Dec. 8, 1953 C. R. VEGREN 2,661,692

HELICAL GAS FLOW CHANNEL FOR SOLID PROPELLANTS

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Fig. 1.

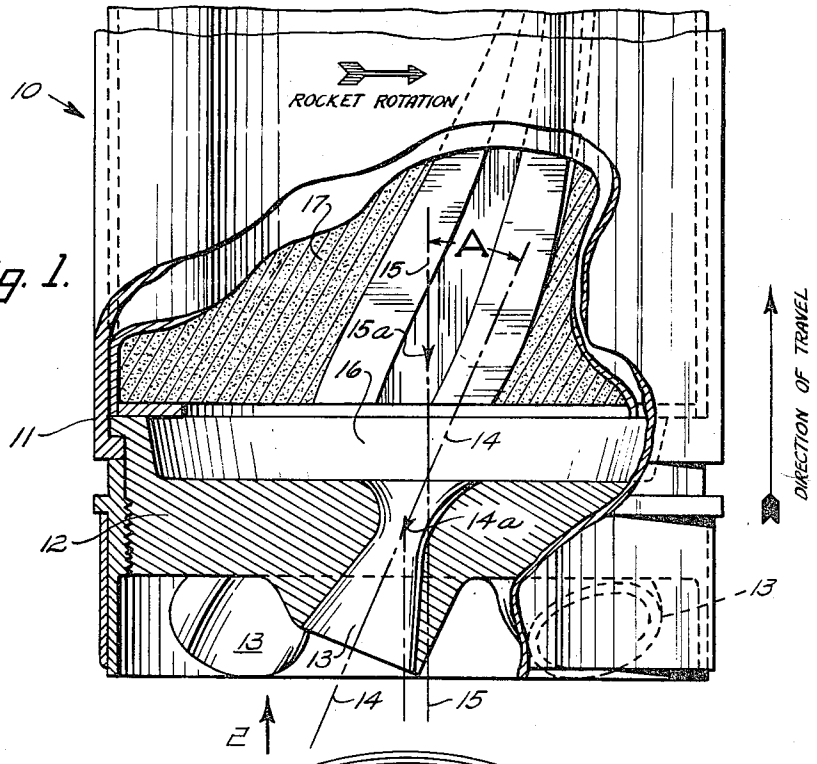
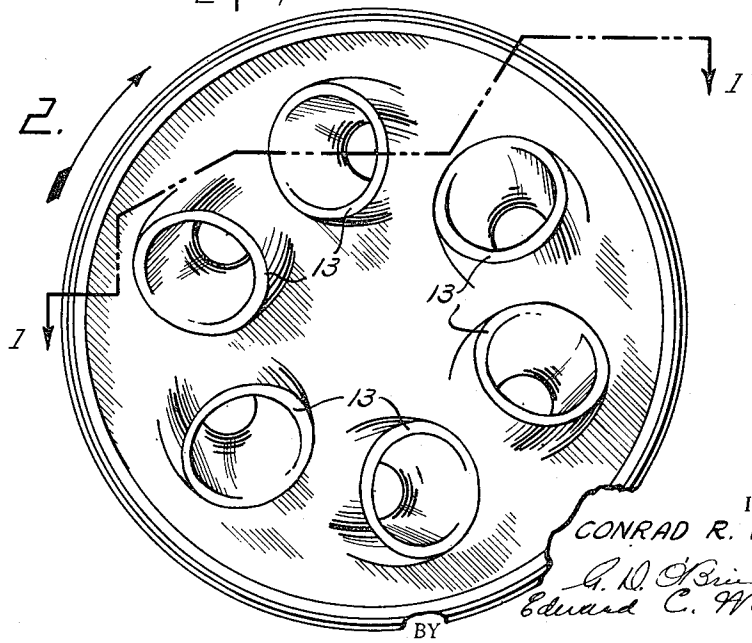



Fig. 2.




INVENTOR
CONRAD R. VEGREN
BY G. D. O'Brien
Edward C. Walsh

ATTORNEYS

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Fig. 3.

