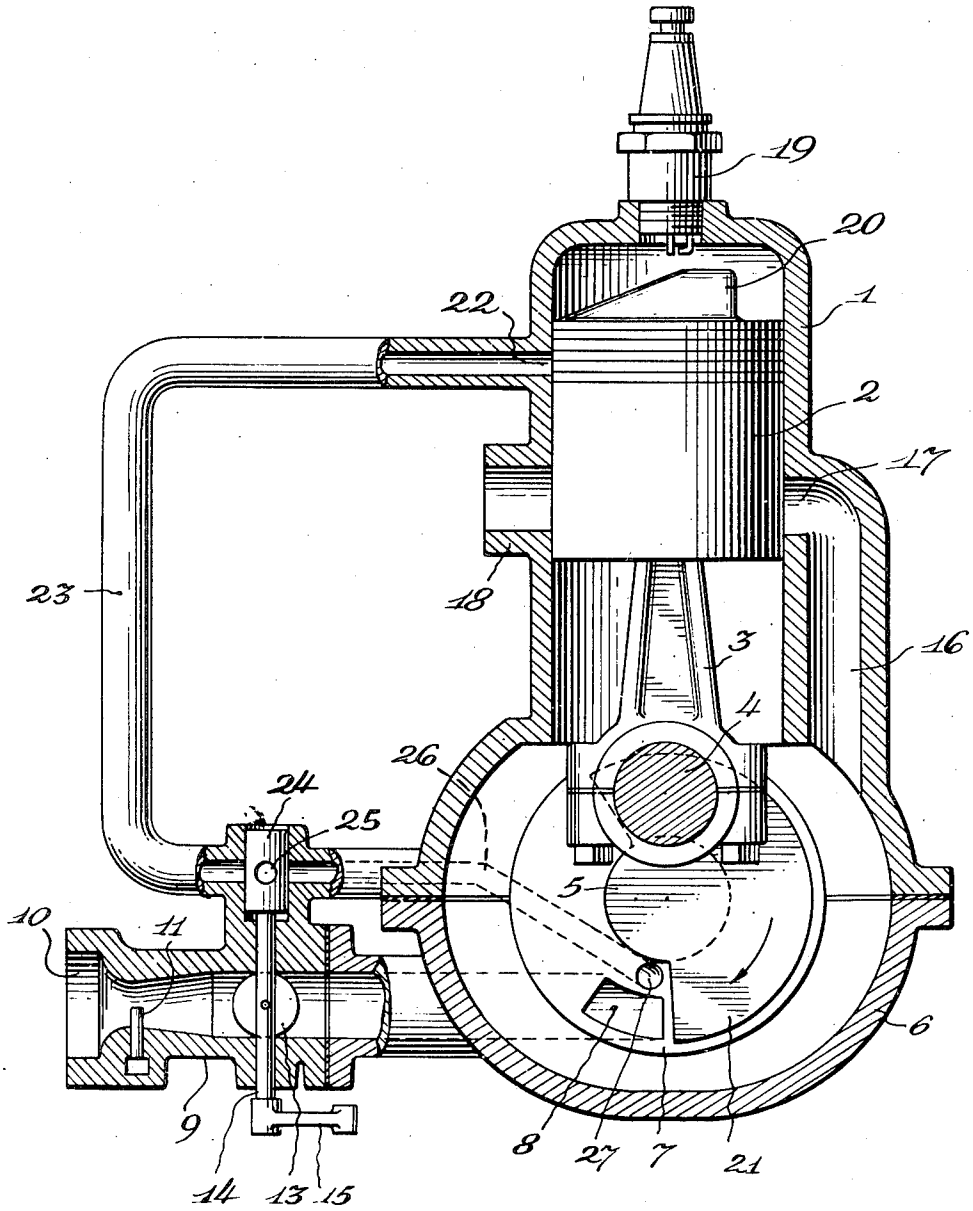
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TWO-CYCLE ENGINE AND METHOD OF OPERATING SAME

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TWO-CYCLE ENGINE AND METHOD OF OPERATING SAME

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My invention relates to two cycle engines and to a method of operating the same.

