Dec. 13, 1938. A. SCHWARZ 2,139,977

CYLINDER HEAD FOR INTERNAL COMBUSTION ENGINES

Filed July 22, 1936 2 Sheets-Sheet 1

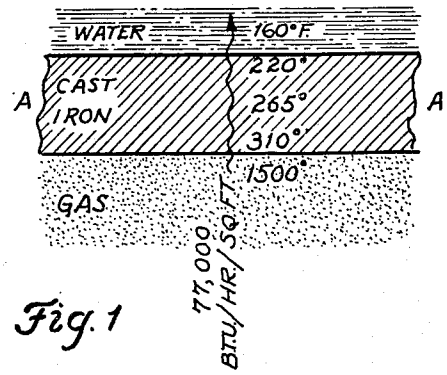


Fig. 1

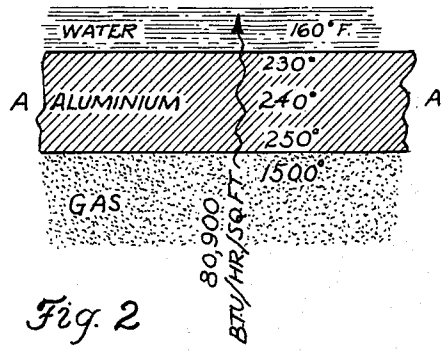


Fig. 2

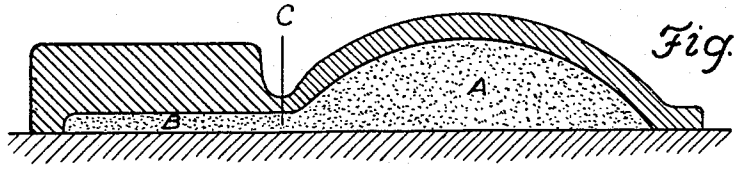


Fig. 3

Fig. 4.

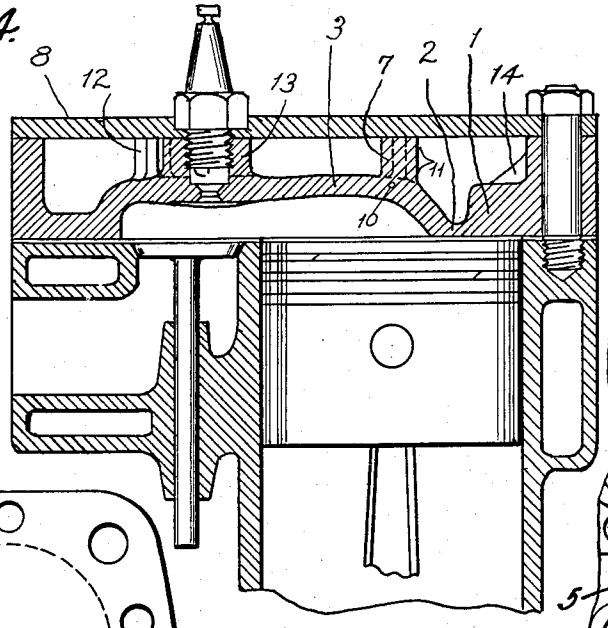


Fig. 5.

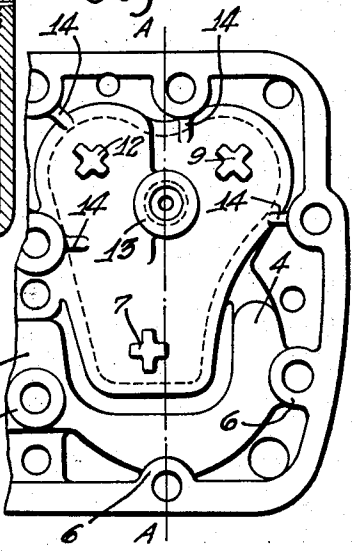
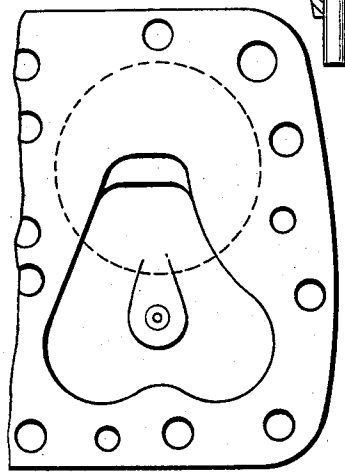


Fig. 6.