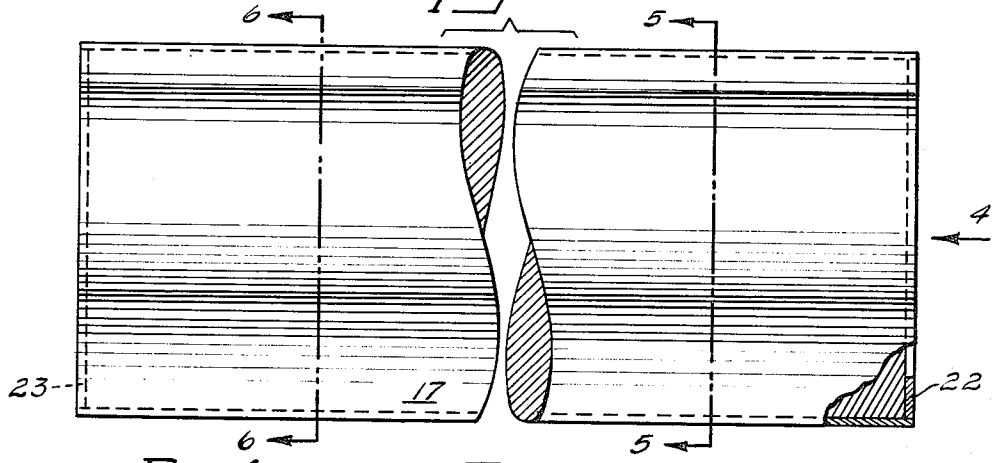



Fig. 4

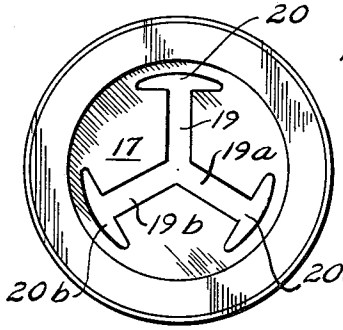



Fig. 5

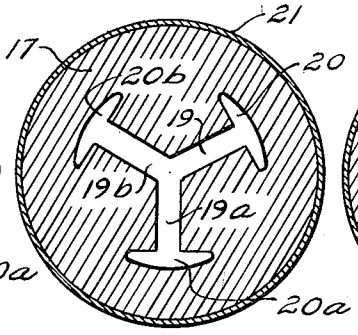
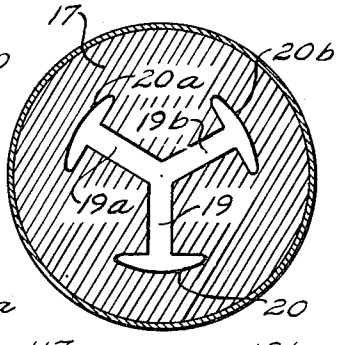



Fig. 6.



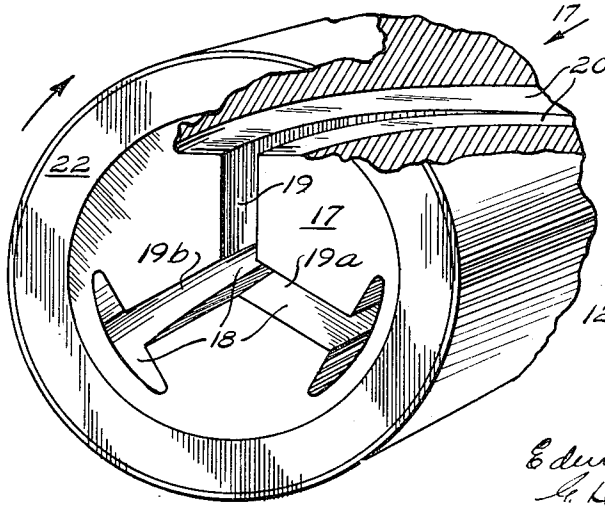




Fig. 7.

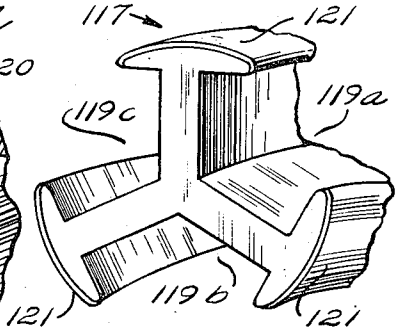



Fig. 8.

INVENTOR
CONRAD R. VEGREN
Edward C. Walsh
G. D. O'Brien
BY

ATTORNEYS

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## HELICAL GAS FLOW CHANNEL FOR SOLID PROPELLANTS

Conrad R. Vegren, Washington, D. C.

Application May 7, 1952, Serial No. 286,588

7 Claims. (Cl. 102—49)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to spin stabilized rockets and more particularly to novel powder grains employed in combination therewith.

In a certain type of spin stabilized rocket a plurality of angularly spaced nozzles are provided at the rear end thereof, the axes of which are canted to discharge gaseous products of combustion along a plurality of generally helical paths to effect spinning of the rocket about its longitudinal axis. In such type of rocket it is also the practice to provide a propellant fuel, such as a powder grain, which produces flow of gas, as it burns, in a direction generally axially to the rocket. In such arrangement of nozzles and the propellant referred to, the direction of gas flow must be changed from a generally axial direction to a plurality of generally helical directions which, due to the high velocity of the gas, produces considerable gas turbulence and attendant loss in efficiency.

One of the objects of this invention is to provide a novel powder grain which will reduce the gas turbulence previously referred to in prior art devices of this type.

