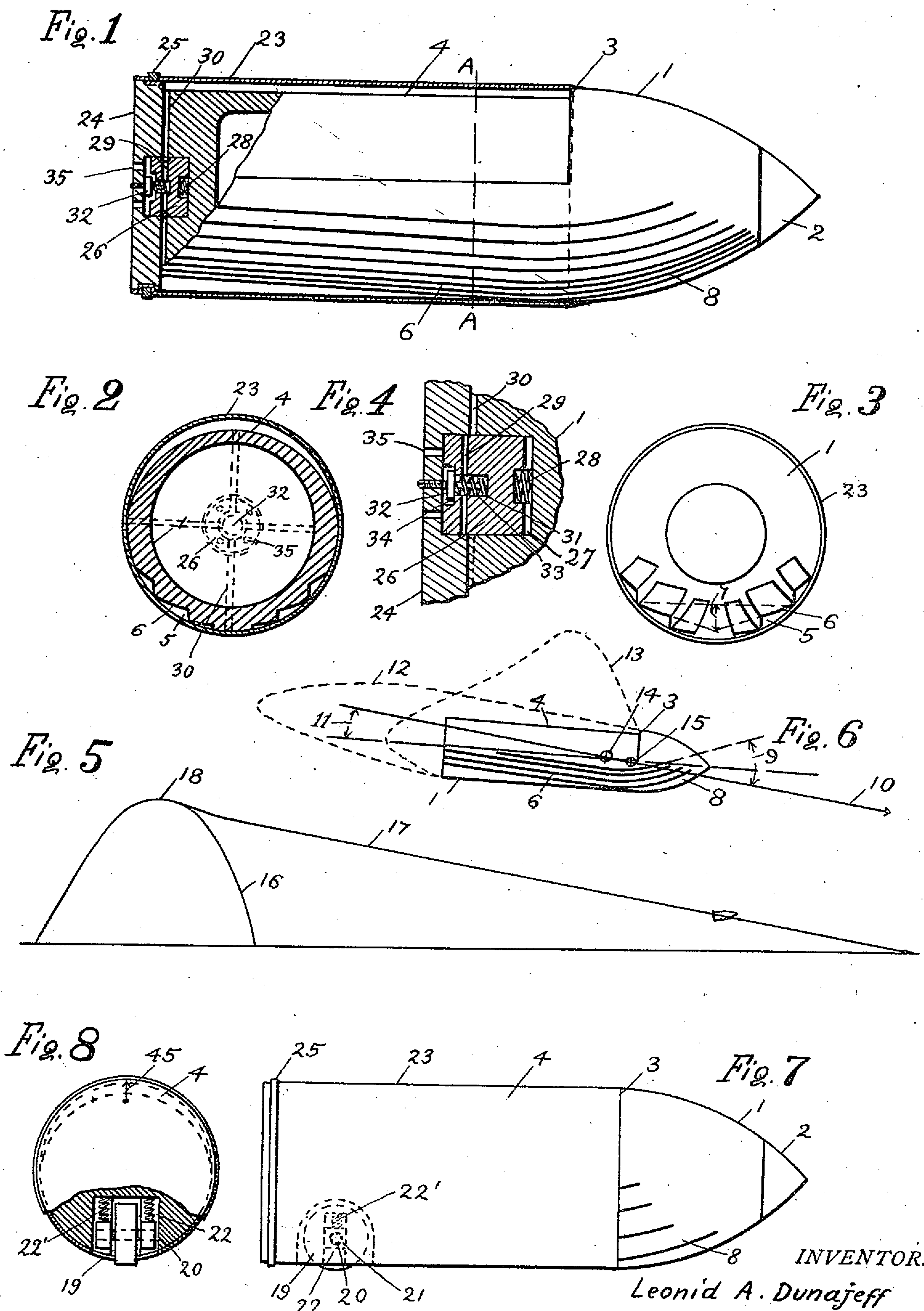
June 19, 1923. 1,459,198

L. A. DUNAJEFF

PROJECTILE

Filed May 2, 1921 2 Sheets-Sheet 1



INVENTOR.

