No. 702,246. Patented June 10, 1902.

J S ROGERS.

INTERNAL COMBUSTION ENGINE.

(Application filed May 4, 1901.)

(No Model.) 2 Sheets—Sheet 1.

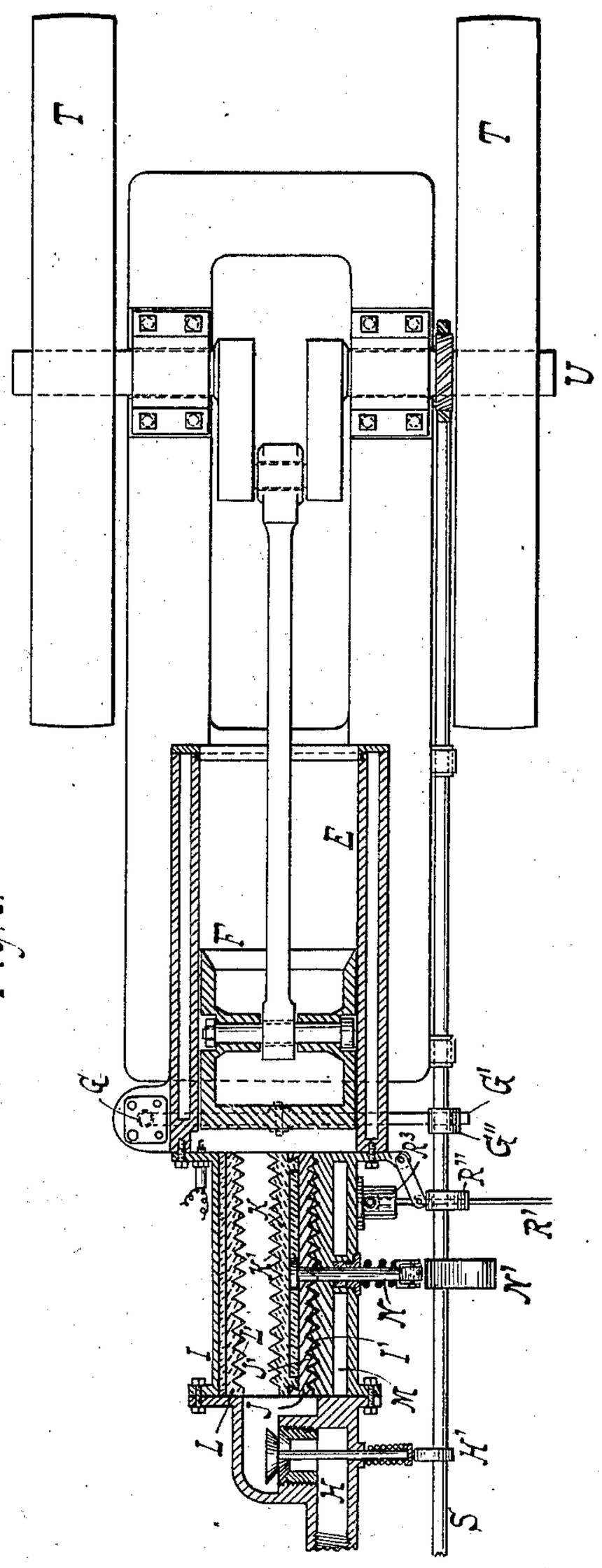

Fig. 1.

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Fig. 2.

