Dec. 26, 1922. 1,439,798.

H. M. CRANE.

COMPRESSION RELIEF DEVICE FOR INTERNAL COMBUSTION ENGINES.

FILED JULY 9, 1921.

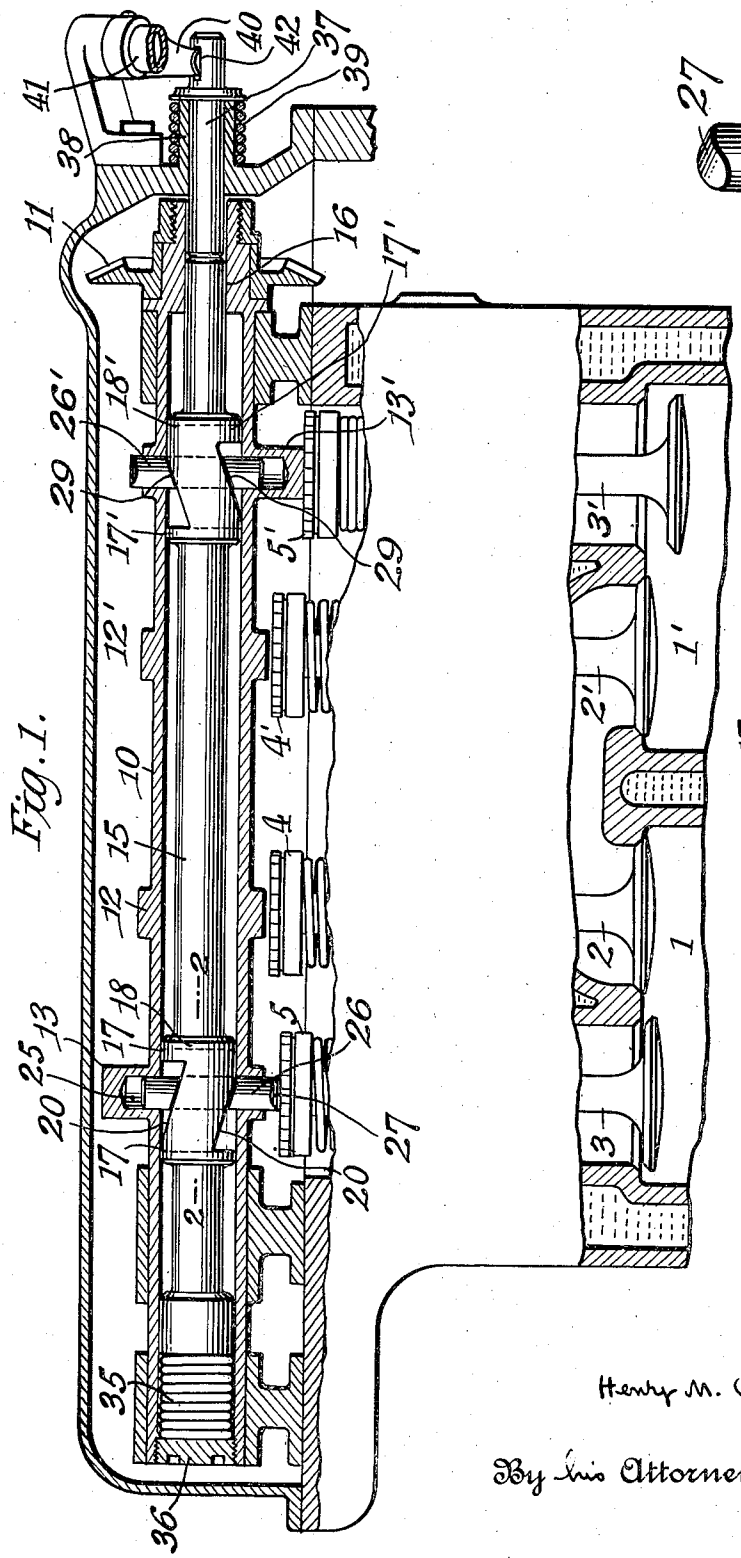



Fig. 1.

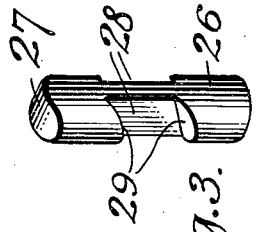



Fig. 3.