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By John P. Nikonow

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Fig. 9

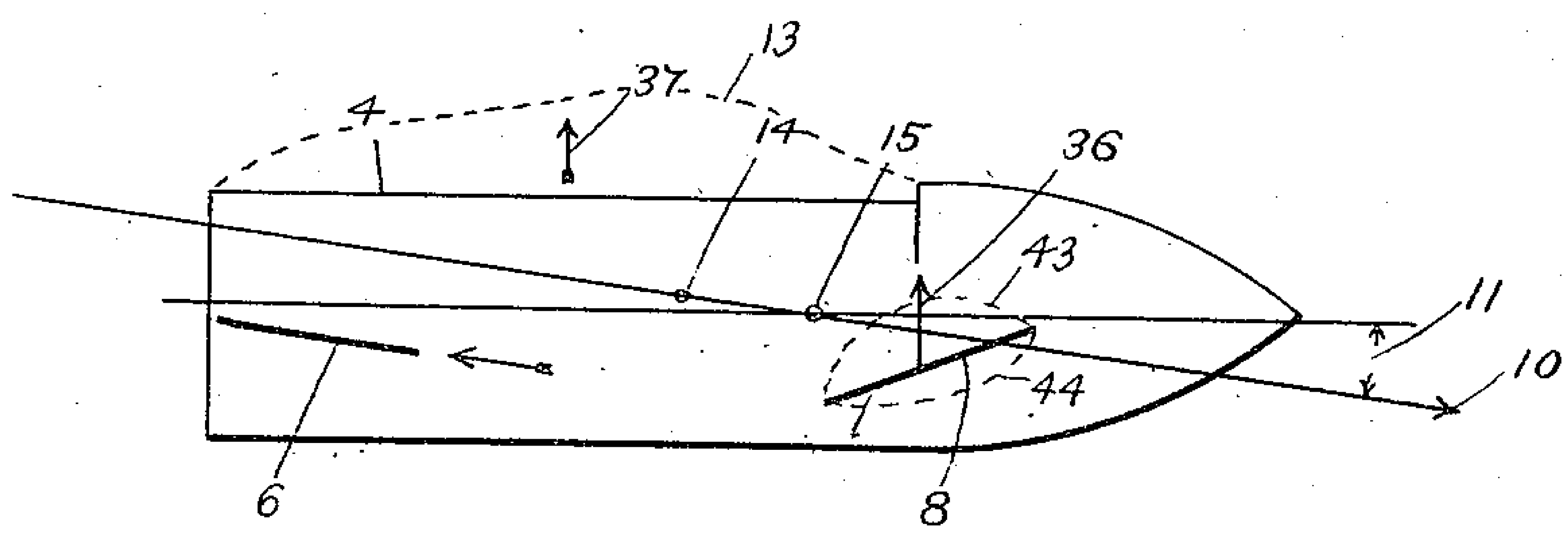


Fig. 10

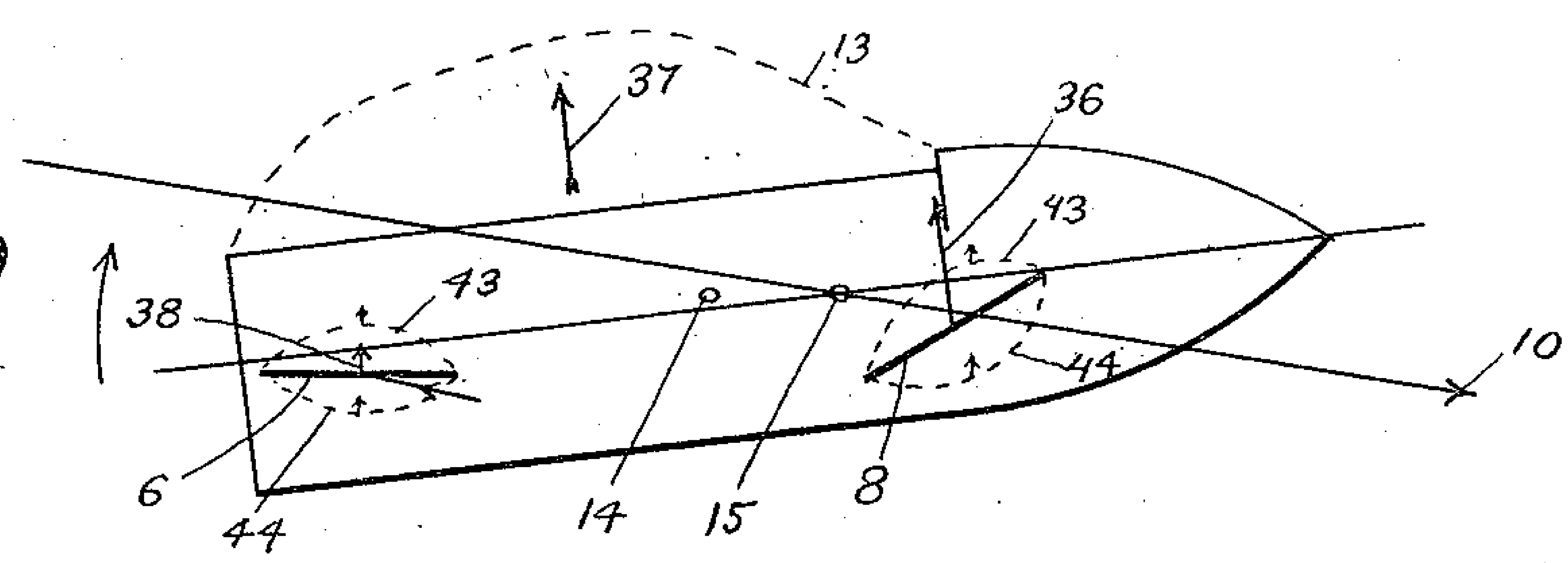


Fig. 11

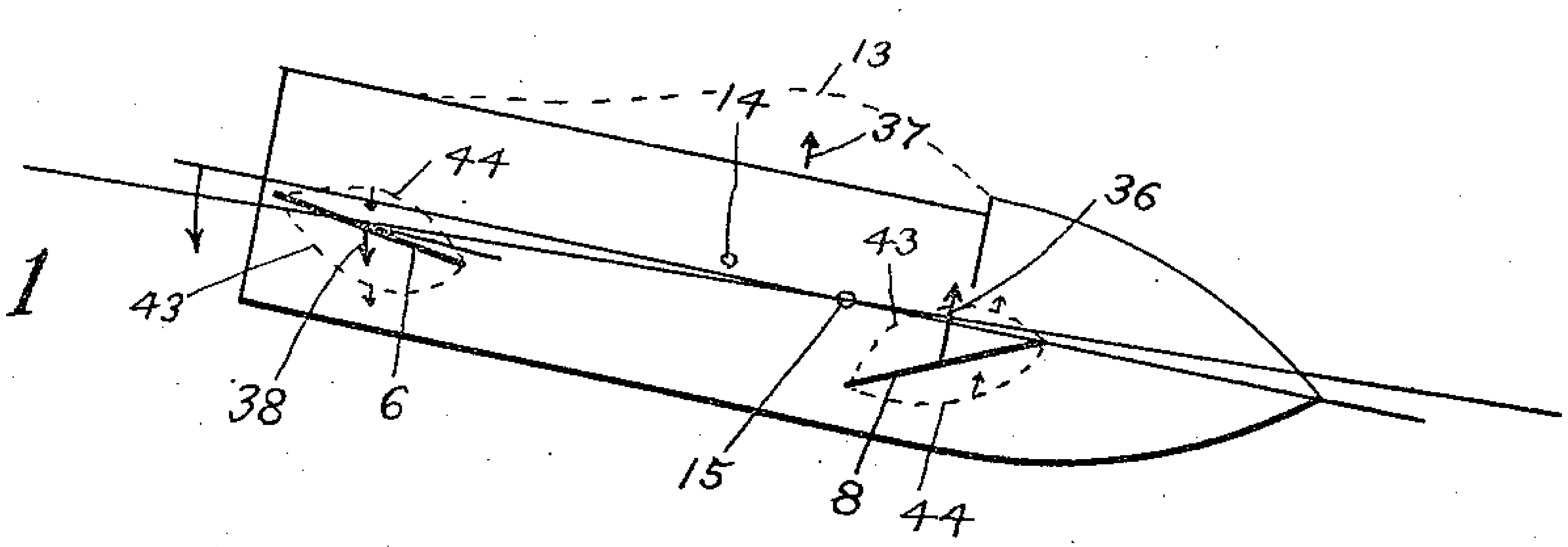
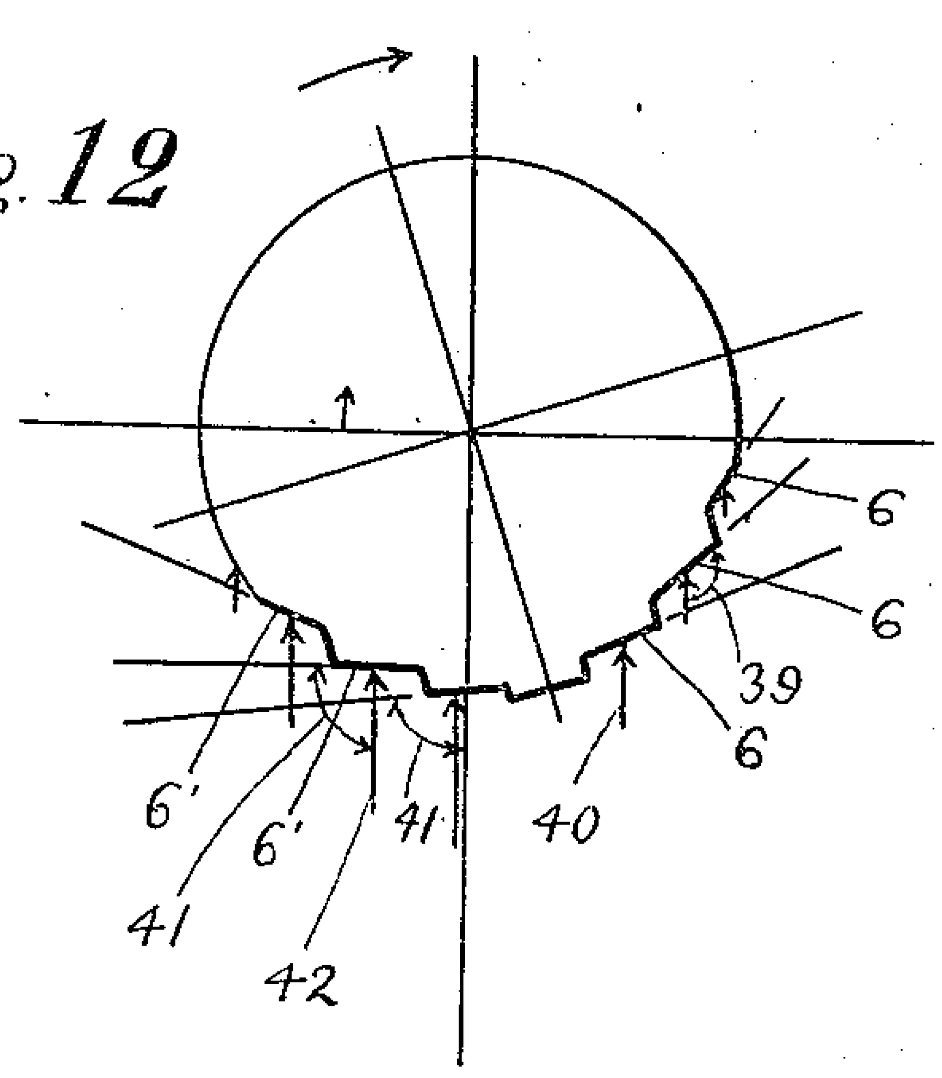


Fig. 12



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Patented June 19, 1923. **1,459,198**

UNITED STATES PATENT OFFICE.

LEONID A. DUNAJEFF, OF NEW YORK, N. Y.

PROJECTILE.

Application filed May 2, 1921. Serial No. 466,034.

To all whom it may concern:

Be it known that I, Leonid A. Dunajeff, citizen of Russia, and resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Projectiles, of which the following is a specification.

My invention relates to projectiles and has for its object to provide a projectile especially suitable for firing at a very long range.

For firing at a long range a high initial velocity is required in order to store in the projectile a sufficient amount of energy to overcome the air resistance. High initial velocity necessitates a very long gun, a slow burning powder and a high initial pressure. These factors greatly increase stresses in the gun, its burning, erosion and general deterioration, and shorten considerably the life of such a high powered gun.