In a conventional two cycle engine of the internal combustion type, the stroke of the piston which creates a compression of the combustible mixture in the engine cylinder also creates a suction in the crank case, and this suction is utilized to draw a mixture of fuel and air thereinto through the usual carburetor. On the succeeding or power stroke of the piston, this mixture is compressed in the crank case and is transferred from the crank case to the engine cylinder as the piston approaches the end of its power stroke and for a brief period thereafter. The rush of combustible mixture under the pressure created in the crank case is relied upon to cleanse the cylinder of burned gases and to force all such gases out of the exhaust port.

The power and speed of such engines are usually controlled by regulating the quantity of combustible mixture drawn into the engine crank case. When the engine is idling or operating at low speed under light load, the quantity of combustible mixture drawn into the crank case is materially reduced. Likewise the pressure produced in the crank case for transferring this combustible mixture to the engine cylinder is also reduced. The result is that a lesser quantity of combustible mixture is supplied to the engine cylinder under a lesser pressure and poorer scavenging results. These factors make it difficult, if not impossible, to cause such an engine to idle smoothly at low speed and also interfere with smooth low speed operation at light load. An object of my invention is to overcome these difficulties.

Another object of my invention is to provide a novel means and method to increase the charge of combustible mixture supplied to the engine cylinder at idle and under low speed, low load conditions.

Another object of my invention is to provide a novel means and method to increase the pressure at which the combustible mixture is supplied to the engine cylinder at idle and under low speed, low load conditions.

Another object of my invention is to provide a novel means and method to relieve the engine cylinder prior to combustion of part of its charge of combustible mixture when the engine is operating at idle or under low speed, low load conditions.

Another object of my invention is to provide a novel means and method to vary the quantity of combustible mixture released from the engine cylinder prior to combustion inversely with the

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load requirements of the engine and to eliminate such relief entirely when not desired.

Other objects and advantages will become apparent as the description proceeds.

In the drawing the single figure is a sectional view through a two cycle engine embodying a preferred form of my invention.

The engine shown in the drawing has a cylinder 1 provided with a piston 2 which is shown in the top dead center position. A connecting rod 3 connects the piston 2 to the crank 4 of crank shaft 5 suitably carried in bearings of any desired construction. The crank case 6 has a flat surface 7 provided with a fuel supply port 8 communicating with the carburetor 9. The carburetor 9 has an air inlet 10, a high speed fuel jet 11, and the usual idling jets (not shown) so that suction created in the crank case 6 by the upward stroke of the piston 2 draws a combustible mixture into the crank case by way of the port 8. The carburetor 9 is provided with the usual throttle valve 13 for controlling the quantity of combustible mixture drawn into the crank case 6. The throttle valve 13 is mounted on a rotatable shaft 14 provided with an arm 15, which may be connected to any suitable manual or automatic control.

The crank case 6 communicates with the cylinder 1 by way of a transfer passage 16 and inlet port 17 and the burned gases are discharged through an exhaust port 18 which may be connected to any suitable muffler or underwater exhaust outlet if desired. The combustible mixture is ignited by the usual spark plug 19 and the piston 2 is provided with a conventional deflector 20 to facilitate scavenging of the engine cylinder. The crank shaft 5 is provided with a cheek 21 which serves as a rotary valve to control communication between the fuel inlet port 8 and the interior of the crank case 6. This cheek or valve 21 is so arranged that during most of the down or power stroke of the piston, such communication is cut off, but during most of the up or suction stroke of the piston, this port is open so that combustible mixture may be drawn into the crank case 6. The parts thus far described are conventional.

