June 17, 1952 D. H. SMITH 2,600,440

PISTON CONSTRUCTION FOR INTERNAL-COMBUSTION ENGINES

Filed May 17, 1950 2 SHEETS—SHEET 1

Fig. 1.

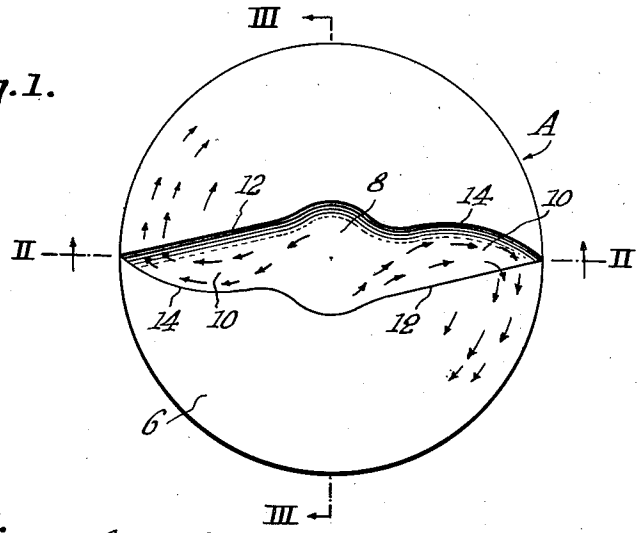


Fig. 2.

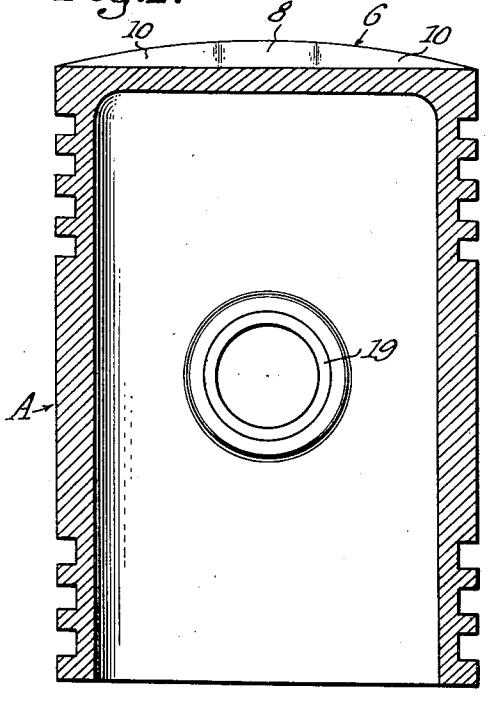
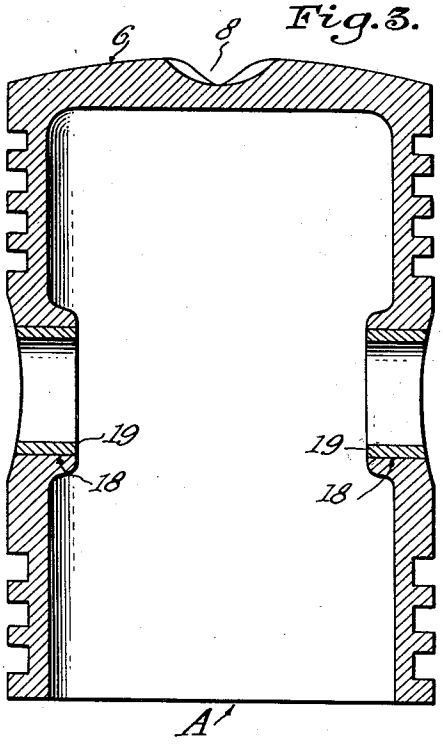


Fig. 3.



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Fig. 4.

