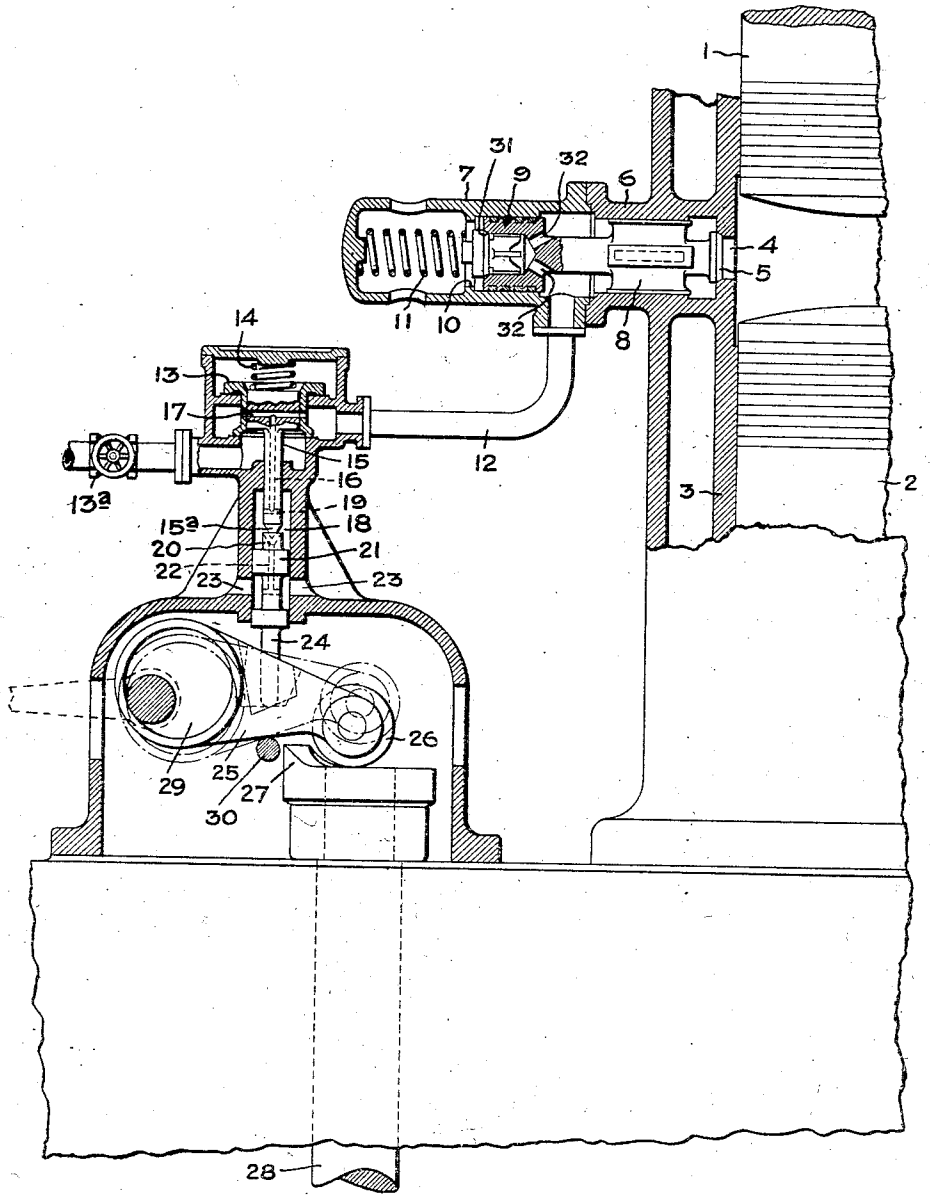
B. KRÄMER.

INTERNAL COMBUSTION ENGINE.

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1,122,009.

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

1,122,009. Specification of Letters Patent. Patented Dec. 22, 1914.

Application filed February 4, 1914. Serial No. 816,530.

To all whom it may concern:

Be it known that I, BERNHARD KRÄMER, a subject of the Emperor of Germany, residing at Charlottenburg, Germany, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention relates to internal combustion engines which have a valve for admitting fluid under pressure to a cylinder for starting the engine, which valve is yieldingly held on its seat so as to also act as a safety valve in case of excessive pressures. Such a valve may be termed a combined starting and safety valve and the object of the present invention is to provide in connection with such a valve an improved arrangement of parts for controlling and cooperating with the same in the performance of its various functions.

The various features of novelty of my invention will be pointed out in the course of the following specification wherein I have described what I now believe to be the best embodiment thereof, such embodiment being illustrated in the accompanying drawing.

In the drawing, the figure is a somewhat diagrammatic sectional view illustrating my invention.

