

PROJECTILE WITH SELECTABLE KINETIC ENERGY

5 FIELD OF THE INVENTION

This invention relates to projectiles having variable kinetic energy that is selected when the projectiles are fired. In particular, although not exclusively, the invention is concerned with selective ignition of one or more of a plurality of propellant charges associated with a
10 projectile, typically of the mortar type and stacked axially in a barrel for sequential firing.

BACKGROUND OF THE INVENTION

The kinetic energy (KE) of conventional projectiles, for example standard mortar rounds,
15 may be varied by tailoring the amount of propellant that is associated with each projectile before firing. This may require different internal propellant loads produced during manufacture or the use of auxiliary propellant charges, where possible.

In mortar rounds, the projectiles and auxiliary propellant charges are generally separate
20 from one another before firing. The auxiliary propellant is typically provided in a number of small parcels that may be supplied in different volumes or in the same volume for incremental use. Depending on the range that is required, the mortar operator manually attaches one or more parcels providing the appropriate amount of propellant to the mortar round before insertion into a tube or barrel for firing. This procedure also considerably
25 slows the rate of fire that can be achieved by the weapon and is prone to human error when loading.

It will be appreciated that a more cost effective, convenient and reliable arrangement for varying the kinetic energy of projectiles is desirable, particularly where a high rate of fire
30 is required. Particularly where the projectile firing weapon is of the type including a plurality of rounds stacked in a barrel for sequential firing and required to be remotely controlled. It would be of further advantage if the construction of individual rounds was substantially homogeneous.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved projectile having selectable kinetic energy, or at least to provide a useful alternative to existing projectiles of this type.

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In one aspect the invention may be said to consist in a projectile for a weapon, including: a body having a nose portion and a tail portion, a plurality of propellant charges contained within the body, a plurality of selectable initiators for ignition of respective propellant charges, and one or more ports for exit of ignition gases produced by the charges.

10 Preferably the ports are located in the tail portion of the body for propulsion of the projectile from the weapon, or in the nose portion of the body for propulsion of a leading projectile from the weapon. Preferably the charges are distributed around a longitudinal axis of the body or are distributed along the axis.

15 In another aspect the invention includes in a weapon having a barrel containing a stack of projectiles as defined above, with an ignition system that triggers sequential firing of the projectiles by selecting one or more of the propellant charges within each projectile. Preferably the ignition system triggers individual propellant charges by inductive coupling of a signal to the respective initiator. The invention may also consist in a barrel assembly

20 having a barrel containing a stack of projectiles as defined above.

In a further aspect the invention also consists in a method of firing projectiles from a barrel, including: loading the barrel with a stack of projectiles arranged axially nose to tail, sequentially selecting the leading projectile in the stack for firing, determining a required

25 kinetic energy or muzzle velocity of the leading projectile, and selecting a combination of propellant charges within the leading projectile to achieve the required energy or velocity, and triggering the selected propellant charges. Preferably each projectile has a tail portion with one or more exit ports directed backwards for propulsion of the projectile from the weapon.

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In another aspect the invention consists in a method of firing projectiles from a barrel, including: loading the barrel with a stack of projectiles arranged axially nose to tail, sequentially selecting the leading projectile in the stack for firing, determining a required kinetic energy or muzzle velocity of the leading projectile, and selecting a combination of

propellant charges within the projectile following the leading projectile to achieve the required energy or velocity, and triggering the selected propellant charges to fire the leading projectile. Preferably each projectile has a nose portion with one or more exit ports directed forwards for propulsion of a leading projectile from the weapon, and any
5 remaining propellant charges in the following projectile are triggered once the leading projectile has been fired.

