MORTAR ADAPTED FOR FIRING FROM A LIGHT VEHICLE

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ABSTRACT

A mortar comprising a gun barrel mounted on a hinged support and provided with an elastic device to accommodate recoil and return the barrel to initial position after firing. The elastic device is constructed as an assembly of overlapping annular elastic elements which surround the gun barrel and are carried in a cradle mounted on the support. The annular elements undergo sliding on one another during recoil at which time the elements undergo radial deformation, and subsequently the annular elements elastically return to their original configuration to restore the gun barrel to its initial position. Various ways are disclosed to limit the stress applied to the endmost annular elements to make the stress distribution in the annular elements more uniform along the length of the assembly. The mortar is rear loaded through a radially movable loading head which in the firing position is in rearward prolongation of the gun barrel.

6 Claims, 13 Drawing Figures
MORTAR ADAPTED FOR FIRING FROM A LIGHT VEHICLE

FIELD OF THE INVENTION

The invention relates to mortars, and particularly to medium-caliber high-angle fire ordnance manned by infantry units.

PRIOR ART

The light-mortar ordnance in current use is transported in separate parts (gun tube, bedplate, bipod) by being carried and must be assembled each time to be ready for firing. The parts are carried with difficulty and slowly, which is particularly inconvenient inasmuch as after they have fired a small number of rounds, mortars are easily pinpointed, by radar for example, and the gunners are not protected. It is therefore extremely desirable that such ordnance be carried, manned and fired on light transport vehicles.

Furthermore, mortars of the aforesaid type are muzzle loaded, which involves a certain number of disadvantages. Firstly the risks of accidents are fairly large because of the chances of double loading. Also, the length of the gun tube is restricted, which precludes increasing the performance of such ordnance. It is therefore an advantage if these mortars can be breech loaded.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a mortar which meets the aforesaid conditions.

The mortar of the invention is particularly noteworthy in that it comprises an elastic connector or buffer device composed essentially of a spring collar which absorbs the kinetic energy of recoil by elasticity and friction.

It is known that spring collars, composed of annular spring elements having taper faces and sliding over each other have the characteristic of restoring only a small proportion of the kinetic energy they have absorbed, the restored kinetic energy being used to obtain the return to firing position. Due to such a buffer device, the stress of the gun mounting during each firing is greatly reduced and it then becomes possible to fire from a light armored vehicle.

According to one embodiment of the invention, the buffer device comprises a spring collar arranged concentrically around the gun tube and surrounded by a cradle which is provided at both of its ends with an inside stop and, two rotary pistons, namely a recoil piston and a return piston floatably mounted on the gun tube on both sides of the spring collar and abutting against a respective inside stop of the cradle.

Such a floating assembly allows the recoiling mass to act compressively in both directions on the spring collar.

The annular members of the spring collar are subject to great impact forces which produce extremely high stresses in very short periods of time. The maximum stress is of the order of several metric tons per square centimeter and this is reached in a few thousandths of a second when firing. This time interval is very substantially less than the stress propagation constant along the annular spring collar, which constant is dependent on the inertia of the spring members or rings and their frictional strength. It therefore follows that the end rings undergo very great strain whereas the middle rings are subjected to a substantially lesser strain. The distribution of these strains and consequently the deformation of the rings is therefore not uniform all along the length of the annular spring collar. The end rings subjected to the greatest stresses tend to become fatigued and wear away quickly, consequently altering the spring characteristics.

A further object of the invention is to provide an embodiment of an annular spring collar in which the stresses are distributed as evenly as possible whereby the life of the annular spring collar is increased.

According to the invention, the flexure capacity, i.e. the capability of radial deformation of the end rings of the annular spring collar is restricted to a value less than the equivalent of the maximum deformation of the ring.

Preferably, to obtain uniform distribution of stresses the capacity for flexure of the rings is increased gradually from one end toward the central portion of the spring collar, the flexure capacity being greatest in the central portion.

According to a particular embodiment of the invention, the flexure capacity is restricted by means of a hoop mounted around an inside ring of the spring collar between two outer rings. This hoop can, for example, be made of piano wire.

In one variant of the invention, the sectional area of the rings in the central portion of the spring collar is less than that of the end rings.

In another variant, the width of the rings in the central portion of the spring collar is less than that of the end rings.

In still another variant, the frictional resistance of the rings of the central portion of the spring collar is less than the frictional resistance of the end rings.

In still another variant, the angles of inclination of the sliding surfaces of the rings are different for the end rings and those at the central portion.

