Nov. 20, 1945. A. J. NICHOLAS 2,389,383

BOMB NOSE FUSE

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Fig. 1.

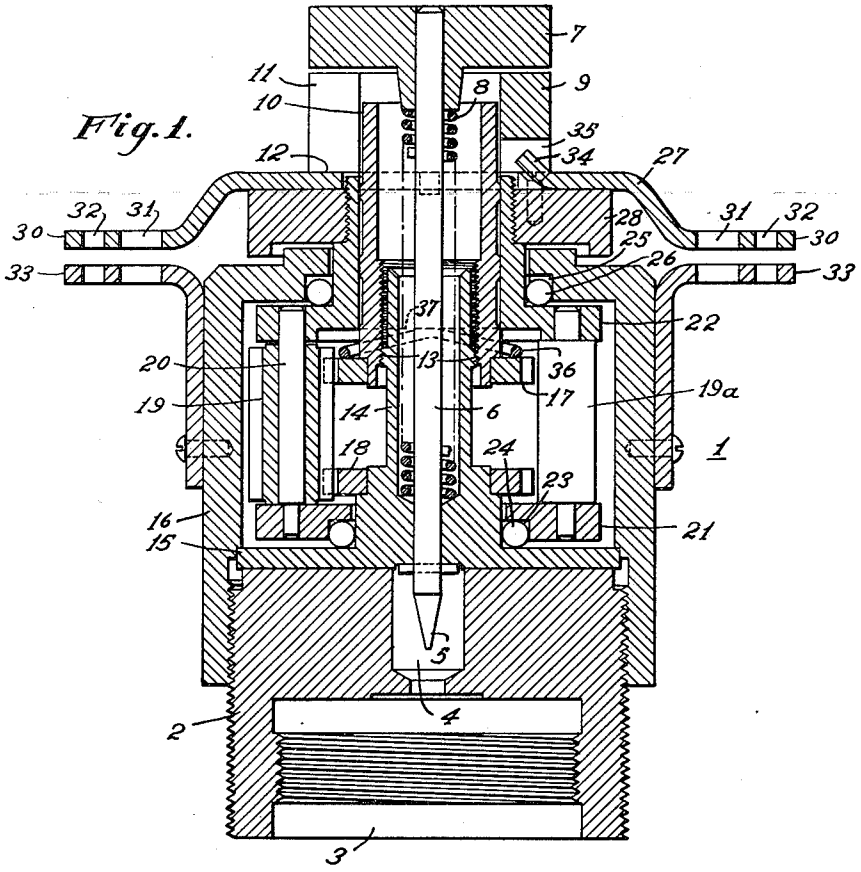
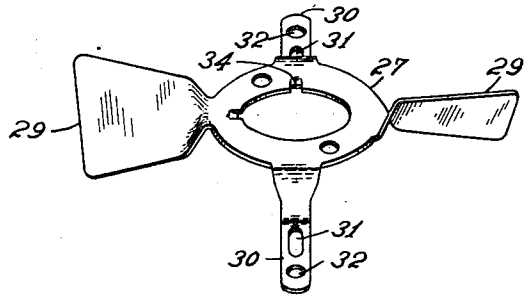


Fig. 2.