In carrying out my invention I provide a spring seated starting valve for controlling the passage of fluid to the engine cylinder and connected to the stem thereof is the piston of a motor. This piston is actuated against the pressure of a spring to open the valve for starting the engine, by the starting fluid, a common conduit being provided for conveying the air to both the cylinder of the motor and to the region surrounding the admission valve. Arranged in the conduit and controlling the passage of starting fluid therethrough is a balanced controlling valve suitably biased to its closed position as by a spring, and adapted to be opened by a cam driven from the engine shaft. Operating in connection with the controlling valve is a second valve controlling an escape or pressure relieving passage through which the starting fluid conduit may be connected from a point between the controlling valve and the starting valve to atmosphere or other region of lower pressure. This second valve is likewise controlled from the engine shaft and is so arranged that it is always closed prior to the opening of the controlling valve and cannot open until the controlling valve has closed. By this arrangement during the starting of the engine the portion of the conduit between the controlling valve and the starting valve is alternately connected to the starting fluid supply and to a region of lower pressure, as to atmosphere, thereby permitting the use of a single conduit for starting purposes. During the normal running of the engine the relief passage remains connected to the region of the lower pressure. If, while running, an excessive pressure occurs in the engine cylinder, the starting valve will function as a safety valve, being forced open against the pressure of its spring. This will relieve the pressure, the gases escaping by way of the admission conduit and escape passage to the atmosphere or other region of lower pressure as the case may be. By this arrangement it will be seen that I utilize a single conduit both for the admission of starting fluid and for relieving the pressure due to any cause in the region of the starting valve. This escape passage is relatively restricted as will appear more fully hereinafter, but owing to the comparatively large capacity of the region surrounding the starting valve and the admission conduit it will ordinarily be sufficient to take care of and relieve all pressure occurring. In order to provide against an unduly high pressure and one which would not be safely taken care of by the escape passage, I provide a high pressure supplementary relief valve. In the form illustrated this valve is shown as being seated on the piston of the motor which operates the starting valve and is preferably pressed to its seat by the same spring which holds the starting valve seated. By this means a single spring performs both functions and a simple and compact structure results.

Referring now to the drawing by reference characters for a more detailed description of my invention, I have shown an internal combustion engine having oppositely moving pistons 1 and 2 working in cylinder 3. My invention is not, however, limited to this type of engine. Communicating with the cylinder 3 is an opening or port 4 having a seat for the outwardly opening starting and relief valve 5. The valve casing is formed preferably in two parts, the part 6

being cast integral with the cylinder and having fastened thereto the separately formed cap 7. Formed on the stem of the valve are guide members 8 and piston 9, which piston coöperates with the valve casing to form a motor for positively opening the valve 5. The travel of the piston 9, and hence that of the valve 5, is limited by a stop 10 which is conveniently in the form of an annular projection formed inside the valve casing. The valve 5 is held on its seat by the spring 11 arranged between the end of the cap 7 and the piston 9.

Communicating with the casing of the valve 5 is the conduit 12 which serves to supply the starting fluid to both the motor cylinder and to the region around the starting valve. I have shown the motor cylinder and the region around the starting valve as being in substance a single chamber. This is preferable as it permits of a simple compact structure and one having but a single conduit connection. Arranged in this conduit 12 is a balanced controlling valve 13 biased to the closed position as by spring 14, and a hand-operated shut-off valve 13ª. The stem 15 of a valve 13 has a longitudinally extending passage 16 therein communicating at the upper end with the conduit 12 by way of cross passage 17 and at the lower end with the cylinder 18 by way of cross passage 19. The end of the stem 15 is formed into a cone-shaped valve 15ª which engages the valve seat 20 carried by the piston 21. Extending longitudinally of the piston 21 is a passage 22 opening at one end into the valve seat 20 and at the other end to the atmosphere, or other region of lower pressure, by way of openings 23. The piston 21 carries a stem 24, the end of which is in engagement with the lever 25. This lever 25 carries a roller 26 coöperating with a crown cam 27 driven from the shaft 28. This latter may be any suitable shaft suitably driven by the engine. The lever 25 is pivoted on an eccentric 29 and as shown in full lines in the drawing normally rests against abutment 30. By rotating the eccentric 29 by a suitable handle, the lever 25 can be made to fulcrum on the abutment 30 and be thus moved to the dotted line position and out of operative relation to the cam 27.