Another characteristic feature of the invention is the provision of a guide for the annular spring collar constituted as one or several intermediate rings.

According to another characteristic feature of the invention, the mortar comprises one or more movable loading heads perpendicularly displaceable relative to the gun tube axis in a rear extension of the gun tube.

According to another embodiment of the invention, the mortar comprises a breech, the movable portion of which carries a loading head and moves in a mortise attached to a foot of the gun tube.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be described hereunder in detail with reference to the attached drawings, wherein:

FIG. 1 is a sectional view of a mortar according to the invention, showing the buffer device;

FIG. 2 is a sectional view of the mortar as seen in FIG. 1, illustrating the loading device in detail;

FIG. 3 is a transverse view of the mortar of FIG. 1, looking toward the loading head;

FIG. 4 illustrates diagrammatically the mortar according to the invention in a turret mounting;

FIG. 5 is a sectional view of the charging head;

FIGS. 6a, 6b and 6c respectively illustrate the moving portion of the block breech in a front view; a side elevation view and a sectional view taken on line 6c-6c in FIG. 6b;
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3. FIG. 7 is a section illustrating the attachment of the loading head.

FIG. 8 is a graph diagrammatically explaining the operation of the spring collar;

FIG. 9 shows the characteristic curve of a spring collar,

FIG. 10 illustrates a partial section of a spring collar according to the invention; and

FIG. 11 illustrates a spring collar provided with intermediate guide rings.

**DETAILED DESCRIPTION**

The mortar illustrated in FIG. 1 essentially comprises a gun tube 1 and a loading and firing device which will be described later. In accordance with the invention, the mortar is equipped with a buffer device composed essentially of a spring collar 11 which at each time of firing absorbs the kinetic energy and restores only a small portion thereof to the gun tube mounting. The spring collar 11 is arranged concentrically on gun tube 1. Arranged respectively at both ends of the spring collar 11 are a recoil piston 12 and a return piston 13 floatably mounted on gun tube 1. A cradle 8 surrounds the assembly of the spring collar and pistons 12 and 13 and the pistons impinge internally in cradle 8 when the mortar is at rest. Advantageously, a protective shield 9 is attached to the cradle 8. The assembly of cradle 8 and shield 9 is fastened by means of trunnions 18 (FIG. 3) to the mortar mounting, which for example can be a light armored vehicle. The trunnions 18 allow the inclination of the mortar to be changed. Air holes 14 machined in cradle 8 allow cooling of the spring collar 11.

The spring collar is essentially composed of annular members or rings 101, 102 which are slidable on one another and which upon firing of the weapon are subjected to axial force produced by recoil of the barrel 1. The axial force is applied to the spring collar via pistons 12 and 13 and the rings slide on one another and resist recoil while storing energy due to radial deformation of the rings so that at the end of stroke, the rings return to their original diameter and in the course of sliding on one another return the gun barrel 1 to its initial position. The construction of the spring collar will be described in greater detail later with reference to the assembly by which the application of excess stress to the endmost rings is avoided.

FIG. 8 shows the operation of the spring collar of the buffer device and the applied force is plotted on the ordinate and the deformation of the spring collar along the abscissa. The first working stage is shown at 1 this being the phase at time of recoil, the shaded portion corresponding to the recoil energy, the spring collar then acting as a resistance to recoil. Phase II corresponds to the return, the spring collar then acting as a recuperator and the corresponding shaded zone representing spring expansion energy. During the other two phases III and IV, the spring collar acts as a return buffer, the corresponding shaded areas respectively representing the return energy and the spring relaxation energy.

FIG. 9 illustrates the characteristic curve of a ring of the spring collar wherein the stresses exerted are plotted on the ordinate and the elongation of the spring on the abscissa. The top curve corresponds to the stressed phase of the spring and the bottom curve to its relaxation phase. If the spring is under strain at the maximum admissible load during its use, its life is drastically limited. On the other hand, if it is subjected to stresses not exceeding 60 percent of its maximum permissible stress, 10,000 cycles can be imposed before the spring will become fatigued, that is to say until its characteristics alter. That is why, according to the invention, the force applied to the end rings of the spring collar which are the first to undergo strain, is limited. The operation of the spring can, for example, be precluded in zone A as indicated below, while providing operation in zone B with zone C forming a safety zone.

In one arrangement in which the stresses to which the end rings are subjected is limited, hoops are mounted on the inside rings of the spring between the outer rings. This is illustrated in FIG. 10 where one end of the spring collar is shown in section.

