[54] MUFFLE ATTACHMENT FOR REDUCING THE RECOIL AND BLAST EFFECT OF GUNS

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[57] ABSTRACT

In order to reduce the relatively high blast effect customarily encountered by personnel in the vicinity of the breech end of a large caliber gun equipped with a muzzle brake having a forwardly expanding conical nozzle for directing the discharge gases against a baffle plate spaced therefrom to the extent required to promote maximum braking efficiency, the portion of the brake between the muzzle end of the gun tube and the baffle plate is formed by forwardly extending diametrically spaced longitudinal bars which provide a minimum of interference with the shock waves produced by the passage of the discharge gases through the muzzle brake. The distance between the nozzle and the baffle plate can be adjusted without the necessity for removing the muzzle brake from the gun tube.

7 Claims, 5 Drawing Figures
MUZZLE ATTACHMENT FOR REDUCING THE RECOIL AND BLAST EFFECT OF GUNS

BACKGROUND OF THE INVENTION

This invention relates to muzzle brakes for guns and is particularly directed to a brake for a large caliber gun capable of substantially reducing the blast effect usually transmitted to the breech end of the gun without necessitating a corresponding reduction in the efficiency of the braking action imparted thereto.

In those guns which utilize muzzle brakes to reduce the recoil forces produced during firing, the efficiency of the braking action is largely dependent on the angle at which the discharge gases exiting from the muzzle end of the gun tube are deflected to the rear. However, in order to minimize the hazardous blast effect on the personnel in the vicinity of the breech end of the gun, muzzle brakes are generally designed to function at a small fraction of their maximum efficiency.

Various studies of the blast effect produced by existing muzzle brakes have shown that it is initiated by the extremely rapid expansion of the jet of hot, high pressure gases exiting from the muzzle end of the gun tube immediately following the emergence therefrom of the projectile. The expansion of these gases proceeds with such rapidity that the resulting shock waves overtake the similar but relatively slower waves formed by the forward travel of the projectile and produce an extremely turbulent concentration of shock waves within the interior of the muzzle brake. At the same time, the rapid emergence of the hot jet of gas from the muzzle end of the gun tube produces a rarefaction wave which travels down the bore of the gun tube and is reflected from the closed breech to return to the muzzle end of the tube. The area of high turbulence, commonly termed "a shock bottle" due to the particular shape of its boundary, tends to assume a relatively steady state during the passage therethrough of the high pressure jet of discharge gases. However, once such jet emerges from the forward end of the muzzle brake, the resulting pressure drop in the shock bottle area triggers a sudden collapse thereof which frees the shock waves for an extremely rapid expansion thereof in all directions. The rapidity of such expansion produces an undesirable blast effect which is even further intensified by the forward moving rarefaction wave returning from the breech end of the gun tube. At the same time, the rearward deflection of the discharge gases from the baffle plate in the muzzle brake augments the rearwardly expanding segment of the high intensity shock waves to such extent that the blast effect on the personnel of the gun crew generally causes considerable auditory discomfort and in many instances reaches a level which will inflict actual physical harm.

Accordingly, it is an object of this invention to provide a muzzle brake for a gun which will inhibit or, at least, drastically reduce the formation therein of a turbulent concentration of shock waves without, at the same time, producing any appreciable reduction in the braking efficiency thereof.

It is a further object of the present invention to provide a muzzle brake, as aforesaid, wherein longitudinal exit openings are provided between the muzzle end of the gun tube and the baffle plate against which the discharge gases are directed to minimize interference with the normal expansion of the shock waves formed therein.

Another object of this invention is the provision of a muzzle brake, as aforesaid, wherein the discharge gases passing therethrough will be rapidly dissipated both rearwardly and forwardly of the baffle plate utilized to provide the required braking action.

A further object of this invention lies in the provision of a muzzle brake, as aforesaid, wherein the conical nozzle utilized to direct the discharge gases against the baffle plate is supported by the muzzle end of the gun tube rather than by the muzzle brake itself and consequently does not require the considerable weight and rigidity designed into conventional brakes in order to adequately withstand the relatively high stress imparted thereto by the forward thrust imparted to the baffle plate.