In order to increase the firing range without increasing the initial velocity of the projectile, I am providing a special projectile for high angle firing, of such a form, that my projectile, upon reaching the highest point in its flight, glides downwards at a small angle with the horizon, being supported partly by the vacuum in the air above, partly by the air pressure underneath, in a manner somewhat similar to the gliding of an airplane. For this purpose I provide my projectile with specially shaped upper and lower surfaces, also with a protective device adapted to prevent these special surfaces to act until the projectile begins to descend.

My invention is more fully described in the accompanying specification and drawing in which—

Fig. 1 is an elevation of my projectile partly in section, Fig. 2 is a section through A—A, Fig. 3 is a front view of the projectile, Fig. 4 is a sectional view of a locking mechanism for the protective casing, Fig. 5 is a diagrammatic view of a trajectory of flight of my projectile as compared with a trajectory of an ordinary projectile, Fig. 6 is a diagrammatic view of my projectile in flight, showing distribution of forces and the lines of vacuum, Fig. 7 is a sectional elevation of a modified arrangement, and Fig. 8 is a rear view of same, Figs. 9, 10, 11 and 12 are diagrammatic views of the projectile in flight.

My projectile consists of a body or shell 1 with a pointed nose containing a fuze or detonator 2, which may also be screwed in the rear portion according to whether it is a shrapnel, high explosive or piercing shell.

The cylindrical portion of my shell is shaped differently on its sides. One side, which is an upper side in flight, is machined off eccentrically, forming a straight shoulder 3. The machining is done by simply placing the shell on a lathe eccentrically or off centers and taking a straight cylindrical cut, until it reaches approximately across the diameter, thereby forming a recess 4.

The lower portion is provided with longitudinal grooves 5 forming lateral shoulders 6. These shoulders extend from the rear of the shell to the front, terminating on the ogive or pointed portion. These shoulders are arranged symmetrically on both sides of the plane passing vertically through the longitudinal axis of the shell. The purpose of these shoulders is to provide gliding surfaces for the shell. The forward portions of these surfaces 8 are raised so as to form a proper angle 9 of incidence with the direction of flight, indicated by the arrow 10. The rear portions of the surfaces 6 are inclined to the axis of the shell so as to be almost parallel to the direction of flight 10 of the projectile.

The inclined forward surfaces 8 tend to raise the front portion of the projectile in flight, so that its axis will form a small angle 11 with the direction of flight 10. The air under the forward portion will be compressed in proportion to the square of the velocity of the projectile, producing a lifting force and tending to raise the projectile higher in the air against its weight. At the same time the recess 4 and the shoulder 3 will produce a vacuum above and behind the projectile also tending to raise same in the air. The approximate distribution of the vacuum is indicated by the dotted line 12. The dotted line 13 indicates the distribution of a lifting force as caused by the vacuum, which is the strongest nearer the front portion of the projectile.

The combined action of the lifting forces, produced by the pressure and the vacuum, supports the projectile in the air at a certain angle with the line of flight, this angle depending also on the velocity of flight. With the center of pressure 14 behind the center of gravity 15 a stable condition of flight will be produced, the projectile maintaining its angular gliding position and travelling at a practically constant speed. Such condition would have been difficult to accomplish without a provision for a vacuum lift.

In adjusting itself to a certain angle the projectile will turn more or less around its center of gravity 15, so that the change from the front curved surfaces 8 to the rear inclined shoulders 6 should be near the vertical plane containing this center of gravity.

The rear shoulders act only as stabilizers, offering but a little resistance to the air and being almost parallel to the normal line of flight. But if the projectile turns and its front portion rises in the air, then the angle of incidence of the rear portion becomes greater, and its moment arm being longer than that of the front portion, it can easily overcome the front lifting force, thereby returning the projectile to its normal angle of flight. If the angle of incidence becomes smaller, or the projectile turns downwards, then the vacuum decreases, the lifting force also diminishes, and the rear portion sinks until the projectile rights itself.

