Feb. 14, 1961 C. RAYNAUD 2,971,473

LAUNCHING APPARATUS FOR MOVABLE OBJECTS

Filed Dec. 27, 1956 2 Sheets-Sheet 1

Fig. 1

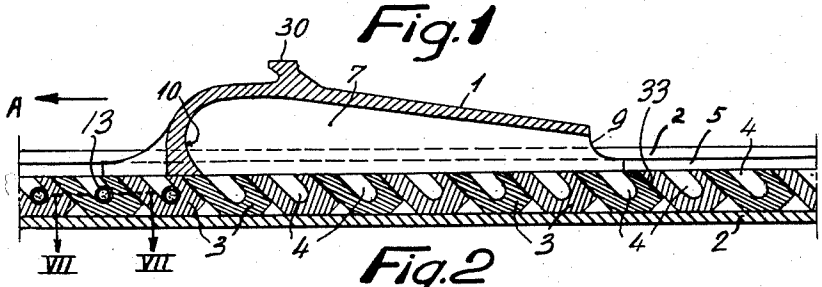


Fig. 2

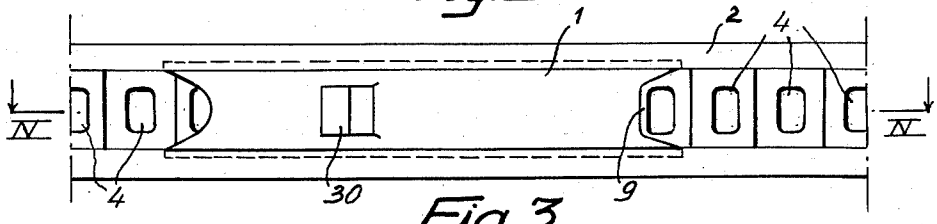


Fig. 3

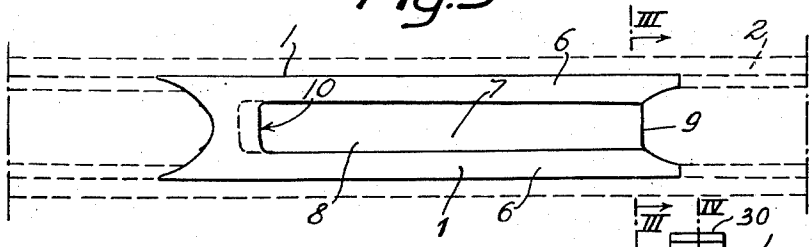


Fig. 3a

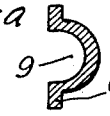


Fig. 5

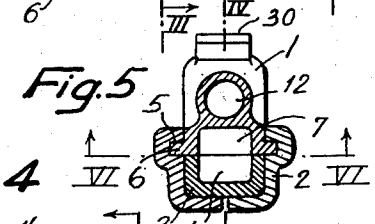
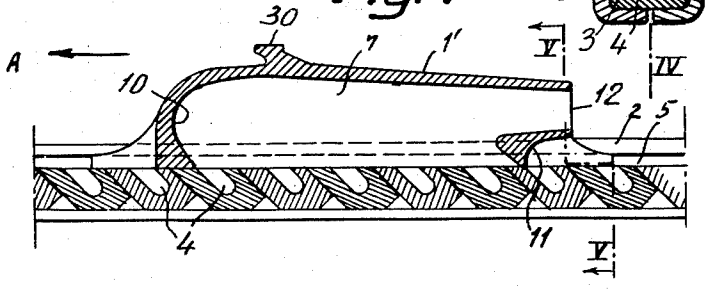


Fig. 4



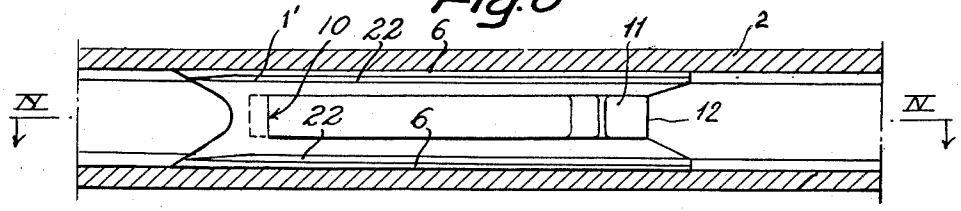
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LAUNCHING APPARATUS FOR MOVABLE OBJECTS