An additional object of this invention is to provide a muzzle brake, as aforesaid, which is mounted to the gun tube so as to permit the braking efficiency thereof to be changed without the necessity for removing the brake from the gun tube.

Still another object of this invention is to provide a muzzle brake, as aforesaid, wherein the baffle plate is of a "bow-tie" or winged configuration to provide maximum braking efficiency with a minimum of weight.

It is also an object of this invention to provide a muzzle brake, as aforesaid, characterized by a high degree of braking efficiency, a substantially reduced muzzle blast, a minimum of muzzle flash, and a considerable reduction in the tendency for the rapidly expanding shock waves to aggravate the customary obscuration encountered in the viewing of the target area.

SUMMARY OF THE INVENTION

It has been found that the foregoing objects can be readily accomplished by a muzzle brake provided with at least two diametrically spaced bars of annular sector configuration arranged to support a circular baffle plate disposed at right angles to the bore axis of the gun tube and at a predetermined distance from the muzzle end thereof. The substantial width and length of the openings between the bars permits a relatively unrestricted dissipation of the hot discharge gases emerging from the gun tube immediately behind the projectile and consequently inhibits the formation of the shock bottle effect normally encountered in conventional muzzle brakes. The shock waves which are formed within the interior of the brake do not attain their maximum intensity until after their exit therefrom and consequently are not significantly reinforced by either the rarefaction wave created by the exit of the gas jet from the relatively restricted area within the bore of the gun tube or by the additional shock waves produced by the deflection of a portion of the gas jet from the baffle plate. The bars are preferably extended forwardly beyond the baffle plate but with a reduced spacing therebetween to similarly inhibit the formation of a shock bottle effect by those gases which pass through the projectile opening in the center of the baffle plate.

A cone shaped nozzle is adjustably secured to the rear end of the muzzle brake and extends sufficiently forward to bring the circular opening in the front end thereof into coextensive relation with the circular baffle plate. The gap between the front end of the nozzle and the baffle plate is selected to provide optimum braking efficiency and can be readily adjusted to com-
pensate for any significant change in the recoil forces imparted to the gun without the necessity for removing the muzzle brake from the gun tube. Moreover, since the nozzle is mounted directly to the muzzle brake and is therefore not subjected to the relatively high axial forces imparted to the baffle plate, the strength and rigidity of the nozzle need only be sufficient to withstand the shock waves which are reflected from the baffle plate plus the slight back pressure produced during the passage of the discharge gases into the interior of the nozzle thereby permitting a desirable decrease in the wall thickness thereof. In the event an even further reduction is required in the weight of the muzzle brake, the baffle plate may be provided with a "bow-tie" or winged configuration coextensive with the limited area in which the discharge gases actually exit through the openings between the bars.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical section taken through a preferred version of the muzzle brake of the present invention;
FIG. 2 is a section taken along line 2-2 of FIG. 1;
FIG. 3 is a perspective view of the muzzle brake with the baffle plate partially cut away to show the configuration of the rear set of bars;
FIG. 4 is a fragmentary vertical section similar to that of FIG. 1 but with a baffle plate of alternate structure wherein the deflecting surface area thereof is limited to the exit path of the discharge gases through the openings between the rearward bars; and
FIG. 5 is a sectional view taken along line 5-5 of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

While the muzzle brake of the present invention is shown and described herein for use with guns of artillery size, it should be understood that the caliber of the gun is not a limiting factor in the design since the principles thereof are equally applicable to guns in the small arms category. As best shown in FIG. 1, the muzzle brake is provided with a cylindrical rear end portion 12 which is internally threaded, as indicated at 14, to mate with a correspondingly threaded section 16 on the muzzle end of a gun tube 18. A shoulder 17 is provided at the rear end of threaded section 16 to properly locate the muzzle brake on gun tube 18. The rear end portion 12 of the muzzle brake is also exteriorly threaded, as at 20, to adjustably retain an annular collar 22 integrally connected with a forwardly expanding conical nozzle 24. In order to retain the desired longitudinal position of nozzle 24 on muzzle brake portion 12, a plurality of set screws 26 are provided in collar 22 to engage with threads 20. Nozzle 24 is additionally locked in the desired position by a suitable jam nut or locking ring 30 threaded against the rear of collar 22. In order to guard against the considerable vibration encountered during the firing of the gun, locking ring 30 is also provided with set screws 32. Thus, the position of nozzle 24 on cylindrical portion 12 may be changed without the necessity for removing the muzzle brake from the gun, simply by unloosening set screws 26 and 32 and backing off on locking ring 30. Once the new position of nozzle 24 is established, set screws 26 are tightened and locking ring 30 is returned into contact with collar 22.