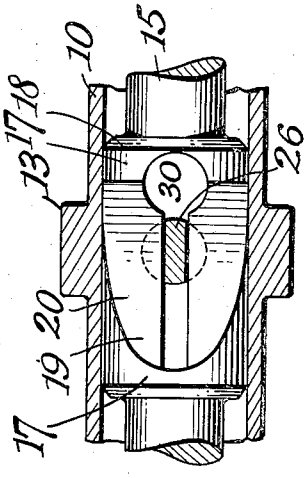



Fig. 2.

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By his Attorney. Stephen H. Phillips.

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# UNITED STATES PATENT OFFICE.

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## COMPRESSION-RELIEF DEVICE FOR INTERNAL-COMBUSTION ENGINES.

Application filed July 9, 1921. Serial No. 483,637.

*To all whom it may concern:*

Be it known that I, HENRY M. CRANE, a citizen of the United States, residing in borough of Manhattan, city, county, and State of New York, have invented new and useful Improvements in Compression-Relief Devices for Internal-Combustion Engines, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to a compression relief device for facilitating the starting of internal combustion engines.

A very serious and important difficulty in starting internal combustion engines is caused by the fact that in order to turn the crank shaft of the engine sufficient force must be applied to compress the gas within one of the cylinders. In a four-cycle engine, for example, during one stroke of each piston both the intake and exhaust valves are closed, so that if an attempt is made to turn the crank shaft of the engine during this stroke sufficient effort must be applied to compress the gas contained in the cylinder in which both valves are closed. In engines having four or more cylinders the compression is always taking place in one or another of the cylinders, so that at no time can the crank shaft be turned without overcoming the compression resistance.

In accordance with the present invention, movable auxiliary mechanism is provided which serves to vent each cylinder to the atmosphere only during its compression stroke. The auxiliary mechanism is provided with a control by which it may be thrown into action during starting and thrown out of action when the engine has started.

By means of the invention the compression of each cylinder may be relieved, so that the crank shaft may be turned with facility in starting the engine, while at the same time the explosive mixture drawn into the cylinders during their intake strokes is not diluted and consequently the initial explosion may easily be obtained. This relief of the compression may take place during a whole or a part of the compression stroke.

While the invention may advantageously be used in connection with all types of internal combustion engines, including both four-cycle and two-cycle engines, it has peculiar advantages when applied to airplane engines. When so used, it not only facilitates the starting of the engine when the airplane is on the ground, but facilitates the starting of the engine when the airplane is in the air, and when the propeller is turned solely by means of the air resistance upon it, occasioned by a steep dive.

Various different mechanisms may be used to carry out the invention. In the device shown in the accompanying drawings, the desired results are obtained by means of a movable auxiliary cam member incorporated in the cam which operates the exhaust valve and arranged so that the operator may position it to form, on the exhaust cam, an auxiliary cam surface which serves to hold the exhaust valve open during the compression stroke of each piston.

In the drawings:—

Fig. 1 is a sectional elevation of the valve operating mechanism of an internal combustion engine showing auxiliary valve members and means for operating them;

Fig. 2 is a sectional plan view of one of the exhaust valve cams and associated mechanism, taken on the line 2—2 of Fig. 1; and

Fig. 3 is a perspective view of one of the auxiliary cam members.

As shown in the drawings, two engine cylinders 1 and 1′ are each provided with an intake valve 2, 2′, and an exhaust valve 3, 3′. As is customary, the valves are provided with valve stems having at their upper ends cam followers, 4, 5, 4′, 5′, and springs for retaining the cam followers in contact with cams and holding the valves normally closed.

Above the valves is mounted a cam shaft 10 provided with a gear 11 by means of which it is driven from the crank shaft of the engine by means of the usual connecting gearing which is not shown in the drawing. Upon the outer surface of the cam shaft 10 are formed two cams 12, 12′ which cooperate with the cam followers 4, 4′ to open the intake valves 2, 2′ during the intake stroke of each piston in the usual manner. Upon the cam shaft are formed also two cams 13, 13′ which cooperate with the cam followers 5, 5′ to open the exhaust valves 3, 3′ during the exhaust stroke of each piston.

