Nov. 2, 1965 F. W. DIETSCH ETAL 3,215,041

STRAIN LOCKED NOZZLE FOR RECOILLESS WEAPONS

Filed April 30, 1964 2 Sheets-Sheet 1

Fig. 1

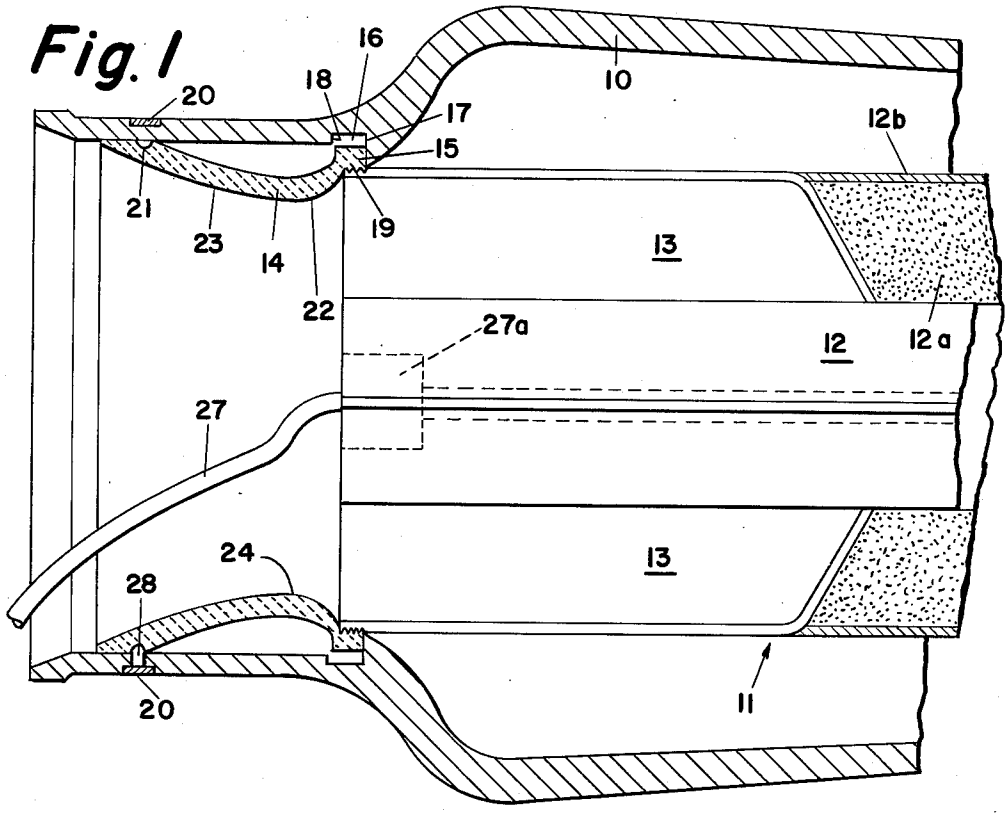
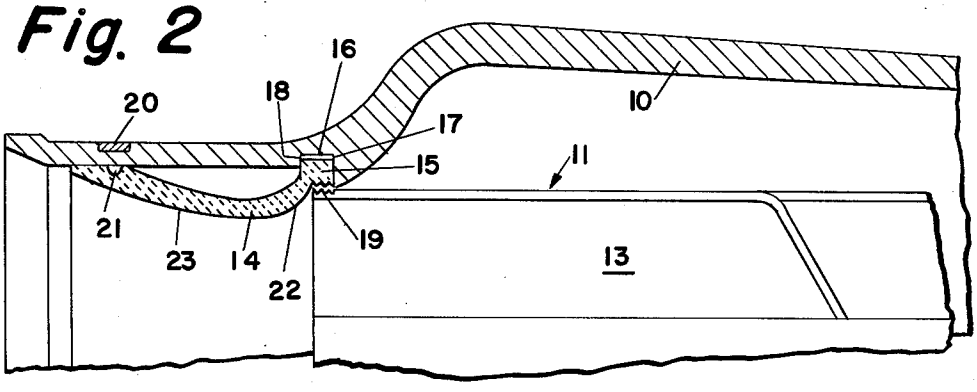