I provide the cylinder 1 with a relief port 22 for permitting part of the charge of combustible mixture delivered to the cylinder to escape from the cylinder prior to combustion. This port 22 communicates with a conduit 23 controlled by a rotary relief valve 24 attached to the upper end of the throttle valve shaft 14 and rotatable therewith. The relief valve 24 is illustrated as being in the form of a cylinder having a cross bore 25 which is out of communication with the conduit

23 when the throttle valve 13 is in the open position shown in the drawing. When the throttle valve is in the idle position, the cross bore 25 establishes communication between the conduit 23 and a duct 26 leading to a port 27 located in the flat surface 7 of the crank case 6 and opening into this crank case. This port 27 is also controlled by the cheek 21 of the crank shaft so that in general this port is closed during the power stroke of the piston and is open during the return stroke of this piston.

The operation of my new and improved two cycle engine is as follows: When the engine is operating at full load and the throttle valve is fully open as shown in the drawing, the rotary valve 24 cuts off communication between conduit 23 and duct 26 so that the relief port 22 is inoperative and the engine operates like any conventional two cycle engine of this type. On the other hand, when the engine is idling and the throttle valve 13 is in nearly closed position, cross bore 25 is in substantial alignment with conduit 23 and duct 26 and provides free communication therebetween. While the throttle valve 13 is in idle position, it reduces the quantity of combustible mixture drawn into the crank case on each upward stroke of the piston but for scavenging purposes this is compensated for by return of combustible mixture to the crank case through the relief port.

On the power stroke of the piston, the combustible mixture in the crank case is compressed and when the piston uncovers the port 17, this combustible mixture flows into the cylinder by way of transfer passage 16 and port 17. A greater charge of combustible mixture under higher pressure is delivered to the cylinder than in the ordinary engine and this charge properly scavenges the cylinder of all burned gases which are discharged through the exhaust port 18. On the upward stroke of the piston, part of the combustible mixture is returned to the crank case by way of port 22, conduit 23, cross bore 25, duct 26 and port 27 until the upward motion of the piston closes the relief port 22. Thereafter, the mixture in the cylinder is compressed and is fired by the spark plug 19 in the usual manner. The combustion of the mixture forces the piston downward on its power stroke but the cheek 21 closes port 27 and prevents any escape of gases through the relief port 22 after the piston uncovers this relief port.

The position of the relief port 22 may be varied to give different engine operating characteristics, and I have found that a desirable location is to position this port so that the degree of compression resulting in the cylinder is that which gives the desired idling operation. As the throttle valve is moved toward open position more mixture is drawn into the crank case on each upward stroke of the piston but communication between conduit 23 and duct 26 is gradually restricted and then completely cut off. The point at which this cut off occurs and the rate of restriction of this communication can be varied to secure different operating characteristics. I have found that excellent operation is attained where this cut off occurs at approximately half throttle.

The part of the combustible mixture which is returned to the engine crank case may carry with it some burned gases and for some purposes this might be undesirable. This can be avoided if the duct 26 discharges to atmosphere instead of into the crank case. With such an arrangement it would be necessary to provide an additional rotary valve on the crank shaft located outside of the crank case for controlling communication between the duct 26 and atmosphere in the same manner in which the crank cheek 21 controls communication between this duct and interior of the crank case. Such discharge of combustible mixture to atmosphere would be less economical of fuel and would also tend to reduce the degree of compression attained in the crank case. This latter disadvantage could be overcome by arranging the throttle valve so that for any setting of the control within the operating range of the relief valve, more mixture would be drawn into the engine crank case by the suction created therein.

While I have illustrated and described my invention as applied to a common type of two cycle engine wherein the fuel mixture is drawn into the crank case by suction created therein by operation of the piston, my invention is not limited to this type of engine. In some engines a blower is used to force air into the crank case and create the necessary flow through the carburetor to provide the combustible mixture of fuel and air. In such an arrangement the duct 26 could either discharge into the blower inlet where maximum fuel economy is desired or could discharge to atmosphere where fuel economy is less important than preventing burned gases from entering the crank case. In either form the outlet end of duct 26 would be controlled by a rotary valve attached to the engine crank shaft.