LIST OF FIGURES

10 In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate preferred embodiments of the invention, wherein:

FIGS. 1A – 1F show a first embodiment in which a projectile has forward ports for exit of propellant gases;

15 FIGS. 2A – 2D show a second embodiment in which a projectile has rearward ports for exit of propellant gases;

FIGS. 3A, 3B show an inductive firing system for the projectiles;

FIG. 4 is a sectional side elevational view of a projectile of another embodiment of the invention, prior to firing;

20 FIG. 5 is a sectional side elevational view of the projectile of the embodiment, after firing the third and fourth propellant charges;

FIG. 6 is a sectional side elevational view of the projectile of the embodiment, after firing the second, third and fourth propellant charges;

25 FIG. 7 is a sectional side elevational view of the projectile of the embodiment, after firing all propellant charges;

FIG. 8 is a sectional end elevational view of the projectile of the embodiment;

FIG. 9 is a sectional side elevational view of a variation to the projectile of the embodiment;

30 FIG. 10 is a sectional side elevational view of a projectile of another embodiment of the present invention, prior to firing;

FIG. 11 is a sectional end elevational view of the projectile of the embodiment;

FIG. 12 is a sectional side elevational view of a projectile of a embodiment of the present invention, subsequent to firing all propellant charges;

FIG. 13 is a sectional side elevational view of a projectile of a embodiment of the

present invention;

FIG. 14 is a sectional end elevational view of the projectile of the embodiment;

FIGs. 15, 16 and 17 depict a projectile assembly of a embodiment of the present invention; and

5 FIGs 18, 19 and 20 depict a projectile assembly of another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 Referring to the drawings it will be appreciated that the invention can be implemented in various ways for a variety of projectiles and purposes. The invention may be provided as a single projectile, as a weapon containing projectiles, or as a barrel assembly containing stacked projectiles for insertion in a weapon, for example.

15 The embodiments described herein relate to mortar rounds of up to about 60mm calibre, it will be appreciated that the invention finds application in variety of projectile configurations. In particular, projectile configurations adapted for axial stacking in a barrel assembly and arranged for sequential firing, suitably by electronic means, as disclosed in earlier patent applications originating from either or both of these inventors.

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Figure 1A shows a projectile having a body 10 with nose and tail portions 11 and 12 adapted to be stacked in a barrel with other similar projectiles. The projectile typically includes a payload 13 which may be of various kinds such as explosive, flash-bang, smoke-generating or fire retardant for example. Propellant charges 14 are contained by
25 cavities within the projectile and are selectively ignited by respective initiators 15, preferably inductive elements such as semiconductor bridges (SCBs), although a range of wired or wireless primer systems may be used. The charges are held in their cavities by plugs 16 which may be threaded or glued in place, for example. Ports 17 are provided in the nose portion for exit of the gases produced by combustion of the charges. In this
30 example the ports open forwards and propel a leading adjacent projectile from the barrel. This projectile is in turn propelled by charges in a trailing adjacent projectile or by charges in the base of the barrel. The nose portion is preferably shaped to fit the tail portion of the leading projectile and similarly the tail portion is shaped to fit the nose portion of the trailing projectile. This provides a degree of sealing between the projectiles and may be

achieved in various ways.

Figures 1B and 1C are end views of the projectile in Figure 1A showing the nose and tail portions. There are four propellant charges 14 located symmetrically around the longitudinal axis of the projectile, retained by four plugs 16 and correspondingly provided with four ports 17 for exit of combustion gases. The number and arrangement of the charges may be varied to suit the purpose of the particular projectile. It should be borne in mind however, that the flight characteristics of the projectile may change when the charges are selected and ignited, unless all of the charges are ignited before the projectile is fired from the barrel. The centre of mass of the projectile may shift for example.

Figure 1D shows how two projectiles of this kind may be stacked in a barrel. The nose portion 11 of the trailing projectile fits the tail portion 12 of the leading projectile, and preferably expands the tail portion 12 into a sealing contact with the inside of the barrel. In this example, a convex curved surface of the nose portion matches a concave surface in the tail portion, and the tail portion also includes a rim 18 that contacts the body of the trailing projectile. One or more charges in the trailing projectile are selected and ignited to propel the leading projectile from the barrel with a required kinetic energy. Once the leading projectile has departed any charges remaining in the trailing projectile are ignited to produce a predetermined weight and centre of mass in the trailing projectile, which is now the leading projectile. Each projectile therefore has reasonably standard and predictable characteristics for flight.

