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R. H. GODDARD  
CIRCUIT CLOSING DEVICE FOR FUEL FEED APPARATUS  
AND HAVING QUICK-ACTING THERMAL CONTROL  
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2,528,134

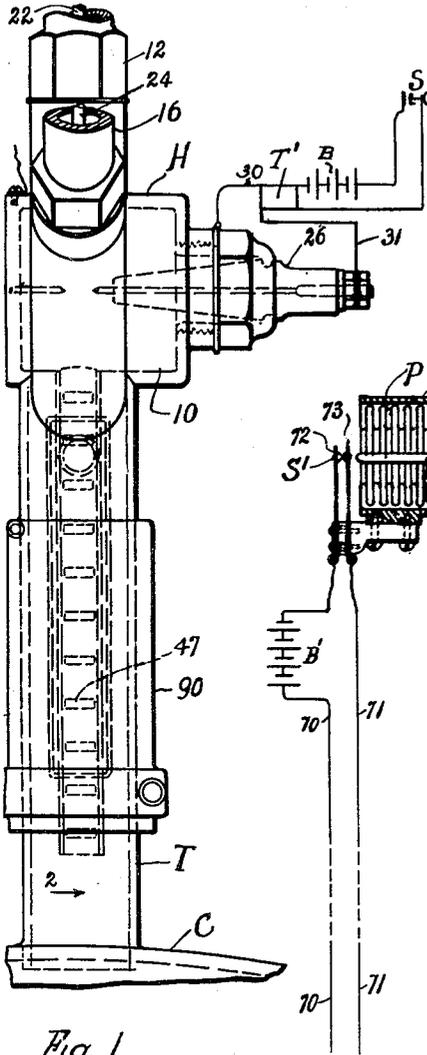


Fig. 1

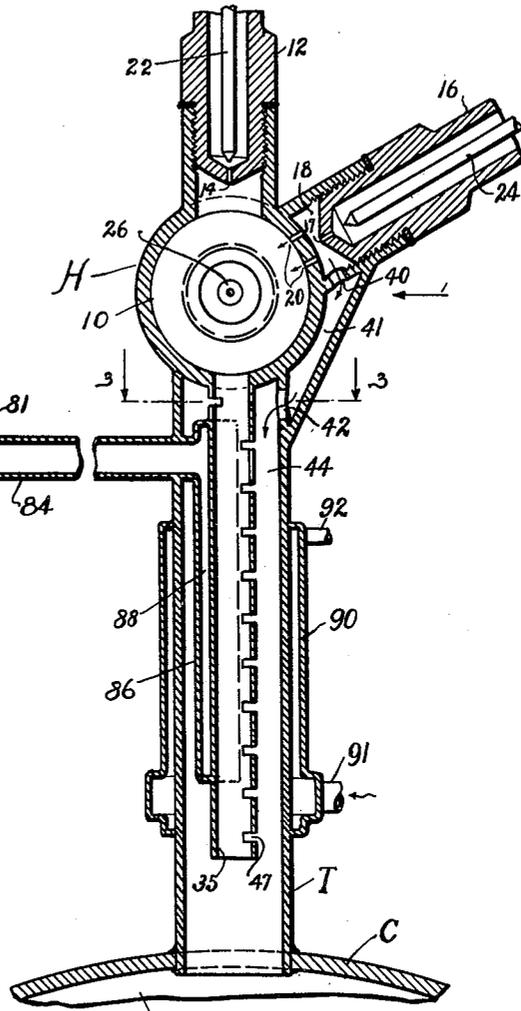


Fig. 2

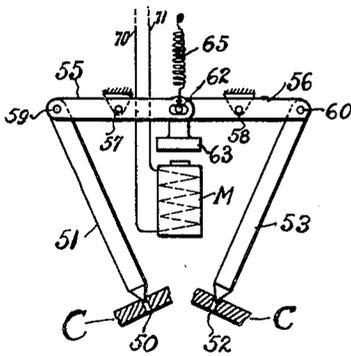


Fig. 4

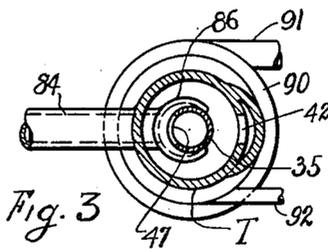


Fig. 3

INVENTOR.  
ROBERT H. GODDARD, d'cd.  
ESTHER C. GODDARD, EXECUTRIX.  
BY

Chas. T. Hawley  
ATTY.