With the parts as shown in the drawing, it will be noted that the conduit 12 is connected to the atmosphere by way of passages 17, 16, 19, cylinder 18, passage 22 and openings 23. I term this my pressure relieving passage and find that in general it is sufficient for relieving the pressures which occur in conduit 12 and the valve casing 6, due either to the starting fluid when starting the engine or to the pressure occurring when valve 5 opens owing to excessive cylinder pressure. In order to take care of very high pressure, however, which may occasionally occur, I provide a high pressure supplementary by-pass or relief valve which opens to connect the region around the starting valve directly to atmosphere. This valve is preferably seated on the piston 9, as shown at 31, and its face is subjected to the pressure in the valve casing 6 by way of the openings 32. By this arrangement I utilize the spring 11 which holds valve 5 on its seat for also holding the valve 31 on its seat, although I am not necessarily limited to such arrangement. Such an arrangement, however, has the advantageous already pointed out.

The operation is as follows: Assuming the parts to be in the position as shown in the drawing in full lines, the valve 13ª being closed, the engine if not in starting position will be cranked over to a position where the crown cam 27 raises lever arm 25. This first serves to raise stem 24 and piston 22 and cause the valve seat 20 to engage the cone-shaped valve 15ª on stem 15. Conduit 12 is now shut off from connection with atmospheric openings 23 but still connects with cylinder space 18. Upon further movement, the valve 13 is unseated, the roller 26 now resting substantially at the highest point of cam 27. The hand valve 13ª now being opened, starting fluid passes through controlling valve 13, and conduit 12 to the casing of the starting and relief valve 5. The relative relation of the surface of valve 5 and the strength of spring 11 to the surface of piston 9 is such as to cause the piston to be moved by the starting fluid to open the starting valve 5. This admits starting fluid between the engine pistons 1 and 2 causing the engine to turn over. When valve 13ª is opened to admit starting fluid to the conduit 12, starting fluid will at the same time pass by way of passages 16 and 19 to the cylinder 18, building up a pressure therein. As the engine turns over, cam 27 will be moved from under roller 26. Spring 14 will quickly force valve 13 on to its seat and the pressure in cylinder 18 will force piston 21 downward thereby forcing arm 25 to follow quickly the contour of the cam and removing valve seat 20 from the cone-shaped valve 15ª on stem 15. This connects conduit 12 by way of the pressure relief passage to a region of lower pressure as already explained, permitting the pressure in the valve casing 6 to escape and the spring 11 to quickly reseat valve 5. As the pistons 1 and 2 again reach the end of their inward stroke the cam 27 will again operate the arms 25 to cause the starting cycle as already explained to be repeated, as will be readily understood. The spring 11 is of such a strength as compared to the surface of the supplementary relief valve 31 exposed to the starting fluid pressure as not to permit of the unseating of the same, although it permits of the movement of pis-

ton 9 as already explained. The engine having been started, valve 13ª will be closed and arm 25 may be moved out of operative relation to cam 27. Conduit 12 will then be connected to atmosphere by way of the relief passages 17, 16, 19, 18, 22, 23. If now a dangerously high pressure occurs in the engine cylinder, the valve 5 will function as a relief valve, opening against the action of spring 11, which spring will quickly reseat the valve as soon as the excessive pressure is relieved. In view of the fact that the chamber between the valve 5 and piston 9 and the conduit 12 have quite some capacity, quite a large volume of high pressure gas can be taken care of by the relief passage. In case, however, the pressure is excessive, the supplemental relief valve 31 will open providing a direct connection to atmosphere.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In an internal combustion engine, the combination of a cylinder, a working piston, a starting valve, a conduit for conveying starting fluid to the valve, means whereby said valve is controlled by the starting fluid, a normally closed controlling valve in said conduit; a pressure relieving passage communicating with the conduit at a point between the starting valve and the controlling valve, a normally open valve controlling said passage, and automatic means for successively operating said controlling valve and last named valve to start the engine.

2. In an internal combustion engine, the combination of a cylinder, a working piston, a starting valve, a conduit for conveying starting fluid to the valve, means whereby said valve is controlled by the starting fluid, a normally closed controlling valve in said conduit, a pressure relieving passage communicating with the conduit at a point between the starting valve and the controlling valve, a normally open valve controlling said passage; and means for operating said controlling valve and said last named valve, said means arranged to close the last named valve prior to the opening of the controlling valve.

3. In an internal combustion engine, the combination of a cylinder, a working piston, a starting valve, a piston connected to the valve, a cylinder in which said second named piston works, a conduit for conveying starting fluid to the last named cylinder and to the region around said valve, a normally closed controlling valve in the conduit, a pressure relieving passage communicating with the conduit at a point between the starting valve and the controlling valve, and a normally open valve controlling said passage.

4. In an internal combustion engine, the combination of a cylinder, a working piston, a starting valve, a piston connected to the valve, a cylinder in which said second named piston works, a conduit for conveying starting fluid to the last named cylinder and to the region around said valve, a normally closed controlling valve in the conduit, a pressure relieving passage communicating with the conduit at a point between the starting valve and the controlling valve, a normally open valve controlling said passage, and means for operating said controlling valve and said last named valve, said means arranged to close the last named valve prior to the opening of the controlling valve.

