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MULTI-STAGE ROCKET

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FIG. 1

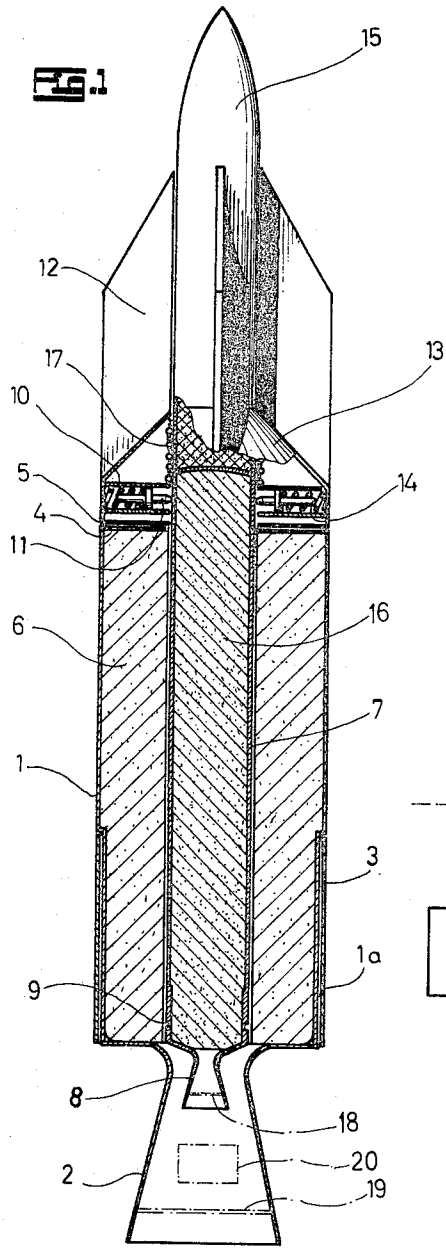
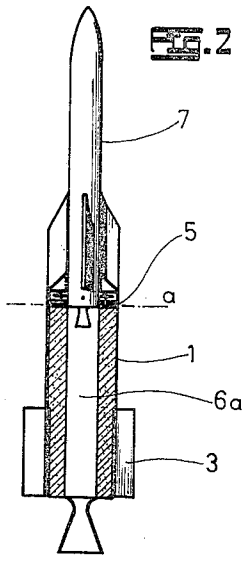


FIG. 2



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MULTI-STAGE ROCKET

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U.S. Cl. 102—49.4 12 Claims

ABSTRACT OF THE DISCLOSURE

A multi-stage solid fuel rocket construction includes an outer first stage rocket having an annular solid charge located so that when it burns, the thrust gases are directed through a rear nozzle of relatively large size. An inner second stage rocket is disposed within the hollow interior of the annular charge of the first stage and its forward end carries a pay load and it is shaped aerodynamically to a point. The outer first stage includes fin-forming elements constructed to be arranged around the forward end of the second stage when the second stage is positioned within the first stage in a condition ready for firing by a device such as a gun barrel. Immediately after firing, the second stage is displaced in respect to the first stage so that it extends outwardly by substantially its whole length from the second stage.

SUMMARY OF THE INVENTION

This invention relates in general to construction of rockets and in particular to a new and useful multi-stage solid fuel rocket which is adapted to be fired from a tube, such as a gun barrel, which is closed at one end.

It is known to fire rockets from gun barrels with rifled bores or from other tubes which are closed at one end and have smooth inner walls. In such instances the gun launching represents the first acceleration stage of the rocket. The great economic efficiency of this launch system as compared with conventional launching systems leads to increased experiments and tests in the field of altitude research as well as in tactical artillery use. A barrier heretofore difficult to overcome in the firing of rockets from tubes is the extremely high acceleration to which the missile must be exposed. Such acceleration may be in excess of 10,000 *g* and there is a danger that the solid fuel blocks will no longer hold. Because of the impact stress, the solid fuel breaks or distintegrates so that an explosion of a combustion chamber of the engine is likely. An attempt has been made to overcome such difficulties by providing coverings or sheaths for the solid propellant blocks in the form of jackets of a material, such as plastic, which is resistant to shock and vibration. It has been found, however, that such measures do not give sufficient safety against breakage of solid fuel blocks especially when multi-stage rockets are concerned. With multi-stage rockets, the launching of propellant charges as inner burners are particularly susceptible to breaking apart.