Figures 1E and 1F show how the last projectile in a stack of projectiles of this kind may be fired. Propellant charges 14 may be provided in the base of the barrel as either a separate removable element 19E, or as a fixed element 19F of the barrel itself. The charges 14 in each of these figures are contained and ignited in a manner similar to that of the charges in the projectiles. The separate base element 19E is preferably loaded down the barrel before the projectiles while the fixed base element while charges in the fixed element 19F may be loaded as individual items from the rear of the barrel. These charges may be selected and fired to provide a predetermined kinetic energy to the last projectile.

Figure 2A shows an alternative projectile having a body 20 with nose and tail portions 21 and 22, adapted to be stacked in a barrel with other similar projectiles if required. The

projectile includes a payload 23 in this example. Propellant charges 24 are contained by cavities within the projectile and are selectively ignited by respective initiators 25, preferably inductive elements such as semiconductor bridges (SCBs), although a range of wired or wireless primer systems may be used. The charges are held in their cavities by
5 plugs 26 which may be threaded or glued in place, for example. Ports 27 are provided in the tail portion for exit of the gases produced by combustion of the charges. In this example the ports open rearwards and propel the respective projectile from the barrel. The nose portion is preferably shaped to fit the tail portion of the leading projectile and similarly the tail portion is shaped to fit the nose portion of the trailing projectile. This
10 provides a degree of sealing between the projectiles and may be achieved in various ways.

Figures 2B and 2C are end views of the projectile in Figure 2A showing the nose and tail portions. There are four propellant charges 24 located symmetrically around the longitudinal axis of the projectile, retained by four plugs 26 and correspondingly provided
15 with four ports 27 for exit of combustion gases. The number and arrangement of the charges may be varied to suit the purpose of the particular projectile, bearing in mind that the flight characteristics of the projectile may change when the charges are selected and ignited. The weight and centre of mass of the projectile may change for example. On the other hand, the rearward exit ports are less likely to create drag.

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Figure 2D shows how two projectiles of this kind may be stacked in a barrel. The nose portion 21 of the trailing projectile fits the tail portion 22 of the leading projectile, and preferably expands the tail portion 22 into a sealing contact with the inside of the barrel. In this example, a convex curved surface of the nose portion matches a concave surface in the
25 tail portion, and the tail portion also includes a rim 28 that contacts the body of the trailing projectile. It will be appreciated that a wide range of shapes and dimensions may be used in any of the projectiles described herein. One or more charges in each projectile are selected and ignited to propel the respective projectile from the barrel with a required kinetic energy. The projectiles generally have less predictable flight characteristics than
30 those of Figure 1A.

Figure 3A shows a typical propellant charge 14 or 24 from Figures 1 and 2 in more detail. The charge material 300 is contained by a metal housing 301, open fully at one end 302 and with a smaller aperture 303 at the other end 304. A disc 305 of composite material

- blocks the aperture 303 but is ruptured on ignition of the charge material so that combustion gases can pass through the aperture into a respective exit port. An initiator 306 is threaded or press-fitted into end 302, based on an SCB igniter in this example. The initiator includes the SCB 307 connected across a coil 308, both mounted in a fitting 309
- 5 of plastic for example. A small amount of pyrotechnic material 310 surrounds the SCB to act as a booster in combustion of the charge material. Many alternative structures could be used for the propellant charges and for the initiator, which could also be introduced directly to cavities in the projectile without need of the housing 301 for example.
- 10 Semiconductor bridges are known devices having the appearance of a microchip with two terminal wires, such as shown in US 4,708,060 and subsequent US patents. If an electric potential is placed across these two wires, the semiconductor bridge releases a small amount of energy, most in the form of heat. The energy released by the SCB may in some cases be insufficient to ignite the propellant charges directly and the initiators may further
- 15 require a set-up chemical compound (i.e. a compound which is capable of being initiated by an SCB and will, in turn, ignite the charge). SCBs can be designed and arranged such that a current induced between the two terminals can cause energy release. It is considered that the various means of inducing a current in a coil of wire using a magnetic field (induction) are well enough understood by those proficient in the art that such details need
- 20 not be discussed here, save one example. It is therefore to be taken that all such means of providing a suitable firing current, whether by inducing said current or otherwise, are within the ambit of this invention.