Fig. 2



INVENTORS.
FRANCIS W. DIETSCH
ANDREW J. GRANDY
BY Harry M. Saragovitz, et al
Edward J. Kelly, Herbert Berl &
I. Dubroff

ATTORNEYS

Nov. 2, 1965 F. W. DIETSCH ETAL 3,215,041

STRAIN LOCKED NOZZLE FOR RECOILLESS WEAPONS

Filed April 30, 1964 2 Sheets-Sheet 2

Fig. 3

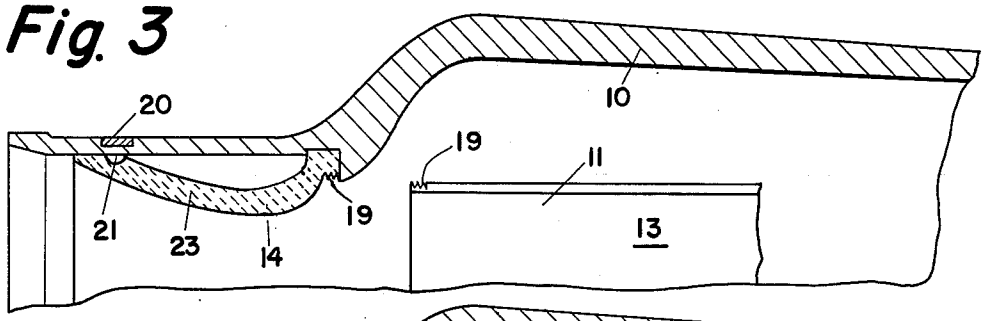


Fig. 4

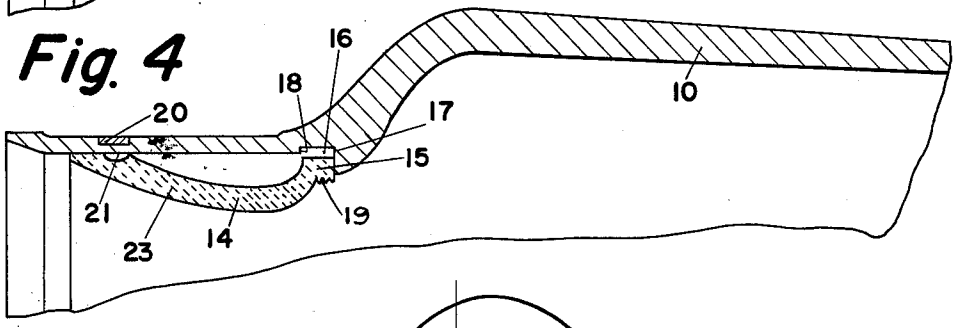


Fig. 5

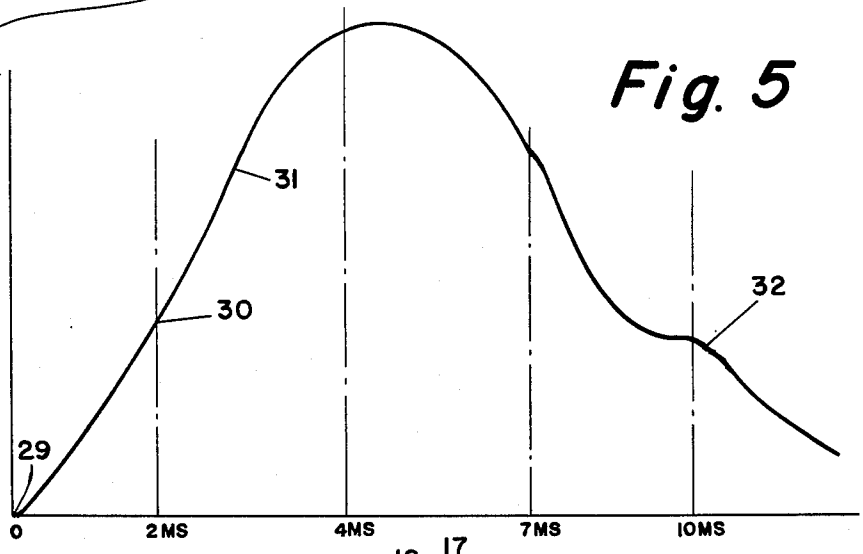
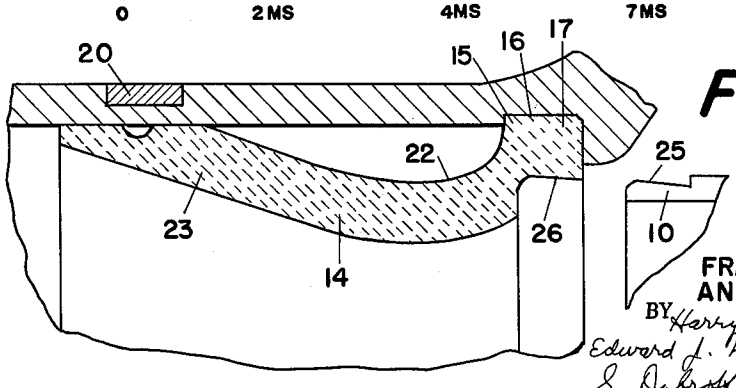


Fig. 6



INVENTORS.
FRANCIS W. DIETSCH
ANDREW J. GRANDY
BY Harry M. Saragovitz, Edward J. Kelly, Herbert Berl & S. Dubroff
ATTORNEYS

United States Patent Office 3,215,041
Patented Nov. 2, 1965

3,215,041

STRAIN LOCKED NOZZLE FOR RECOILLESS WEAPONS

Francis W. Dietsch, Levittown, and Andrew J. Grandy, North Hills, Pa., assignors to the United States of America as represented by the Secretary of the Army

Filed Apr. 30, 1964, Ser. No. 364,041
5 Claims. (Cl. 89—1.7)
(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 the payment to us of any royalty thereon.

This invention relates to recoilless guns and has for an object to increase the rate of fire and to minimize the weight and mechanical complexities of such weapons. Another object is to increase the useful life of these guns.