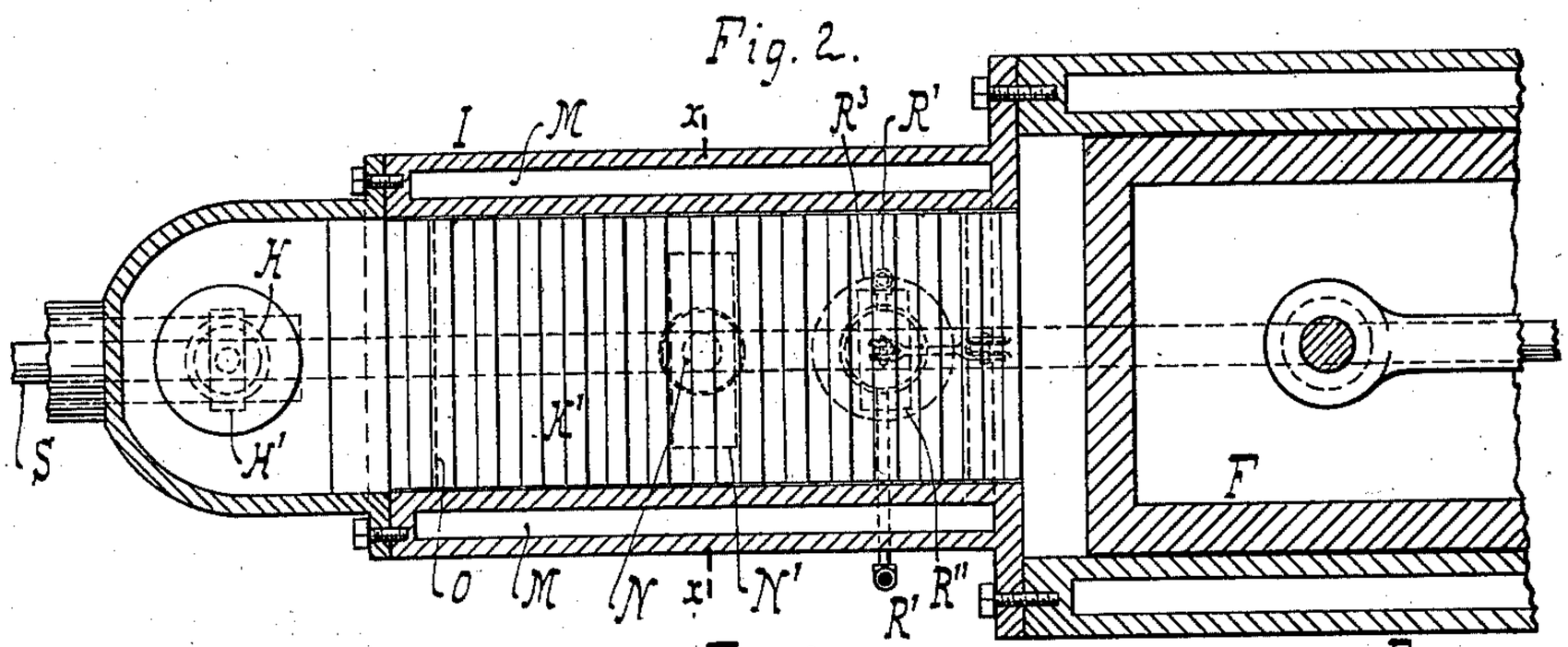
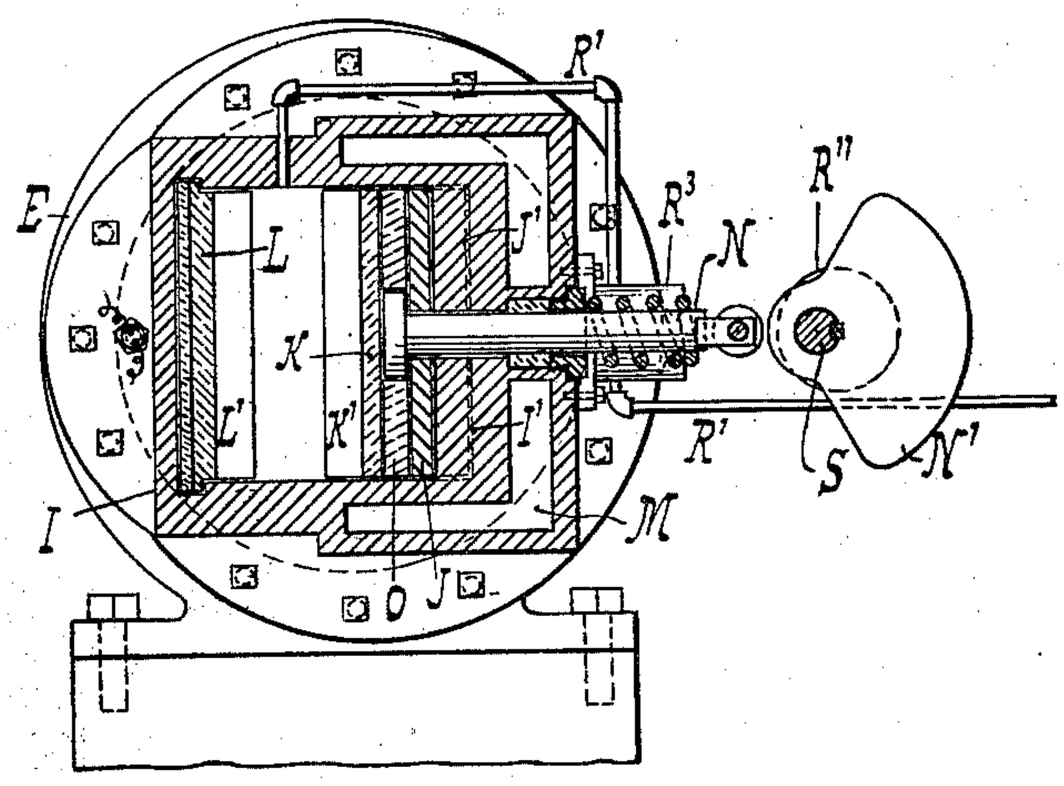