## UNITED STATES PATENT OFFICE

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## CIRCUIT CLOSING DEVICE FOR FUEL FEED APPARATUS AND HAVING QUICK-ACTING THERMAL CONTROL

Robert H. Goddard, deceased, late of Annapolis, Md., by Esther C. Goddard, executrix, Worcester, Mass., assignor of one-half to The Daniel and Florence Guggenheim Foundation, New York, N. Y., a corporation of New York

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6 Claims. (Cl. 60—44)

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This invention relates to internal combustion chambers particularly adapted for use in the propulsion of rockets and rocket craft and using liquid fuel, and relates more particularly to the coordinated operation of the igniter and the fuel feed control. Combustion in said chamber produces a large volume of combustion gases which are forcibly ejected from a discharge opening in said chamber with propulsive effects.

More specifically, the invention relates to a circuit-closing device associated with the fuel feed and under quick-acting thermal control by the igniter of the combustion chamber.

It is the general object of the invention to provide a construction by which fuel feed will automatically follow activation of the igniter and with much reduced delay. Such a construction is particularly useful where a combustion chamber is intermittently operated.

The invention further relates to arrangements and combinations of parts which will be hereinafter described and more particularly pointed out in the appended claims.

A preferred form of the invention is shown in the drawing, in which

Fig. 1 is a front elevation of an igniter and a feed control device adapted for use with this invention;

Fig. 2 is a sectional side elevation, looking in the direction of the arrow 2 in Fig. 1;

Fig. 3 is a transverse sectional view, taken along the line 3—3 in Fig. 2; and

Fig. 4 is a side elevation of an illustrative valve control device.

Referring to the drawing, a combustion chamber C is shown as provided with an igniter H which may be of the general type shown in the prior Goddard Patent No. 2,090,039, issued August 17, 1937. As in said patent, the igniter H comprises a relatively small igniter chamber 10 mounted on a tube T and to which gasoline or other liquid fuel may be fed through a pipe 12 and feed opening 14. A liquid oxidizer, such as liquid oxygen, is also fed to the chamber 10 through a pipe 16, feed port or opening 17, recess 18, and additional inner feed ports or openings 20.

The gasoline feed is controlled by a needle valve 22, and the oxygen feed is similarly controlled by a needle valve 24. A spark-plug 26 is mounted in the side of the igniter chamber 10 and may be activated by a battery B or other source of current through a transformer T', wires 30 and 31 and a manually operated switch S.

When fuel and oxidizer are admitted to the

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igniter chamber 10 and the switch S is closed, ignition promptly takes place and the resultant igniter flame is projected through a tube 35 to the combustion chamber C, thus igniting the fuel supplied to said combustion chamber.

The recess 18 in the oxygen connections has a port 40 in its side wall which communicates through a passage 41 and port 42 with the annular space 44 between the flame tube 35 and the outer tube T by which the igniter is mounted on the combustion chamber C.

A series of slots 47 in one side of the flame tube 35 permit portions of oxygen to be introduced into the igniter flame at successive points along the length of the tube 35, thus keeping the flame hot and insuring complete combustion of any unconsumed fuel.

A portion of the oxygen also enters the combustion chamber C through the tube T and helps to prevent accidental failure of the igniter flame at the point where it is introduced to the chamber.

The construction thus far described is similar to the construction shown in the prior Goddard patent above cited and certain features of the described construction are similar to the disclosure in copending Goddard application Serial No. 770,312, filed August 23, 1947, now Patent No. 2,498,263.

The needle valves 22 and 24 may be opened simultaneously with the closing of the switch S by any suitable coordinating device, such as is shown in Fig. 3 of the first cited Goddard patent.

It is desirable that the fuel feed to the chamber C be started as soon as possible after the igniter flame is in effective operation.