Figure 3B schematically shows an inductive firing system that may be used to launch the

25 projectiles shown in Figures 1 and 2. A magnetic field suitable to activate an SCB can be induced using a signal transmitting coil 33 wrapped around the barrel 30, suitably in the vicinity of projectiles 31 therein, i.e. one transmitting or primary coil 33.1, 33.2, etc. for each projectile 31.1, 31.2, etc. The current in the primary coils 33 can be selectively turned on or off by a fire control unit (FCU) 39 and thus the resulting current in receiving or

30 secondary coils 35.1, 35.2 can be manipulated in the same fashion. The primary coils may be connected separately to the FCU or in series. The FCU may be operated in various ways to select the kinetic energy and therefore the charges to be ignited for the next projectile to be fired. A manual user could operate a rotatable switch that simply indicates 1, 2, 3 ... or all of the charges are to be ignited. The user or an automated firing system

determines the kinetic energy required for a particular projectile according to the environment in which the user or the automated system is located.

5 In order to fire the charges in a designated projectile (for example projectile 31.2), the FCU 39 applies firing signal current to the primary coil 33.2 wrapped around the barrel 30 for that projectile 35.2. The resultant magnetic field induces a current in the secondary coil 35.2, which is applied to the two terminals of the initiators 32, 33, 34. Ignition of one or more propellant charges 36a, 36b, 36c occurs in response to those initiators arranged to ignite upon receipt of the firing signal.

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SCBs can also be designed such that they will not initiate due to a simple current but only when a particular "type" of current occurs. Indeed, SCB technology now offers the ability to manufacture SCBs that require various and distinct levels of energy of ignition signal to activate the energetic material. Encoders and decoders could also be used in conjunction with SCB technology, if required. Where encoders/decoders and other logic circuits are employed, a signal modulation scheme may comprise any pulse wave modulation (PWM), pulse code modulation (PCM) or pulse amplitude modulation (PAM) scheme, or in any other suitable encoding scheme. This allows the separate, smaller propellant charges 36 to be discretely ignited via the common induction coil pairs 33, 35.

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We now turn to consider the use of variations in current to embed an ignition signal as an example. In order to fire propellant charge 36a for the designated (or any particular) projectile 35.2 the FCU 39 applies current (with the appropriate modulated variations embedded within it) to the primary coil 33.2 associated with that projectile. The resultant current in secondary coil 35.2 (induced by the magnetic field) thus varies in intensity in proportion to the variations in current the FCU has applied. The induced current that is delivered to the SCBs thus also varies in proportion with the variations in intensity of the magnetic field. Thus the appropriate SCB 32 in propellant load 36a of the projectile 35.2 can be delivered the appropriate coded signal and therefore be initiated without the initiation of propellant charges 36b or 36c, through the use of a single induction coil 33 per projectile.

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It will be appreciated that, upon initiation of a selected propellant charge or charges 36, the rapid combustion thereof operates to discharge the associated projectile from the barrel 30.

Where only one propellant charge is initiated, eg. centre charge 36b by SCB 33, the kinetic energy imparted to the projectile will be considerably lower than imparted when all three propellant charges 36a, 36b, 36c are initiated.

- 5 FIGs 4 to 8 of the drawings depict a projectile 45 of another embodiment of the invention having a projectile body 46 with a cavity 49 wherein a plurality of propellant charges 50 are disposed longitudinally in the projectile. In contrast, the propellant charges of the embodiments discussed above were disposed laterally within the projectile. For reasons of clarity, the initiators and secondary or receiving coils have been omitted from these
10 drawings.

The projectile 45 is depicted in FIG. 4 prior to ignition of any of the propellant charges 50, which charges are separated from one another with the cavity 49 by wall members. The propellant charges 50 are composed of a mouldable material in the present embodiment,
15 whereby the rearmost charge 50.4 is exposed through the aperture 58 communicating with the exterior of the projectile adjacent a tail portion of the body 46. Suitably the wall members are in the form of sealing discs 51 having edge surfaces with profiles arranged to wedge into a shallow inwardly tapered wall of the cavity 47. Accordingly, the shaped propellant charges and alternating sealing discs may be located into the cavity 49 via the
20 aperture 58 from the tail 48 of the projectile 45.