In this respect my projectile acts very similarly to an ordinary airplane, gliding down at a constant angle and with a constant gliding speed. An ordinary projectile, after reaching the highest point of flight, begins to descend with increasing velocity, and the second half of its trajectory is even shorter than the first one on account of the decrease of the velocity as caused by the air friction. About 30 to 40 degrees elevation produces usually the longest range. The line 16 Fig. 5 indicates the trajectory of an ordinary projectile.

With my projectile the trajectory, after its highest point, becomes an almost straight line 17, forming a small angle with the earth, and although the velocity will be comparatively low, the projectile, nevertheless, will glide at a constant speed a very long distance, depending on the height of the apex 18 of the trajectory. It is possible to make the total gliding distance eight times the height of the trajectory, for instance.

It should be noted, however, that my projectile should not revolve in flight and therefore it must be fired from a gun with a smooth bore. The possible shorter straight flight in the absence of the rotation is more than compensated in my projectile by the enormously increased total range of the trajectory. On the other hand, a smooth bore means much longer life for the gun.

The symmetrical arrangement of the gliding shoulders and their inclination to the central vertical plane provides means to maintain the vertical balance of the projectile and to prevent its rotation in flight.

As an additional security against any such rotation a gyroscope may be employed. It represents a gyroscopic wheel 19 on a shaft 20 mounted in bearings 21.

The bearing blocks may slide in slots 22 in the sides of the shell under action of springs 22′. The friction between the wheel and the bore will set the wheel in a rapid rotation which will be maintained during the flight. The gyroscopic force of the wheel will prevent any axial rotation of the projectile.

The most of the lifting force is produced by the vacuum recess 4 which, although small, is very effective on account of the high speed of the projectile. Its action, however, is not desirable until the projectile begins to descend, so that I provide my projectile with a protective shell or cartridge 23. It is made of a thin metal sheet and is forced under slight pressure over the cylindrical portion of the projectile. The rear end of the protective casing is closed with a heavy bottom plate 24. A copper band 25 may be fitted in the edge in order to seal the shell in the gun and prevent the leakage of gases during their expansion.

When the projectile is still inside of the gun, the pressure of the expanding gases will keep the protective casing pressed tightly against the projectile. During the flight the air will be forced under pressure through the grooves 5 inside of the casing 23 and may easily throw it off. In order to prevent this I provide a relief valve for the air. It consists of a heavy block 26 sliding in a recess 27 formed partly in the projectile, partly in the back wall of the protective casing. A spring 28 tends to move the block back away from the bottom of the recess in the projectile and to press it against the bottom of the recess in the back plate 24. The block 26 is drilled through, and the holes 29 are in a communication with grooves 30 in the bottom of the projectile, when the block is pressed forward against the spring 28. The holes 29 pass into a hole 31 in the block containing a valve 32. A spring 33 forces the valve away from its seat 34, thereby opening the space 31. The holes 35 establish a communication between the air outside and inside of the casing.

The pressure of the gases in the gun, acting through the holes 35, will force the block 26 forward, but, at the same time, will close the valve 32, thereby preventing the gases from escaping through the holes 29 and grooves 30. But after the projectile leaves the gun, the light spring 33 will force the valve open thereby establishing a communication between the air inside of the protective casing 23 and the outside and relieving the pressure inside, so that the protective casing will stay on the projectile in flight. The air friction will cause a deceleration of the projectile, so that the inertia of the block 26 will keep it pressed against the tension of the spring 28.

During the ascent of the projectile the air will flow continuously through the channels 5, grooves 30 and holes 29, 31 and 35 to the rear of the shell, coming out in a stream and partly filling the vacuum behind, forming an elastic streamline extension to the projectile, thereby reducing materially its resistance in flight.

When the projectile reaches the highest point of flight and begins to descend, its velocity becomes constant, and the block 26 will move away from the front wall under action of the spring 28 since there will not be any more force to compress this spring. The holes 29 will move away from the grooves 30, as it is shown in Fig. 4, thereby closing the passages for the compressed air inside of the protective casing. The accumulated compressed air will force the protective casing off the projectile, exposing the vacuum recess 4 and the grooves 6. From that moment on the projectile will glide down at a constant speed and at a constant angle, its trajectory being practically straight line 17.

