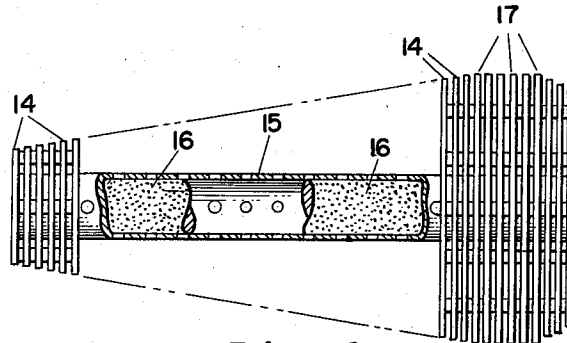


Fig. 4

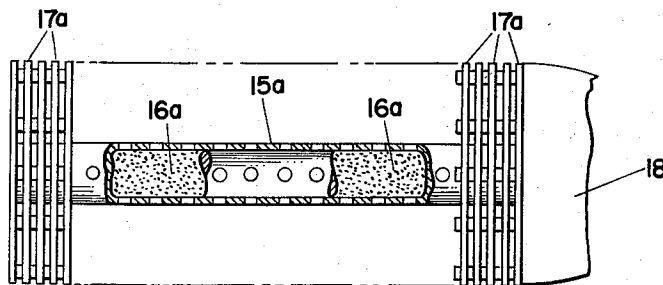


Fig. 5

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1

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SHEET PROPELLANT

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4 Claims. (Cl. 102—49)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without payment of any royalty thereon.

This invention relates to a propelling charge for a projectile fired from a gun and has for an object to provide a propelling charge in a form suitable for use without the necessity for usual enclosing case being present, whereby a substantial saving in weight is made possible. Another object is to provide a propellant capable of giving a close approach to uniformity in pressure of gas produced and in the rate of burning. A still further object is to provide a propellant for recoilless guns in which there is less unburned propellant ejected from the gun.

In larger caliber guns, separate loading ammunition has been used, the propellant being wrapped in a consumable silk bag, loaded into the gun after a projectile has been rammed home. In the smaller caliber guns, of a diameter in the order of 4 inches, fixed or semi-fixed ammunition has been customary, a soft metal cartridge case being used to house the propellant and secure the projectile in an end portion of the cartridge case. With the advent of recoilless guns of the Kroeger-Musser type disclosed in U.S. Patent 2,466,714 dated April 14, 1949, efforts have been made to keep the gun and ammunition as light in weight as is possible for desirable portability in rough terrain. The cartridge case for ammunition for that gun was made as light as was reasonably possible. It was made perforate for a substantial part of its length for the primary purpose of allowing the gases to be directed radially outward and then rearwardly through the nozzles for overcoming the thrust of recoil. As a result a considerable reduction in weight of the cartridge case was effected. It was realized that the lightest cartridge would be one having no propellant case at all. Making the propellant separately loaded after the manner of the larger caliber guns was not feasible because too large a proportion of the propellant would be blown rearwardly and its effectiveness in raising the gas pressure behind the projectile lost, thus reducing the effectiveness of the weapon.

According to the present invention, the weight of the propellant case has been eliminated making possible a great saving in weight of the ammunition that has to be supplied to the gun while at the same time reducing the loss of unburned propellant that would otherwise be blown rearwardly.

More specifically, the present propellant is made in sheet form with portions of it connected to reduce the portion of discrete particles of incompletely burned material being blown rearwardly. Still more specifically, one connection is the sheet material itself whereby the entire unitary mass is a spirally wound sheet of propellant. Another type of connection forming a unit is between discrete layers fitting over a supporting arbor or tube, which may or may not be filled with black powder or other igniter material and which when so

2

filled will have a number of perforations through the walls thereof whereby flames of the igniter material will ignite many of the layers.

Fig. 1 is the top plan view showing a sheet constituting one embodiment of this invention.

Fig. 2 is a section on the line 2—2 of Fig. 1.

Fig. 3 is an end view of the roll of the sheet material of Figs. 1 and 2.

Fig. 4 is a side view of a collection of circular discs cut from the material of Figs. 1 and 2 and mounted on a supporting tube.

Fig. 5 is another collection of circular discs cut from the material of Figs. 1 and 2 but being of uniform diameter.

Referring to Figs. 1 and 2, a corner of a sheet of propellant material 10 is shown as being provided with protuberances 11 formed during the process of rolling the material in manufacture. A nominal, though not exact, composition of a typical sheet material is nitrocellulose 55%, nitroglycerine 43%, ethylcentralite 2%, lamp black 2%, moisture 1%, the total volatiles of the foregoing being about 50%. Many other compositions for a sheet propellant will be apparent to those skilled in this art. A typical size for the sheet material of Figs. 1 and 2 is a thickness of .0205 inch for the sheet with the protuberances rising .013 above the surfaces of the sheet, the protuberances being .10 inch in diameter, and spaced between the centers about .375 inch. The geometry of the elements of the sheet propellant can be varied to suit the ballistic requirements of special weapon systems.

In Fig. 3, a sheet of the material of Figs. 1 and 2 is shown as rolled into a spiral roll 12 upon a tube 13 after the manner in which a carpet is rolled. The supporting tube 13 serves as a structural element of the cartridge and also as an element of the ignition system as is described more in detail for the embodiments of Figs. 4 and 5. Although the embodiment illustrated in Fig. 3 is not the preferred one, nevertheless it possesses an advantage in that the spaces between layers due to the protuberances are effective in providing a path for the ignition gases to impinge on the major portion of the ignitable propellant surfaces thereby facilitating the ignition process and initially directing the products of combustion longitudinally of the gun and rearwardly.