Since recoilless weapons have demonstrated their practicability, they have become of increasing importance during the last fifteen years or more. One object has been their short life due to rapid wear at the constricted throat portion of the venturi nozzle carried by such guns. According to this invention that constricted throat is made for attachment to a round of fixed ammunition in a manner easily attached to each round by screw threads and in other ways for quick attachment and separation from the round when fired. Such nozzles may be made of light weight steel or other materials for attachment in the field, and reused on subsequent rounds or not as desired. The gun, having no heavy breech with a nozzle, is lighter.

Referring to the drawings:

FIG. 1 illustrates a separable nozzle fixed to the rear end of a round and located in the rear end of a gun before being fired.

FIG. 2 shows the same nozzle when the projectile is ready to be started forward under propellant pressure but with the nozzle expanded into its locking groove.

FIG. 3 corresponds to FIG. 2 except that the projectile has become disengaged from the nozzle which is fully locked under a near peak pressure in the gun.

FIG. 4 has the nozzle relaxed and ready to be ejected rearwardly under residual pressure in the gun.

FIG. 5 exemplifies a typical pressure-time graph such as occurs in the forward end portion of a nozzle secured to a gun.

FIG. 6 is a view corresponding to FIG. 3 except that a cam surface is on the projectile rear instead of an ordinary screw thread.