In the particular form of engine shown, the crank cheek 21 controls communication between the carburetor and the interior of the crank case, and it is convenient to use this same cheek to control communication between the duct 26 and the interior of the crank case. In other engines, it is common to provide other means for controlling communication between the carburetor and interior of the crank case and in such other engines a special crank cheek or other form of rotary valve would be driven by the crank shaft for controlling communication between the relief duct 26 and the interior of the crank case.

While I have illustrated only a single form of my invention, it is to be understood that my invention may assume numerous forms and includes all variations and modifications coming within the scope of the appended claims.

I claim:

1. An internal combustion engine of the two cycle type comprising a cylinder, a piston operating therein, a crank case for holding combustible mixture under pressure, means for supplying combustible mixture to said crank case, means for varying the rate at which combustible mixture enters said crank case, a transfer passage connecting asid crank case and cylinder, an exhaust port for said cylinder, a relief port for said cylinder located between said port and top dead center position for said piston, a valve controlling said relief port and operated by said last named means, and a second valve controlling said relief port and operated in timed relation with said piston.

2. An internal combustion engine of the two cycle type comprising a cylinder, a piston operating therein, a crank case for holding combustible mixture under pressure, means for supplying combustible mixture to said crank case, means for varying the rate at which combustible mixture enters said crank case, an inlet port for said cylinder, an exhaust port for said cylinder, a relief port for said cylinder located between said ports

and top dead center position for said piston, a valve controlling said relief port and operated by said last named means, a second valve controlling said relief port and operated in timed relation with said piston, and means connecting said inlet port with said crank case.

3. An internal combustion engine of the two cycle type comprising a cylinder, a piston operating therein, a crank shaft to which said piston is connected, a crank case enclosing part of said shaft and adapted to have combustible mixture compressed therein, a carburetor for supplying a combustible mixture to said crank case, a port controlling communication between said carburetor and crank case, means rotatable with said crank shaft controlling said port, a throttle valve controlling said carburetor, a transfer passage connecting said crank case and cylinder, a relief port for said cylinder through which unburned mixture may be discharged, a conduit connecting said port with said crank case, said conduit having an outlet and controlled by said rotatable means, and a second valve controlling said conduit and operably attached to said throttle valve.

4. A two cycle engine comprising a cylinder having a head at one end and inlet and exhaust ports spaced from said head, a piston reciprocal in said cylinder and effective to control said ports, said piston movable from a position adjacent said head to a position uncovering said ports, a crank shaft connected to and driven by said piston, a crank case associated with said cylinder and adapted to hold a combustible mixture of fuel and air under pressure, means providing a passage connecting said crank case with said inlet port, means for supplying a mixture of fuel and air to said crank case, a throttle valve for variably controlling said supply, means for controlling communication between said crank case and said supply means, a relief port for said cylinder, a valve associated with said throttle valve for variably controlling discharge through said relief port, and a second valve preventing escape of fluid through said relief port during the power stroke of said piston.

5. A two cycle engine comprising a cylinder having a head at one end and opposed inlet and exhaust ports spaced from said head, a piston reciprocal in said cylinder and effective to control said ports, said piston movable from a position adjacent said head to a position uncovering said ports, a crank shaft connected to and driven by said piston, a crank case associated with said cylinder and adapted to hold a combustible mixture of fuel and air under pressure, means providing a passage connecting said crank case with said inlet port, means for supplying a mixture of fuel and air to said crank case, a throttle valve for variably controlling said supply, a valve including a part rotating with said crank shaft for controlling communication between said crank case and said supply means, a deflector carried by said piston for directing fuel and air entering said inlet port toward said cylinder head, a relief port located between the first-named position of said piston and said other ports, a valve associated with said throttle valve for variably controlling discharge through said relief port, and a second valve preventing escape of fluid through said relief port during the power stroke of said piston.