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Fig. 6



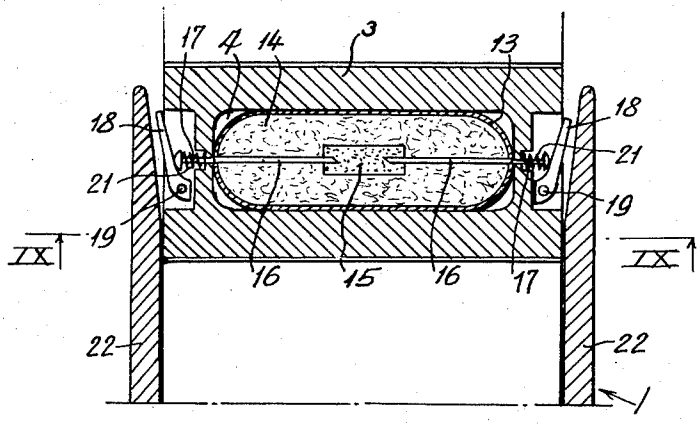


Fig. 7

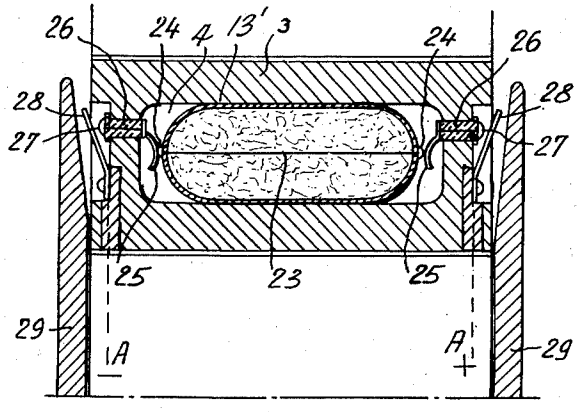


Fig. 8

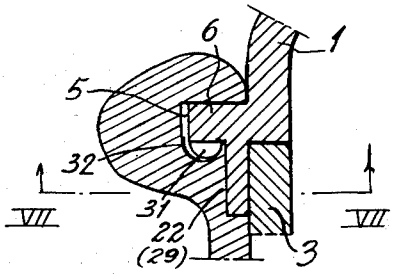


Fig. 9

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LAUNCHING APPARATUS FOR MOVABLE OBJECTS

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20 Claims. (Cl. 104—134)

The present invention refers to launching apparatus, and more specifically to launching apparatus for movable objects wherein the propelling force for the launching is applied to the object from an outside source.

More particularly, though not exclusively, the invention concerns apparatus of the type set forth which are based on the use of the action and reaction occurring with the expansion of gases due to combustion or explosions.

It is a main object of this invention to provide a launching apparatus for movable objects in which a member that may be a conveyance for a movable object, or the object itself, is launched from a launching strip by a propelling force generated at the surface and along the surface thereof and caused to act on that member while it is moving along that strip.

It is another object of this invention to provide an apparatus in which the propelling power is obtained from a series of recessed blocks receiving combustible or explosive charges and arranged along the launching strip for successive ignition so as to exert the force resulting from combustion or detonation of the charges, on the launched object.

It is still another object of the invention to provide a launching apparatus in which the sequence of impulses derived from explosion or combustion of the explodable or combustible units is controlled in relation to the speed of the movable object along the track.

It also is an object of this invention to provide an apparatus of the type set forth in which the sequence of detonating the explosive substance or of igniting the combustible substance is controlled by the movable object itself in time relation to its movement.

It is still another object of the invention to provide a launching apparatus of the type set forth in which cartridges of explosive substance are used as units for generating the propelling force.

A further object of the invention is to provide an apparatus of the type mentioned in which liquid fuel is distributed along the launching strip and successively ignited for yielding the propelling force for the movable object.