Fig. 9 represents my projectile in a normal flight during the descent with the center of pressure 14 on the line with the center of gravity 15 and with the forces balanced. The front inclined planes are represented diagrammatically with a line 8. The air pressure on these surfaces produces a vertical lifting component force 36. Distribution of the lifting forces due to the air pressure is marked with dotted lines 44, the vacuum forces are marked in the lines 43. The rear planes are represented diagrammatically with a line 6 almost parallel to the line of flight 10. No vertical lift is exerted on these planes in a normal position as shown. The vertical lift due to the vacuum above the recess 4 is indicated with an arrow 37, and distribution of forces with a line 13. The turning moment produced by the force 36 around the center of gravity will be balanced by the opposite turning moment produced by the force 37 around the same center of gravity 14. Therefore in this position the projectile will tend to conserve its longitudinal position in relation to the line of flight 10, or the angle 11.

Fig. 10 shows distribution of forces when the projectile accidentally turns upwards. In this case the angle of the planes 8 will be increased and consequently the force 36 will increase also. But to balance this increase the vacuum force 37 will also increase and there will appear a new force 38 acting on the rear planes 6 which will be directed now at an angle to the line of flight. The moment arm of the forces 37 and 38 being much larger than that of the force 36, there will be a strong unbalanced turning moment tending to lift the rear portion of the projectile and to restore its normal flying position.

Fig. 11 represents an opposite case, when the projectile turns downwards. In this case the force 36 will be decreased on account of a decrease of the angle of the front plane 8. To balance this decrease, however, the vacuum force 37 will be also greatly decreased and its component shifted to the front of the shell, shortening the moment arm, the force 38 will reverse its direction and will act downwards. The resultant turning moment will tend to lower the rear end of the projectile until it takes its normal flying position.

Fig. 12 represents a case when the projectile turns sidewise in flight. In this case the right surfaces or planes 6 will form large angles 39 with the vertical lifting forces 40, while the corresponding planes 6′ on the other side will be more nearly at right angles to the vertical components 42. As a result the forces 42 will be greater than the forces 40, so that the left side of the shell will be lifted until the forces become balanced, which will take place with the symmetrical position of the planes 6 and 6′ around the vertical line.

My projectile will not function properly unless it is fired in a correct position in regard to its vertical axis, so that the cartridge and the shell itself should have some marks 45 or other provision for correct loading. Important advantages of my projectile are, that it can be used for firing at a very long distance with ordinary amount of powder charge and with ordinary sizes and calibers of the guns, also that with my projectile the expensive and difficult rifling of the guns can be dispensed with. The initial velocity not being necessarily high, the projectile can be made comparatively light with a large charge of an effective explosive, compressed gas or an incendiary material.

I claim as my invention:

1. In a projectile, the combination with a shell, a shoulder on the upper side of said shell near its forward portion, and a longitudinally extending recess back of said shoulder.

2. In a projectile, means to form a vacuum above said projectile in flight, and means to prevent formation of said vacuum until the projectile reaches the predetermined point of its trajectory.

3. In a projectile, the combination with a shell having a pointed front portion and a cylindrical rear portion, a shoulder back of said pointed portion on one side of said shell, and an eccentrically formed recess back of said shoulder and extending to the rear end of said shell.

4. In a projectile, the combination with a

shell, a shoulder and a recess on one side of said shell, a protective casing covering said recess, and means to release said protective casing from said projectile at a predetermined point of flight.

5. In a projectile, the combination with a shell, gliding surfaces on the lower side of said shell, vacuum forming recess on the upper side of said shell, a protective device adapted to cover said vacuum forming recess, air passages between said shell and said protective device, and an inertia operated air valve in the rear of said projectile, adapted to close said passages at the predetermined point of flight.

6. In a projectile, a protective casing for said projectile, means to admit the air under compression in flight inside of said protective casing, a valve adapted to release said compressed air back of said projectile, and inertia operated means to control said valve.

7. In a projectile, a gyroscopic wheel, the axis of said wheel being perpendicular to the axis of said projectile, and a spring adapted to press said wheel against the bore of the gun.

8. In a projectile, the combination with a shell, a transverse shoulder and a recess on the upper side of said shell, and a gyroscopic wheel in said shell.

Signed at New York, in the county of New York and State of New York, this fifteenth (15) day of April, A. D. 1921.

LEONID A. DUNAJEFF.