Therein it can be seen the annular spring collar is composed of inside rings 101 and outside rings 102. The spring collar comprises at one end one-half of an inside ring 103 acting as a supporting ring. The inside and outside rings are staggered, each outside ring contacting two inside rings and vice versa. Contact is made along symmetrical annular sliding surfaces 104 and 104' which are inclined in section relative to the centerline of the spring.

According to the invention, the deformation of the end rings is limited by means of hoops 105 mounted around rings 101 between two outside rings 102. The thickness of hoop 105 defines the maximum deformation of the rings, as a matter of fact, when the spring collar is subjected to stress, the outside rings impinge on hoop 105 and the stress is transmitted directly to the succeeding inner rings. Thus the deformation of the end rings is limited by distributing the strain borne by the spring collar over all of the rings starting from the end where the strain is exerted to the other end. Stated in another way, the hoops 105 prevent the outer rings from undergoing radial expansion beyond a particular limit thereby restricting the stress to which the outer rings will be subjected.

The hoops 105 must be made of a substance offering sufficient strength to resist the compression imposed by the outside rings 102 when they abut the hoops. By way of example, hoops 1.5 mm diameter piano wire are applicable for a spring collar of a diameter of 14 cm. Such a spring collar is shown in FIG. 11 and the spring collar comprises 50 elements, each element corresponding to one outside halfling and one inside halfling as shown at 108 in FIG. 10. To avoid deflection of the spring collar because of its length, intermediate guide rings 106 are uniformly spaced along the interior of the collar. The rings 106 are internal rings provided with an annular flange 107 completely filling the space between two corresponding outside rings.

The spring collar is advantageously provided with the hoops 105 throughout its length and all elements are similar. This in fact allows spring re-assembly operations to be simplified, for example, after overhaul. This is important, since the maintenance operations must be capable under difficult conditions and by unskilled personnel.

If the stresses are to be more evenly distributed along the spring collar, the deformations of the rings can be limited to various pre-determined values, the value of maximum deformation increasing from the end rings toward the middle rings. This can be obtained, for instance, by the use of hoops whose thickness decreases from the ends toward the middle portion of the spring.
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collar. Because the spring collar operates in both directions, it is advantageous for it to be of symmetrical design.

The desired distribution of stresses can also be obtained by acting on the stress propagation constant in the spring collar. Thus, in one variant of the invention, the cross-sectional area of the rings, i.e. their inertia, is made to vary, the central rings having the smallest sectional area. Likewise the width of the rings can be decreased, the narrowest rings being in the middle portion.

To change the inertia of the rings, their frictional resistance can also be modified especially by altering the angles of inclination of the sliding surfaces.

The invention allows production of annular spring collars whose length of life corresponds with that of the other components of the mortar so that the annular spring collar does not have to be changed. Furthermore, because of the better distribution of stresses, the spring collar can be subjected to greater stresses and thereby heavier charges can be used for the mortar.

The mortar is charged or loaded by means of one or more movable loading heads which are displaceable perpendicularly to the gun tube axis so as to extend into an extension at the rear of the gun tube.

In the embodiment specifically illustrated in FIGS. 5-7, the mortar comprises a single loading head 4 which is rigidly connected with the movable portion 3 of a breech whose carrier block 2 is attached to the rear end of gun tube 1 and comprises a mortise in which the portion 3 is slidable mounted. The loading head extends in prolongation of the gun tube when the breech is in closed position. The head 4 is made of gun steel and accordingly proportioned. The portion 3 is illustrated in detail in FIGS. 6-a, 6-b and 6-c.

The loading of the mortar according to the invention is effected by placing a projectile in the loading head 4 when the breech is open (the position shown in FIG. 2), then the breech is closed by moving the portion 3 to the position shown in FIG. 1.

The projectile percussion is controlled shot by shot, for example, automatically when the breech reaches its closed position. The firing mechanism is shown diagrammatically at 7. To facilitate loading, a feed aperture 10 is formed along the gun tube in extension of the head 4 when the portion 3 is in open position. In this way, as can be seen from FIG. 2, the loading is effected in a particularly simple manner, since all that is needed is to insert the projectile 6 into aperture 10, after which the projectile then drops automatically into head 4 by gravity. A device can be provided for locking the breech in its open position, and a pushrod controlled by the gunner can release the breech so that it can automatically arrive at a closed position.