Still another object of the invention is to provide cartridges to be used as units in the apparatus as set forth and to be ignited or detonated by electrical or mechanical means.

With above objects in view, an embodiment of the invention comprises a launching strip formed with a row of recesses for receiving a charge capable of rapidly developing a sizable quantity of gases through combustion or explosion when ignited or detonated, a guide track extending along the row of recesses, a slide member guided along the track and formed with a chamber having an opening extending over at least one of the recesses in the launching strip and forming together with the respective recess a combustion chamber with an exhaust opening towards the rear, and means for successively detonating or igniting the charge so that in this manner the launching movement of the slide member is effected.

In a preferred embodiment of the invention the apparatus as set forth comprises a launching strip including a series of individual blocks each of which has a recess for receiving the charge.

In another embodiment of the invention the launching apparatus as set forth includes means for introducing a charge of liquid fuel into each of the recesses in the launching strip and means for successively igniting the charges.

In still another embodiment of the invention the charges in the individual recesses are cartridges having detonator or igniting means projecting therefrom that can be actuated from the outside.

In a further development of the apparatus as set forth the cartridges include actuator means and the launching strip includes operating means that are successively engaged by a portion of the moving slide member for igniting or detonating the cartridges in timed relation to the movement of the movable object along the track.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a sectional view of a launching apparatus according to the invention including the guide track and a slide member, the section being taken along line I—I of Fig. 2;

Fig. 2 is a plan view of the apparatus shown in Fig. 1;

Fig. 3 is a bottom view of the slide member of Fig. 1;

Fig. 3*a* is a partial cross-section of the slide member, the section being taken along line III—III of Fig. 3;

Fig. 4 is a sectional elevation of another embodiment of the invention showing the guide track and a different slide member, the section being taken along line IV—IV of Fig. 5;

Fig. 5 is a cross-section of the apparatus of Fig. 4 the section being taken along line V—V of Fig. 4;

Fig. 6 is a bottom view of the slide member of Fig. 4 with the track sectioned along VI—VI;

Fig. 7 is a horizontal section view of part of the apparatus shown in Fig. 1, the section taken along line VII—VII thereof and of Fig. 9, illustrating one type of cartridge in position;

Fig. 8 is a similar view in the same sectional plane with another type of cartridge in position; and

Fig. 9 is a fragmentary cross-sectional elevation at larger scale showing certain details of track and slide, the section being taken along line IX—IX in Figs. 7 and 8.

Referring now to Figs. 1–6, the launching apparatus comprises the guide track 2 on which a slide member 1 is free to slide along in longitudinal direction. In the track 2 a series of blocks 3 are disposed and held so as to form a flush upper surface. Each block 3 is provided with a recess 4 which is inclined forwardly in launching direction, it being assumed that the slide member 1 is to be moved in direction of arrow A. The track 2 has on either side of the row of blocks 3 a guide groove 5 to guide the slide member 1 along the track by means of flanges or cleats 6 as shown in Fig. 5.

In this embodiment the recesses 4 are formed with two opposite walls inclined towards the forward end of the track so that the top opening is of rather substantial size as measured in the top plane which is common to the whole set of blocks 3 and is flush with the sliding surface of the track. The inclination of the recesses 4 results in directing the gas stream from a combustion or explosion taking place in the individual recesses 4, as will be described later, in a direction inclined forward with a component of force in the launching direction A.

In this embodiment the recesses 4 are formed in blocks 3 of uniform shape which are interchangeable and can be replaced individually in case of need for repair. The blocks have lateral faces that fit into a corresponding groove formed in the track 2 (see Fig. 5), while their other surfaces are formed at such angles that they can be fitted together as shown in Fig. 1, preferably with interposition of plastic or fibrous material 33, as for example fibre board, for absorbing shocks in operation of the device and for assuring gas tightness between them.

The slide member 1 is formed with a chamber 7 which with its open area 8 facing the track extends over a number of the recesses 4, the width of opening 8 being substantially the same as that of the recesses 4 in transverse direction. In this manner the chamber 7 together with at least one of the recesses 4 covered by the member 1 constitutes a combustion chamber into which the gases resulting from ignition or explosion of a charge placed into that recess expand abruptly. This combustion chamber is a closed space for building up pressure, except for an exhaust opening 9 provided at the rear end of the member 1.