5. In an internal combustion engine, a combined starting and relief valve, comprising a casing, a valve therein, a piston in the casing for opening the valve, a spring for normally holding the valve on its seat, a conduit for conveying starting fluid to the valve casing, a controlling valve in the conduit, a pressure relieving passage communicating with the conduit at a point between the valves, a valve for such passage, and means for controlling the two last named valves.

6. In an internal combustion engine, the combination of a cylinder, a working piston, a starting valve, a casing therefor, a conduit leading to the casing, and automatic means for alternately connecting the conduit to the supply of starting fluid and to a region of lower pressure to start the engine.

7. In an internal combustion engine, the combination of a cylinder, a working piston, a starting valve, a casing therefor, a conduit leading to the casing, means for alternately connecting the conduit to the supply of starting fluid and to a region of lower pressure, and means in said casing controlled by the starting fluid for opening the starting-valve.

8. In a combined admission and relief valve mechanism, a valve, a casing therefor, a piston for operating the valve, a valve seat carried by the piston, a valve seated thereon, and resilient means for holding said valves on their seats.

9. In a combined admission and relief valve mechanism, a valve, a casing therefor, a piston in the casing connected to the valve for operating it, a valve seat carried by the piston, a valve seated thereon, and a single spring bearing on the second named valve for holding both valves seated.

10. In an internal combustion engine, the combination of a cylinder, a working piston, a starting valve, a casing therefor, a piston

in the casing connected to the valve for operating it, a conduit leading to the casing for conveying starting fluid thereto, a pressure relieving passage for connecting the conduit to a region of lower pressure, and a supplemental relief valve associated with the valve casing.

11. In an internal combustion engine, the combination of a cylinder, a working piston, a starting valve, a conduit for conveying starting fluid to the valve, means whereby said valve is controlled by the starting fluid, a normally closed controlling valve in said conduit, a stem for said valve, a cylinder into which said stem extends, said stem having a passage therein connecting at one end with said conduit, and at the other end with the second named cylinder, a piston in the second named cylinder, a valve operated by such piston for controlling the passage of fluid from such cylinder to a region of lower pressure, and means controlled by the engine for moving the last named piston to first close the last named valve and then opening the controlling valve.

12. In an internal combustion engine, the combination of a cylinder, a working piston, a starting valve, a casing therefor, a conduit leading to the casing, means for alternately connecting the conduit to the supply of starting fluid and to a region of lower pressure, means in said casing controlled by the starting fluid for opening the starting valve, and a supplemental relief valve associated with the valve casing.

13. In an internal combustion engine, the combination of a cylinder, a working piston, a starting valve, a piston connected to the valve, a cylinder in which said second named piston works, a conduit for conveying starting fluid to the last named cylinder and to the region around said valve, a normally closed controlling valve in the conduit, a pressure relieving passage communicating with the conduit at a point between the starting valve and the controlling valve, a normally open valve controlling said passage, and a supplemental relief valve carried by the second named piston.

14. In a combined admission and relief valve mechanism, a valve, a casing therefor, a piston for operating the valve, a valve seat carried by the piston, a valve seated thereon, resilient means for holding said valves on their seats, a conduit connected to the casing, and engine controlled means for alternately connecting the conduit to the supply of starting fluid and to a region of lower pressures.

15. The combination with an internal combustion engine having a cylinder and working piston of a combined starting and relief valve therefor comprising a valve casing, an outwardly opening valve therein which is exposed to cylinder pressure, fluid actuated means for opening said valve to admit starting fluid to the cylinder, a conduit through which starting fluid is conveyed to the fluid actuated means, a controlling valve therein, a passage connecting the interior of the valve casing to a region of lower pressure, a normally open valve controlling the passage, and operating mechanism for the last named valves which operates to close the normally open valve and open the controlling valve.

16. The combination with an internal combustion engine having a cylinder and working piston of a combined starting and relief valve therefor comprising a valve casing, an outwardly opening valve therein which is exposed to cylinder pressure, fluid actuated means for opening said valve to admit starting fluid to the cylinder, a conduit through which starting fluid is conveyed to the fluid actuated means and the valve casing, a controlling valve therein, a passage connecting the interior of the valve casing to a region of lower pressure, a normally open valve controlling the passage, and operating mechanism for the last named valves which operates to close the normally open valve prior to the opening of the controlling valve.

In witness whereof, I have hereunto set my hand this 14th day of January, 1914.

BERNHARD KRÄMER.

Witnesses:
HEINRICH DECHAMPS,
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