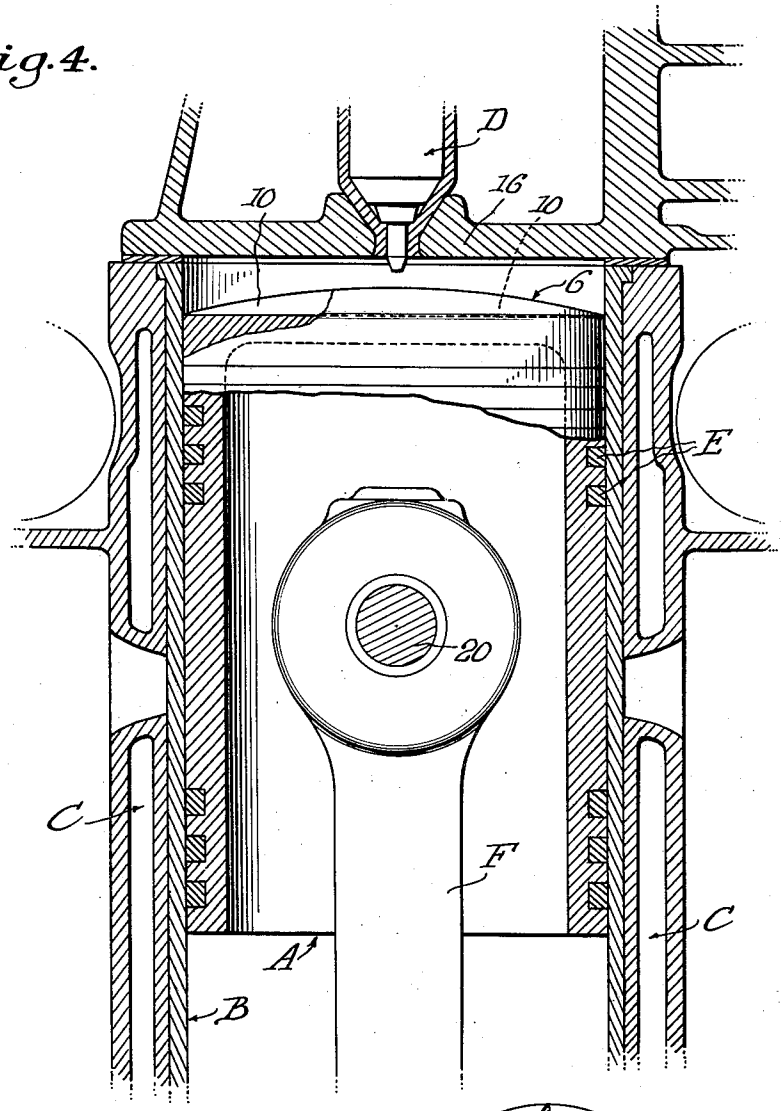


Fig. 5.

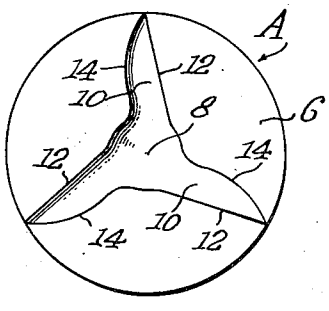
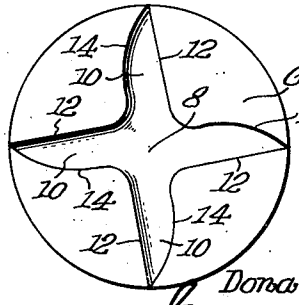


Fig. 6.



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PISTON CONSTRUCTION FOR INTERNAL-COMBUSTION ENGINES

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5 Claims. (Cl. 123—32)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without payment to me of any royalty thereon.

In the standard constructions of internal combustion engines, particularly such engines of the diesel type, it not infrequently happens that operating efficiencies of the engines are impaired by carbon deposits on the piston head which act to increase the pressures between the cylinder head and piston with attendant impaired operating efficiencies, as well as carbon deposits on the injector nozzle which require frequent cleaning thereof, such frequent cleanings requiring corresponding interruptions to the operating service of the engine. A further difficulty from operating standpoints lies in the tendency of the injector nozzles to become burned-off frequently during service. Such frequent interruptions to service obviously should be eliminated, but prior to the present invention, no efficient means have been devised which actually accomplish their intended purpose.