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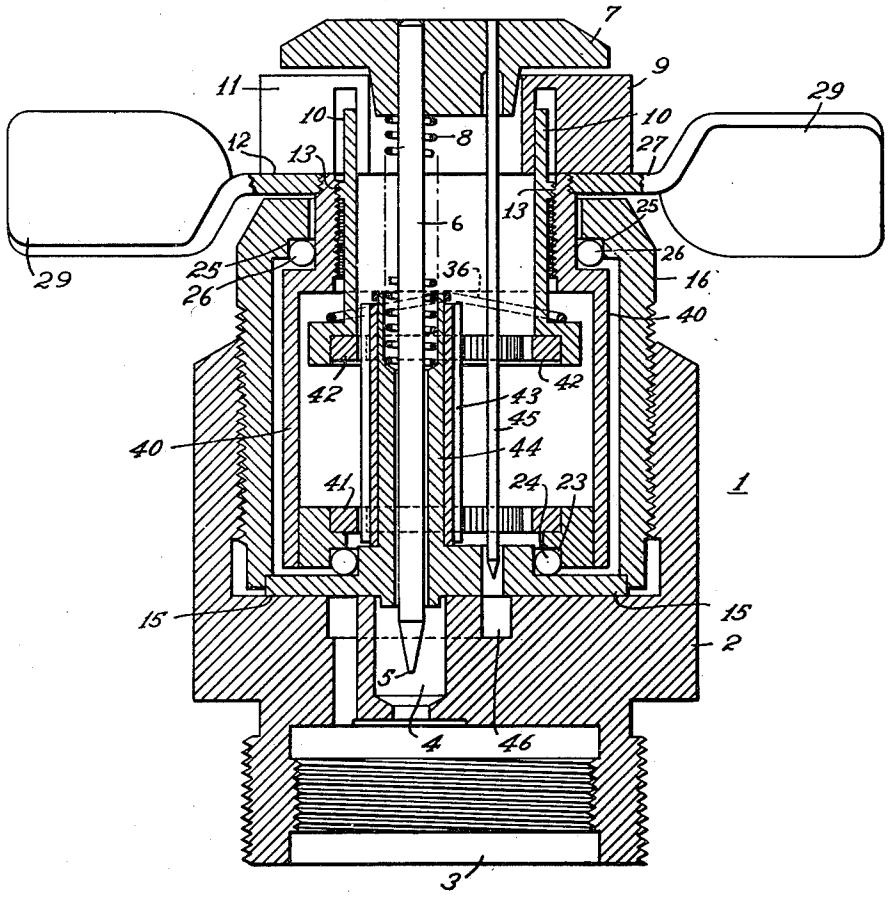
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Fig. 3.



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2,389,383

BOMB NOSE FUSE

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6 Claims. (Cl. 102—81.2)

My invention relates to aerial bomb fuses and more particularly to an improved arrangement of mechanism for arming a fuse adapted to be connected to the nose of an aerial bomb.

Aerial bombs are commonly provided with a striker rod which is adapted to be driven into a percussion device with considerable force when the bomb strikes a target. In order to prevent accidental operation of the striker rod during handling, the fuse is provided with a safety block for preventing operation of the striker rod. To render the striker rod operative, the safety block must be released during the flight of the bomb, and to this end, the fuse is provided with rotatable mechanism driven by a wind operated propeller vane for effecting release of the safety block.

With increasing airplane speeds trouble has been encountered in the operation of the arming mechanism, and it has been found that mechanism which operates satisfactorily at lower speeds will not operate satisfactorily at high speeds. Consequently, the number of duds due to failure of the arming mechanism has increased with higher speeds of operation in connection with the type of fuses with which this invention deals. Actual specimens taken from test bombs have shown the mechanism jammed and the gears employed to operate the arming mechanism stripped or out of effective meshing relationship.

In addition, for reliable operation of the arming mechanism, it is also desirable that the arming mechanism be capable of decreasing the time necessary to effect arming with increases in the speed of the airplane from which the bomb is released. In this respect, the arming mechanism of fuses heretofore employed has not proven entirely satisfactory.

Accordingly, one of the principal objects of this invention is to provide arming mechanism for a bomb nose fuse which will arm in shorter periods of time with increases in the speed of bomb flight, and which will provide reliable arming operation at all speeds.

A further object of this invention is to provide an improved arrangement of differential gearing for effecting arming of the bomb.

A further object of this invention is to provide an improved arrangement of differential gearing in bomb arming mechanism, in which the axial alignment of the operating gears is effectively maintained at all times to thereby prevent striping of the gears and movement of the gears out of meshing relationship.

A further object is to provide bomb arming mechanism in which all the rotating parts are effectively counter-balanced to prevent the effects of centrifugal force from interfering with the operation thereof.

Other objects and advantages of this invention will become apparent from the following description and accompanying drawings, in which:

Figure 1 is a vertical sectional view of a bomb nose fuse constructed in accordance with the principles of this invention.

Fig. 2 is a perspective view of the operating propeller and locking device shown in Fig. 1, and

Fig. 3 is a vertical sectional view similar to Fig. 1 of a modified form of bomb nose fuse.

Referring to the drawings, the numeral 1 designates as a whole a bomb nose fuse having a connecting member 2 provided with external threads by which it may be secured to the nose of a bomb in conventional manner. The connecting member 2 is provided with an internally threaded opening 3 in which a percussion device may be mounted. The opening 3 communicates with a smaller opening 4 into which the end 5 of a striker rod 6 projects. The striker rod 6 is provided with a head 7 and a spring 8 for maintaining the head 7 and rod 6 in position shown in Fig. 1. To prevent accidental operation of the striker rod 6, a safety block 9 is provided intermediate the head 7 and body of the fuse 1 and the striker rod 6 is rendered operative after release of the safety block 9 in a manner to be described. The striker rod 6 is driven into a percussion cap, not shown, mounted in the opening 3 with considerable force when movement of the head 7 is arrested by striking an object after the bomb is released from an airplane.