In accordance with the present invention, a preceding or first rocket stage is arranged as a jacket for a later or second rocket stage which is movably mounted therewithin. In this manner, the two combustion stages are

combined in a single compact firing unit for the firing operation. An essential advantage achieved by the invention is that the second stage forms an internal support for the first stage. By arranging each following stage of the multi-stage rocket concentrically within the preceding stage and mounting each following stage so that it is movable longitudinally in respect to the preceding stage, an unusually compact and advantageous arrangement is achieved. The overall rocket construction in which the preceding stage forms the outer housing or casing wall is adapted to the caliber of the firing barrel of the tube or gun which is to be used for the firing purpose. The preceding stage is designed as an inner burner and in the hollow interior of the propellant charge the following stage is located. In the case of only two stages, the following or second stage is constructed as an end face burner which is displaceably mounted within the preceding stage. The nesting of the stages in accordance with the invention permits not only a compact design of the rocket body but also a support of one propellant charge in respect to the other which permits them to attain a higher rupture strength during firing. Rocket firing from conventional movable guns is therefore facilitated and the resultant shortening of the rocket body which may be carried out provides a favorable effect in respect to transportation and handling.

The construction of the present invention is such that the second stage is mounted so that after firing it may move outwardly in respect to the first stage and form the forward portion of the combined stages during the burn-off of the first stage. In some cases it is desirable that the two stages be moved relatively in flight by means of a gas generator which is operative shortly after firing and is of sufficient power to move the two stages relatively so that the second stage is oriented at the front end of the preceding stage. Several means may be provided for causing the second stage to lead the first stage in respect to the direction of flight and while the two stages are connected together. One such method may comprise exploding a charge between the interior of the nozzle of one and the nozzle of the other which are first closed by damming plates in order to cause the second stage to advance within the chamber defined by the other position at which it extends outwardly in front of the preceding stage. This may also be accomplished by propellant charges or by the use of aerodynamic braking surfaces. In all of the arrangements, however, it is desirable that the second stage be moved to an extraction position at which it is well forward of the first stage but held at the outer end of the cavity of the first stage so that the combustion surfaces of the propellant charge of the preceding stage which is designed as an inner burner becomes exposed in a desirable manner.

Accordingly it is an object of the invention to provide an improved rocket construction in which a preceding stage forms an outer casing for a secondary stage or stages and wherein the secondary stage is displaceable relative to the outer casing and may move to a position at which the forward end thereof projects outwardly in front of the casing and exposes the inner face of the propellant charge of the first stage.

A further object of the invention is to provide a rocket engine having a preceding stage constructed with an annular solid charge designed as an inner burner and with a second stage with a solid propellant charge de-

signed as an end burner displaceably mounted within the first solid charge and being movable relative to the first solid charge in the casing therefor to extend outwardly from the front thereof, and wherein the second stage advantageously carries a head with the payload, the two charges being nested one within the other during firing and the second stage being extractable to the outer end of the first stage during the burning of the second stage; and the stages being separable completely from each other after the burn-out of the preceding stage.