The inner surface of the forward wall 10 of the member 1 is partly inclined at an angle substantially equal to that of the inclination of the recesses 4 and is curved to act as a deflector of the gas stream mentioned above whereby the latter produces a component of force in the launching direction A.

In the embodiment illustrated by Figs. 4–6, which is generally similar, the slide member 1' is provided with a second deflecting wall 11 near the rear end thereof for the purpose of utilizing also the residual gas stream of the explosion or combustion in one particular recess still available at the moment when the member 1' has moved a certain distance forward.

In this case the exhaust opening 12 is of tubular shape as shown by Fig. 5, and may have a circular cross-section.

The cross-sectional area of the chamber 7 decreases towards the rear end mainly due to the inclination of the top wall so that the velocity of the gas stream deflected by the front wall 10 increases towards the exit opening whereby a jet-like impulse is obtained in addition to the above-mentioned forward component of propelling force.

The slide member 1 or 1' may be assumed to be fixed to a larger movable object that is to be launched by the apparatus described. It may, however, be considered also as a conveyance serving only to launch a larger object which may be attached to, or gripped by, a hook or prong 30 arranged at the top of the member 1'. In this case the slide member 1' could be recovered for further use after the launching operation, for instance by the braking effect of a layer of water into which the member 1 moves at the end of its run.

It is desirable to assure a certain amount of lubrication of the cooperating gliding surfaces of the track 2 and the glide member 1. As Fig. 9 shows, the guide groove 5 (Fig. 1) of the track 2 is provided with a continuous lower lubrication groove portion 32 along the track into which a suitable lubricating fluid may be poured or placed at the time when the launching operation is started. The flange 6 of the member 1 is in this case provided with a scoop 31 of a form matching substantially the cross-section of the lubricating groove portion 32 so that it projects into the fluid therein. During the movement of the member 1 along the track 2 the fluid is scooped up and vigorously thrown between the surfaces that need lubrication.

The fluid in question is preferably a solution or aqueous suspension of wetting or lubricating substances as for instance sulphonated fatty alcohols, or graphite.

As for the substance to be used for the abrupt generation of a gas stream as propelling power, this may be, to give one example, a pyrotechnical or explosive powder of suitable composition.

Good results have been obtained with a composition of the following type:

	Grams
Potassium chlorate	735
Hexamethylene tetramine	140
Sulphur	96

Preferably a charge of such a substance is prepared in form of cartridges of suitable size which are conveniently placed into the recesses of the launching strip at the time of launching. According to the invention, cartridges of different reaction time may be used in order to take into account the acceleration of the mobile object as it travels along the track. Likewise, it is possible to use cartridges containing different quantities of the substance in question the quantity varying in accordance with the position of the respective recess within the series of recesses. In particular, the recesses at the starting end might be filled with cartridges loaded with a substance acting more slowly, but having greater mass.

The firing of the cartridges can be effected conveniently by one of the actuating devices illustrated by Figs. 7 and 8.

Referring to the example of Fig. 7, a detonating device is provided in connection with a cartridge 13 which contains an explosive charge 14 and a fuse 15 sensitive to friction or shock. The cartridge is further provided with friction rods 16 projecting to the outside of the cartridge. Strikers 17 held in inoperative position by a small spring 21 are arranged for actuating the rods. Small levers 18 pivotably mounted on the outside of the block 3 by means of a pivot pin 19 are provided for acting upon the strikers and project slightly from the outer surface of the blocks 3. The side member 1 has slanting control portions 22 which during movement of the member 1 act as cams on the levers 18 projecting into the path of the control portions 22 so as to push the actuating strikers 17, against the action of the springs 21, against the rods 16 so that the latter penetrate into the fuse 15 and ignite the latter. The details of the device shown in Figs. 7 and 8 have been omitted from Fig. 5 for the sake of clarity. Figs. 6 and 9 show the location of portions 22.