The safety block 9 is provided with an arming sleeve 10 controlling its operation. The function of the arming sleeve 10 and the construction and operation of the safety block 9 are well known in the art, and it will be understood that this invention is limited to the mechanism for effecting reliable operation of the arming sleeve 10. With respect to the safety block 9 and arming sleeve 10, it is sufficient to point out that the safety block 9 is rotated during the flight of the bomb and is removed by centrifugal force after the sleeve 10 has been moved downwardly, as shown in the drawings, to an arming position where it will not interfere with the outward movement of the safety block 9. The safety block 9 is in the nature of a cylindrical member having an opening 11 at one side thereof sufficient to clear the spring 8 and striker rod 6. The opening 11 unbalances the member 9, thereby causing a centrifugal force upon rotation thereof which will be

effective upon movement of the sleeve 10 to a position beneath the lower surface 12 of the block 9 for moving the opening 11 toward the striker rod 6 and thence outwardly from underneath the striker head 7.

The arming sleeve 10 is internally threaded at its lower end and has threaded engagement as at 13 with external threads formed on a stationary arming hub 14 projecting upwardly from a base member 15 which is secured to the member 2 by a housing 16. Upon rotation of the arming sleeve 10 with respect to the arming hub 14, the sleeve 10 will be moved downwardly to its arming position for effecting release of the safety block 9. Rotation of the arming sleeve 10 with respect to the hub 14 and housing 16 is effected by differential gearing comprising a gear 17 secured to the arming sleeve 10, a gear 18 secured to the arming hub 14, and a pinion 19 meshing with both the gears 17 and 18. The pinion 19 is rotatably mounted on a shaft 20 having its lower end anchored in an annular member 21 and its upper end anchored in an annular member 22. The annular member 21 is provided with an annular notch as at 23 for the reception of ball bearings 24 to thereby provide a ball bearing race for the member 21 about the stationary part 15. The housing 16 is provided with an annular notch as at 25 for the reception of ball bearings 26 to thereby provide a ball bearing race for the annular member 22 within the housing 16. Rotation of the members 21 and 22 is effected by means of a propeller 27 secured to a block 28 having a threaded connection to the upper end of the annular member 22. Upon rotation of the propeller 27, the parts 20, 21 and 22 will be rotated as a unit about the gears 17 and 18 to effect arming operation of the sleeve 10. As best shown in Fig. 2, the propeller 27 is provided with vanes 29 effective upon movement of the bomb through the air after its release to rotate the propeller 27.

The gears 17 and 18 have the same pitch diameter but are provided with a different number of teeth in order that rotation of the gears 17 and sleeve 10 with respect to the stationary parts may be effected. In an actual model, the arming hub gear 18 is provided with 35 teeth and the arming sleeve gear 17 is provided with 36 teeth, and the pinion 19 is provided with 12 teeth. Accordingly, it will be apparent that the gear 17 will be rotated through the pitch of one tooth upon one complete revolution of the shaft 20 about the gear 18, and that during this time the pinion 19 will rotate 3.91 revolutions about its shaft 20. It will thus be seen that a complete revolution of the gear 17 with respect to the gear 18 will be had after 36 revolutions of the shaft 20 about the gear 18. Since the threads 13 are formed at 32 threads per inch in the actual model referred to, it will be seen that a complete revolution of the gear 17 will move the arming sleeve downwardly $\frac{1}{32}$ of an inch toward its arming position. The number of revolutions which the gear 17 must make is, therefore, dependent upon the length of the sleeve portion 10 extending upwardly within the safety block 9.

The difficulty of securing effective operation will be more readily appreciated when it is considered that complete movement of the sleeve 10 to arming position must be had in a few seconds time at the lowest speed of operation and in decreasing periods of time at higher speeds of operation. The problems encountered will be further appreciated when it is considered that the scale of the drawing of Fig. 1 is approximately 3 times as large as the size of the actual fuse.