The cam shaft 10 is made hollow and within it is located mechanism for opening the exhaust valves during the compression stroke. This mechanism includes an axially

slidable rod 15 in the hollow cam shaft 10. One end of the rod has a running fit in a bore 16 of reduced diameter in one end of the cam shaft 10. The rod has enlarged portions 18, 18′ which lie within the portions of the hollow cam shaft 10 bearing the exhaust cams 13, 13′. The enlarged portions 18, 18′ have near each of their ends cylindrical surfaces 17, 17′ which have a running fit in the inner surface of the hollow shaft 10 and serve to retain the rod 15 in axial position. Between its bearing surfaces 17, the enlarged portion 18 is provided with a diametrically extending slot 19, and with two parallel surfaces 20, each of which is inclined to the axis of the cam shaft. The enlarged portion 18′ is provided with a similar slot and inclined surfaces.

The cam 13 is provided with a blind transverse hole 25, which is bored in from the part of the surface of the cam which is in contact with the cam follower 5 during the compression stroke in the cylinder 1. In the hole 25 is located the auxiliary cam member 26 which, as shown in Fig. 3, is in the form of a pin. Upon the outer end of the auxiliary cam member 26 is formed a cam surface 27 which is parallel to the axis of the cam shaft 10. In the central part of the cam member 26 are two opposite grooves 28, each having parallel upper and lower surfaces 29 which are inclined to the axis of the cam shaft at the same angle as the inclined surfaces 20 of the enlarged portion 18 of the rod 15. For the purposes of convenient assembly, the rod 15 may contain a transverse hole 30 at the right of the inclined surfaces 20. When the rod 15 is moved to the left, the hole 30 becomes in alignment with the hole 25. The auxiliary cam member 26 is then inserted in the slot 19 of the enlarged portion 18 with its inclined surfaces 29 in engagement with the inclined surfaces 20. When the auxiliary cam member has been placed in the slot 19 its engagement with the sides of the slot and with the hole 25 in the cam 13 prevents the rod 15 from turning relatively to the cam shaft 10. The engagement of the cam member in the slot 19 serves also to prevent the cam member from turning in the hole 25, and thus retains its cam surface 27 parallel to the axes of the cam shaft.

It is apparent that when the rod 15 is pushed to the left, as shown in Fig. 1, the cooperating inclined surfaces 20, 29 of the enlarged portion 18 and the auxiliary cam member 26 will move the auxiliary cam member diametrically of the cam shaft 10, so that its cam surface 27 projects beyond the periphery of the exhaust cam 13, forming an auxiliary cam surface upon the cam 13 which will cooperate with the cam follower 5 to open the exhaust valve 3 during the compression stroke in the cylinder 1. The parts are then in position for starting the engine. When, on the other hand, the rod 17 is moved to the right, the inclined surfaces will draw the auxiliary cam member 26 into the bore 25 in the cam 13 so that its cam surface 27 does not extend beyond the periphery of the cam 13. In this, the running position, the auxiliary cam member 26 will not contact with the follower 5 so that the exhaust valve will be opened only during the exhaust stroke in the cylinder 1.

The auxiliary cam member 26′ in the cam 13′ is mounted and operated in the same way as the auxiliary cam member 26.

Controlling means are provided for effecting a longitudinal movement of the rod 15 at the will of the operator. In the form of control shown in the drawing, the rod 15 is normally held in running position by a compression spring 35 reacting between one end of the rod and of the plug 36 in the end of the hollow shaft 10. A plunger 37 slidably mounted in the casing 38 may be projected into the end of the hollow shaft 10 and against one end of the rod 15. A compression spring 39 holds the plunger 37 normally out of contact with the rod and outside the hollow shaft 10. An arm 40 mounted upon the control shaft 41 extends into a slot 42 near the outer end of the plunger 37. Suitable linkage, or other means, are provided for enabling the operator to turn the shaft 41 so as to cause the arm 40 to push the plunger 37 against the rod 15.

The use of the device described is as follows:—When the operator desires to start the engine, he rotates the shaft 41 so as to cause the plunger 37 to push the rod 15 to the left, Fig. 1, causing the cooperating inclined surfaces to project the auxiliary cam members 26, 26′ beyond the peripheries of the exhaust cams 13, 13′. The crank shaft of the engine is then turned over or rotated and during this operation the cam surfaces of the auxiliary cam members form auxiliary cam surfaces upon the exhaust cams which serve to open the exhaust valve of each cylinder during the compression stroke in that cylinder. Consequently, only such force as is necessary to overcome the friction of the moving parts need be applied in turning the crank shaft. At the same time the proper mixture is drawn into each cylinder during its intake stroke so that an explosion is quickly secured. As soon as the explosions begin, the operator releases the shaft 41, whereupon the spring 39 throws the plunger 37 to the right, Fig. 1, drawing it out of the hollow shaft 10 so that it does not contact with any moving part. At the same time the compression spring 35 pushes the rod 15 to the right, Fig. 1, which causes the cooperating inclined surfaces to draw the auxiliary cam members 26, 26′ into the exhaust cam 13, 13′ so that they do not contact with the

cam followers 5, 5′, and the normal operation of the exhaust valve is secured.

