Oct. 11, 1949. J. W. PARSONS 2,484,355

REACTION MOTOR WITH PROPELLANT CHARGE MOUNTED IN IT

Filed April 23, 1945 3 Sheets-Sheet 1

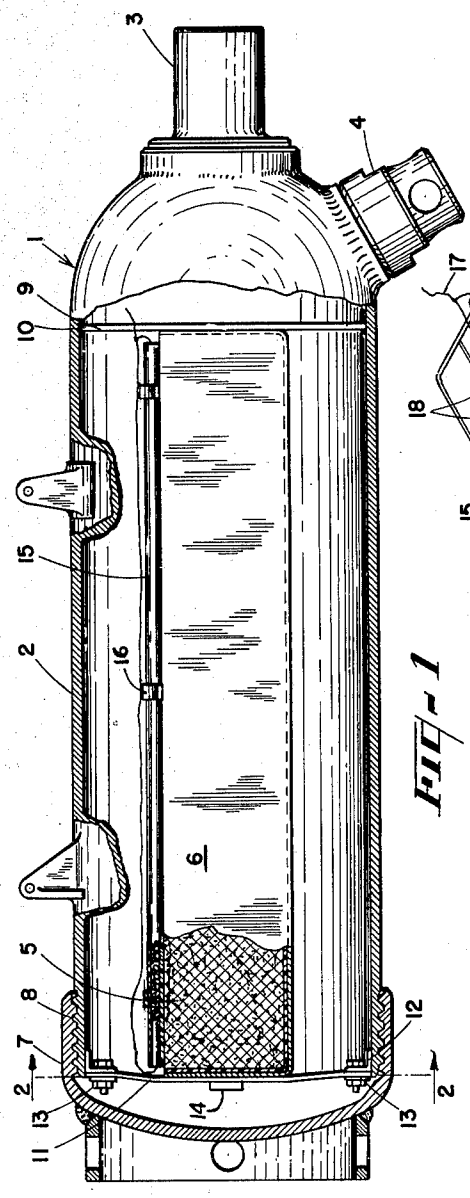

FIG-1

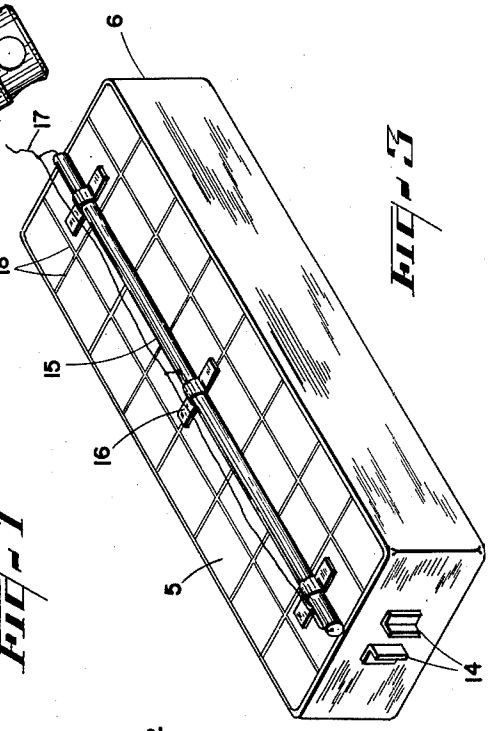

FIG-3

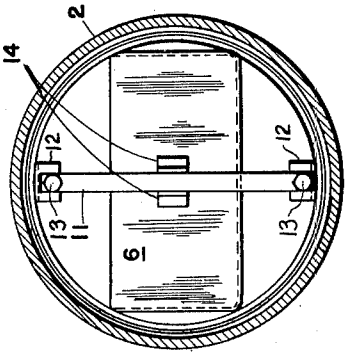

FIG-2

INVENTOR.
JOHN W. PARSONS
BY
Christie and Angus
ATTORNEYS

Oct. 11, 1949. J. W. PARSONS 2,484,355

REACTION MOTOR WITH PROPELLANT CHARGE MOUNTED IN IT

Filed April 23, 1945 3 Sheets-Sheet 2

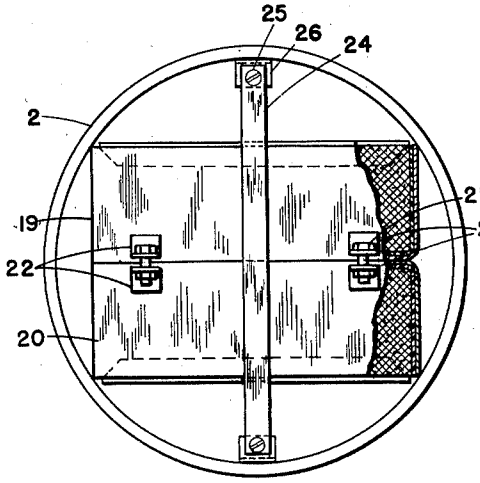

FIG-4

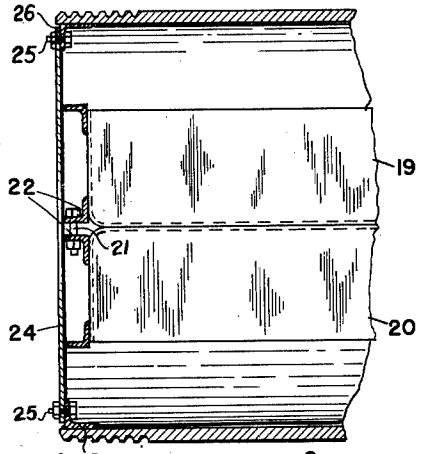

FIG-5

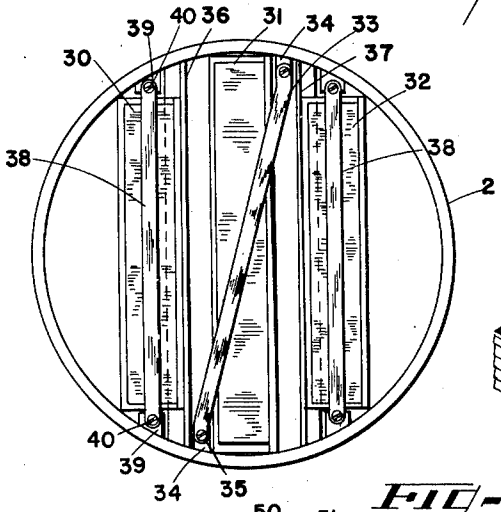

FIG-6

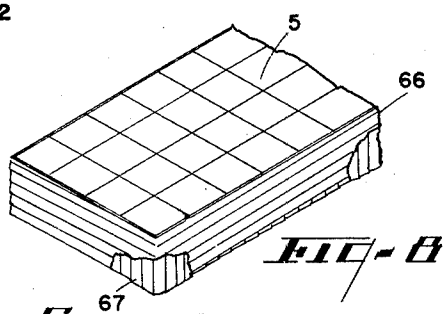

FIG-8

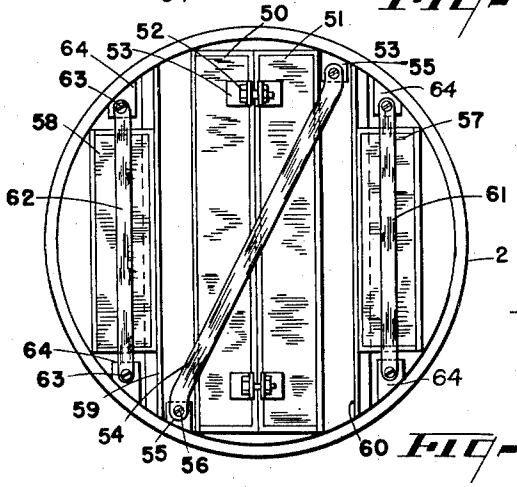

FIG-7

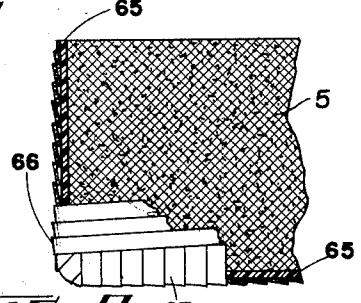

FIG-9

INVENTOR.
JOHN W. PARSONS
BY Christie and Angus
ATTORNEYS

Oct. 11, 1949. J. W. PARSONS 2,484,355

REACTION MOTOR WITH PROPELLANT CHARGE MOUNTED IN IT

Filed April 23, 1945 3 Sheets-Sheet 3

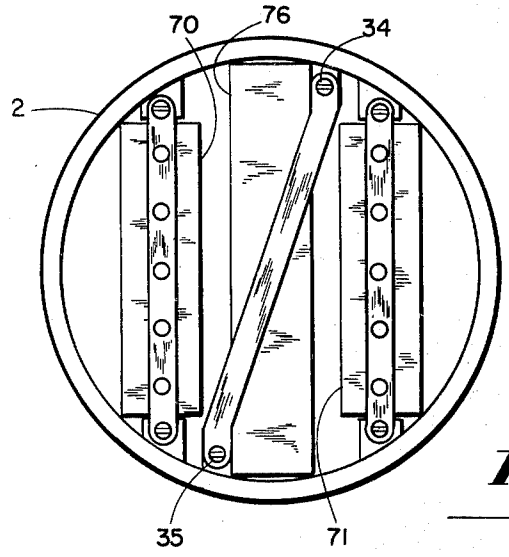