A further object of the invention is to provide a rocket construction which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a partial longitudinal sectional view and elevational view of a two-stage rocket constructed in accordance with the invention; and

FIG. 2 is a view similar to FIG. 1 but on a reduced scale showing the rocket in a flight position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in particular, the invention embodied therein comprises an outer or first stage rocket section having a cylindrical casing **1** terminating at its lower end in an outflow nozzle **2** for the thrust gases. The casing **1** is recessed on the exterior adjacent its trailing end at **1***a* to accommodate a plurality of flaps or tail surfaces **3** which initially are held inwardly against the surfaces of the recess **1***a* but which may move outwardly to provide guiding surfaces **3** as indicated in FIG. 2 after firing from a gun (not shown). Before launching the casing **1** and the flap surfaces **3** apply against the interior barrel of the gun (not shown) and they are opened such as by resilient biasing means (not shown) or by an aerodynamic construction which facilitates their opening after they are subject to the moving air stream after firing.

At their forward or front end, the casing **1** is closed by means of an annular cover **4**. The cover **4** carries a device (not shown) which operates either pyrotechnically or mechanically to cause the separation of the first or preceding stage from the second stage or stages after the first stage has burned out and the remaining stages of the rocket which will fly on. A predetermined breaking point provided for this process of separation is designated by the numeral **5**. The complete first stage or preceding stage includes a tubular propellant charge **6** which is advantageously designed as an inner burner and which defines a hollow cavity **6***a* for receiving a casing **7** of the following second stage when the second stage is arranged in a firing position as indicated in FIG. 1.

The following or second stage includes a nozzle **8** at its rear or trailing end for the discharge of thrust gases after it is ignited. The casing **7** also includes several blind holes **9** which are arranged to align with and receive locking pins **11** when the second stage is moved outwardly after firing to the position indicated in FIG. 2. Helical springs **10** urge the locking pins **11** into the blind holes **9** of the casing **7** immediately after firing so that the forward end of the second stage with a payload **15** becomes oriented in advance of stabilizing surfaces or control fins **12** which are secured to the forward end of the first stage. The stabilizing surfaces **12** are firmly connected by means of conically curved guide or resistance plates **13** to the top cover **14**. The interior adjacent

the resistance plates **13** is provided with a cylindrical wall having rolling bodies **17** which facilitate the movement of the casing **7**. The casing **7** will move outwardly in the direction of flight until the lock pins **11** engage in the holes **9** at which point the second stage **7** becomes fixed in respect to the first stage **1** in a position at which the guiding surfaces **12** and **3** permit accurate flight of the missile. The casing **7** carries a solid charge **16** at its rear portion which is advantageously designed as an end phase burner.

The device operates as follows:

After firing of the rocket from a gun barrel, the tail unit surfaces or flaps **3** automatically move into an operative position as indicated in FIG. 2. The second stage propellant charge **16** is then ignited. The reaction force drives the casing **7** of the second stage into the position shown in FIG. 2 in which the locking pins **11** engage in the blind holes **9**. At the same time the flame jet issuing from the nozzle **8** ignites the propellant charge **6** of the preceding stage. This preceding stage, being of a faster burning substance, will burn out first and when it does, it will be freed from the second stage either by an explosive release or by results of the aerodynamic forces which will act. The separation will take place preferably in a single plane at the predetermined breaking plane **5**, as shown in FIG. 2.

The separation of the two stages can be effected, either partly or wholly, by aerodynamic forces which react more strongly on the guide plates **13** of the first stage than on the head portion **15** of the second stage so that the first stage is delayed in relation to the second stage to cause the separation of the two stages.

An alternate arrangement for effecting the separation of the two stages is schematically indicated, and this comprises a propellant charge **20** which is located between the nozzle **8** and the outer end of the nozzle **2**. The apertures of the nozzles **2** and **8** are first closed by burst plates **18** and **19** to permit the build-up of pressure within the combustion chamber after the ignition of the propellant charge **20**.

What is claimed is:

1. A multi-stage rocket particularly of a type which is adapted to be fired from a tube closed at one end, such as a gun barrel, comprising an outer casing defining a preceding rocket stage terminating at its rear in a first thrust gas nozzle discharge, an inner-burner solid propellant located within said outer casing and having a bore extending therethrough, at least one additional stage located within said bore and terminating at its rear in at least one second thrust gas nozzle discharge, said additional stage being movable relative to said first stage and having a propellant charge therein, said additional stage including at least a portion extending through and supportably engaging said propellant charge of said preceding rocket stage in the firing position.