The present invention provides an improved construction of internal combustion engine pistons which overcomes the foregoing difficulties as demonstrated by prolonged operating periods of the engine without formation of carbon deposits on the pistons and without any burning of the injector nozzles in any of the cylinders of the engine. It will be apparent as the description proceeds that the improved construction of the invention is applicable primarily to diesel engines, although not necessarily limited thereto, as advantageously the construction is applicable to internal combustion engines generally as preventing carbon deposits on the piston with attendant compressional difficulties in the cylinders, which will be transmitted in various ways to other operating conditions existent in the engine.

Generally speaking, the improved construction of this invention is dependent upon the causing of controlled movements of the combustion gases away from the injector nozzle of the respective cylinders, thereby eliminating burning of the injector nozzles, with a controlled swirling action produced in such combustion gases which cleanses the top of the piston and prevents the formation of carbon thereon; and illustrative embodiments of the invention are illustrated in the accompanying drawings, in which

Fig. 1 is a plan view showing the top surface

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of a piston embracing the principles of the improvements of the present invention;

Fig. 2 is a sectional elevation of the piston taken on the line II—II of Fig. 1, looking in the direction of the arrows;

Fig. 3 is a view similar to Fig. 2, but taken on the line III—III of Fig. 1, looking in the direction of the arrows;

Fig. 4 is a fragmentary sectional elevation of the piston as shown in Fig. 2, the piston being shown in its cylinder with the piston rod attached thereto; and

Figs. 5 and 6 show modifications of the embodiment of the invention shown in Fig. 1, which modifications, however, produce results similar to those obtained by the embodiment of Fig. 1.

The drawings show the construction of a piston for a diesel-type internal combustion engine, although when the features are embodied in pistons for internal combustion engines generally, improved operating results are obtained especially from the standpoint of elimination of carbon deposits on the top surface of the piston.

Referring more particularly to the drawings, the improved piston of the present invention is designated at A, shown as operating in cylinder B having cooling jackets C and a fuel injection nozzle D opening through the top end of the cylinder B and directing fuel against the top surface of the piston A. The piston A is provided with the usual piston rings E and is connected to piston rod F in a suitable manner which will be mentioned hereinafter.

The top surface 6 of the piston A is provided with the improvements of this invention. This top surface 6 is domed in configuration as is clearly shown on the drawings, the injected fuel from the fuel injection nozzle D being directed into a cup-shaped recess 8 in the center of the domed top surface 6, from which recess 8 extends radially away from the cup to the edge of the piston head, fluted grooves or channels 10, which may be diametrically oppositely disposed as indicated in Figs. 1 and 4, or equally spaced around the central cup recess 8, as shown by Figs. 5 and 6. Each of the radially extending channels 10 has a substantially straight side 12 and an arcuate side 14, such being on opposite sides of adjacent channels, as will be seen from the drawings.

The domed top surface 6 has a radius of approximately twice the diameter of the piston, and the clearance between the cylinder head 16 and the top of the piston head dome 6 is much

less than the clearance between the cylinder head 16 and the radial channels 10. The combustion gases, following the path of least resistance, are directed along the fluted channels 10, where the arcuate sides 14 of the channels start the gases swirling around the domed top surface 6 of the piston. This swirling action accomplishes three results:

1. The swirling action directs the hot gases of combustion away from the injection nozzle D, and eliminates burning of the nozzle.

2. The swirling action of the gases cleanses the top of the piston and prevents carbon from forming on the top of the piston.