At the speeds of operation necessary, a small amount of friction or slight misalignment of the moving parts of the operating mechanism will be effective to interfere with the operation thereof. The arming mechanism of this invention is effective to maintain the rotating parts thereof in axial alignment concentrically of the housing 16 and to prevent direct frictional engagement between the relatively moving surfaces of the housing 16 and rotating parts. This is accomplished by reason of the fact that the rotating parts comprising the members 21 and 22 and the parts connected thereto constitute a unit, the position of which is effectively maintained within the housing 16 by the lower bearings or race 24, and the upper bearings or race 26. It will be apparent that these bearings being spaced from each other along the housing 16 are effective to align the position of the rotating unit and to absorb the thrust of such unit on the housing 16. Any serious frictional engagement of surfaces on the rotating unit with relatively stationary surfaces on the housing 16 is thus effectively prevented.

The support for the pinions 19 provided by the annular members 21 and 22 effectively anchors both ends of the pinions 19, since the shafts 20 have their ends respectively anchored in the members 21 and 22. This arrangement effectively prevents misalignment of the axes of the pinions 19 during assembly of the fuse, which misalignment would otherwise be possible in view of the delicacy and lightness of the pinion supporting shaft.

The mounting for the pinion 19 provided by the members 21 and 22, in effect, provides a gear cage which is rotatable about the gears 17 and 18. In this arrangement it will be noted that the gear 19 is a planetary gear which rotates about the axis of the shaft 20 and also about the axis of the sun gears 17 and 18.

In order to balance out the effect of centrifugal force due to the rapid rotation of the pinion 19 about the axis of the gears 17 and 18, a counterweight 19*a* is mounted in position at a point diametrically opposite the pinion 19. In this manner, the centrifugal forces developed by rotation of the gear 19 and weight 19*a* about their axis of rotation are balanced out.

Since a small amount of unbalance will effect the operation of the device, it will be noted that the propeller 27 has been made symmetrical so as to provide a completely balanced operating device. The propeller 27 is provided with two downwardly and outwardly projecting lugs 30 having openings 31 and 32 for cooperation with similar openings formed in a lug 33 secured to the housing 16. By inserting pins through the openings 31 and 32, undesirable operation of the arming mechanism may be prevented prior to the release of a bomb from an airplane. In order to positively drive or rotate the safety block 9, the propeller 27 is provided with an up-turned portion 34 for engagement in a slot 35 formed in the safety block 9.

In the intended operation of the bomb fuse, the propeller 27 is rotated so as to move the arming sleeve downwardly. However, it is possible for the sleeve 10 to move upwardly due to reversal of rotation of the propeller for some reason such as, for example, turning over of the bomb after it is released from the airplane. Such reversal of rotation and upward movement of

the arming sleeve 10 might interrupt the threaded connection 13 between the arming sleeve 10 and arming hub 14. To permit such interruption of the threaded connection 13 without damage a coil spring 36 is provided. The coil spring is deformed in such manner that a portion thereof will rest on the upper surface of the gear 17, as viewed in Fig. 1, and another portion thereof will engage with an annular ledge 37 on the inner surface of the annular member 22. Upon reversal of rotation tending to move the sleeve 10 upwardly from the position shown in Fig. 1, the deformed spring 36 will be compressed prior to interruption of the threaded connection 13. Such compression of the spring 36 will provide a bias tending to move the arming sleeve 10 toward the arming hub 14 so as to automatically reestablish the threaded connection 13 upon subsequent rotation of the parts in their normal intended manner. The spring 36 and its relation to the parts described above provides a device in the nature of an overrunning clutch which permits free rotation of the sleeve 10 in a reverse direction without damage and is operative to immediately reestablish the connection upon rotation in an opposite direction. Were it not for the spring 36 and the construction enabling disengagement of the threaded connection 13, continued upward movement of the sleeve 10 would be had until the gear 17 engaged with the annular member 22. Thereafter the differential gearing would operate as a jack and either press the gear 17 off the sleeve 10 or so deform it as to render the same useless.

