Sept. 6, 1949. A. AFRICANO 2,481,059

ADJUSTABLE ROCKET NOZZLE

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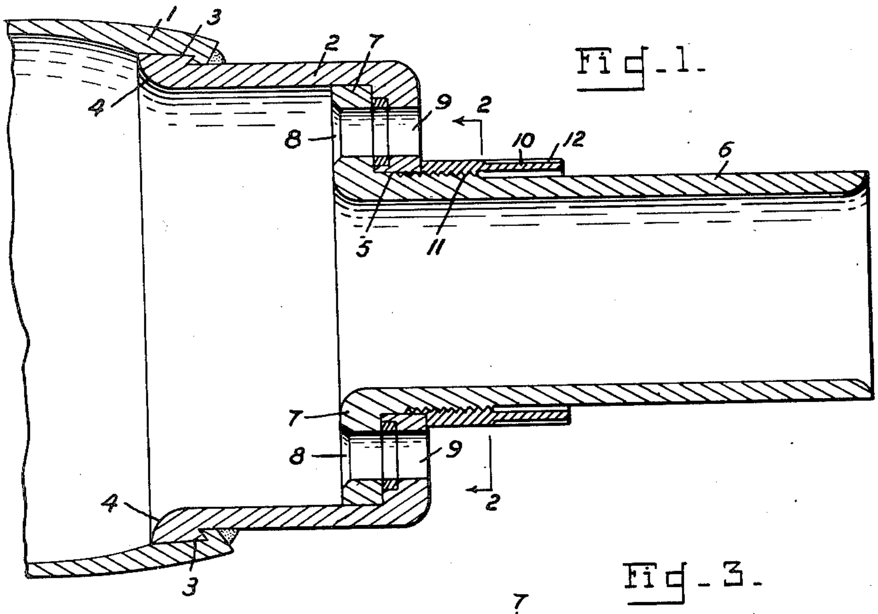

Fig-1.

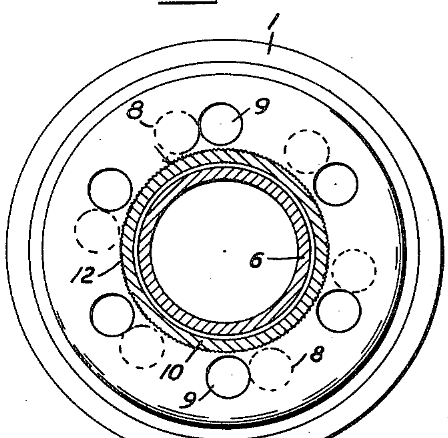

Fig-2-

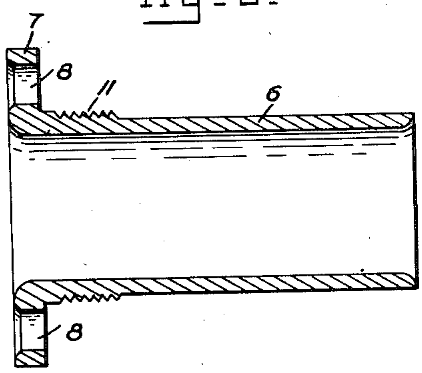

Fig-3-

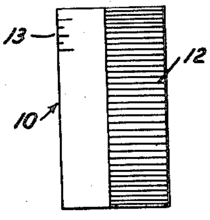

Fig-4-

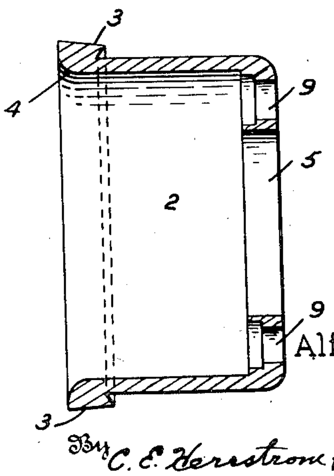

Fig-5-

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Fig. 6.

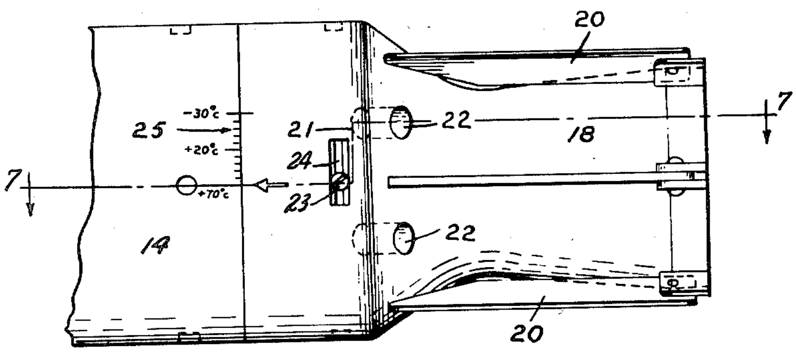


Fig. 7.