3. The domed and grooved piston head 6 results in increased volumetric efficiency.

In constructing the improved piston, the radius of the domed head 6 is approximately twice the diameter of the piston, as has been mentioned above, and each of the radially extending grooves or channels 10 has one substantially straight side and one arcuate side, as also has been mentioned above, while the diameter of the central cup recess 8 is approximately one-fourth the diameter of the piston. The arcuately curved side 14 of the channels 10 has a radius slightly longer than the radius of the central cup recess 8. The aforesaid shape of the channels 10 and the aforesaid proportions are found to be rather critical in practice, as any substantial departure from these specifications will result in a loss of the desired swirling action and an increase in uncontrolled turbulence. Preferably, two oppositely disposed radially extending channels projecting diametrically oppositely from the cup-shaped recess 8 are provided, this cup-shaped recess 8 being located in the center of the domed piston head 6 and directly beneath the injection nozzle D. While it is preferred to provide two oppositely disposed, radially extending fluted channels as shown in the embodiment of Figs. 1, 2, 3 and 4, the desirable effects of the invention are obtained by using more than two of such fluted grooves, as illustrated in the embodiments shown in Figs. 5 and 6, Fig. 5 showing three of such grooves and Fig. 6 showing four thereof. In all embodiments of the construction, the fluted grooves open into the central cup-shaped recess 8 and are disposed at equal distances therearound. With reference to the embodiments of the construction shown in Figs. 5 and 6, it may be mentioned that a loss in efficiency increases in proportion to the number of fluted grooves employed above two, because of the proportionate loss of control of the swirling action, while if only one such groove be used, an unbalanced condition exists. However, it is found that the embodiments of Figs. 5 and 6 are operative for the desired purpose. Optimum operating conditions are obtained, however, by the use of two diametrically oppositely disposed fluted grooves of the type shown in Figs. 1, 2, 3, and 4, with the use of proportions as indicated above. It may be noted that the piston A is provided with oppositely disposed holes 18 provided with bushing linings 19 for the reception of a pin 20 for attachment of the piston rod F, in the usual manner.

It may be noted that the improved piston of the present construction has been tested experimentally by the military establishment of the United States, the form of the piston shown in Figs. 1, 2, 3 and 4 being used in all six cylinders of a diesel-type engine manufactured by General Motors Corporation, Model No. 671, for a period of three months. During such service, no replacement of any of the injector nozzles was required, there was increased volumetric efficiency and there were no deposits of carbon formed on the piston head, whereas in the case of comparative pistons of the usual construction, without the present improved features, during the same period of service under similar service conditions, replacements of the injector nozzles were required every fifty or sixty hours because of burning of the nozzle tips and carbon deposits on the pistons were heavy.

An important result, therefore, attained by the present improved piston construction, is the controlled swirling action of the gases obtained by the provisions of the oppositely directed, radially extending, fluted grooves or channels which prevent formation of carbon deposits on the piston head because of the controlled swirling action produced in the gases by the present construction as compared with uncontrolled turbulence produced by various prior art constructions; also, the burning of the injector nozzles is obviated by the present improved construction; and while, as has been indicated herein, the invention is capable of modification of structural details, this controlled swirling action of the gases is an important feature of the present invention as distinguished from an uncontrolled turbulence, and so long as there is obtained a controlled swirling action which leads the gases radially outwardly away from the injector nozzle, it will be understood that such accomplishment is considered to lie within the scope of the present invention; and, therefore, it will be understood that it is intended and desired to embrace within the scope of the invention such modifications and changes as may be necessary to adapt it to varying conditions and uses, as defined by the appended claims.

Having thus described my invention, what I claim as new and wish to secure by Letters Patent is:

1. In a piston assembly for internal combustion engines including a cylinder having a cylinder head provided with a fuel injection nozzle, and a piston operating in the cylinder, the improvements which include a convexedly-domed piston head for the piston provided with a cup-shaped recess opposite to the injection nozzle, and a plurality of fluted, equally spaced, radially extending channels leading from the cup-shaped recess to the periphery of the piston head for producing a controlled swirling action of the gases in the cylinder for eliminating burning of the injector nozzle and carbon deposits on the piston head.