In FIG. 1 is shown the rear end portion **10** of a breechless, recoilless gun having a projectile **11** therein with the usual boom **12** around which is placed a usual propellant **12***a*, which may be surrounded by a consumable or combustible case **12***b*. The projectile is of a type having stabilizing fins **13** which rotate at a low rate for stabilizing the projectile by both fins and a low spin rate. A venturi nozzle **14** is secured to the rear end of the fin periphery by a mating pair of screw threads **19**, one of the pair being formed on the nozzle forwardmost inner ledge or surface and the other on the fin rearmost outer surfaces. A flange **15** on a forward end of the nozzle **14** is of a size to engage and be received in an internal groove **16** in a rear portion of the gun **10**. The groove **16** has a front side wall **17** which is longer than its rear side wall **18**. Wall **17** takes some of the thrust imparted to the projectile **10** by the propellant pressure immediately after being fired and before such pressure has built up to a value high enough to expand the nozzle flange **15** into groove **16** and before the threads **19** on the nozzle and fins have become disengaged. The rear portion of the gun has a plurality of projections **28** of any desired angular extent. The projections **28** are biased inwardly by snap ring **20** for reception in a groove **21** on the rear outer surface of nozzle **14** for the purpose of holding the round including both the projectile **10** and the nozzle **14** against falling out the rear end of gun **10**, particularly when its muzzle is steeply elevated. Those familiar with recoilless guns know that the venturi nozzle **14** has a forward taper or slope **22**, a rearward taper or slope **23** and a constriction or throat **24**.

In FIG. 2 is shown the same round immediately after firing by a few milliseconds and just before the projectile starts forward. At this time the propellant pressure acting on the forward slope **22** of nozzle **14** has expanded such nozzle portion an amount to engage the flange **15** far enough into groove **16** such that rear wall **18** of flange **15** will be engaged by the rear side wall of flange **15** and prevent the increasing propellant pressure from pushing the nozzle rearwardly. Since the threaded means **19** between nozzle **14** and projectile **10** cannot be disengaged at the exact instant the flange **15** engages wall **18**, it is safer to have such flange **15** engage wall **18** of groove **16** before the threads **19** are disengaged. At this time the pressure is not a simple one of radial outward application because there is a forward pressure on the projectile opposed by threads **19** as well as by flange **15** and wall **17**, and a forward component of pressure on taper **23** and a smaller rearward component of pressure on taper **22** and the wall **18**. The threads **19** having sloping surfaces may be regarded as multi-part cam surfaces tending to expand flange **15**. A plurality of fins are provided and radially spaced equally about the longitudinally extending projectile axis.

According to FIG. 3 the projectile **11** has become disengaged from the nozzle **14** and propellant pressure is at a near peak, forcing flange **15** well into groove **16**, thus locking nozzle **14** against ejection by the rearwardly moving stream of igneous gases.

As shown in FIG. 4 the pressure within nozzle **14** has been considerably reduced with the result the expansion stresses and their resulting strains have been so far reduced that with the projectile no longer in the gun, the flange **15** has become almost fully disengaged from wall **18** and the nozzle **14** is almost ready to be pushed rearward by the residual pressure within the gun which is fast dropping. As soon as the nozzle is relaxed enough and freed of pressure to be pushed rearwardly, the nozzle is free to be pushed that way.

FIG. 5 is a pressure-time curve showing conditions within the nozzle during one firing cycle. At the zero presure shown at point **29** before the propellant has been fired and the pressure begun to be formed, the outside diameter of flange **15** is a few thousandths of an inch smaller than the inside diameter of the portion of the gun that is adjacently rearward of groove wall **18** and surrounding the nozzle. At point **30** the nozzle has been expanded enough for flange **15** to have its rear wall engage wall **18** of groove **16** and the threads **19** just about to be disengaged from the projectile which is ready for its forward flight. At point **31** on the FIG. 5 graph the projectile has begun to move under a near peak of propellant pressure. This delay in forward motion of the projectile results in it having a higher acceleration and muzzle velocity than would be the case were its forward motion not delayed, and this practice is known in the art as a "shot start." At about point **32** on the graph the nozzle has just been released from its holding groove **16**. Pressure of propellant at point **32** may be called residual pressure, which is useful for ejecting the nozzle rearwardly from the gun.

