(No Model.)

J. HARGREAVES.

INTERNAL COMBUSTION THERMOMOTOR.

No. 436,781. Patented Sept. 23, 1890.

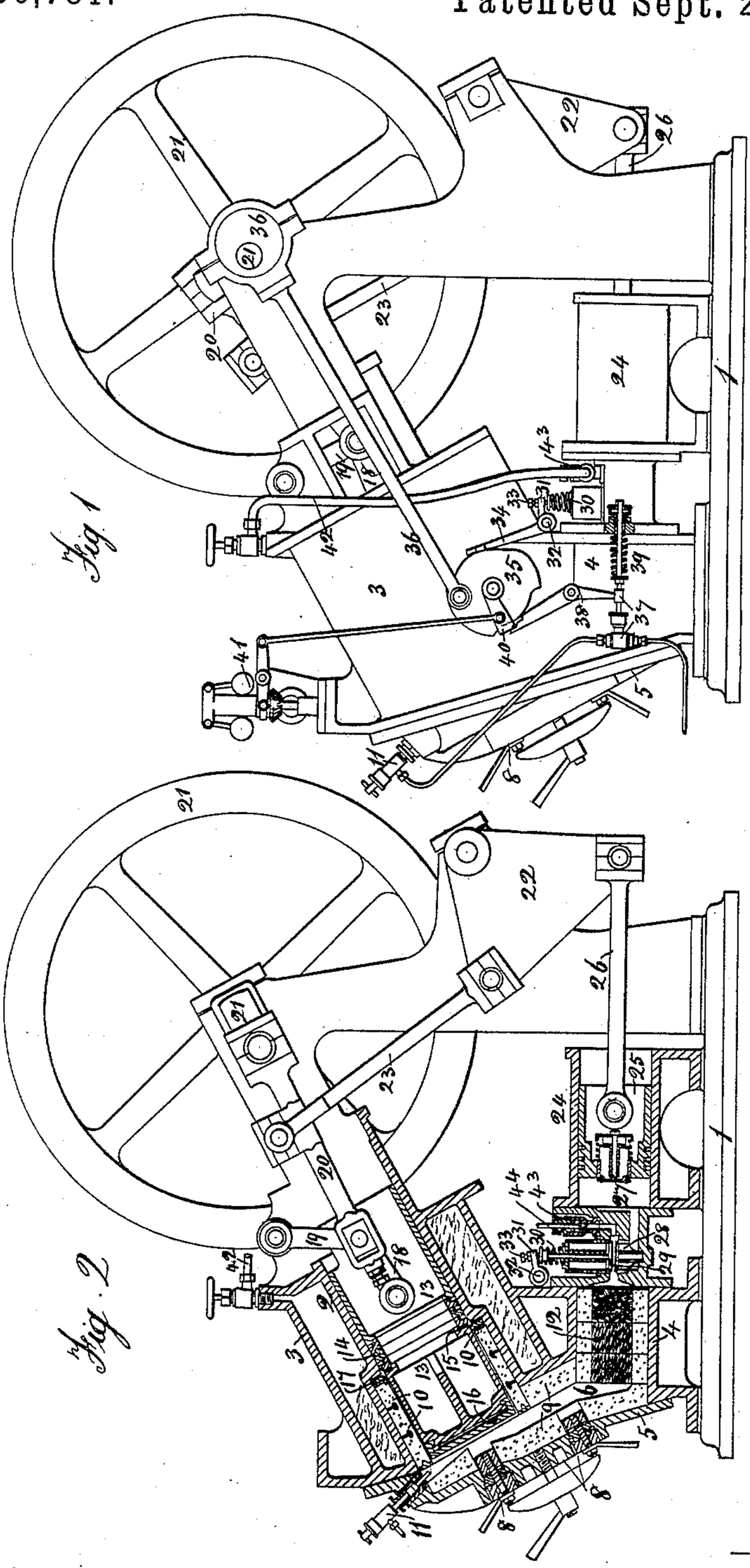

Fig. 1

Fig. 2

Witnesses

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JAMES HARGREAVES, OF FARNWORTH, ENGLAND.