It is apparent from the above description that the device shown in the drawings possesses a number of important advantages. The mechanism is extremely simple and adds little, if anything, to the weight of the engine. The operation of the auxiliary cam members involves no movement of the cam shaft, thus making it possible to retain a bevelled gear drive for the cam shaft. The mechanism causes no friction during the running of the engine, and only a very slight friction, namely, that between the abutting ends of the rod 15 and the plunger 37 during the starting of the engine. Obviously, the invention may be incorporated in many forms of mechanism other than the one here described. For example, the auxiliary cam member may be located on the cam shaft at a point other than within the exhaust cam.

What I claim is:

1. In an internal combustion engine, the combination with valve operating mechanism including a cam and cam follower arranged to open the exhaust valve during the exhaust stroke, of a movable auxiliary cam member located within the cam shaft, controlling means arranged to project said auxiliary cam member outwardly beyond the peripheral surface of said cam, and means for drawing said member inwardly so that it does not project beyond the peripheral surface of the cam.

2. In an internal combustion engine, the combination with valve operating mechanism including a cam and cam follower arranged to open the exhaust valve during the exhaust stroke, of a movable auxiliary cam member located within the cam shaft, and controlling means arranged to project said auxiliary cam member outwardly beyond the peripheral surface of said cam and also to draw said member inwardly so that it does not project beyond the peripheral surface of the cam.

3. In a compression relief device for internal combustion engines, the combination with a hollow cam shaft and a cam upon the exterior of said cam shaft, of an auxiliary cam member located in a transverse hole in said cam and having at one of its ends an auxiliary cam surface, a longitudinally movable member within said cam shaft, adapted to move said auxiliary cam member transversely of the cam shaft so as to project its auxiliary cam surface beyond the periphery of the cam, and means for moving said longitudinally movable member in either direction.

4. In a compression relief device for internal combustion engines, the combination with a hollow cam shaft and a cam upon the exterior of said shaft and containing a transverse hole, of a longitudinally movable member within the cam shaft and containing a transverse slot, and an auxiliary cam member located in said hole and extending through said slot, said cam member and said longitudinally movable member having cooperating surfaces inclined to the axis of the cam shaft and adapted to move said cam member transversely of the cam shaft.

5. In a compression relief device for internal combustion engines, the combination with a hollow cam shaft and a cam on the exterior of said shaft and containing a transverse hole, of a longitudinally movable member in the cam shaft containing a transverse slot and having at the ends of said slot parallel surfaces inclined to the axis of the shaft, and an auxiliary cam member located in said hole and engaging the inclined surfaces of said longitudinal member.

6. In a compression relief device for internal combustion engines, the combination with a hollow cam shaft, of an auxiliary cam member mounted in said cam shaft, a longitudinally movable rod mounted within said cam shaft, means whereby a longitudinal movement of said rod causes a movement of said auxiliary cam member transversely of the cam shaft, and means for causing a longitudinal movement of said rod in either direction.

7. In a compression relief device for internal combustion engines, the combination of a hollow cam shaft, an auxiliary cam member in said cam shaft, a longitudinally movable rod mounted within said cam shaft and controlling the position of said auxiliary valve member, a spring tending to move said rod in one direction, a slidable plunger at one end of said cam shaft, means for projecting said plunger into the end of said cam shaft and into contact with said rod to move the rod against the opposition of said spring, and a spring tending normally to withdraw said plunger from the cam shaft and retain it out of contact with said rod.

8. In a compression relief device for internal combustion engines, the combination of a hollow cam shaft, an auxiliary cam member in said cam shaft, a longitudinally movable rod mounted within said cam shaft and controlling the position of said auxiliary valve member, a spring tending to move said rod in one direction, a slidable plunger at one end of said cam shaft, and means for projecting said plunger into the end of said cam shaft and into contact with said rod to move the rod against the opposition of said spring.

HENRY M. CRANE.