6. A two cycle engine comprising a cylinder having a head at one end and opposed inlet and exhaust ports spaced from said head, a piston reciprocal in said cylinder and effective to control said ports, said piston movable from a position

adjacent said head to a position uncovering said ports, a crank shaft connected to and driven by said piston, a crank case associated with said cylinder and adapted to hold a combustible mixture of fuel and air under pressure, means providing a passage connecting said crank case with said inlet port, a carburetor for supplying a mixture of fuel and air to said crank case, a throttle valve for variably controlling said supply, a valve including a part rotating with said crank shaft for controlling communication between said crank case and said supply means, a deflector carried by said piston for directing fuel and air entering said inlet port toward said cylinder head, a relief port located between the first-named position of said piston and said other ports, a valve associated with said throttle valve for variably controlling discharge through said relief port, a second valve preventing escape of fluid through said relief port during the power stroke of said piston, and a conduit connecting said relief port and crank case.

7. A two cycle engine comprising a cylinder having a head at one end and opposed inlet and exhaust ports spaced from said head, a piston reciprocal in said cylinder and effective to control said ports, said piston movable from a position adjacent said head to a position uncovering said ports, a crank shaft connected to and driven by said piston, a crank case associated with said cylinder and adapted to hold a combustible mixture of fuel and air under pressure, means providing a passage connecting said crank case with said inlet port, means for supplying a mixture of fuel and air to said crank case, a throttle valve for variably controlling said supply, a deflector carried by said piston for directing fuel and air entering said inlet port toward said cylinder head, a relief port located between the position of said piston nearest said cylinder head and said other ports, a valve associated with said throttle valve for variably controlling discharge through said relief port, a conduit connecting said relief port and crank case, and common means controlling communication between said crank case and said conduit and said supply means.

8. That method of operating a two cycle engine under varying speed and load conditions which comprises supplying an excess of combustible mixture to the engine cylinder when the engine is operating at minimum speed and no load, releasing part of said mixture from the cylinder prior to combustion, compressing and burning the mixture remaining in the cylinder, increasing the supply of combustible mixture to the engine cylinder and simultaneously reducing the proportion of said mixture released from said cylinder prior to combustion, and further increasing the supply of combustible mixture to said cylinder and cutting off the release of combustible mixture therefrom prior to combustion.

9. That method of operating a two cycle engine which comprises supplying a greater quantity of combustible mixture to the engine at idling speed than is required to furnish the power necessary to operate the engine, releasing from the cylinder a part of the combustible mixture prior to combustion and compressing and burning the mixture remaining in the cylinder, and increasing the quantity of combustible mixture supplied to the engine cylinder to increase the power output of the engine while reducing the amount of mixture released from the cylinder prior to combustion.

10. That method of operating a two cycle engine which comprises supplying a quantity of

combustible mixture, compressing said mixture prior to introduction into the engine cylinder, releasing from the cylinder a part of the combustible mixture prior to combustion, compressing and burning the mixture remaining in the cylinder, varying the quantity of combustible mixture supplied to the engine to provide primary speed and power control, and varying the quantity of combustible mixture released from the cylinder prior to combustion to provide secondary speed and power control, and maintaining a fixed relationship between the variation in quantity of combustible mixture supplied to the engine and the variation in quantity of combustible mixture released from the cylinder prior to combustion.

11. That method of operating a two cycle engine which comprises supplying a quantity of combustible mixture, compressing said mixture prior to introduction into the engine cylinder, releasing from the cylinder a part of the combustible mixture prior to combustion, compressing and burning the mixture remaining in the cylinder, varying the quantity of combustible mixture supplied to the engine to provide primary speed and power control, and inversely varying the quantity of combustible mixture released from the cylinder prior to combustion to provide a secondary speed and power control, and maintaining a fixed relationship between the variation in quantity of combustible mixture supplied to the engine and the variation in quantity of combustible mixture released from the cylinder prior to combustion.

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