In the illustrative device shown in Fig. 4, a fuel port 50 in the chamber C is controlled by a needle valve 51, and an oxidizer port 52 is controlled by a needle valve 53. Levers 55 and 56 are mounted on fixed pivots 57 and 58 and are pivotally connected to the needle valves 51 and 53 at the points 59 and 60.

The levers 55 and 56 have a pin-and-slot connection 62 to an armature 63 controlled by a magnet M. A spring 65, also connected to the levers 55 and 56 at the point 62, holds the needle valves 51 and 53 normally in closed position.

Wires 70 and 71 connect the magnet M through a battery B' to the normally spaced contacts 72 and 73 to a switch S'. When this switch is closed, the magnet M is energized and the armature 63 is drawn downward, thus raising the needle valves 51 and 53 and starting the feed of liquid fuel and oxidizer to the combustion chamber C.

The switch S' is controlled by a plunger 80 attached to a disc 81 forming the movable inner end of an annular bellows operator P which is mounted within a casing 83 supported by a tube 84 extending through and secured to the tube T which supports the igniter H.

At its inner end, the tube 84 is connected to a segmental casing 86 which partially surrounds the igniter tube 35 and which is substantially extended lengthwise thereof as shown in Fig. 2.

The casing 83, tube 84 and space 88 between the segmental casing 86 and the tube 35 are filled with a temperature-responsive fluid by which the bellows operator P is compressed as the temperature increases and by which the plunger 80 is thereby advanced to close the switch S'.

As soon as the igniter flame is produced and traverses the tube 35, the liquid in the space 88 inside of the segmental casing 86 very quickly increases in temperature and expands to close the switch S'. Such closing operates through the magnet M to open the fuel and oxidizer valves 50 and 52 of the chamber C. Consequently, the production of the igniter flame and the feed of fuel and oxidizer to the main combustion chamber C are closely and accurately coordinated, and the fuel feed to the chamber C follows the production of the igniter flame with extreme promptness.

If the tube T tends to overheat between the igniter chamber 10 and the combustion chamber C, the tube may be provided with a jacket 90 to which cooling water may be supplied by a pipe 91 and from which the heated water may escape through a discharge pipe 92.

Having thus described the invention and the advantages thereof, it will be understood that the invention is not to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what is claimed is:

1. In combustion apparatus having a combustion chamber, means to supply liquid fuel and a liquid oxidizer to said chamber under electric control, a flame-type igniter with a supporting outer tube and a flame-conducting inner tube, and means to produce a flame in said inner tube, that improvement which comprises a switch for such electric control, switch-shifting means responsive to temperature changes in a confined heat-responsive liquid, and a container for such liquid which consists in part of an elongated hol-

low segmental casing positioned in said igniter and between said inner and outer tubes and partially surrounding said flame-conducting tube.

2. The combination in combustion apparatus as set forth in claim 1, in which the switch-shifting means includes a bellows operator in direct communication with said hollow segmental casing.

3. The combination in combustion apparatus as set forth in claim 1, in which means is provided to introduce additional oxidizer to the flame through that portion of the inner tube which is not enclosed by said segmental casing.

4. The combination in combustion apparatus as set forth in claim 1, in which the segmental casing encloses a major part of the periphery of said flame-conducting tube.

5. The combination in combustion apparatus as set forth in claim 1, in which the segmental casing encloses a major part of the periphery of said flame-conducting tube and is in intimate association therewith.

6. In combustion apparatus having a combustion chamber, means to supply liquid fuel and a liquid oxidizer to said chamber under electric control, a flame-type igniter with a supporting outer tube and a flame-conducting inner tube, and means to produce a flame in said inner tube, that improvement which comprises a normally-open switch for such electric control, switch-closing means responsive to temperature changes in a confined heat-responsive liquid, and a container for such liquid which includes a bellows operator for said switch and an elongated hollow segmental casing connected to said bellows operator and positioned between said inner and outer tubes and surrounding a large part of the heated surface of said flame-conducting tube.

ESTHER C. GODDARD,

*Executrix of the Last Will and Testament of Robert H. Goddard, Deceased.*

#### REFERENCES CITED

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

#### UNITED STATES PATENTS

Number	Name	Date
2,090,039	Goddard	Aug. 17, 1937
2,269,157	Levine	Jan. 6, 1942