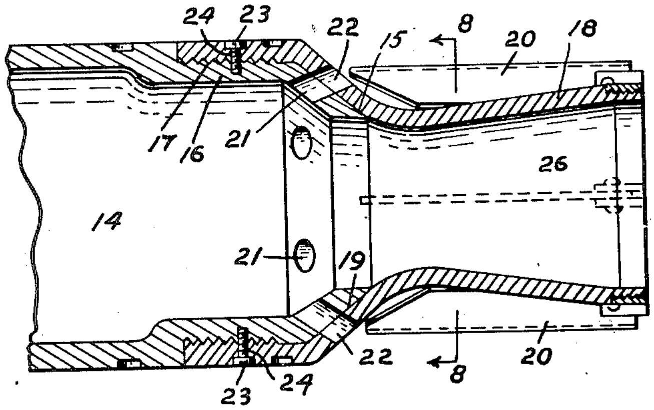
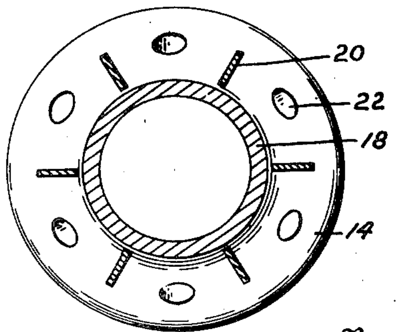


Fig. 8.



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ADJUSTABLE ROCKET NOZZLE

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1 Claim. (Cl. 60—35.6)

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This invention relates to an adjustable nozzle for rocket propelled projectiles.

The propellent material frequently used in rocket projectiles comprises a double base powder. The burning rate of such powder inherently varies considerably with the temperature of the powder. The optimum performance of a rocket projectile can be obtained only when the powder temperature is such that the burning rate will produce a certain equilibrium operating pressure within the rocket. In other words, if the temperature of the powder rises above the optimum temperature to produce a burning rate required for the desired equilibrium conditions, the mass rate of formation of the combustion products will be increased by the increased burning rate.

Conversely, if the temperature of the powder is lower than the prescribed optimum temperature for such powder the mass rate of formation of the combustion products will then be decreased by the lower burning rate of the powder. At equilibrium conditions the mass rate of formation of the combustion products is equal to the mass rate of discharge of these products thru a nozzle at the end of the motor chamber of the rocket projectile.

It is apparent to those skilled in the art that high powder temperatures greatly accelerate the burning rate of the powder and thus rapidly build up the pressure within the rocket motor chamber, frequently beyond safe limits. As it has been theoretically shown and substantiated by experiment that the dispersion of a rocket increases as the cube of the burning time of powder, it is apparent that an increase in the burning time is not desired from a ballistic standpoint. Further, if the temperature of the powder falls so low that pressure will not be built up within the chamber, it is extremely difficult to sustain ignition of the powder charge.

Because burning rates of the particular powder propellants which are used in prior art motors are sensitive to temperature variations it has been found necessary to limit the temperature range of operation of the rocket and to design such rocket for optimum performance only thru the upper limit of the range of atmospheric temperatures.

Accordingly, it is an object of this invention to provide an adjustable nozzle for a rocket projectile to permit such rocket projectile to be operative under extreme variations in atmospheric temperature.

The specific nature of the invention as well as other objects and advantages thereof will clearly

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appear from a description of a preferred embodiment as shown in the accompanying drawings in which:

Fig. 1 is a fragmentary longitudinal sectional view of a rocket projectile showing an adjustable rocket nozzle.

Fig. 2 is a cross sectional view taken along the plane 2—2 of Fig. 1.

Fig. 3 is a detail longitudinal cross sectional view of the nozzle shown in Fig. 1.

Fig. 4 is a side elevational view of the locking collar showing the port opening graduations.

Fig. 5 is a detail longitudinal sectional view of the adjustable rocket nozzle adapter.

Fig. 6 is a fragmentary side elevational view of a rocket motor showing a modified form of an adjustable rocket nozzle.

Fig. 7 is a longitudinal sectional view taken along the plane 7—7 of Fig. 6.

Fig. 8 is a cross sectional view taken along the plane 8—8 of Fig. 7.

The rockets of this invention consist mainly of a combustion chamber containing the double base propellent material, a nozzle having a constricted port opening or throat formed at the rear of the chamber and a "pay load" carried by the motor. The equilibrium pressure developed within such a rocket motor chamber is dependent upon the rate of discharge of the gases as well as upon their rate of formation. Thus, the equilibrium pressure can be regulated by adjusting the port opening for the discharge of the combustion products. In order to obtain a substantially constant motor chamber pressure at all temperatures within the operating range, it would be necessary to increase or decrease the port opening with an increase or decrease in pressure to provide a greater or smaller discharge rate to compensate for the higher or lower rates of burning.

In accordance with this invention an adjustable port area for the discharge of the combustion gases is readily obtained by providing a plurality of auxiliary jets formed in the motor chamber just forward of the throat where the walls of the chamber converge to form the approach to the nozzle throat and providing means for varying the area of such auxiliary jets.