Another object is to provide a powder grain which, due to its physical construction and manner of burning, will effect gas flow to canted nozzles without substantial change in direction of gas flow.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a fragmentary side elevation of the rear end of a rocket, a portion being broken away to line 1—1, Fig. 2;

Fig. 2 is a rear elevation of Fig. 1 as viewed in the direction of arrow 2, Fig. 1;

Fig. 3 is a reduced scale side elevation of the powder grain employed in the rocket of Figs. 1 and 2, portions being broken away;

Fig. 4 is a reduced scale end elevation of Fig. 3 as viewed in the direction of arrow 4, Fig. 3;

Fig. 5 is a reduced scale section taken on line 5—5, Fig. 3;

Fig. 6 is a reduced scale section taken on line 6—6, Fig. 3;

Fig. 7 is an enlarged fragmentary isometric

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view of one end of the powder grain, a portion being broken away; and

Fig. 8 is a fragmentary isometric view of an alternative form of powder grain.

Referring in detail to the drawing, and particularly Figs. 1 and 2, rocket 10 is provided with an outer cylindrical casing 11, to which is affixed adjacent the rear end thereof, a nozzle plate 12 having a plurality of nozzles 13. The axis 14 of each nozzle, as best shown in Fig. 1, is canted to a longitudinal line 15 by an angle A, axis 14 lying generally along a helix. A chamber 16 is provided forwardly of the nozzle plate from which gas is distributed to the nozzles. The construction so far described is conventional and it will be apparent that if gas flow were in the general direction of arrow 15a, as in the prior art, it would be necessary for it to change direction to a plurality of axes 14 as indicated by arrow 14a, thus effecting a condition of gas turbulence in the chamber and entry mouths of the nozzles.

To minimize the turbulence just referred to, a powder grain 17 is employed which is provided with a helical channel between the ends thereof indicated in its entirety as 18. This channel is generally Y-shaped, having three equiangularly spaced radially extending channels, 19, 19a, 19b, rectangular in cross-section, which communicate at their outer ends with helical channels 20, 20a, 20b, respectively, of the cross-section shown. A suitable covering 21 encloses the outer surface of the grain and similar coverings 22, 23 are provided at the ends to partially cover the grain, these being for the purpose of inhibiting burning of the grain except at the exposed surfaces of channel 18 and the exposed surfaces at the ends of the grain. Materials for this purpose are well known in the art.

The grain may be either fixed relative to casing 11, or permitted to rotate therein. If fixed, it is preferably fixed in such manner that the rear ends of channels 19, 19a, 19b and 20, 20a, 20b are generally aligned with the nozzle axes to minimize turbulence of gas discharged through these channels and into the nozzles. With the arrangement shown, wherein three channels are employed with six nozzles, the rear ends of the channels will preferably be disposed in a position such that each radial channel and its associated channel at the outer end thereof discharges into a pair of adjacent nozzles and as the powder burns and the channels enlarge the enlarged channels will remain generally aligned with an adjacent pair of nozzles. It is to be understood, however, that the arrangement shown

s exemplary only and that the number of channels may be the same as the number of nozzles. If the grain is permitted to rotate within casing 11, it will be apparent that the rear ends of the channels, due to the relative movement, will successively pass by the entry mouths of the nozzles. The discharge of gas from the channels will, however, be in the same general direction as the angle of cant of the nozzles to thus minimize gas turbulence.

Fig. 8 illustrates a modification of the invention wherein the grain 117 is generally Y-shaped and the channels 119a, 119b and 119c are disposed outside of the grain rather than within its confines. These channels are also helical as in the first described embodiment. It will be apparent that the direction of burning will be from the exposed surfaces inwardly rather than outwardly as in the first described embodiment. Burn inhibiting covers 121 may also be employed as in the first described embodiment.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A rocket grain of solid propellent fuel having a plurality of longitudinally extending channels spaced angularly about its longitudinal axis, each channel extending in a helical direction about said axis and between opposite ends of the grain to provide exposed burning surfaces on the grain, the channels being adapted to carry gaseous products of combustion, as said surfaces burn, for delivery from one end of the grain in a plurality of angularly spaced streams of gas, each stream issuing from its carrying channel in a direction canted to a longitudinal direction of the grain.



2. A rocket grain in accordance with claim 1 wherein the channels are disposed inside of the grain.

3. A rocket grain in accordance with claim 1 wherein the channels are disposed outside of the grain.

4. A rocket grain in accordance with claim 1 in combination with a spin stabilized rocket containing same, the rocket having a plurality of angularly spaced canted nozzles adapted to receive said streams of gas.

5. In a spin stabilized rocket of the type having a plurality of angularly spaced exhaust nozzles adjacent the rear end thereof, the axis of each nozzle being canted to a longitudinal direction of the rocket to effect spin thereof, the improvement comprising in combination; a powder grain disposed within the rocket forwardly of the nozzles having a plurality of longitudinally extending channels spaced angularly about the longitudinal axis of the grain and the rocket, at least the rear ends of the channels extending in a direction canted to a longitudinal axis of the grain adapted to discharge gaseous products of combustion to the nozzles in a direction substantially aligned with the direction of the nozzle axes.

6. A rocket in accordance with claim 5 wherein the channels are disposed inside of the grain.

7. A rocket in accordance with claim 5 wherein the channels are disposed outside of the grain.

CONRAD R. VEGREN.

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