Since the propellant cavity becomes smaller in diameter toward the head portion 47 of the projectile, if the first loaded sealing disc 51 is forced toward the head 47 of the projectile, wedging will occur between the band edge and the tapered interior wall of the cavity 47,
25 and the disc will retain the forwardmost charge 50.1 in place. Accordingly, when a similarly directed force is applied during firing, e.g. the force resulting from combustion of the second propellant charge 50.2 being initiated, the sealing disc 51 will further be wedged into place with said interior wall 56. This "wedge-sealing" action aims to reduce the likelihood of ignition of propellant charge 50.2 causing any sympathetic or "blow-by"
30 ignition of propellant charge 50.1.

Ignition of propellant volume 50.1 however will push the adjacent sealing band in the other direction, both unlocking it and forcing it toward the tail 48 of the projectile 45. The sealing disc 51 will not move far before the edge of the sealing disc loses contact with the

cooperating interior wall 56 of the cavity, thereby allowing burning propellant 50.1 to reach rearward propellant charge 50.2. The next rearward propellant charge 50.2 is thus ignited and the process continues rapidly until propellant volume 50.4 is ignited. In summary, the ignition of a particular propellant charge 50 will not ignite a propellant charge that is closer to the nose of the projectile, as explained above.

FIGs 5, 6 and 7 show the consequences of igniting a selected propellant charge in the projectile 45. In FIG. 5 the third propellant charge 50.3 has been ignited resulting in the combustion of charges 50.3 and 50.4. In FIG. 6, the second propellant charge 50.2 has been ignited resulting in the combustion of charges 50.2, 50.3 and 50.4. In FIG. 7, the first propellant charge 50.1 has been ignited, resulting in the combustion of all propellant charges.

The aperture includes means for resisting the expulsion of the sealing discs from the cavity, which take the form of a plurality of inwardly radially extending fingers or catch points 57 (as depicted in FIGs 4 to 8) to stop or at least resist the sealing discs 51 from being expelled or otherwise leaving the projectile cavity 49 entirely. There are several small catch points 57 disposed around the periphery of the aperture 58, as will be apparent from the view of FIG. 8. A preferred alternative involves the catch points extending fully across the aperture in the form of a crossbar to ensure that the discs are contained within the projectile. In another form, the wall members or sealing discs may be constructed of a combustible material which has an outer face treated in order to resist combustion, ie. consumption may only be initiated by propellant burning forward of the wall member.

Since it may or may not be viable for the catch points to be conveniently manufactured as part of the projectile, the catch points 57 may be formed as a separate component 59 that is removably retained in the tail portion 48', such as by cooperating screw threads (not shown), once the cavity 49 has been loaded with propellant charges 50 and respective sealing discs. This component modification of the fourth embodiment is shown in FIG. 9.

In a further modification, the entire cavity portion 49 including the rearward aperture 58 may be formed as a separate component and similarly removably retained in the projectile body 46. The separate component containing the cavity could alternatively be formed with the lateral arrangement of propellant charges and respective expansion bleed ports as

described above.

In a fifth embodiment of the present invention depicted in FIGs 10 and 12 (again omitting the initiators and secondary or receiving coils), a projectile 60 includes wall members 61 that are themselves screw threaded into place via cooperating threads 62 provided on the wall member edges and the interior wall of the propellant cavity 63, respectively. Furthermore, as shown in Figure 10, the wall members 61 each include sealing plugs 64 that are wedged into place in the wall members in a similar fashion as the sealing discs discussed above.

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The sealing plugs 64 are outfitted with a small T-shaped retaining member 65 that stops or at least resists the plugs from leaving the projectile cavity 63 entirely. It is presently expected that the sealing plugs 64 would need to be manufactured as two pieces (ie. plug and retaining member) and assembled in situ. In a similar fashion to the fourth embodiment discussed above, the T-shaped portion is made up of several small catch points, rather than using the entire ring. However, in this embodiment, the catch points are a plurality of radially outwardly extending fingers 66 of somewhat cruciform configuration. Also as above, this is so that when a T-shaped member 65 hits its respective wall member 61, it does not close off the propellant charge 67 to the exterior of the projectile 60, as shown in the enlarged cross-sectional view of the Figure 11.