Extending forwardly from diametrically opposite locations in the forward face of cylindrical end portion 12 are a pair of acutely shaped longitudinal bars 34 forming an annular sector in cross-section which is concentric with the exterior periphery of a circular baffle plate 36 fixed to or integral with the forward ends of bars 34. Although more than one pair of bars 34 may be utilized, the desirability of keeping the weight of the muzzle brake to a minimum renders it preferable to provide a single pair oriented to extend from the top and bottom of end portion 12 in order to minimize the extent of the blast effect being directed toward the ground. While the diametrical spacing between bars 34 is dependent on the degree of braking efficiency desired, experimentation has shown that the distance between the inner peripheral surfaces of bars 34 should be at least 1.2 calibers or, in other words, more than 20 percent larger than the bore diameter of the gun tube. Furthermore, for best results, the sides of each bar 34 are sloped, as shown at 35, to form an included angle of at least 120°. Although the vertical dimension of bars 34 is not specifically limited, it should be sufficient to provide the degree of strength necessary to resist the thrust produced by the action of the discharge gases against baffle plate 36.

Baffle plate 36 is located forwardly of nozzle 24 to the extent required by the desired braking efficiency thereof but, for best results, should be within 1½ to 3 caliber lengths from the muzzle end of gun tube 18. In addition, the circumference of baffle plate 36 should be substantially coextensive with the conical opening at the forward end of nozzle 24. In order to withstand the considerable thrust of the discharge gases directed thereagainst by nozzle 24, baffle plate 36 is preferably of relatively thick cross-section and rigidly joined to the forward ends of bars 34 by means of suitable fillets 38 or other equivalent structure.

Extending forwardly from the forward face of baffle plate 36 is a second set of longitudinal bars 40 which are similar to bars 34 in orientation and configuration but spaced closer together in view of the lesser amount of discharge gases to be dissipated therebetween. Where bars 34 are spaced apart at a distance of 1.2 calibers, as previously explained, bars 40 are preferably spaced at 1.06 calibers and are correspondingly reduced in thickness and length. Baffle plate 36 is, of course, provided with a central opening 42 therethrough for the passage of the fired projectile and the undeflected portion of the accompanying discharge gases.

When the gun is fired, the hot discharge gases which exit from the muzzle end of gun 18 are free to expand and pass through the openings between bars 34 in a relatively unrestricted manner which inhibits the formation of the shock bottle effect normally encountered in current muzzle brakes. The expanded gases are then directed forwardly from the conical interior of nozzle 24 to impinge against baffle plate 36 and thereby provide a forward braking action against the rearward recoil of the gun tube. As the gases are thereafter deflected back and forth between nozzle 24 and baffle plate 36, the resulting shock waves are uniformly dissipated through the annular gap therebetweens. The discharge gases which pass through opening 42 exit through the openings between bars 40 and the accompanying shock waves are dissipated in the same manner.
as by bars 34. Because of the absence of any shock bottle effect, the peak intensity of the shock waves is not reached until they have exited from the muzzle brake and begun to move down range therefrom. As a result, the shock waves which do reach the breech end of the gun are of relatively low intensity.

Where the muzzle brake is being utilized on guns required to fire at extremely high elevations, the weight of the brake adds to the load on the elevating mechanism and consequently must be kept to a minimum. Accordingly, the circular configuration of the baffle plate can be altered to eliminate the portions against which little or no discharge gases are directed by nozzle 24. Thus, as best shown in FIGS. 4 and 5, the present invention also contemplates a baffle plate 44 wherein relatively large upper and lower portions thereof are removed, as indicated at 46, to leave a "bow-tie" or winged configuration corresponding to those areas between bars 34 from which the discharge gases are directed in significant amounts. Since the sides of bars 34 slope to form an included angle of 120°, the cut out portions 46 are preferably provided with an equal slope. However, the vertical dimensions of cut out portions 46 are designed to leave a deflecting surface between bars 34 and the periphery of opening 42 for receiving the thrust of those discharge gases which may not continue on the path initially imparted thereto by the sloping sides of bars 34.

