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ACCELERATING PARTICLES TO HIGH VELOCITIES

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FIG. 1

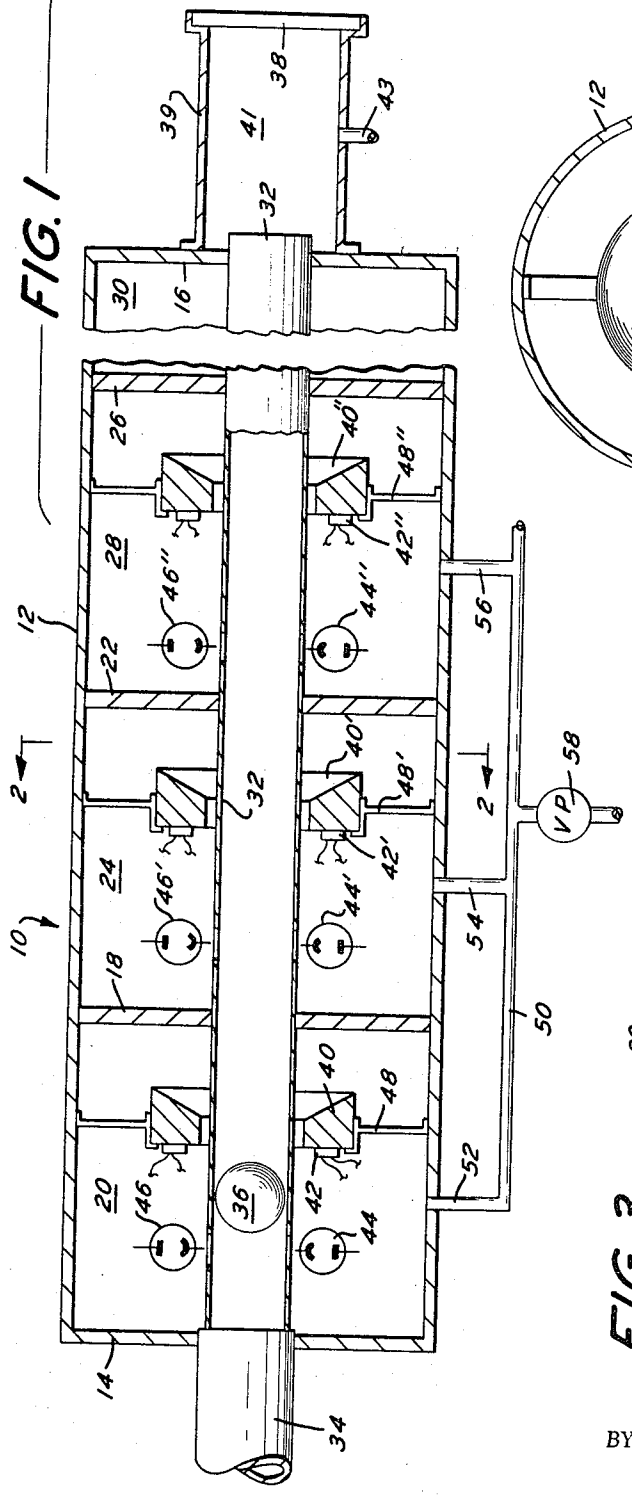



FIG. 2

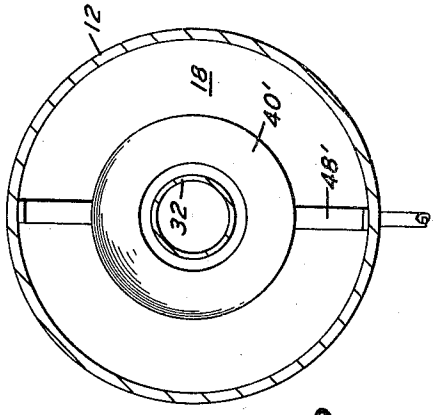
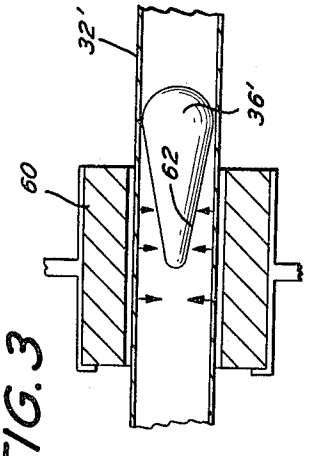



FIG. 3




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# ACCELERATING PARTICLES TO HIGH VELOCITIES

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This invention relates to apparatus invented for accelerating particles or projectiles so that they may attain high velocities.