Fig. 6a

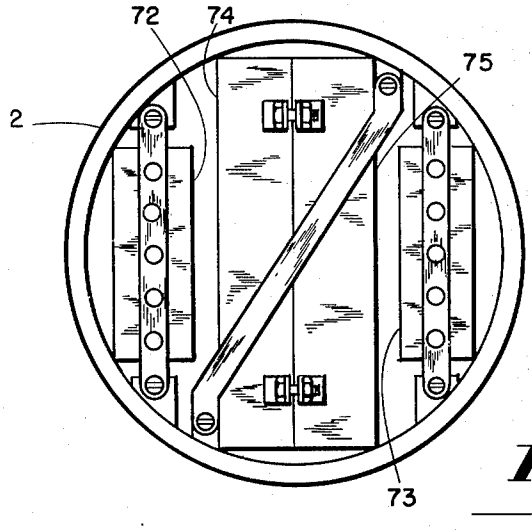

Fig. 7a

INVENTOR.
JOHN W. PARSONS
BY
Christie and Angus
ATTORNEYS

Patented Oct. 11, 1949 2,484,355

UNITED STATES PATENT OFFICE

2,484,355

REACTION MOTOR WITH PROPELLANT CHARGE MOUNTED IN IT

John W. Parsons, Pasadena, Calif., assignor to Aerojet Engineering Corporation, Azusa, Calif., a corporation of Delaware

Application April 23, 1945, Serial No. 589,795

14 Claims. (Cl. 60—35.6)

1

This invention relates to jet propulsion and more particularly to means for improving the burning rate of propellants used in jet motors.

A jet motor usually comprises a tubular firing chamber, closed at one end and equipped at the other end with an exhaust nozzle. The propellant charge is placed or cast in the tubular firing chamber and is ignited by some suitable device when the motor is to be placed in operation. The exhaust nozzle is preferably designed according to the De Laval type and the exhaust gases from the combustion of the propellant charge issue through the exhaust nozzle at high velocity thereby creating thrust. The propellant charge in the firing chamber of the motor may be either of the smoke-producing type or smokeless type. The smoke-producing type is usually compounded from a mixture of potassium perchlorate and asphalt while the smokeless variety may be compounded from a mixture of ammonium perchlorate and asphalt.

Although it would be desirable to employ smokeless propellants in many instances, the application of ammonium perchlorate type of propellants has been limited, due to the fact that charges compounded from ammonium perchlorate and asphalt usually possess lower burning rates than burning rates which may be attained with the potassium perchlorate type of propellant. As a result the ammonium perchlorate type has generally been satisfactory only for operations where a low thrust is required over longer periods of time than can be obtained from the potassium perchlorate type.