Referring now to the example of Fig. 8, the cartridge 13' is provided with an electric resistance wire 23 passing through the charge from end to end and ending in terminals 24 projecting from the outside of the cartridge. The wire 23 is adapted to be brought to red heat by application of a weak current. The recess 4 is equipped at either side with a contact spring 25 insulated by a bushing 26 from the block 3 and connected with an outside contact button 27. Another contact spring 28 is mounted on the outside of the block 3 opposite the button 27 and ordinarily out of contact with the button 27. The actuating contact springs 28 are connected into an electrical circuit diagrammatically indicated at A, A. The springs 28 project beyond the outer surface of the block 3 and into the path of insulated bevelled control portions 29 (similar to portions 22) of the slide member 1. When the slide member moves along the track in the direction of the arrow, the portions 29 will in passing press the actuating springs 28 into contact with the buttons 27 so as to close the circuit for the particular wire 23 and thus ignite the charge in the cartridge.

Preferably the cartridges have a shell of a material that will be consumed without leaving traces when the cartridge is exploded.

The arrangement can be improved or supplemented by providing a system of ignition in which the latter takes place in advance of the moment when the front wall 10 of the member 1 passes the particular recess 4. The time interval for this as well as the power of the particular charge is to be determined as a function of the velocity acquired by the glide member at the time of passing that recess. The actuating means, 18 and 28, may be more widely spaced in the starting part of the track, and gradu-

ally more closely spaced toward the forward end of the track to compensate for the time required for reaction of the charge to actuation so that explosion in each recess takes place when the accelerated slide member covers the respective recess.

It should be understood that a launching apparatus of the type described can be applied to various purposes. First of all, the slide member may be a unit separate from the object to be launched and may be provided, as mentioned above, with means for attaching the slide member to the object to be launched so that the latter is pulled along the launching strip by the slide member. In this case, the launching apparatus is provided not only with the launching strip and guide track described above, but also with runways or slide tracks which would serve to support and to guide the wheels or skids of the object to be launched.

On the other hand, the slide member **1** could be the base of the object to be launched or in some manner form part of the structure of the latter.

It should be understood that while the slide member described in reference to Fig. 1 has only one wall **10** acting as a deflector, and the device shown in Fig. 4 has one second deflecting wall **11** near the rear end thereof, in certain cases more walls or partitions of similar type and likewise serving the purpose of deflecting the gas streams originating in the respective recesses, might be used.

The exhaust opening at the rear end of the slide member, and particularly the tubular end **12**, being located in the plane of symmetry of the launching strip, may be formed around an axis more or less inclined towards the launching strip, or also be formed to be directed towards both sides of the launching direction so as to cause the kinetic energy of the exhaust gases to coact with the effect of the gas streams originating from the combustion or explosion in the recesses of the launching strip.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of launching apparatus differing from the types described above.

While the invention has been illustrated and described as embodied in a launching apparatus for movable objects, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. Launching apparatus for movable objects comprising, in combination, a launching strip formed with a row of recesses, each recess adapted to receive an explosive charge; guide track means extending along said row of recesses; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and the respective recess together form a combustion chamber for the explosive charge contained in the respective recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction in such a manner that consecutive detonation of the explosive charges contained in said recesses effects forward movement of said slide member for launching a movable object through the jet-effect of the combustion gases escaping through said exhaust opening; and means for detonating said explosive charges successively in launching direction.

2. Launching apparatus for movable objects comprising, in combination, a launching strip formed with a row of recesses, each recess adapted to receive a charge of fuel; guide track means extending along said row of recesses; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and the respective recess together form a combustion chamber for the charge of fuel introduced into the respective recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction in such a manner that consecutive ignition of the fuel contained in said recesses effects forward movement of said slide member for launching a movable object through the jet-effect of the combustion gases escaping through said exhaust opening; and means for igniting said explosive charges successively in launching direction.

3. Launching apparatus for movable objects comprising, in combination, a launching strip formed with a row of recesses, each recess adapted to receive a charge of fuel; guide track means extending along said row of recesses; a series of igniting means arranged along said strip and respectively associated with said recesses; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and the respective recess together form a combustion chamber for the charge of fuel introduced into the respective recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction in such a manner that consecutive ignition of the fuel contained in said recesses effects forward movement of said slide member for launching a movable object through the jet-effect of the combustion gases escaping through said exhaust opening; and operating means for successively operating said igniting means in launching direction.