INTERNAL-COMBUSTION THERMO-MOTOR.

SPECIFICATION forming part of Letters Patent No. 436,781, dated September 23, 1890.

Application filed February 24, 1890. Serial No. 341,386. (No model.) Patented in England July 30, 1888, No. 10,980; in France June 5, 1889, No. 198,738; in Belgium June 6, 1889, No. 86,540; in Italy June 7, 1889, No. 25,609; in Germany June 13, 1889, No. 50,570, and in Spain August 20, 1889, No. 9,676.

To all whom it may concern:

Be it known that I, JAMES HARGREAVES, chemical engineer, of Farnworth, in the county of Lancaster, England, have invented a new and useful Improvement in Internal-Combustion Thermo-Motors, (for which I have obtained a patent in Great Britain, No. 10,980, dated July 30, 1888; in France, No. 198,738, dated June 5, 1889; in Belgium, No. 86,540, dated June 6, 1889; in Germany, No. 50,570, dated June 13, 1889; in Italy, No. 25,609, dated June 7, 1889; in Spain, No. 9,676, dated August 20, 1889, and nowhere else;) and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to an improvement in motors which are driven by power obtained from the combustion of liquid or gaseous fuel and air within a working chamber or cylinder; and the object is to provide a motor which, while of simple construction and easily accessible in all its parts, shall to a large extent utilize in the performance of work the heat developed by combustion.

Figure 1 is an elevation, and Fig. 2 is a vertical longitudinal section, of my improved motor.

1 is the frame carrying the various parts of the motor.

2 is the working-cylinder cast or fitted with a jacket 3 and with a regenerator-chamber 4, which chamber and also the working-cylinder at the piston end are secured to the frame 1.

5 is a cover for the combustion end of the working-cylinder, formed so that there is a passage 6 between the regenerator-chamber 4 and the working-cylinder 2; 8, openings and doors to allow of access being obtained to the working-cylinder without removing the cover 5; 9, lining of refractory material to prevent too great transmission of heat to the metal when combustion takes place. The lining of the combustion end of the working-cylinder is made of blocks of refractory material held in position by rings 10, made with projections or grooves, so as to prevent displacement of the refractory material.

11 is apparatus of any suitable construction for allowing of the injection of fuel into the space between the cover 5 and the working-cylinder 2.

The regenerator 4 is filled with spirals 12 of refractory material. The spirals near the passage 6 are preferably formed into cylindrical blocks, while the opposite end is filled loosely with spirals or other forms of refractory material readily removable so that they may be cleaned from tar or carbonaceous matter.

13 is the working-piston, provided with packing-rings 14, and divided into two portions by a ring of non-conducting material 15, so that heat is not readily conveyed from one end of the piston to the other.

16 is a facing piece.

17 is a scraper-ring for removing tar or deposit from the piston.

18 is a link pivoted to the piston 13, to the radius-rod 19, and to the connecting-rod 20. By this arrangement side strain on the piston is much reduced.

21 is the crank, crank-shaft, and fly-wheel.

22 is a bell-crank lever pivoted to the frame 1 and actuated by a connecting-rod 23, coupled to the connecting-rod 20.

24 is an air-pump cylinder containing a plunger 25, coupled to the lever 22 by a connecting-rod 26.

27 is an air-admission valve.

28 is a discharge-valve, past which air flows into the regenerator-chamber 4.

29 is an exhaust-valve for products of combustion.

30 is a spring for keeping the valve 29 closed.

31 is an arm secured on a rocking shaft 32, and provided with an adjusting-screw 33.

34 is an arm secured to the rocking shaft 32 and resting against a cam 35.

36 is an eccentric and rod for giving motion to the cam 35.

37 is a pump and connections for forcing liquid feed through the injector 11.

Motion is given to the pump-plunger in one direction by means of a lever 38 actuated by the cam 35, and in the other direction by a spring 39.

40 is a rocking piece actuated by a cen-

trifugal governor 41, so that as the speed of the engine increases the said piece is placed in front of the lever 38 for a longer or shorter time, thus preventing the lever 38 from moving and the pump from supplying fuel to the injector.