The modification illustrated in Fig. 3 is essentially the same as that shown in Fig. 1, except for the parts to be described, and like numerals have been employed to designate like parts. The essential difference of the construction illustrated in Fig. 3 lies in the arrangement of gearing for operating the sleeve 10. In this showing, it will be noted that the arming sleeve 10 has a threaded connection 13 to an arming hub 40 which is rotatable instead of stationary as is the case with the arming hub 14 of Fig. 1, the arming hub 40 being connected directly to the propeller 27 for rotation thereby. The arming hub 40 is provided with an internal gear 41 and the arming sleeve 10 of Fig. 3 is provided with an internal gear 42, the internal gears 41 and 42 being differentially related and meshing with a pinion 43 rotatably mounted on a stud 44 projecting upwardly from the base 15. The stud 44 is provided with an opening through which the striker rod 6 may project into the opening 4 for movement into the chamber 3. The advantage of this arrangement of gearing lies in the fact that a larger pinion 43 may be obtained thereby enabling a larger number of teeth to engage with the gears 41 and 42, thus reducing the stress on the gear teeth. In this construction, the striker rod 6 is offset from the center of the housing 16 and an additional striker rod 45 may be employed and driven into an annular chamber 46 adapted to contain a capsule for providing a time delayed explosion of the bomb. The modification of Fig. 3 operates in the same manner as that of Fig. 1, and it will be noted that the bearings 24 and 26 function to maintain the alignment of the rotating parts and absorb end thrust on the housing 16 in the same manner as in Fig. 1. A spring 36 is engaged with the arming sleeve 10 and functions in the same manner as does the spring 36 in Fig. 1. The safety block 9 is of a different type from that shown in Fig. 1, but is a type well known in the art and need not therefore be referred to in detail.

From the foregoing, it will be apparent that there is provided an arming mechanism for bomb fuses having a differential gear unit for operating the same in which the rotating parts are effectively maintained aligned, and in which sliding frictional engagement of relatively moving surfaces is effectively eliminated. By maintaining the position of the rotating parts aligned, the stability of the structure in operation is increased and such structure will function reliably at increased speeds of operation to arm the fuse in decreasing periods of time.

Since certain changes may be made in the above construction and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In a fuse housing the combination of a housing for connection to the nose of an aerial bomb, the combination of a sleeve movable axially with respect to said housing to an arming position, and driving means for said sleeve comprising an arming hub having a threaded connection with said sleeve, a pair of differential gears respectively mounted on said hub and said sleeve, a planetary gear engaged with said differential gears, a cage for said planetary gear comprising a pair of parts rotatably mounted in said housing, each of said parts respectively supporting an end of said planetary gear, and a propeller connected to one of said parts for rotating said cage and thus rotating the planetary gear about said differential gears.

2. The combination claimed in claim 1 wherein said planetary gear is provided with a counterbalance mounted on said gear cage.

3. The combination claimed in claim 1 wherein said arming sleeve is moved to arming position upon rotation of said cage in one direction, and said sleeve and hub are disengaged upon rotation of said cage in an opposite direction, together with resilient means compressible upon disengagement of said hub and sleeve and effective to provide a biasing force to reengage the threaded connection between said hub and sleeve upon subsequent rotation of said cage in said one direction.

4. In a fuse having a housing for connection to the nose of an aerial bomb, the combination of a sleeve movable axially with respect to said housing to an arming position, and driving means for said sleeve comprising an arming hub having a threaded connection with said sleeve, and means for rotating said sleeve, said sleeve being movable to arming position upon rotation in one direction, and out of threaded engagement with said hub upon rotation in an opposite direction, and resilient means compressible for exerting a bias to maintain said sleeve in a position reestablishing said threaded engagement upon subsequent rotation of said sleeve in said one position.

5. In a fuse having a housing for connection to the nose of an aerial bomb, the combination of a sleeve movable axially with respect to said housing to an arming position, and driving means for said sleeve comprising an arming hub having a threaded connection with said sleeve, a pair of differential gears respectively mounted on said hub and said sleeve, a planetary gear engaged

with said differential gears, a cage for said planetary gear comprising a pair of parts rotatably mounted in said housing, each of said parts respectively supporting an end of said planetary gear, a ball bearing race positioned between each of said parts and said housing, said races being effective to position said cage concentrically of said housing and to absorb the end thrust of said cage in said housing, and a propeller connected to one of said parts for rotating said cage and thus rotating the planetary gear about said differential gears.

6. In a fuse having a housing for connection to the nose of an aerial bomb, the combination of, a sleeve movable axially with respect to said housing to an arming position, driving means for said sleeve comprising a sleeve-like arming hub having a threaded connection with said sleeve, two internal gears mounted, respectively, on said hub and on said sleeve, said gears having different numbers of teeth, a pinion carried by said housing meshing with each of said gears to thus provide a differential gear transmission between the hub and sleeve, a propeller connected to said hub for rotating the same, said sleeve being movable to arming position upon rotation of said hub in one direction and, upon rotation of said hub in the opposite direction, said sleeve and hub are moved out of threaded engagement, and resilient means compressible upon disengagement of the threaded connection of said sleeve and hub and effective to provide a biasing force to reestablish said threaded connection between said hub and sleeve upon subsequent rotation of said sleeve in said one direction.

ANDREW J. NICHOLAS.