It is of advantage for the length of the loading head to be sufficient so that the top end of projectile 6, when inside the head, may be located at a very small distance from the front edge of the loading head. This serves as a protection against faulty entry of projectile 6 inside the loading head, since in such case, the end of the projectile will project beyond the loading head and hinder the closing of the breech. To adapt the mortar to various types of projectiles, all that is necessary is to provide easy replacement of the loading head for the type of missile used. A larger movement of head 4 toward the top of portion 3 can be provided, so as to free the loading head 4 completely from the foot of gun tube 1 and bring it out of portion 3 through the top. A single loading head can also be provided whose dimensions are equivalent to the longest projectile likely to be used in the mortar.

When closed, the loading head 4 makes contact at its front flange with a gas obturator 5 arranged at the rear portion of gun tube 1, such obturator being of known type to allow good tightness to be obtained during the firing.

As shown in FIG. 4, the mortar according to the invention, can easily be placed in a turret 16 rotatable on a runway 17. Such turret can be located on a light vehicle, which allows the mortar and its gun crew to be moved quickly keeping them under shelter at the same time. According to one variant, the mortar may be provided with a plurality of charging heads arranged so as to form a barrel, each head successively entering the portion 3 as an extension of the gun tube.

The mortar according to the invention offers a number of advantages. First of all, as already mentioned above, because of the presence of the spring collar buffer, it can be carried and fired on a light vehicle on which it is mounted. It is, therefore, extremely mobile and can be readied for firing in an extremely short time. Moreover, the gun crew can be protected by armor plating carried by the vehicle. The safety of the crew is much improved because there is no muzzle loading but rather breech loading, the mortar being manned wholly inside the protective armor.

Furthermore, there is no restriction as to weight or of gun tube length as the mortar can be carried on a vehicle and loaded through the rear. Mortars can therefore be contemplated using projectiles offering better performance than those currently known, especially in regard to range.

It is to be noted that the manning of the weapon remains identical in every respect as that of conventional mortars in current use, since loading and closing of the breech are effected by gravity.

The mortar according to the invention offers a high degree of safety since it is loaded from the rear and the percussion is controlled. Moreover, there no longer is any risk of accident due to a double loading.

By the use of a turret, a bearing angle of 360 degrees can be obtained.

What is claimed is:

1. A mortar comprising a gun barrel having front and rear ends, support means for said gun barrel, and elastic means connecting the gun barrel and the support means and permitting recoil of the barrel upon firing while absorbing energy to return the barrel to initial position after firing, said elastic means including an assembly of annular elastic elements surrounding the gun barrel, said annular elements being arranged as alternating overlapped inner and outer rings having inclined surfaces in slidable arrangement on one another, said outer rings having spaces between adjacent rings to enable the outer rings to slide on the inner rings and undergo radial expansion, and means for limiting radial expansion of adjacent outer rings at the ends of the assembly to limit the maximum stress applied to such rings and thereby distribute the stresses to the outer rings over the entire length of the assembly, the latter said means comprising hoops surrounding the inner rings substantially centrally thereof and freely mounted in the spaces between said adjacent outer rings, and spaced therefrom, said hoops having a pre-determined
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thickness defining the maximum deformation for said outer rings and thereby limiting the maximum stress to which the outer rings are subjected at the ends of the assembly.

2. A mortar as claimed in claim 1 wherein the elastic means further comprises a pair of spaced pistons loosely mounted on the gun barrel, said annular elements extending between said pistons and a cradle attached to said support means and carrying said pistons and annular elements.

3. A mortar as claimed in claim 2 wherein the width of the rings at the middle portion of the assembly being less than that of the rings at the ends of the assembly.

4. A mortar as claimed in claim 3 wherein the width of the rings at the middle portion of the assembly being

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less than that of the rings at the ends of the assembly.

5. A mortar as claimed in claim 2 wherein said elastic means is so constructed that the deformation capability of the annular rings increases progressively from the ends of the assembly to the middle portion thereof, the deformation capability being greatest in said middle portion, the sliding surfaces of the rings in the middle portion of the assembly having frictional resistance which is less than that of the rings at the ends of the assembly.

6. A mortar as claimed in claim 2 wherein said elastic means is so constructed that the deformation capability of the annular rings increases progressively from the ends of the assembly to the middle portion thereof, the deformation capability being greatest in said middle portion, the sliding surfaces of the annular rings having different angles of inclination for the rings in the middle portion and for the rings at the ends of the assembly.

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