According to my invention I provide an arrangement which increases the amount of propellant burned per unit time in a chamber of even size, and thereby permits the use of the slower burning smokeless propellants. I carry out my improvement by the provision in the chamber of one or more pans for holding the propellant, and arranged in the chamber so as to provide a greater propellant burning surface than would be had by merely casting the propellant in the chamber. By selecting the number of pans and the extent of the exposed propellant surfaces, I am able to adjust the amount of propellant burned per unit time in the chamber as may be desired.

Features of my invention relate to the shape and arrangement of the propellant container pans.

The above and other features will be better understood by referring to the following detailed

2

description and accompanying drawings in which:

Fig. 1 is a cutaway view partly in cross section showing the pan charge installed inside of a jet motor;

Fig. 2 is a cross section view on line 2—2 of Figure 1 taken at the end of the motor showing the pan in position;

Fig. 3 is a perspective view of a pan, charge and ignitor;

Fig. 4 is a partial view partly in cross section showing an alternative construction in which two pans are employed instead of one;

Fig. 5 is a cross section view showing the two pans in position in the shell;

Fig. 6 is a view partly in cross section showing an alternative construction employing three pans;

Fig. 6*a* shows a modification of the arrangement of Fig. 6;

Fig. 7 is a cross sectional view showing another alternative embodiment employing four pans;

Fig. 7*a* shows a modification of the arrangement of Fig. 7;

Fig. 8 shows a cartridge type propellant charge; and

Fig. 9 shows a cross section through a portion of the propellant charge, showing the thermoplastic and tape liner in position.

Referring to the device illustrated in Fig. 1, a jet motor 1 having a firing chamber 2 and an exhaust nozzle 3 and a safety plug 4, capable of releasing excessive pressure, is charged with a propellant charge 5 which is cast in a rectangular pan 6 having four sides and a bottom, and the top open to expose the propellant. The surface of the propellant charge is crisscrossed with a series of grooves 18 to assist burning. An end cover 7 is secured to the firing chamber 2 by threads 8, these threads 8 permitting removal of the end cover when a new propellant charge is to be installed in the motor.

The propellant charge container is constructed to fit snugly in the inside of firing chamber 2 as shown in Fig. 2. A bar 9 is installed diametrically across the firing chamber at position 10, which is at the point where the firing chamber undergoes the transition between the cylindrical to the spherical, and is secured at this point in any suitable manner such as welding the bars at both ends. The charge is prevented from sliding in the opposite direction toward the open end by securing it in position with a bracket 11 which is in turn secured to angles 12 which are diametrically fastened by any suitable means such as welding to the firing chamber wall. This

bracket is held in place by bolts 13 and rests against a U-shaped member 14 fastened to the end of the propellant pan.

An ignitor 15, which in this embodiment is shown as a cylindrical tube, extends the entire length of the firing chamber and is secured to the charge by brackets 16. The ignitor charge is fired, preferably by electrical contact made through the hot wires 17.

Figs. 4 and 5 show alternate embodiments of this invention in which the single pan 6 is substituted by a pair of pans 19 and 20, which are inserted in the jet motor back to back and are held together at the ends by bolts 21 passing through corresponding holes drilled in angle irons 22, which are attached to the pans in any suitable manner, preferably by welding. Since the two pans both have an exposed surface, each of which is of the same size as that of the single pan charge, this device will burn twice as much propellant per unit time as will be burned by the single pan device. The assembled pans are held in position by a bar at the rear end similar to the bar 9 of Fig. 1 and at the front end by a strap member 24 which is attached to the firing chamber shell 2 by bolts 25 passing through angle irons 26, which are attached inside the shell of the firing chamber at the desired point by any suitable method, preferably welding.