In Fig. 4 is shown a large quantity of discs 14 a majority of which are of varying diameters, stamped from the sheet material from Figs. 1 and 2 and mounted upon a supporting tube 15 filled with black powder 16, the tube 15 being perforated so that the products of combustion of the black powder may radially outwardly move into and ignite the sheet propellant. A special purpose of the embodiment shown in Fig. 4 is the use of the propellant charge in a recoilless rifle having a central venturi opening, the tapers to the charge being effective in providing increasing spaces, one directed toward the rear venturi opening and the other directed in an opposite direction toward the gun barrel but not shown for the full length. The purpose of the increasing annular areas is to accommodate the increasing flow of gases. The taper forward and that rearward may or may not be the same. The black powder in the tube 15 is ignited by any appropriate form of primer and the tube 15 may or may not be secured to a projectile in front of the propelling charge. Where tube 15 is not secured to the projectile, provision must be made for centrally supporting the end of reduced diameter of the propelling charge. The size of the charge depends upon the gun in which used, but one size found desirable for a 90 mm. recoilless rifle had the large end 3.25 inches in diameter with a half-dozen sheets of the propellant

of the same uniform diameter 17 at the right end. At the left end, the diameter of the smaller disc was 1.55 inches while the metal tube 15 was 1.157 inches in the outside diameter. Inasmuch as each disc has a thickness of .025 inch $\pm$.013 inch, the total length of the tapered discs was 254 times this, inasmuch as there were 254 discs in the embodiment shown.

In Fig. 5, the propellant there illustrated is a quantity of discs all of the same diameter 17a mounted upon a metal or consumable tube 15a and filled with black powder 16a, the tube being perforated to facilitate ignition of the many sheets mounted thereon. The embodiment shown in Fig. 5 finds special use in the Kroeger-Musser type recoilless rifle disclosed in U.S. Patent No. 2,466,714 dated April 14, 1949. The tube 15a is secured to a projectile 18. Propellant supporting tubes in Figs. 3 and 4 may also be of consumable material.

Among the advantages of the present invention may be mentioned the reduction in weight of the cartridge because of the elimination of the cartridge case, this reduction being as much as about 20% to 25% where the standard of comparison is the usual metal cartridge case for containing a propellant charge. Another advantage of the present invention is a reduction of about 15% to 20% in the amount of unburned propellant which is ejected rearwardly through the venturi openings. Perhaps this reduction in weight of propellant ejected may be said to be due to the fact that the major portion of the propellant being of sheet material is connected with adjacent sheets either through the supporting tube on which mounted or as in Fig. 3 by the same being a continuous sheet or nearly so. An important advantage in the present invention is the better reproducibility in results due to the fixed geometry of propellant and the uniform space distribution during ignition. The embodiments illustrated in Figs. 4 and 5 are preferred for the Kroeger-Musser recoilless rifle, and of these, those illustrated in Figs. 4 and 5 are arranged to direct the products of combustion initially radially outward. The cartridge for use with either the roll or disc type propellant may be fin or spin stabilized. Either the roll or disc propellant is retained and fixed in position between and with respect to both a primer and a projectile. A flexible, tough, consumable covering that is light in weight and impervious to moisture should be wrapped around the propelling charge of this invention and enable such charge to be fixed, retained, and protected substantially as fully as does the usual metal case yet without the usual weight of the metal case. The long taper toward a central venturi provides increasing space through which the products of combustion move rearwardly. In a usual cylindrical propellant chamber a saving in weight of the gun is possible because the large prior art longitudinally tapered gas passageways outside the propellant chamber no longer need to be as large with the result a reduction in size or possibly the elimination of these previous passageways effects a substantial reduction in weight of the gun.

We claim:

1. In combination with a projectile, a lightweight propelling charge a major portion of which needs no

rigid case, a rearwardly extending substantially inelastic tubular support filled with an explosive for ignition of said propelling charge, said propelling charge comprising a plurality of layers of sheet propellant, means for mounting said layers of sheet propellant on said tubular support passing through said layers to maintain substantial uniformity in arrangement with respect to each layer and the longitudinal axis of said tubular support, each layer of sheet propellant being solid and imperforate in planes parallel and perpendicular to the longitudinal axis of said tubular support and radially beyond said tubular support; each layer of sheet propellant having protuberances affixed to at least one face of said layers, said protuberances spacing each layer a uniform distance apart from a contiguous layer, the outer end surface of each protuberance engaging a side surface of an adjacent layer, whereby ignition of said layers proceeds radially outward from said tubular support.

2. A lightweight propelling charge according to claim 1, in which said layers are circular discs mounted on said tubular support such that a perpendicular to their side faces is parallel to the longitudinal axis of said tubular support, said tubular support being perforate, and said discs gradually reducing in diameter toward one end of said tubular support.

3. A lightweight propelling charge according to claim 1 in which said layers are circular discs mounted on said tubular support such that a perpendicular to their side faces is parallel to the longitudinal axis of said tubular support, said tubular support being perforate, and said layers of discs gradually reducing in diameter toward both ends of said tubular support.

4. A lightweight propelling charge, a major portion of which is of a type needing no rigid case, comprising a plurality of connected imperforate layers of sheet propellant, means for mounting said layers on at least one substantially inelastic support passing through said layers, each layer having protuberances spacing one layer a uniform distance apart from a contiguous layer, whereby products of combustion will be directed outwardly between unburned layer portions, such fixed geometry of arrangement of propellant in a gun with respect to surface distribution and with respect to progress of combustion enables an improved approach to uniformity in ballistic reproducibility between successive charges by maintenance of uniform spacing between said layers during ignition, said layers being integrally connected in a single sheet wound in a roll having a general spiral cross section.

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