4. Launching apparatus for movable objects comprising, in combination, a launching strip formed with a row of recesses, each recess adapted to receive an explosive charge; guide track means extending along said row of recesses; a series of detonator means arranged along said strip and respectively associated with said recesses; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and the respective recess together form a combustion chamber for the explosive charge contained in the respective recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction in such a manner that consecutive detonation of the explosive charges contained in said recesses effects forward movement of said slide member for launching a movable object through the jet-effect of the combustion gases escaping through said exhaust opening; and means for successively operating said detonator means in launching direction.

5. A launching apparatus as set forth in claim 1, wherein said launching strip includes a continuous series of blocks, each block being formed with at least one of said recesses adapted to receive an explosive charge.

6. A launching apparatus as set forth in claim 1, wherein said launching strip includes a continuous series of blocks, each block being formed with one of said recesses and having two walls inclined towards the launching direction bounding the respective recess so that upon detonation of said explosive charge the explosion is directionally controlled by said inclined walls into said combustion chamber to give rise to a force having a component in the launching direction.

7. A launching apparatus as set forth in claim 1, wherein said combustion chamber is formed with at least

one wall transverse to the launching direction and shaped as a deflector for deflecting the combustion products resulting from the explosion of said charge towards said exhaust opening and to give rise to a force having a component in the launching direction.

8. Launching apparatus for movable objects comprising, in combination, a launching strip formed with a row of recesses, each recess adapted to receive a charge of fuel; guide track means extending along said row of recesses; a series of igniting means arranged along said strip and respectively associated with said recesses; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and the respective recess together form a combustion chamber for the charge of fuel introduced into the respective recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction in such a manner that consecutive ignition of the fuel contained in said recesses effects forward movement of said slide member for launching a movable object through the jet-effect of the combustion gases escaping through said exhaust opening; and operating means for operating said igniting means successively in launching direction and including a control member secured to said slide member and successively engaging said operating means for said igniting means.

9. Launching apparatus as set forth in claim 8 wherein said igniting means include an electrical ignitor located within the respective recess, and wherein said operating means include electric circuit means, said circuit means including a switch member having an operative and an inoperative position and being connected to said ignitor for actuating the same when said switch member is moved into operative position.

10. Launching apparatus for movable objects comprising, in combination, a launching strip formed with a row of recesses, each recess adapted to receive an explosive charge; guide track means extending along said row of recesses; a series of detonator means arranged along said strip and respectively associated with said recesses; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and respective recess together form a combustion chamber for the explosive charge contained in the respective recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction in such a manner that consecutive detonation of the explosive charges contained in said recesses effects forward movement of said slide member for launching a movable object through the jet-effect of the combustion gases escaping through said exhaust opening; and means for operating said detonator means successively in launching direction and including a control member secured to said slide member and successively engaging said operating means for said detonator means.

11. Launching apparatus as set forth in claim 10 wherein said detonator means include a fuse located within said explosive charge and transmitting means for transmitting a detonating force to said fuse, and wherein said operating means include a striker mounted in said launching strip for operating said transmitting means when said operating means are engaged by said control member.

12. Launching apparatus for movable objects comprising, in combination, a launching strip formed with a row of recesses, each recess being adapted to receive an explosive charge; a plurality of explosive charges respectively located in each of said recesses, a number of said explosive charges differing from others in propelling effectiveness, charges of relatively increasing effectiveness being located in recesses nearer the forward end of said launching strip with respect to the launching direction; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and the respective recess together form a combustion chamber for the explosive charge contained in the respective recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction in such a manner that consecutive detonation of the explosive charges of increasing effectiveness contained in said recesses effects forward movement of said slide member at increasing speeds for launching a movable object through the jet-effect of the combustion gases escaping through said exhaust opening; and means for detonating said explosive charges successively along with said launching strip.