In Fig. 1 there is shown a rear portion of a rocket motor 1. A cup shaped nozzle adapter 2 is welded to the end of rocket motor 1, a suitable bearing surface and locking shoulder as shown at 3 being preferably provided to increase the rigidity of support of the nozzle adapter 2. The inside corner 4 of the forward end of nozzle adapter 2 is rounded as shown in Fig. 1 so as not to obstruct the flow of propellent gases thru the nozzle. An axial hole 5 is provided in the end of nozzle adapter 2 thru which is inserted a nozzle 6. The nozzle 6 is a cylindrical tube provided at the forward end with an integral flange 7. The flange 7 bears against the inside surface of the end of nozzle adapter 2.

A plurality of radially disposed holes 8 are provided in flange 7 of nozzle 6. A corresponding number of identical holes 9 are likewise radially disposed about the face of nozzle adapter 2. Holes 8 in the flange 7 of nozzle 6 can be readily brought into alignment with holes 9 in the nozzle adapter 2 by merely rotating nozzle 6 until such holes are in alignment. A locking collar 10 is provided to lock nozzle 6 in any desired position so that holes 8 may be wholly or partially aligned with holes 9. Collar 10 is secured to nozzle 6 as by threads 11 provided on the outer periphery of nozzle 6. The outer surface 12 of locking collar 10 is preferably knurled to provide a non-slipping, grasping surface. Hence nozzle 6 may be locked with the holes 8 open or closed or in any other desired position by simply screwing collar 10 tightly against the end of nozzle adapter 2. This procedure draws the inside of flange 7 tightly against the inside of nozzle adapter 2 thereby locking nozzle 6 to nozzle adapter 2. If desired suitable temperature graduation marks 13 may be provided in the periphery of collar 10 to indicate the proper port opening for any particular atmospheric temperature.

From the above description it is readily apparent to any one skilled in the art that the port area of the rocket motor may be varied to permit greater or lesser escape of propellent gases through the port. In the event of high temperatures where rapid burning time of the propellant may be anticipated, holes 8 may be brought into alignment with holes 9 by unloosening collar 10 and revolving nozzle 6 until such alignment is effected whereupon collar 10 is again tightened. With holes 8 exposed to the atmosphere it is obvious that greatly increased port area is available and hence the propellent gases can escape more readily in order that equilibrium may be retained within rocket motor 1 when high temperatures are prevalent and the burning rate of powder is exceedingly high. Conversely, if the temperature is low, the holes 9 may be closed by turning nozzle 6 a sufficient amount to block the holes. The port area is thereby lessened and as there is less escape of the propellent gases, greater pressure can be built up within rocket motor 1. Hence faster burning of the propellent charge will be promoted and will thus sustain ignition of such charge.

A modification of the adjustable nozzle is illustrated in Fig. 7. Referring to Fig. 7 the extreme rear end of a rocket motor 14 is flared inwardly to form a conical section as shown at 15. Adjacent conical section 15 a reduced diameter portion 16 is provided and such portion has threads 17 thereon. A nozzle 18 is screwed onto threads 17. The nozzle 18 defines an orifice 26 and is provided with a conical interior surface 19 which mates with conical surface 15 on the rear end of rocket motor 1. A plurality of collapsible fins 20 are pivotally secured to the rear end of nozzle 18 as shown in Figs. 6 and 7.

A plurality of holes 21 are provided spaced about the conical surface 15 of rocket motor 1. Corresponding holes 22 are provided in conical surface 19 of nozzle 18. The holes 21 in rocket motor 1 may be either wholly or partially blocked off by simply rotating nozzle 18 sufficiently to produce the desired blocking effect. Nozzle 18 may then be locked by tightening a plurality of screws 23. Such screws are inserted in suitable slots 24 in nozzle 18 and engage tapped holes in rocket motor 1. Thus the port area of the rocket may be readily varied by slight rotation of nozzle 18 with respect to motor 14. A graduated temperature scale 25 is preferably provided about the periphery of rocket motor 1 as shown in Fig. 6 to indicate the proper port opening to be utilized for a particular ambient temperature.

From the foregoing description it is apparent that a rocket motor embodying this invention can be readily adjusted to compensate for variations in atmospheric temperature which strongly affect the burning time of the propellent material generally utilized in rocket projectiles. By increasing or decreasing the port area of the rocket projectile the rate of burning of the propellent material can be controlled to a very large degree which in turn controls the internal pressure within the rocket motor. It should be understood that this invention is independent of the shape of the holes 8 and 9 as such could take a variety of forms.

I claim:

In combination, a nozzle for a rocket motor including a first cylindrical member having a flanged surface extending generally inwardly thereof, said surface having a plurality of openings formed therein, a second member of smaller cross section than said first member forming a constriction and discharge passage for the propulsion fluid within said motor, said second member having a flanged surface extending outwardly therefrom and conforming generally with the flanged surface of said first member, said flanged surface of said second member also having a plurality of openings therein, means securing said first and second members to said motor with their respective flanged surfaces abutting, said means permitting relative rotational movement to vary the overlapping portions of said opening to vary the port area for discharge of the propulsion fluid of said motor, and means locking said first and second members against relative angular movement.

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