Thus, there is here provided a superior muzzle brake which is remarkably effective in reducing the intensity of the blast reaching the breech end of the gun tube in the area occupied by the personnel required to service and load the gun. This lower blast effect is achieved without any appreciable sacrifice in the braking efficiency of the muzzle brake. Furthermore, these desirable results are attained with a muzzle brake which does not require the relatively high weight and strength ordinarily introduced into those designs in current use. In addition, the muzzle brake of the present invention provides a significant decrease in the degree of flash normally encountered at the forward end thereof and a substantial reduction in the obscuration of the target area usually caused by the impact of the blast waves on dusty or loose terrain. Another important advantage of the muzzle brake of this invention is the ability to adjust the gap between the nozzle and the baffle plate to compensate for changes in the propellant charge of the ammunition or in the mounting arrangement of the gun carriage without the time-consuming effort involved in removing the brake from the gun tube in order to make the necessary adjustment.

Although the preferred embodiments of the present invention are limited to the two structures shown and described herein, it will also become obvious to persons skilled in the art that other forms thereof, as well as changes in the particular form described, are possible within the spirit and scope of the present invention. Therefore, it is desired that the present invention shall not be limited except insofar as it is made necessary by the prior art and by the spirit of the appended claims.

I claim:

1. A muzzle brake for reducing the recoil forces imparted to a gun during the firing thereof, comprising,
a cylindrical end portion removably secured to the muzzle end of the gun,
a plurality of longitudinal bars extending forwardly from diametrically opposed locations on said end portion,
a baffle plate fixed to the forward ends of said bars perpendicular to the bore axis of the gun, and
a forwardly expanding conical nozzle secured to said end portion to surround said longitudinal bars and terminate in predetermined rearwardly spaced relation to said baffle plate whereby the unrestricted openings between said bars combine with the annular gap between said nozzle and said baffle plate to provide a maximum of braking efficiency with a minimum of blast.

2. The muzzle brake of claim 1 including means for adjustably locking said nozzle to said cylindrical end portion.

3. The muzzle brake of claim 1 wherein the circumference of said baffle plate is coextensive with the opening in the forward end of said nozzle.

4. In a muzzle brake secured to a gun tube for reducing the recoil forces produced during the firing of the gun, means for controlling the discharge of gases from the muzzle brake comprising,
a first pair of diametrically spaced bars on the brake extending forwardly beyond the muzzle end of the gun tube,
a baffle plate fixed to the forward ends of said first pair of bars perpendicular to the bore axis of the gun tube,
a second pair of bars extending forwardly from said baffle plate and similar to said first bars in structure and orientation, and
a forwardly expanding conical nozzle adjustable secured to the muzzle brake rearwardly of the muzzle end of the gun tube to extend forwardly over said first pair of bars and terminate at a predetermined distance rearwardly of said baffle plate whereby the openings between said bars combine with the annular gap between said nozzle and said baffle plate to minimize the blast effect of the discharge gases without detracting from the efficiency of the muzzle brake.

5. The invention defined in claim 4 wherein said second pair of bars are shorter and spaced apart to a lesser extent than said first pair of bars.

6. The invention defined in claim 4 wherein the exterior contour of said baffle plate is shaped to limit the deflecting surface thereof to the areas against which the flow of the discharge gases is directed by the configuration of the openings between said first pair of bars.

7. The invention defined in claim 4 including means for adjusting the position of said nozzle relative to said baffle plate comprising:
an annular collar at the rear end of said nozzle threadably engageable with the rear end of the muzzle brake,
set screw means in said collar for locking said nozzle in a selected position on the muzzle brake, and
locking means engageable with the rear of said collar to prevent unloosening of said nozzle.