Dec. 28, 1965 G. P. MICHELSON 3,225,694

MISSILE

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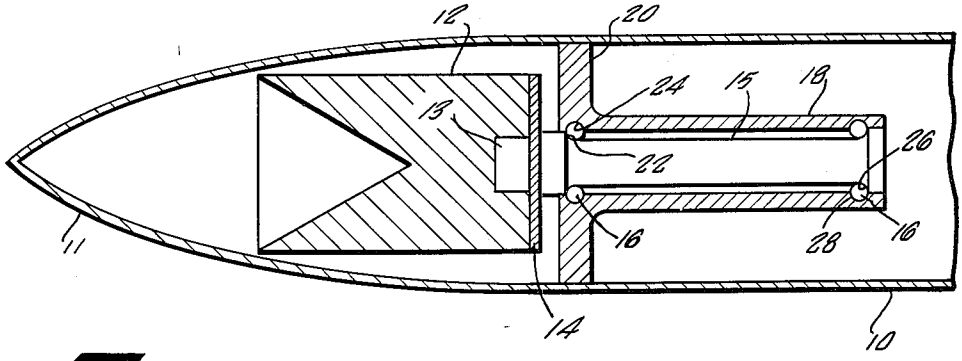

FIG. 1

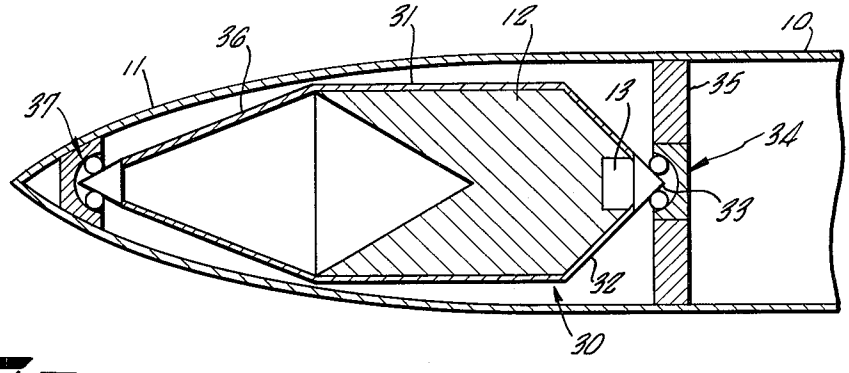

FIG. 2

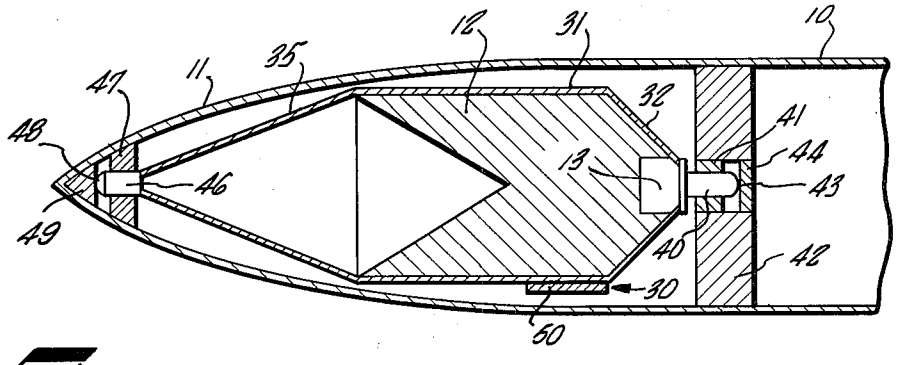

FIG. 3

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This invention relates to missiles which use shaped charges.

As is well known, a shaped charge is a body of explosive with a forwardly opening cavity that focuses the force of the explosive when it is detonated, thereby providing much greater penetrating power than if the focusing cavity were not present. Shaped charges have found many uses, including anti-tank missiles.

The effectiveness of a shaped charge decreases rapidly with the rate of rotation of the charge about its longitudinal axis. Unfortunately, most missiles do or should rotate to achieve maximum accuracy.

This invention provides a missile in which a shaped charge is mounted to be rotatable with respect to the missile housing so that even though the missile rotates, the inertia of the shaped charge tends to keep it stationary, or at least causes it to rotate at a much slower rate than the missile housing.