Fig. 3.



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UNITED STATES PATENT OFFICE.

J. S. ROGERS, OF NEW YORK, N. Y.

INTERNAL-COMBUSTION ENGINE.

SPECIFICATION forming part of Letters Patent No. 702,246, dated June 10, 1902.

Application filed May 4, 1901. Serial No. 58,753. (No model.)

To all whom it may concern:

Be it known that I, J. S. ROGERS, a citizen of the United States, residing in Bronx borough, New York city, in the county and State of New York, have invented new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

In the internal-combustion or explosive engines of the so-called "four-cycle" or "Otto" type the cycles or steps as known consist, first, in the suction or charging stroke; second, in the compressing stroke; third, in combustion and expansion to give a working stroke, and, fourth, in exhausting. By means of this invention the heat retained in the working fluid or in the products of combustion at or near the completion of the working stroke can be absorbed or stored, so as to be utilized, or, as it might be called, "restored," to the succeeding fresh charge of working fluid at or near the completion of the following compression-stroke.

This invention is set forth in the following specification and claims and illustrated in the annexed drawings, in which—

Figure 1 is a plan view of the engine, parts being sectioned. Fig. 2 is a longitudinal sectional view of the regenerator and refrigerator. Fig. 3 is a section along *x x*, Fig. 2.

In the drawings is shown a cylinder E, with piston F, connecting with a fly-wheel T on shaft U. This shaft has a connection, such as a worm or gear, with what may be called a "secondary" shaft S, which can be made to operate the valves and igniting mechanism and displacer. In the example shown the shaft S makes one-half the number of revolutions of main shaft U and by means of cam G″ and arm G′ actuates the supply or air valve G. The cam R″ acts in connection with pump R^3 of the pipe R′, supplying petroleum or combustible to the cylinder. The cam N′ and rod N actuate what may be called the "displacer" O, the refrigerating and regenerating or heating action of which will be presently explained. The cam H′ actuates a valve or exhaust H. These cams can be single-acting, so as to move their parts but one way, in which case return-springs will be applicable, or the cams could be made double-acting by suitable straps or connections known in the art. Builders of these machines have, however, been found to prefer return-springs.

The case or receptacle for displacer O is indicated at I and is shown of rectangular form. The refrigerating side and the regenerator side may be separate parts suitably joined together. The displacer sits loosely in the receptacle and has at one side a facing or frame J, with ridges J′ matching or fitting between the ridges or grooves I′ of a like facing or lining in the receptacle. The frame J is connected to or forms part of the displacer. These parts I′ and J are made of heat-conducting material, iron having been found suitable. A water-jacket M is shown at the cooling-face I. At the heating side or facing L the receptacle could be lagged or covered with heat-retaining substance.