42 is a pipe leading from the jacket 3 to a valve-box 43.

44 is a valve actuated by the cam 35, rock-shaft 32, eccentric 36, or other convenient part of the engine.

The space between the jacket 3 and cylinder 2 is partly filled with water.

To induce primary ignition for starting the motor, a lamp burning petroleum or other oil, or a gas-jet, is placed opposite the opening marked 8 on Fig. 2 of the drawings. A blast of air will cause intense combustion and make the regenerator, the port 6 leading thereto, and the refractory material 9 red-hot. When once red-hot, the door of opening 8 is closed and the engine started, the parts being once made red-hot, as specified, being sufficient to ignite the fuel injected.

When the motor is at work and the piston in the position shown, liquid fuel is injected into the space at the combustion end of the cylinder, while air is forced by the pump 24 through the regenerator to support combustion. When the piston, acted on by the products of combustion, has moved out and is beginning to return, the exhaust-valve 29 is opened and the products pass through the regenerator and escape. The heat imparted to the walls of the working-cylinder raises the temperature of the water between the jacket and cylinder to boiling-point and generates steam, which is admitted to the regenerator past the valve 44 at the same time that the air to support combustion is passing therethrough.

The pump 37 will be varied according as liquid or gaseous fuel is used.

In an application, Serial No. 341,385, filed by me on February 24, 1890, I show and describe an internal combustion motor having some of the parts of the motor herein described and illustrated, and I therein claim, *inter alia*, the following items: The combination of a combustion-chamber, regenerator, a water-jacket, an air-inlet leading to the water-jacket and thence to the regenerator; also, the combination, with these elements, of an air-force pump; also, the combination, with the combustion-chamber and regenerator connected by a passage, of a fuel-injector discharging into the passage; and therefore I do not herein claim any of said combinations.

I claim—

1. In an internal-combustion motor having a cylinder and piston and an air-pump, the combination therewith of connecting-rods for the pistons, and an interposed pivoted bell-crank lever for coupling the connecting-rods, substantially as and for the purposes specified.

2. In an internal-combustion motor, the combination, with a water-jacketed working-cylinder, an air-pump, and an interposed regenerator, of a valved steam-pipe, which connects the water-jacket of the cylinder with the passage leading from the air-pump to the regenerator to deliver steam into the air-current entering the regenerator from the pump, and gearing for actuating the valve from a moving part of the motor, substantially as and for the purposes specified.

3. The combination, with an internal-combustion motor, of a regenerator having that portion adjacent to the combustion-chamber of the motor closely packed with refractory blocks and its distant portion filled with loosely-packed removable blocks of refractory material, substantially as and for the purposes specified.

4. In an internal-combustion motor, the combination, with a cylinder having a refractory non-metallic lining and a regenerator arranged in juxtaposition therewith, of a cover common to both, said cover having a non-metallic refractory lining and adapted to couple the cylinder and regenerator by a direct channel or passage, substantially as and for the purposes specified.

5. In an internal-combustion motor, the combination, with a cylinder having a non-metallic refractory lining and a regenerator arranged in juxtaposition therewith, of a head or cover common to both, provided with a non-metallic refractory lining, and having doors or ports for access to the cylinder and channel leading thereto, substantially as and for the purposes specified.

6. In an internal-combustion motor, the combination of a water-jacketed cylinder, an air-pump for supplying the motor with air, and a port or passage which leads directly from the water-jacket of the cylinder and delivers into the air-passage leading from the air-pump to the motor, substantially as and for the purposes specified.

7. The combination, with an internal combustion motor, of a regenerator through which the outgoing products and incoming air pass, said regenerator divided into sections, one of said sections packed loosely with removable spirals of refractory material, and another packed closely with cylindrical blocks of refractory material, substantially as and for the purposes specified.

In testimony whereof I have hereunto set my hand this 25th day of November, 1889.

JAMES HARGREAVES.

Witnesses:
W. B. JOHNSON,
JAMES JOHNSON.