Thus, with the structure of this invention, the missile can rotate at a relatively high speed for maximum accuracy, and the shaped charge need rotate little or not at all so that when it is detonated, it retains its maximum penetrating power.

In one form, the shaped charge includes a rearwardly extending shaft which is mounted in a cantilever fashion in the forward portion of the missile. This arrangement has the advantage that no support members are needed in front of the shaped charge.

In another form, the shaped charge is supported by bearings at its forward and rear ends. In this case, a cone which tapers inwardly and forwardly is preferably attached at its base to the forward end of the shaped charge to secure it to the forward bearing. When the missile strikes the target, the shock of impact is transmitted through the cone, the wall of a container which holds the shaped charge, and to a detonator at the rear of the shaped charge. Preferably, the cone and shaped charge container are made of beryllium or beryllium alloy, or other suitable material which transmits sound at a comparably high rate.

The bearings which support the shaped charge can be either ball bearings, friction bearings, or combinations of both. The ball bearings are preferred for minimum friction, while the friction bearings offer certain advantages in economy.

In one form of the invention, the forward end of the shaped charge is supported by a cylindrical hardened steel trunnion which has a forwardly directed convex face which rests against a dry-lubricated hardened steel plate secured to the missile in front of the trunnion. The rear bearing is similarly mounted to receive the longitudinal forces applied to the shaped charge. When the missile strikes its target, the forward trunnion impacts against its bearing plate and transmits the necessary shock to detonate the shaped charge.

These and other aspects of the invention will be more fully understood from the following detailed description and the accompanying drawing, in which:

FIG. 1 is a fragmentary schematic elevation of the forward end of a missile in which a shaped charge is mounted on a cantilever rotatable shaft.

FIG. 2 is a fragmentary schematic sectional elevation of the forward end of a missile showing a shaped charge mounted on ball bearings at the forward and rear ends of the charge; and

FIG. 3 is a fragmentary schematic sectional elevation of the forward end of a missile in which a shaped charge is mounted on friction bearings at the forward and rear ends of the charge.

Referring to FIG. 1, an elongated cylindrical missile housing **10** includes a pointed nose **11** at its forward end. A conventional shaped charge **12** and detonator **13** are mounted in the nose of the missile on the forward face of a plate **14** secured to the forward end of a rotatable shaft **15** journalled coaxially within the missile housing on ball bearings **16** in a sleeve **18** secured by a flange **20** to the interior of the missile housing. The detonator is rigidly secured to the plate **14** to be in good mechanical contact with it.

The forward end of the rotatable shaft includes an annular rearwardly facing shoulder **22** which bears against ball bearings and urges them against a forwardly facing annular shoulder **24** in the sleeve, which accepts the rearward thrust of the shaped charge when the missile is launched. The missile is launched by any suitable means, such as a rocket motor, or ballistic firing. In any event, the launching mechanism forms no part of this invention, and therefore is not described in detail for the sake of brevity.

The rear end of the shaped charge shaft includes a forwardly facing annular shoulder **26** which bears against the ball bearings and urges them against a rearwardly facing annular shoulder **28** in the rear end of the sleeve to receive any forward thrust to which the shaped charge may be subjected.

In operating the missile shown in FIG. 1, the missile is launched by any suitable means. If the missile housing tends to rotate, which it is ordinarily designed to do for maximum accuracy, the inertia of the shaped charge prevents it from rotating at the same speed as the missile. In fact, the shaped charge will rotate only to the extent caused by the friction in the bearings.

When the missile strikes a target, the shock impact of the rear end of the shaped charge shaft against the ball bearings and rearwardly facing shoulder **28** and the sleeve **18** explodes the detonator and shaped charge. Since the shaped charge is not rotating, or rotating at a relatively low rate, its penetrating effectiveness is not significantly impaired.

In the embodiment shown in FIG. 2, the shaped charge **12** and detonator **13** are mounted in a container **30** which includes a cylindrical portion **31** and a rear conical portion **32** which tapers inwardly and rearwardly to a point **33** supported in a ball bearing **34** mounted in a transverse wall **35** secured to the housing. The detonator is in firm contact with the rear conical portion **32**.

A forward cone **36** has its base attached to the forward end of the cylindrical portion **31** of the container and terminates at its apex in a forward ball bearing **37** secured inside the nose of the missile housing.

