Oct. 31, 1950 R. H. GODDARD 2,528,134

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

Filed Jan. 24, 1949

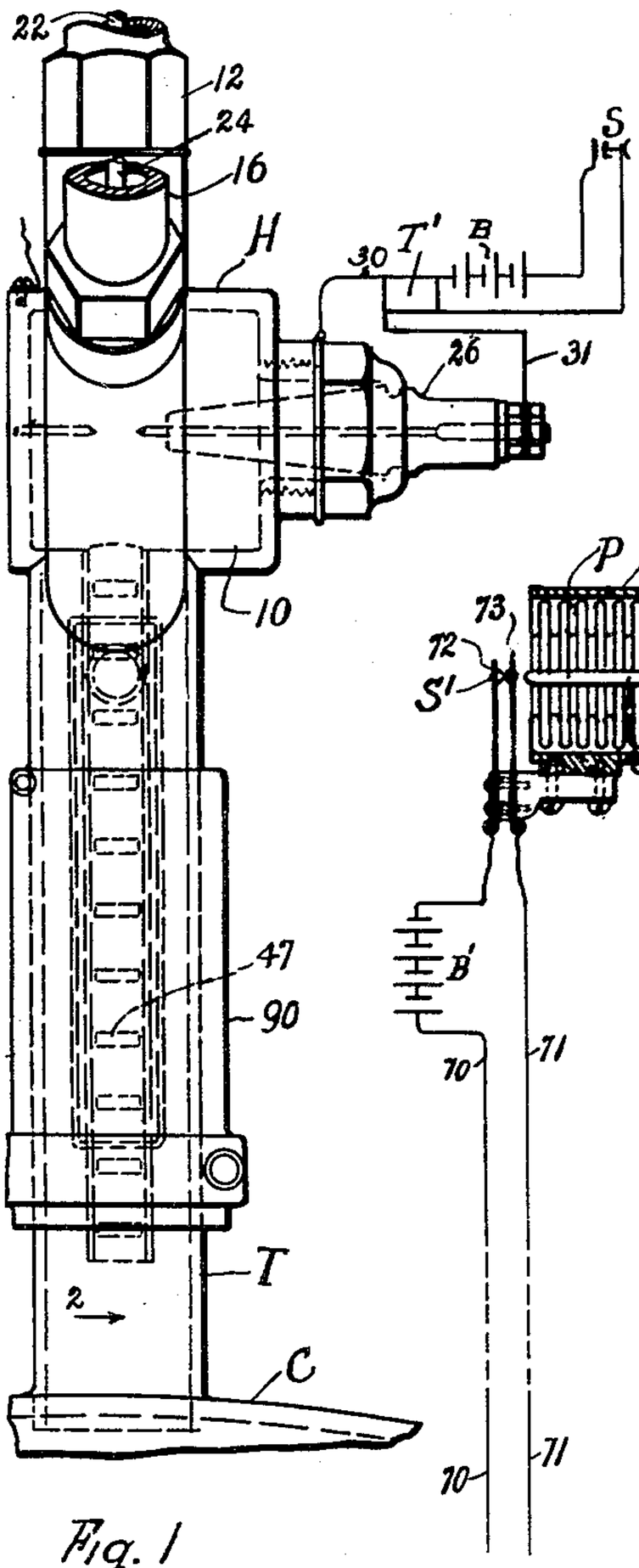

Fig. 1

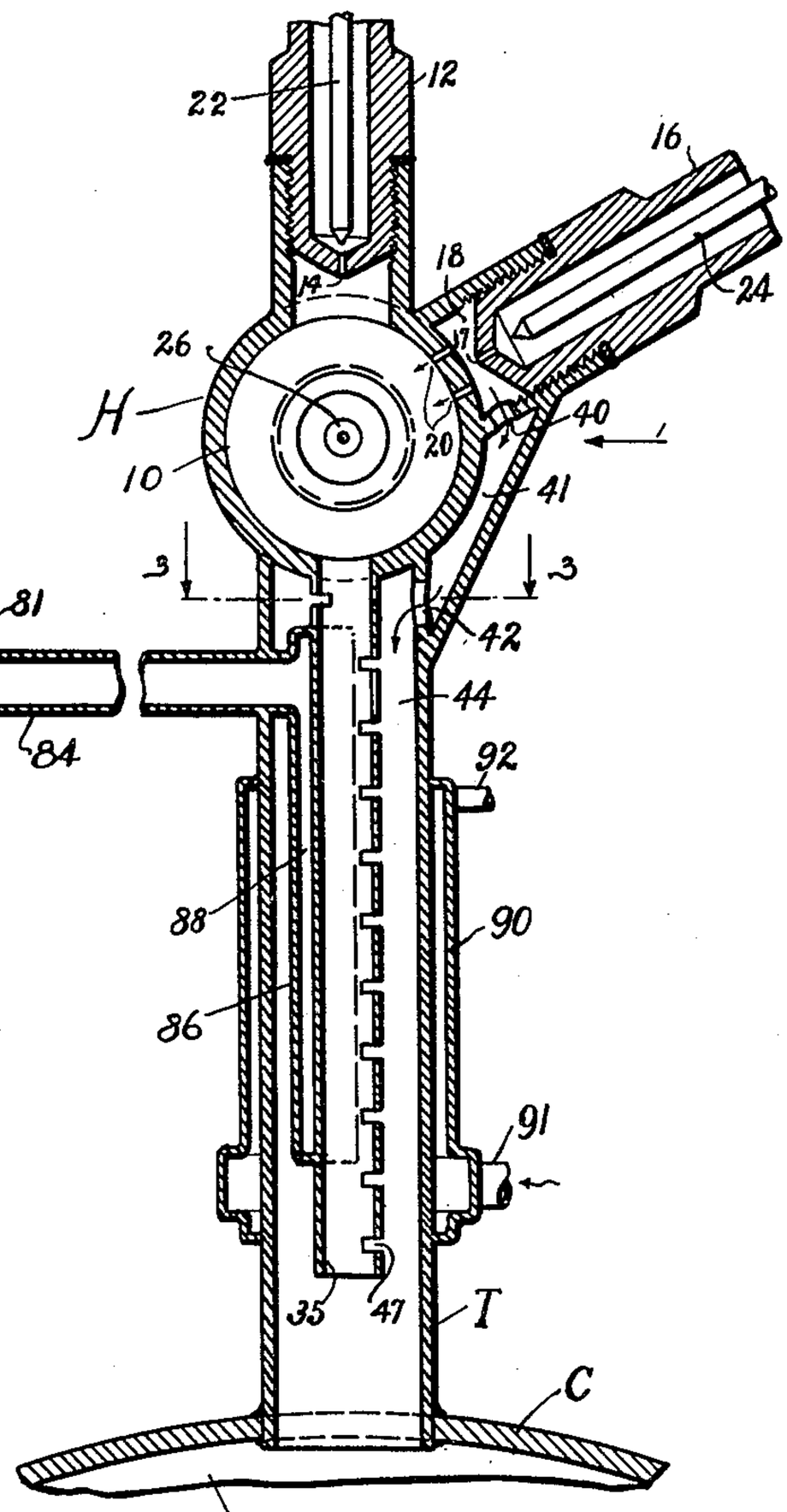

Fig. 2

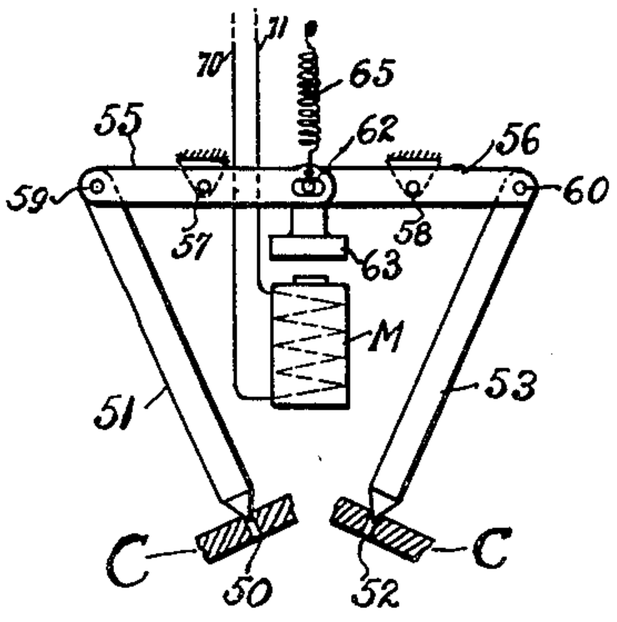

Fig. 4

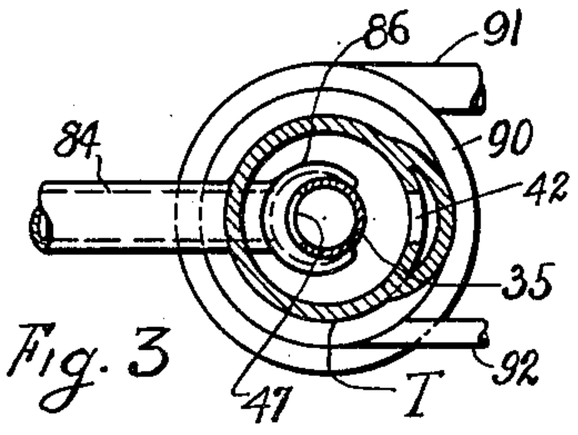

Fig. 3

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2,528,134

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

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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 detais 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 hollow 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