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It is presently considered that the T-shaped retaining member 65 may only be necessary for the screwed-in wall member 61 closest to the rear of the projectile. Figure 12 shows the end result of igniting the forwardmost propellant charge 67.1 in this scenario. The individual propellant charges 67 may be ignited using only one induction coil per projectile (as discussed above in relation to FIGs 1A and 1B) with different coded SCBs for each propellant charge 67.1, 67.2, 67.3, etc. Accordingly four (4) different kinds of code responsive SCBs would be required in the presently illustrated example of the fifth embodiment.

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The above embodiments of the invention all entail the use of separate (and generally volumetrically smaller) propellant charges. Typically the operator can elect or an automated fire control system can determine, to burn $\frac{1}{4}$ of the available propellant, $\frac{1}{2}$, $\frac{3}{4}$ or all of the propellant available to a particular projectile. However, it is to be understood

that propellant volumes need not be divided in this manner, and in fact can be divided in any way desired.

In FIGs 15 and 16 of the drawings there are shown components of a projectile assembly of the type described in the present applicant's International Patent Application No. PCT/AU02/00932. The earlier invention was concerned with the staged or sequential ignition a plurality of propellant charges associated with each projectile in order to reduce in-barrel pressures whilst maintaining projectile muzzle velocity during firing.

The applicant has now realised that the present invention may also find a further application as discussed in relation to this sixth embodiment. Here each projectile assembly 80 includes a main projectile body 81 with a head portion 82 and a rearwardly extending tail portion 83 having a tapered skirt 84, as depicted in FIG. 15. The projectile assembly 80 also includes a plurality of propellant cup members 85 which also include a tail portion 86 with tapered skirt 87 extending rearwardly from a transverse wall 88 similarly to the main body 81, as depicted in FIG. 16. When assembled together in a barrel (not shown) and subject to an axial in-barrel load, the wedging action on the tapered skirt portion effectively seals the respective tail portions against the barrel bore, as described in the applicant's earlier International Applications.

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With reference to FIG. 17, it will be seen that the assembled main projectile 81 and cooperating cup members 85.1, 85.2 effectively form a cavity that is divided by wall members formed by transverse walls 88 of the propellant cups. Thus by provision of coded firing signals to the initiators 90 disposed with the respective propellant charges 89, one, two or all three charges may be simultaneously fired to achieve a desired muzzle velocity.

A further embodiment of the invention is depicted in FIGs 18, 19 and 20, wherein the main projectile body 91 is of the type including a head portion 92 with rearwardly extending central spine 93 and a band or collar 94 disposed on the head portion 92 of the projectile body 91, wherein the collar and head portion include complementary tapered surfaces 95, 96. An auxiliary projectile body 97 also includes a central spine 98 and a similarly configured collar member 99. In both cases, the collar members are arranged to provide an operative seal with the bore of a barrel (not shown).

With particular reference to FIG. 20, it will be appreciated that individual propellant charges 101, 102, 103, 104, 105 and 106 may be selectively simultaneously ignited by receipt of firing signals by respective initiators 111, 112, 113, 114, 115 and 116. In the present embodiment, each initiator is integrated with a receiving means that can receive the firing signals directly from a signal transmitting coil disposed in the barrel (not shown), thus obviating the requirement for secondary receiving coils.

Further, the embodiment illustrates how different propellant charge separating means may be employed together in a projectile assembly, in that a given pair of charges 103-104 is separated from other pairs 101-102 and 105-106 by transverse walls of the auxiliary projectiles 97.1, 97.2, whilst individual charges within the pair may be separated by respective enclosures in the form of non-metallic bags 121, 122, 123, 124, 125 and 126.

In the embodiments discussed above, it will be appreciated that any propellant charges remaining in the barrel after firing a particular projectile may be cleared from the barrel by separate initiation, prior to firing the next projectile in the stack of projectiles.