Another alternative embodiment of my invention is shown in Fig. 6 in which a three pan construction is employed. Pans 30, 31 and 32 are mounted in the motor chamber 2 in the manner shown in Fig. 6. The two outside pans 30 and 32 have their exposed surfaces facing the firing chamber wall and the central pan 31 may open either way and fits into the space between pans 32 and 30. The outside pans, which in the multiple pan type of apparatus ordinarily are placed so that the burning surfaces of the charges face the firing chamber wall, may be, if desired, reversed as shown in Fig. 6*a*, wherein the surfaces 70 and 71 are the burning surfaces with the surfaces 70 and 76 facing each other; so that the burning surfaces of each pan faces the center of the unit and in this manner places the charges so that the burning surfaces face each other. This arrangement is more satisfactory in applications where it is preferable to have a greater open area above the burned surface of the propellant than would be available if the burning surfaces of the propellant charge face the motor walls. Pan 31 fits snugly in the maximum diameter of the motor of the firing chamber shell and is held in position by a bracket 33 which is attached at either end to angle irons 34 which are secured to the inside of the firing chamber shell by bolts 35. The pans 30 and 32 are supported by shelf arrangements 36 and 37 and held securely against the firing chamber shell 2. These pans are also prevented from sliding in a longitudinal direction by brackets 38 which are secured to angle irons 39 by bolts 40.

Fig. 7 shows an embodiment in which four propellant charge pans are employed. The two central pans 50 and 51 are assembled similarly to the two pans used in Fig. 4 only differing from these in depth. Pans 50 and 51 are bolted together at the ends by bolts 52 passing through corresponding holes in brackets 53. A number 54 prevents the pans from sliding in a longitudinal direction. This member is secured to the firing chamber shell 2 by bolting it to angle irons 55 with bolts 56. Pans 57 and 58 are smaller in exposed area than the two central pans 50 and 51 but of the same depth. These pans are held in position by shelf arrangements 59 and 60 and kept from sliding longitudinally by brackets 61 and 62 which are secured by bolts 63 to the angle irons 64 attached to the firing chamber shell. In all of the above multiple pan type of charges it is desirable that the depth of the propellant charge in each pair of pans be the same. This precaution is taken to insure a uniform thrust throughout the firing chamber at all times and to prevent an uneven thrust or deflection of the motor which would result if the charge on one side were consumed more rapidly than that on the other.

Fig. 7*a* shows a slight rearrangement of Fig. 7, in that the surfaces 72 and 73 are the burning surfaces and face inwardly toward each other and toward the respective burning surfaces 74 and 75 of the central charges.

The operation is as follows: A propellant, preferably of the smokeless type, is cast into the rectangular-shaped pan receptacle which is designed to fit snugly inside of the firing chamber section of a jet motor having a removable end. The upper surface of the propellant, which is exposed, is grooved by scratches 18 and supplied with an ignition charge which may be ignited by hot wires heated by electrical contact initiating combustion of the entire exposed area of the propellant. Since the exposed area determines the amount of propellant burned per unit time, the amount of thrust desired can be regulated by increasing or decreasing the size of this exposed area and in this manner a propellant charge may be made available that is suitable to meet a wide variety of thrust requirements. This is better illustrated by Fig. 4 which indicates an embodiment suitable for increasing the burning area to provide a greater thrust than could be achieved by the use of a single pan in the motor such as used in Fig. 1. In all these devices the charge burns lengthwise over the entire exposed area which faces the side of the chamber. The ends are protected to prevent burning such as would occur if the charge were solidly cast in the chamber and ignited at the nozzle end.

A convenient manner in which the apparatus may be employed is as follows: The propellant, preferably of the smokeless type, is cast in rectangular-shaped molds corresponding to the shape of the pans employed in the apparatus, the casting is then extracted from the mold and dipped in a thermoplastic substance so that all surfaces are covered except the burning surface. The dipped charge is wrapped with a suitable tape liner and fireproofed to prevent burning on the outside surface of the charge. This is more clearly shown in Figs. 8 and 9 in which the thermoplastic charge 5 is surrounded by a thermoplastic coating 65 and taped across the bottom and sides in the manner shown by overlapping layers 66 and 67 of a suitable tape material. The liner is then fireproofed and the cartridge casting is ready for insertion in the pans.

An advantage of my invention is that the device makes it possible to provide a greater burning surface than heretofore and thereby increase the amount of available thrust without resorting to extreme motor sizes.

Another advantage of my invention is that the containers for the propellant charges are made cheaply and are easily available. The propellant may be easily cast, then shipped and stored until ready for use.