The displacer O is shown with the face or lining K provided with ridges or elevations K′, and these parts are made of substance adapted to absorb and retain heat, such as iron, as is also the counterpart or facing L, with ridges L′ alternating or fitting with the ridges K′. Between parts K and J is placed a layer of glass or other non-conducting substance or insulator to prevent heat passing from ridges or regenerator K′ to the refrigerator or ridges J′. Between lining L and the receptacle I is placed a layer of glass or other non-conducting substance or insulator to prevent heat passing from lining L to receptacle I. The facing or lining J J′ and facing or lining I′ and the water-jacketed part of receptacle I compose the refrigerator, and the facings or linings K K′ L L′ compose the regenerator or heat storing and restoring parts.

The operation with liquid fuel is as follows: The piston F making an outward stroke or moving away from the valve G or casing I and said valve G being open and valve H closed, air is drawn in through valve G to give the suction-stroke. During this cycle the regenerator proper is closed and the refrigerator open. The piston having completed its outward stroke, the valve G is closed. The valve H remaining closed throughout or during the latter part of a return or inward stroke of the piston, the contained air is compressed. During this time the displacer has held the cooling-face J separated or spaced from cool-

ing-face I′, so that the air entering between or being chilled by these coolers can be more readily compressed. The loose-fitting displacer at or near the completion of this compression-stroke is shifted to close the space between coolers J′ I′ and open the space between the heaters L′ K′, so that the air passes into the last-named space to absorb heat or become warmed, together with the charge of combustible or fuel, which has now been injected. The charge of combustible may be injected gradually during the first part of the working stroke. Such heated mixture being ignited, the resulting combustion or explosion causes the piston to make a second outward stroke—that is, the working stroke. At or near the completion of this working stroke the valve or exhaust H is opened, while valve G remains closed. The piston now making its second return-stroke the products of combustion pass between faces or heaters K′ L′ to store more or less of this heat in the same before escaping at the exhaust. The valve or exhaust being now closed and valve or port G opened and displacer O shifted to close the faces or regenerator K L together while spacing faces I J the operation is repeated, or, in other words, a second suction takes place into the cylinder to be in turn compressed and cooled, then exploded after being heated or passed between faces K L, and then exhausted.

The water-jacket M can be any suitable circulating or cooling appliance arranged at the refrigerator or face I′ for cooling or conducting off heat in the air undergoing compression.

The igniter or spark arrangement for exploding or lighting the combustible or charge need not be set forth, as it is common in explosive or gas engines.

The operation of the device might be expressed for short by saying that during the first two steps of the cycle the heater is closed and the refrigerator open or active and in the last two steps of the cycle the heater is open and the refrigerator closed or inactive—that is, while drawing in and compressing air the regenerating or heating faces K L contact to close the heating-space, while the cooling-faces I′ J are separated to open or form a cooling-space. While exploding and exhausting the cooling-space is closed and the heating-space open. The corrugations shown at I′ J′ and at K′ L′ tend to form an extended surface for effective cooling and heating, as readily understood.

Neither the starting nor governing of the engine need be described, as they are well known in the art. In regard to ignition it may be noted that after the engine has started the opening of the regenerator in connection with the heat stored will cause the vaporization of the liquid fuel in case this is used and also ignite the suitably-compressed combustible, so that the igniter can then be put out of action.

Neither the method of injecting liquid fuel and apparatus therefor nor the method and apparatus for supplying a suitable explosive mixture of gaseous or vaporized fuel and air at the supply-port G are shown, as these are well known in the art.

Liquid fuel—such as petroleum, gasolene, or the like—has been mentioned in connection with the device; but it should be noted that vaporized or gaseous fuel can also be used, in which case a suitable explosive mixture of air and gas would be sucked in at supply-port G and the fuel or petroleum injecting pump and its connected parts would be dispensed with.

The corrugations or plates L K of the regenerator in course of time burn or are deteriorated or destroyed by the heat; but these parts can be readily slipped out and replaced by new ones, and by having these parts suitably separated or spaced by glass or an insulating layer from the receptacle or casing and from the displacer the casing and displacer are protected against excessive heating or destruction.

In the drawings is shown a single-acting piston F; but it is evident that by employing a second regenerator at the other end of cylinder E and using a stuffing-box on the piston-rod of fly-wheel T the engine can be made double-acting.