Furthermore, it is envisaged that the propellant division and selective initiation arrangement of the present invention may be used within many of the present applicant's other earlier projectile designs and barrel assembly configurations. Put more simply, there are existing designs and configurations not mentioned here that could use the method outlined above of separate smaller propellant loads and coded SCBs (or other ignition method) to achieve an electronically selectable range variable projectile.

For example in the barrel assembly 70 of FIG. 13, with projectiles 71 axially stacked with a barrel 72 as illustrated in sectional side elevation, the propellant charge 73 could be split into four loads 73.1, 73.2, 73.3, 73.4, using bags each containing a respective initiator 74, 75, 76, 77, as shown in FIG. 14.

With the addition of different coded SCBs to each bag and an induction coil pair (not shown) for each projectile we have a system similar to that of above. It is to be taken that the present invention is applicable to alternative configurations of projectile and barrel assemblies (not explicitly mentioned here), including but not necessarily limited to those of

the applicant, which are to be considered within the ambit of this patent application.

It is to be understood that the above embodiments have been provided only by way of exemplification of this invention, and that further modifications and improvements thereto,
5 as would be apparent to persons skilled in the relevant art, are deemed to fall within the broad scope and ambit of the present invention described above.

CLAIMS:

1. A projectile for a weapon, including:
a body having a nose portion and a tail portion,
5 a plurality of propellant charges contained within the body,
a plurality of selectable initiators for ignition of respective propellant charges, and
one or more ports for exit of ignition gases produced by the charges.
2. A projectile as in claim 1, wherein:
10 the ports are located in the tail portion of the body for propulsion of the projectile
from the weapon.
3. A projectile as in claim 1, wherein:
the ports are located in the nose portion of the body for propulsion of a leading
15 projectile from the weapon.
4. A projectile as in claim 1, wherein:
each propellant charge has a port for exit of respective ignition gases.
- 20 5. A projectile as in claim 1, wherein:
a single port is provided for exit of ignition gases from all of the propellant charges.
6. A projectile as in claim 1, wherein:
the charges are distributed around a longitudinal axis of the body.
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7. A projectile as in claim 1, wherein:
the charges are distributed along a longitudinally of the body.
8. A projectile as in claim 1, wherein:
30 the nose and tail portions of the projectile are adapted respectively to fit tail and
nose portions of adjacent leading and trailing projectiles in a stack.
9. A projectile as in claim 1, wherein:

the initiators are SCBs adapted to be triggered by induction from firing circuits in the weapon.

10. A projectile as in claim 1, further including:
5 a payload in the nose portion.
11. A barrel assembly having a barrel containing a stack of projectiles as claimed in any one of claims 1 to 10, arranged axially nose to tail.
- 10 12. A weapon having a barrel containing a stack of projectiles as claimed in any one of claims 1 to 10, and an ignition system that triggers sequential firing of the projectiles by selecting one or more of the propellant charges within each projectile.
13. A weapon as in claim 12 wherein the ignition system triggers individual propellant
15 charges by inductive coupling of a signal to the respective initiator.
14. A method of firing projectiles from a barrel, including:
loading the barrel with a stack of projectiles arranged axially nose to tail,
sequentially selecting the leading projectile in the stack for firing,
20 determining a required kinetic energy or muzzle velocity of the leading projectile,
and
selecting a combination of propellant charges within the leading projectile to
achieve the required energy or velocity, and
triggering the selected propellant charges.
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15. A method according to claim 14 wherein:
each projectile has a tail portion with one or more exit ports directed backwards for
propulsion of the projectile from the weapon.
- 30 16. A method of firing projectiles from a barrel, including:
loading the barrel with a stack of projectiles arranged axially nose to tail,
sequentially selecting the leading projectile in the stack for firing,
determining a required kinetic energy or muzzle velocity of the leading projectile,
and

selecting a combination of propellant charges within the projectile following the leading projectile to achieve the required energy or velocity, and triggering the selected propellant charges to fire the leading projectile.

- 5 17. A method according to claim 16 further comprising:
triggering any remaining propellant charges in the following projectile once the leading projectile has been fired.
18. A method according to claim 16 wherein:
- 10 each projectile has a nose portion with one or more exit ports directed forwards for propulsion of a leading projectile from the weapon.