13. Launching apparatus as set forth in claim 12, wherein said plurality of explosive charges includes a number of said charges of larger size than others, those of larger size being located in recesses nearer the forward end of said launching strip with respect to the launching direction.

14. Launching apparatus for movable objects, comprising, in combination, a launching strip formed with a row of recesses, each recess adapted to receive a cartridge containing an explosive charge and a detonating fuse; a series of actuator means for actuating said detonator fuses, said actuator means being arranged along said strip and respectively associated with said recesses and operable to successively actuate said detonator fuses; guide track means extending along said row of recesses; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and the respective recess form a combustion chamber for the explosive charge contained in said cartridge located in said recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction in such a manner that consecutive detonation of the explosive charges contained in said recesses effects forward movement of said slide member for launching a movable object through the jet-effect of the combustion gases escaping through said exhaust opening.

15. Launching apparatus as set forth in claim 14, wherein said detonator fuse is an electric resistance inside said cartridge with terminals projecting outwardly, and wherein said actuator means include switch means located along said guide track and respectively associated with said recesses and circuit means connecting said switch means with a source of electric energy, so that by closing said switch means said resistance is connected into said circuit and said explosive charge is detonated by heat developed in said resistance.

16. Launching apparatus for movable objects, comprising, in combination, a launching strip formed with a row of recesses, each recess being adapted to receive an explosive charge; a series of actuator means for successively detonating said explosive charges in launching direction, said actuator means being arranged along said strip and respectively associated with said recesses; guide track means extending along said row of recesses; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and the respective recess form a combustion chamber for the explosive charge contained in said recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction, the spacing of said actuator means being gradually reduced in launching direction in such a manner that at least some of said explosive charges are detonated by the associated actuator means before said chamber during its movement along said track reaches a position in which it extends over the respective recess and that consecutive detonation of the explosive charges contained in said recesses effects forward movement of said slide member through the jet-

effect of the combustion gases escaping through said exhaust opening, the advanced detonation of said charges making up for the time lag between the action of said actuator means and the explosion thereof after being detonated.

17. Launching apparatus for movable objects, comprising, in combination, a launching strip formed with a row of recesses, each recess being adapted to receive a combustible fluid; means for injecting combustible fluid successively into said recesses; circuit means including electrical igniting means respectively associated with said recesses for successively igniting said combustible fluid injected into said recesses; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and the respective recess together form a combustion chamber for the fluid injected into the respective recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction in such a manner that consecutive ignition of the fluid contained in said recesses effects forward movement of said slide member for launching a movable object through the jet-effect of the combustion gases escaping through said exhaust opening.

18. Launching apparatus for movable objects comprising, in combination, a launching strip formed with a row of recesses, each recess adapted to receive an explosive charge; guide track means extending along said row of recesses and having a longitudinal recess for receiving a lubricant for distribution along said track; a slide member guided along said guide track means and being formed with a chamber having an opening extending over at least one of said recesses so that said chamber and the respective recess together form a combustion chamber for the explosive charge contained in the respective recess, said chamber having an exhaust opening facing rearwardly with respect to the launching direction in such a manner that consecutive detonation of the explosive charges contained in said recesses effects forward

movement of said slide member for launching a movable object through the jet-effect of the combustion gases escaping through said exhaust opening, said slide member including an extension engaging said longitudinal recess for scooping up said lubricant during movement of said slide member along said track and for transferring said lubricant to said track.

19. A cartridge for launching apparatus as set forth in claim 1, comprising, in combination, a shell; an explosive charge within said shell; detonator means located within said explosive charge, said detonator means including a fuse detonatable by mechanical impact and at least one detonating rod projecting from said shell for movement by pressure applied to its projecting end and being connected to said fuse, so that said fuse is caused to ignite said explosive charge when said detonator rod is actuated from outside for movement into said fuse.

20. A cartridge for launching apparatus as set forth in claim 1, comprising, in combination, a shell; an explosive charge within said shell; detonator means including an electric resistance wire extending across said explosive charge and terminals attached to said wire and located on the outside of said shell so that by applying an electric potential to said terminals said explosive charge is ignited by the heat created in said wire by electric current.

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407,860	Italy	Dec. 5, 1944