After ejection, a nozzle **14** may again be attached to an unfired round for use over again until the internal throat diameter becomes objectionably worn. The nozzle **14** is constructed so that when subjected to peak propellant pressure within the nozzle, the accompanying expan-

sion will not stress the nozzle metal in tension above its elastic limit. Preferably, the releasable connecting means **19** on the fins will be stressed beyond its elastic limit. When stressed beyond its ultimate strength the nozzle may be broken into a number of pieces according to its configuration and material but still removed by propellant pressure. Besides steel of a thickness to possess the desired elastic expansion, the nozzle may be made of other elastic materials. For example, aluminum is suitable when coated with a high temperature protective material.

Instead of employing ordinary screw threads **19** between the nozzle and projectile, FIG. 6 shows another embodiment in which one continuous longitudinal cam surface **25** is provided instead of the plurality of short cam surfaces formed by ordinary threads. Surface **25** and its mating recessed surface **26** on the forward end of the nozzle are inclined so that increased pressure tending to move the projectile forward assists in expanding the nozzle flange **15** radially outward. The surface **25** is able to expand flange **15** more easily than threads because the inclination illustrated is more gradual and requires a greater longitudinal movement of the projectile to expand the nozzle the desired amount, whereas the threads have a steeper inclination in a much shorter distance. The FIG. 6 embodiment is not suitable where a maximum acceleration and velocity are required and a most effective type shot start is needed. However, the FIG. 6 construction is desirable where lower than maximum acceleration and velocity are desired in a projectile.

This invention is not limited for use with projectiles having fins but is also suitable with projectiles having suitable, centrally positioned ignition components. Either finned projectiles or other type projectiles are provided with an electric or percussion conductor **27**, passing through the nozzle into a primer **27***a*.

Various modifications and changes may be resorted to without departing from the scope of the invention as defined by the appended claims.

We claim:

1. In a breechless, recoilless weapon having a projectile provided with a venturi nozzle secured to an end of said projectile, a propellant charge carried by said projectile and means for igniting said propellant to fire said weapon and projectile, the combination therewith of the improvement enabling said nozzle to be released by pressure of said propellant and yet held by said gun until after said projectile has been released from said nozzle, said improvement including said nozzle being of a thin expansible metal provided with a shallow but secure flange, groove means at a forward portion of said nozzle for holding the same attached to said projectile, said weapon provided with an internal groove substantially radially aligned with said flange, and said nozzle flange being of a size for engagement in said weapon groove, a forward wall of said weapon groove extending radially inward further than does a rear wall of the same groove to hold an unstressed nozzle against moving forward with said projectile, said nozzle possessing enough residual elasticity to shrink after reduction of propellant pressure and be ejected by residual pressure after pressure reduction and forward movement of said projectile.

2. A combination according to claim **1** including yieldable means for holding a projectile in said weapon against sliding rearwardly when said weapon has its muzzle steeply elevated.

3. A combination according to claim **1** in which said nozzle is of steel.

4. A combination according to claim **1** in which said nozzle is of aluminum provided with a thermal protective coating.

5. A nozzle and projectile arrangement for unitary insertion into a gun comprising,

a projectile having a forward cartridge case and fins extending rearwardly therefrom, said fins having rearmost external thread means, and

a nozzle having a forwardmost portion containing an exterior flange and interior thread means in threaded engagement with said fin thread means, said nozzle being of a thin expansible metal,

so constructed and arranged that the forward portion of said nozzle, upon being subjected to interior propellant gas pressure, will expand radially to disengage said nozzle from said projectile.

References Cited by the Examiner

UNITED STATES PATENTS

2,804,822	9/57	Meneghelli	102—49
2,970,520	2/61	Grandy	89—1.7
2,987,965	6/61	Musser	89—1.7
3,079,752	3/63	Thielman	60—35.6

SAMUEL FEINBERG, *Primary Examiner.*

SAMUEL W. ENGLE, *Examiner.*