I claim:

1. A jet propulsion motor comprising a firing chamber having a longitudinal axis and an exhaust nozzle coaxial with the axis and located at an end of the chamber, a pan within said firing chamber, a propellant charge in said pan, the charge having a flat exposed surface substantially parallel with said axis and means for igniting the charge and means for holding said pan securely in position.

2. A jet propulsion motor comprising a firing chamber having a longitudinal axis and an exhaust nozzle coaxial with the axis and located at an end of the chamber, a plurality of pans within said firing chamber, propellant charges in said pans, the charges having flat exposed surfaces substantially parallel with said axis and means for holding the pans securely in position.

3. A jet propulsion motor comprising a firing chamber having a longitudinal axis and an exhaust nozzle coaxial with the axis and located at an end of the chamber, a plurality of pans within the firing chamber, propellant charges in the pans, the charges having flat exposed surfaces substantially parallel with said axis, said pans being so placed that a space is provided between one pan and the next to permit free exhaust of products of combustion, and means for holding said pans securely in position.

4. A jet propulsion motor comprising a firing chamber having an exhaust nozzle, two pans of similar area and depth so proportioned that when the bottoms are placed against each other the pans fit in the firing chamber, propellant charges in said pans, and means for holding the pans securely in position.

5. A jet propulsion motor comprising a firing chamber having an exhaust nozzle, three pans so proportioned that they fit in different levels of the firing chamber cross section, propellant charges in said pans, and means for holding the pans securely in position.

6. A jet propulsion motor comprising a firing chamber having an exhaust nozzle, four pans so proportioned that they fit into the firing chamber at different levels, propellant charges in said pans, and means for holding the pans in position.

7. A jet propulsion motor comprising a firing chamber having an exhaust nozzle, three pans within said firing chamber, said pans being proportioned so that the two outside pans have a similar exposed area and depth, propellant charges in said pans, said three pans being so spaced that the products of combustion from each charge may easily exit between said pans and escape through the exhaust nozzle, and means for holding the pans securely in position.

8. A jet propulsion motor comprising a tubular firing chamber having a nozzle at one end, a pan in the chamber containing a propellant charge with an exposed burning surface, the pan being so placed that the burning surface of the propellant charge faces the tubular wall of the chamber.

9. A jet propulsion motor comprising a tubular firing chamber having a nozzle at one end, two pans in the chamber each containing a propellant charge with an exposed burning surface, the burning surfaces of the propellant charges facing opposite sides of the tubular wall.

10. A jet propulsion motor comprising a tubular firing chamber having a nozzle at one end, three pans each containing a solid propellant charge with an exposed burning surface, the pans being located in said chamber in such a manner that the burning surfaces of the charges are substantially parallel to each other, two said propellant surfaces facing one side of the tubular wall of the chamber and the other surface facing the opposite side of said tubular wall.

11. A jet propulsion motor comprising a firing chamber having a nozzle at one end, two pans in the chamber each containing a propellant charge with an exposed burning surface, the burning surfaces of the propellant charges facing each other.

12. A jet propulsion motor comprising a firing chamber having a nozzle at one end, four pans each containing a solid propellant charge with an exposed burning surface, the pans being placed in such a manner that the burning surfaces of each pair of pans on each side of center face each other.

13. A jet propulsion motor comprising a firing chamber having a nozzle at one end, a pan placed so that the open side of the pan faces the wall of the chamber, a wrapped propellant cartridge placed in said pan, said wrapped cartridge being substantially the same in shape as the pan, and comprising a propellant charge, a thermoplastic liner covering said charge on all surfaces except the burning surface and a tape wrapping surrounding said thermoplastic liner.

14. In a jet propulsion motor the combination which comprises a firing chamber having a nozzle at one end, a pan disposed longitudinally in the chamber and a propellant charge disposed in the pan, the pan and charge being so arranged that at least one side surface of the charge is exposed and flat and substantially parallel with the longitudinal axis of the chamber so that it burns toward the side of the chamber but the end surfaces of the charge are protected to prevent burning.

JOHN W. PARSONS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
249,192	Mallory	Nov. 8, 1881