In the embodiment shown in FIG. 2, when the missile is fired and tends to rotate, the shaped charge and its container follow the rotation at a rate only to the extent caused by the friction of the bearings. When the missile strikes a target, the impact is received by the apex of the forward cone and the shock wave is transmitted through the forward cone, the wall of the cylindrical portion of the shaped charge container, and the wall of the rear cone to the detonator, causing the shaped charge to explode. For high speed missiles or projectiles, it is advantageous to make these shock-transmitting members of a material which transmits sound at a high speed, for example, beryllium, a beryllium alloy, or the equivalent.

In the embodiment shown in FIG. 3, the shaped charge **12** and detonator **13** are mounted in a container **30** having a cylindrical wall **31**, a rear cone **32**, and a forward cone **35**. A cylindrical rear trunnion **40** is secured to the rear

end of the shaped charge container and is disposed coaxially within a friction bearing 41 carried by a transverse bulkhead 42 mounted within the missile housing. The rear end of the trunnion 40 is convex in a rearward direction to provide a segment 43 of a sphere which bears against a transverse flat rear bearing plate 44 secured to the bulkhead 42.

The forward end of the forward cone carries a cylindrical forward trunnion 46 mounted coaxially within the missile housing and journalled in a bearing 47 secured inside the nose of the missile. The forward end of the forward trunnion has a forwardly facing convex surface 48 in the shape of a part of a sphere which bears against a flat forward bearing plate 49 secured in the missile nose. Preferably, the trunnions are made of hardened steel and the bearing plates are dry-lubricated hardened steel. The bearings in which the trunnions are disposed can be made of any suitable material, such as nylon or Teflon.

To aid in preventing the shaped charge from rotating, a weight 50 is secured to the lower portion of the shaped charge container so the effective center of gravity of the shaped charge is below the axis of rotation defined by the bearings, which lie on the longitudinal axis about which the missile rotates. Alternatively, the shaped charge is mounted to be slightly off center from the bearings. In either case, the effect is sufficient to overcome the friction in the bearings so the shaped charge does not rotate.

When the missile shown in FIG. 3 is launched, the shaped charge does not rotate with the missile. When the missile strikes the target, the shock impact from the forward trunnion is transmitted along the walls of the shaped charge container and to the detonator which explodes the shaped charge. Since the charge is not rotating, it explodes with its full penetrating power.

I claim:

1. A missile comprising a housing, a shaped charge having a forwardly opening recess, a container disposed around the shaped charge, the container including a cylindrical intermediate portion, a hollow front cone secured at its base to the front of the cylindrical portion of the container, a rear cone secured at its base to the rear of the cylindrical portion of the container, a detonator in contact with the shaped charge and rear cone, a nose secured to the housing and disposed around the cone to enclose the cone and shaped charge within the housing, and separate bearings mounted on the housing to support the apex of each cone, the forward cone being mounted to receive the shock impact of the missile nose striking a target to transmit the shock to the detonator and ignite it.

2. A missile comprising a housing, a shaped charge having a forwardly opening recess, a conainer disposed around the shaped charge, the container including a cylindrical intermediate portion, a hollow front cone secured at its base to the front of the cylindrical portion of the container, a rear cone secured at its base to the rear of the cylindrical portion of the container, the container being made of beryllium, a detonator in contact with the shaped charge and rear cone, a nose secured to the housing and disposed around the cone to enclose the cone and shaped charge within the housing, and separate bearings mounted on the housing to support the apex of each cone, the forward cone being mounted to receive the shock impact of the missile nose striking a target to transmit the shock to the detonator and ignite it.

3. A missile comprising a housing, a shaped charge having a forwardly opening recess, a container disposed around the shaped charge, the container including a cylindrical intermediate portion, a hollow front cone secured at its base to the front of the cylindrical portion of the container, a rear cone secured at its base to the rear of the cylindrical portion of the container, a detonator in contact with the shaped charge and rear cone, a nose secured to the housing and disposed around the cone to enclose the cone and shaped charge within the housing, separate bearings mounted on the housing to support the apex of each cone, and a striking plate mounted in the nose of the missile so the apex of the forward cone strikes the plate to receive the shock impact of the missile nose striking a target and transmit the shock to the detonator and ignite it.

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