The present invention permits relatively large projectiles of known mass to be directed toward a target at high velocities. In this manner, laboratory studies for impact effects on various structures and materials are facilitated. Accordingly, meteor impact problems, missile nose cone design, inter alia, may be studied under a condition simulating outer space.

One of the major obstacles to such studies in the laboratory is to provide a means for creating sufficiently high velocities for relatively large projectiles. The present invention overcomes this obstacle by sequentially accelerating a moving projectile. The sequential acceleration is preferably accomplished by sequentially detonating explosive shaped charges along the path of the projectile so that the explosive force of each shape charged further accelerates the projectile.

It is an object of the present invention to provide a novel apparatus for accelerating projectiles.

It is another object of the present invention to provide a novel method of accelerating projectiles.

It is another object of the present invention to provide a novel method and apparatus for accelerating projectiles at very high velocities to facilitate laboratory studies of impact problems and the like.

It is another object of the present invention to provide a method and apparatus for simulating outer space conditions for impact studies of meteorites and the like.

Other objects will appear hereinafter.

For the purpose of illustrating the invention, there are shown in the drawings forms which are presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIGURE 1 is a diagrammatic illustration of the present invention shown in section.

FIGURE 2 is a sectional view taken along the line 2—2 in FIGURE 1.

FIGURE 3 is a view similar to FIGURE 2 but illustrating another embodiment.

Referring to the drawing in detail, wherein like numerals indicate like elements, there is shown in FIGURE 1 an apparatus designated generally as **10**.

The apparatus **10** includes a housing **12** which may be cylindrical as shown more clearly in FIGURE 2. The housing **12** is provided with end walls **14** and **16**. The interior of the housing **12** is provided with partitions **18**, **22** and **26**. End wall **14** and partition **18** cooperate with the housing **12** to define a chamber **20**.

Partitions **18** and **22** cooperate with the housing **12** to define a chamber **24**. Partitions **22** and **26** cooperate with the housing **12** to define a chamber **28**. Partition **26** and end wall **16** cooperate with the housing **12** to form a chamber **30**. The chambers **20**, **24**, **28** and **30** are serially disposed. If desired, a thin walled tube **32** made from a material such as aluminum may be coaxially disposed within the housing **12** and extending between an inlet in the wall **14** to an outlet in the wall **16**. Any suitable means such as nuts and bolts may be used to retain the tube **32** in a predetermined disposition.

The barrel **34** of a gun, not shown, extends through the



inlet in end wall **14** in line with the tube **32**. The gun is preferably a pneumatic gun for firing projectile **36** through the tube **32** toward the target **38**. Target **38** may be supported externally of the housing **12** in any convenient manner or may be completely disconnected from the accelerator. For some laboratory studies, the target **38** may be supported by a tubular extension **39** having a chamber **41** therein. Chamber **41** may be evacuated by means of conduit **43** as will be made clear hereinafter.

Within chamber **20**, there is supported an annular shaped charge **40** having a detonator **42**. A means is provided for sensing the presence of the projectile **36**. This may be simply accomplished by providing suitable apertures in opposite sides of the tube **32**, and utilizing an optical sensing means such as photoelectric cells **44** and **46**. As the projectile **36** interrupts the beam between the cells **44** and **46**, current will be supplied to the detonators **42** to detonate the same. The cells **44** and **46** are spaced from the shaped charge **44** by a distance so that the shaped charge **40** will be detonated at a time interval whereby its explosive force will accelerate propulsion of the projectile **36**.

The shaped charge **40** may be supported in any convenient manner such as by brackets **48**. Within chamber **24**, there is provided comparable photoelectric cells, shaped charge and detonator provided with primed numerals. The photoelectric cells **44'** and **46'** are spaced slightly further from the shaped charge **40'**. The spacing takes into consideration that the projectile will be moving faster when passing through chamber **24**. In chamber **28**, there are provided corresponding elements with double primed numerals. The cells **44"** and **46"** are spaced further from the shaped charge **40"** as compared with the corresponding elements in chamber **24**.