The cylinder E in this device can be cooled or water-jacketed the same as is customary in explosive-engines.

An advantage of this device is that the displacer has to travel but a slight distance—say a stroke of not more than one and a half inches—even for large engines—say twenty-horse power—and at the same time the corrugations provide extended or maximum active surfaces. It may also be noted that the displacer can be made to travel very rapidly—for example, one hundred and fifty complete movements per minute when the fly-wheel revolves at the rate of three hundred revolutions per minute—so that the heat absorbed during the exhaust remains impressed in great part upon the extended heating-surfaces for a short period—say one one-hundred-and-fiftieth of a minute—to be then transmitted to the fresh charge of fluid to which the heating-surfaces are exposed.

What I claim as new, and desire to secure by Letters Patent, is—

1. A combustion or explosive engine combined with a refrigerator and a regenerator or heater, said refrigerator and regenerator arranged parallel with one another and both opening into the combustion-chamber of the engine and mechanism substantially as described for opening the refrigerator and closing the regenerator while the engine is charging and compressing, and for closing the refrigerator and opening the regenerator while igniting and exhausting substantially as described.

2. An internal-combustion engine having a cylinder, a receptacle made to communi-

cate with said cylinder, a refrigerator and regenerator in said receptacle, and a displacer made to alternately contact with the refrigerator and regenerator, said engine having an entrance or charge opening and an exhaust substantially as described.

3. An engine having a cylinder and a receptacle provided with cooling and heating faces, a displacer having cooling and heating faces, and mechanism for shifting the displacer from and to contact with the receptacle-faces, said faces being corrugated or having ridged contact portions substantially as described.

4. An engine having a cylinder, a receptacle provided with a cooler and a heater, a shiftable displacer made to contact with the cooler and heater, and a water-jacket at said cooler substantially as described.

5. A cylinder provided with a supply-port, a regenerator and refrigerator opening at one end into the forward end of said cylinder, and a displacer forming the top wall of the refrigerator and the bottom wall of the regenerator.

6. A cylinder and piston combined with a shaft driven by the piston, a secondary shaft actuated at varying speed from the first-named shaft, a receptacle made to communicate with the cylinder, a port and combustible-supply for the cylinder actuated by the secondary shaft, and a refrigerating and regenerating displacer and exhaust for the receptacle actuated by such secondary shaft substantially as described.

7. An internal-combustion engine of the four-cycle type combined with a regenerator comprising interlocking and separating parts, and mechanism substantially as described for actuating the regenerator so as to cause the latter to control the instant of explosion or ignition of the suitably-compressed explosive mixture substantially as described.

8. An internal-combustion engine combined with a regenerator for storing heat, a refrigerator, said refrigerator and regenerator comprising interlocking or separating parts and mechanism substantially as described for actuating the refrigerator and the regenerator so as to cause the heated parts of the regenerator to ignite the suitably-compressed explosive mixture substantially as described.

9. An internal-combustion engine comprising a cylinder combined with a regenerator made to open permanently into the cylinder and having a liquid-fuel inlet and adapted for storing heat, and mechanism substantially as described for transversely actuating the regenerator so as to cause the heated parts of the same to vaporize and ignite the fuel substantially as described.

10. An internal-combustion engine of the four-cycle type provided with a regenerator and a refrigerator opening directly into one end of the cylinder of the engine, and a liquid-fuel inlet, combined with an exhaust-valve, a cam for opening said valve during the operation of the first part of the compression-stroke of the engine thereby allowing a portion of the air sucked in during the suction-stroke to escape through said exhaust-valve and then allowing said valve to close so that the remainder of said air will be compressed by said compression-stroke, substantially as described.

11. In an internal-combustion engine, a combined reciprocating regenerator and refrigerator opening into the cylinder of the engine.

12. An internal-combustion engine combined with a regenerator and a refrigerator communicating directly at one end with one end of the cylinder of an engine, and a shiftable displacer for alternately opening and closing said refrigerator and regenerator.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

J. S. ROGERS.

Witnesses:
CHAS. E. POENSGEN,
E. F. KASTENHUBER.