2. In a piston assembly for internal combustion engines including a cylinder head provided with a fuel injection nozzle extending through the cylinder head into the cylinder, and a piston operating in the cylinder, the improvements which include a convexedly-domed piston head for the piston provided with a cup-shaped recess opposite to the injection nozzle, and a plurality of outwardly directed, equally spaced fluted channels extending radially from the cup-shaped recess to the periphery of the piston head, each channel having a substantially straight side and an arcuate side, the straight side of one channel being oppositely disposed relatively to the arcuate side of an adjacent channel and the arcuate side of the first-mentioned channel being oppositely disposed relatively to the straight side of the adjacent channel, whereby hot gases are conveyed from the

said recess outwardly through the channels radially away from the injection nozzle with a controlled swirling movement for preventing burning of the injection nozzle with a controlled swirling movement for preventing burning of the injection nozzle and formation of carbon deposits on the piston head.

3. In a piston assembly for internal combustion engines including a cylinder head provided with a fuel injection nozzle extending through the cylinder head into the cylinder, and a piston operating in the cylinder, the improvements which include a convexedly-domed piston head for the piston provided with a cup-shaped recess opposite to the injection nozzle, and a plurality of outwardly directed, equally spaced fluted channels extending radially from the cup-shaped recess to the periphery of the piston head, each channel having a substantially straight side and an arcuate side, the said sides of one channel being in opposition relative to the corresponding sides of an adjacent channel for leading hot gases in an outward direction radially away from the injection nozzle, the dome of the piston head having a radius approximately twice the diameter of the piston, the cup-shaped recess having a diameter approximately one-fourth the diameter of the piston, the arcuate side of each channel having a radius somewhat larger than the cup-shaped recess, and the clearance between the cylinder head and the dome of the piston head being smaller than the clearance between the cylinder head and the channels whereby hot gases are educted outwardly away from the injection nozzle in a controlled swirling motion for eliminating burning of the injection nozzle and formation of carbon deposits on the piston head.

4. In a piston assembly for internal combustion engines including a cylinder head provided with a fuel injection nozzle extending through the cylinder head into the cylinder, and a piston operating in the cylinder, the improvements which include a convexedly-domed piston head for the piston provided with a cup-shaped recess opposite to the injection nozzle, and a pair of diametrically, oppositely disposed, outwardly directed, fluted channels extending radially from the cup-shaped recess to the periphery of the piston head, each channel having a substantially straight side and an arcuate side, the said sides of one channel being arranged oppositely relatively to the corresponding sides of the other channel of the said pair for leading hot gases in

an outward direction radially away from the injection nozzle, the dome of the piston head having a radius approximately twice the diameter of the piston, the cup-shaped recess having a diameter approximately one-fourth the diameter of the piston, the arcuate side of each channel having a radius somewhat larger than the cup-shaped recess, and the clearance between the cylinder head and the dome of the piston head being less than the clearance between the cylinder head and the channels, whereby hot gases are educted outwardly from the injection nozzle in a controlled swirling motion for eliminating burning of the injection nozzle and formation of carbon deposits on the piston head.

5. In a piston assembly for internal combustion engines including a cylinder head provided with a centrally disposed fuel injection nozzle extending through the cylinder head into the cylinder, and a piston operating in the cylinder, the improvements which include a convexedly-dome piston head provided with a centrally disposed, cup-shaped recess opposite to the injection nozzle, and equally spaced, outwardly directed, fluted channels extending radially from the cup-shaped recess to the periphery of the piston head, each channel having a substantially straight side and an arcuate side, the said sides of one channel being arranged oppositely relatively to the corresponding sides of a next adjacent channel for leading hot gases in an outward direction away from the injection nozzle, the said fluted channels imparting a controlled swirling motion to the gases for eliminating burning of the injection nozzle and formation of carbon deposits on the piston head.

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