The various chambers within the housing **12** as well as chamber **41** are preferably evacuated for meteoroid simulation studies, but need not be evacuated for other studies. This may be accomplished by a manifold **50**. Chamber **20** and manifold **50** are interconnected by conduit **52**. Chamber **24** and manifold **50** are interconnected by conduit **54**. Chamber **28** and manifold **50** are interconnected by conduit **56**. Chamber **30** and manifold **50** are interconnected by conduit not shown. Chamber **41** and manifold **50** are interconnected by conduit **43**. A vacuum pump **58** may be provided with its inlet side communicating with the manifold **50**.

The operation of the apparatus **10** is as follows:

A projectile **36** of large mass is fired through barrel **34** into the tube **32**. For meteorite impact studies, a large mass would be one gram. As the projectile **36** interrupts the light beam between cells **44** and **46'**, the detonator **42** is detonated thereby exploding the shaped charge **40**. The explosive force of shaped charge **40** bursts the portion of tube **32** immediately adjacent thereto and accelerates the speed of the projectile **36**. As the projectile **36** enters the chambers **24**, it will interrupt the light beam between cells **44'** and **46'**. As a result thereof, the shaped charge **40'** will be detonated by detonator **42'**. This explosive force will likewise accelerate the speed of the projectile **36**. The above sequence will be repeated throughout the length of the housing **12**, as desired, so that the explosive force of each shaped charge will sequentially increase the speed of the projectile so that speeds of at least 10,000 meters per second may be attained when the projectile contacts the target **38**. If desired, the pressure on opposite sides of the target may be equal or substantially equal by extending the length of the chamber **41**.

Doors not shown are provided in the housing **12** so that access may be had to each of the chambers therein to facilitate replacement of the shaped charge and detonators. After each firing the tube **32** will be replaced. It will be appreciated that the drawing is only schematic in that

reinforced ribbing, and a rigid support to counteract the explosive force from the shaped charges, etc. will be provided. For certain testing operations, the thin walled aluminum guide tube **32** may be eliminated. For purposes of illsutration, the projectile is illustrated as having a spherical shape. It will be appreciated that other contours may be provided for the projectile **36**. It will be appreciated by those skilled in the art that the super high velocity gas jet formed by the explosion of the shaped charges gives the projectile **36** a velocity boost by momentum transfer.

In FIGURE 3 there is illustrated an alternate arrangement wherein a cylindrical charge **60** may be substituted for the shaped charges identified above. When using cylindrical charges, the projectile **36'** should have a conical tail section providing a reaction surface **62**. The force or momentum of the explosion products imploding inwardly in a radial direction from charge **60** immediately destroys the juxtaposed portion of tube **32'** and acts on surface **62** to provide a force component thereon to propel projectile **36'** forwardly in the same manner as described above. In this way it will be seen that, theoretically at least, the terminal velocity of the projectile can exceed the particle velocity of the imploding gas. It will be noted that the charges in FIGURES 1–3 are annular.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

We claim:

**1.** Apparatus for accelerating projectiles to high velocities comprising a housing, means for evacuating said housing, a plurality of aligned annular explosive charges in said housing, said housing having an inlet and an outlet aligned with said charges, sensing means for sequentially firing each charge whereby each charge will accelerate



the speed of a projectile passing through said housing and partitions dividing said housing into separate chambers, means for supporting the charges in said chambers, and each charge having its own sensing means coupled thereto.

**2.** Apparatus in accordance with claim **1** including a thin walled guide tube extending through said partitions between said inlet and said outlet and through which the projectile will be propelled, with the charges being annularly disposed around said tube.

**3.** Apparatus in accordance with claim **1** wherein said sensing means is an optical sensing means.

**4.** Apparatus in accordance with claim **1** including a target supported by the housing, said housing having a chamber between the target and the charge closest to the target, said last mentioned chamber being evacuated by said evacuating means.

**5.** Apparatus in accordance with claim **1** wherein said sensing means includes an optical sensing means associated with each of the charges which are shaped charges, the distance between the shaped charges and their respective optical sensing means being progressively farther from each other in a direction extending from the inlet toward the outlet, whereby the distance between the sensing means and shaped charge adjacent the inlet is less than the corresponding distance between the sensing means and shaped charge adjacent the outlet.

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