2. A multi-stage rocket according to claim **1**, wherein said additional stage is concentrically surrounded by said preceding stage and is longitudinally displaceable within said preceding stage, said second thrust nozzle being movable upon displacement of said preceding stage to pass along the interior of said hollow-burner tubular charge and to ignite it along its interior.

3. A multi-stage rocket according to claim **1**, wherein said preceding stage comprises a casing of a size adapted to fit into a gun barrel, said solid propellant being of annular configuration designed as an inner burner, the hollow interior of said annular inner burner accommodating said additional stage, said additional stage solid propellant charge being formed as an end face burner, said additional stage being movable longitudinally in respect to the preceding stage.

4. A multi-stage rocket, according to claim **1**, including gas generating means disposed between said first thrust gas nozzle discharge and said second thrust gas nozzle discharge, and a bursting plate for closing each of

said first and second nozzle gas discharges to permit building up pressure between said first and second thrust gas nozzle discharges to cause displacement of said stages relative to each other.

5. A multi-stage rocket according to claim 1, wherein the forward end of said first stage is provided with a forward aerodynamic face providing a resistance greater than the forward end of said additional stage, said forward end of said additional stage projecting outwardly from said preceding stage after firing, said forward end of said preceding stage forming an aerodynamic brake to effect a separation movement of the preceding stage from said additional stage.

6. A multi-stage rocket according to claim 1, wherein said preceding stage carries a plurality of forwardly projecting stabilization surfaces which extend around beyond the forward end thereof and surround a portion of said additional stage.

7. A multi-stage rocket particularly of a type which is adapted to be fired from a tube closed at one end, such as a gun barrel, comprising an outer casing defining a preceding rocket stage terminating at the rear in a first thrust gas nozzle discharge, at least one additional stage located within said casing and terminating at its rear in at least one second thrust gas nozzle discharge, said additional stage being movable relative to said first stage, each of said stages having propellant charges which are combined during firing as a mutually supporting unit, said preceding stage carrying a plurality of forwardly projecting stabilization surfaces which extend around beyond the forward end thereof and surround a portion of said additional stage, said additional stage being movable forwardly with respect to said preceding stage to a position at which said stabilization surfaces are located adjacent the rear of said additional stage, and means carried between said stages for locking said preceding stage and said additional stage in position after the additional stage has moved outwardly in respect to said preceding stage.

8. A multi-stage rocket comprising a preceding stage formed by a cylindrical casing terminating at its rear end in a relatively large thrust nozzle discharge ,annular cover means adjacent the forward end of said casing, an annular propellant charge positioned in said casing between said annular cover and said nozzle discharge, a plurality of guide fins extending forwardly from said annular cover, a second stage having a pointed head portion disposed within the center of said guide fins and a body portion extending downwardly into said casing and within and supportably engaged with said annular charge terminating at its rear end in a thrust nozzle discharge, a second solid propellant charge within said body portion constructed as a end burner, said second stage body portion being movable within the annular charge casing of said first preceding stage.

9. A multi-stage rocket according to claim 8, including locking means carried by said preceding stage and engageable with said second stage when the second stage is moved to a position at which the nozzle discharge thereof is substantially aligned with the forward end of said preceding stage.

10. A multi-stage rocket according to claim 9, including a parting line defined between said preceding stage and said second stage when said second stage is in an outwardly extended position in respect to said preceding stage.

11. A multi-stage rocket according to claim 8, wherein said annular front wall of said preceding stage is frustoconical and provides a greater aerodynamic drag than the forward end of said second stage which projects forwardly from the center of said preceding stage.

12. A multi-stage rocket according to claim 11, including fins carried by the trailing portion of said casing of said preceding stage which are foldable against the surface thereof, said casing being recessed for said fins, said fins being extendable outwardly to provide guiding surfaces after firing.

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