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CYLINDER HEAD FOR INTERNAL COMBUSTION ENGINES

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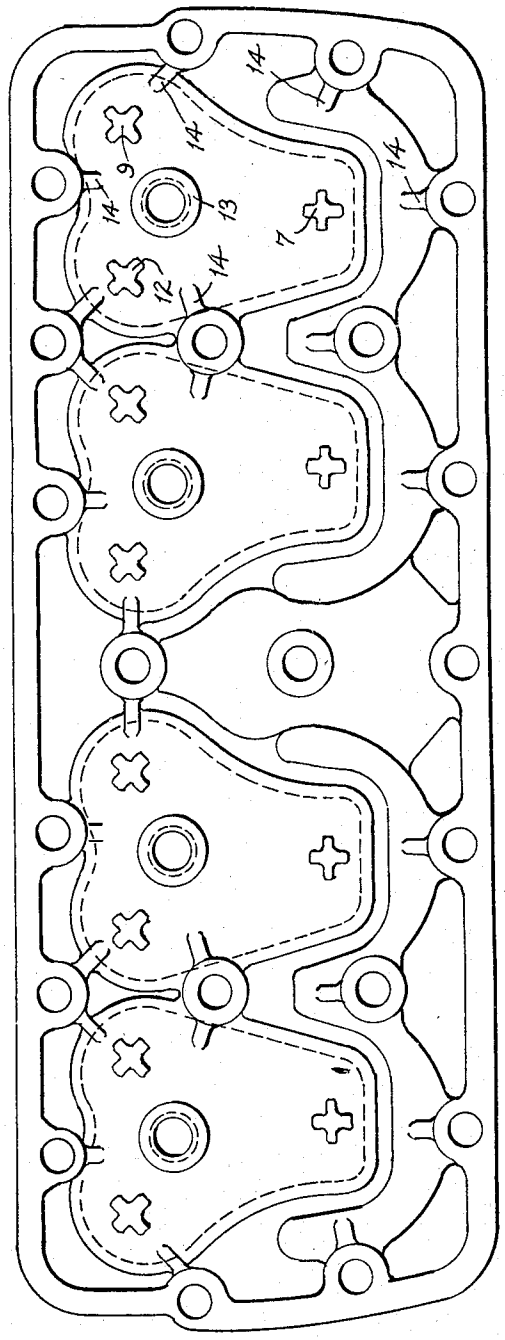


Fig. 7

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Patented Dec. 13, 1938 2,139,977

UNITED STATES PATENT OFFICE

2,139,977

CYLINDER HEAD FOR INTERNAL COMBUSTION ENGINES

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Application July 22, 1936, Serial No. 92,047

3 Claims. (Cl. 123—173)

It is the object of the present invention to construct a cylinder head to conform with the thermal requirements of the engine, particularly for high compression ratios, and combine therewith structural stability.

Heat transfer and structural design are inseparable in an internal combustion engine, particularly so in high speed engines where the time element is limited for a certain necessary amount of radiation. The total radiation area is also limited for a given sized motor, as is the cubical content of the cylinder head for a given compression ratio. All of the factors must be coordinated with the type of metal used for the construction of the cylinder head, because of the widely varying heat transfer abilities of different metals.

It is the object of the present invention to design a cylinder head, transferring the proper amount of heat into the cooling medium during the various parts of the cycle, and yet maintaining the structural stability necessary to withstand the explosion pressure.

In co-pending application No. 680,365 filed July 14, 1933, I have described a method of heat balancing cylinder heads, to correct a limitation of compression ratios which I have determined experimentally. In which experiments I have found that compression ratios are limited by the hottest and coolest portions of the cylinder head.

It has been found that maximum compression, which as is well known will give maximum power and economy, can only be obtained if the cylinder head is substantially of uniform temperature. Such temperature is limited to below the auto-ignition temperatures of the particular fuel used.

It had been determined previously that different sections of standard cylinder heads differed more than one hundred degrees, even during extended continuous operation, and that auto-ignition took place in hotter sections, while the cooler sections caused a secondary detonation, due to a delay in burning up to a period where a broadly developed flame-front set off the remaining charge too fast. Uniform temperatures established in accordance with my previous application, permitted increased compression ratio, and as a result, increased power and economy were obtained. It became a difficult matter to obtain maximum results with a metal of high heat conductivity, because the most desirable minimum cross sections caused structural weakness.

The present invention contemplates to use sections of the cylinder head which require greater cross sections for heat balancing purposes, also for structural purposes, and where such is not permissible, reinforcements are used, and are so designed as to maintain the desired radiation capacity or heat storage, as the case may be.

As is generally known, aluminum is a metal of high heat conductivity and often used for cylinder heads. For the purpose of an example, I will assume that the head is to be made from aluminum, in which case some of the sections required for proper heat balance and radiation capacity are not sufficiently strong to withstand the explosion pressure, which in gasoline engines is approximately 500 lb. per sq. inch, and the average area of a cylinder head may be taken as 15 sq. inches, so that the total explosion pressure exerted against the cylinder head wall is somewhere around 6000 lbs.

Referring now to the drawings there follows below a description of the figures thereof:

Fig. 1 is a fragmentary sectional view of a cast iron plate for use as a cylinder head.

Fig. 2 is a view similar to that of Fig. 1, but showing an aluminum plate.

Fig. 3 is a sectional view through a portion of a cylinder head.

Fig. 4 is a sectional view of a cylinder head taken on line A—A of Fig. 5.

Fig. 5 is a bottom plan view of the cylinder head of Fig. 4.

Fig. 6 is a plan view of the cylinder head viewed from the combustion chamber side, with the cylinder location indicated by a dotted line.

Fig. 7 is a plan view showing a cylinder head for use on a four cylinder motor.

Most metals, particularly aluminum, fatigue with age, and become weaker under increased temperatures, so that it is not uncommon for aluminum cylinder heads to break, although theoretically they may be designed to withstand the pressure. Since it is desirable to use aluminum as a wall for the combustion chamber, the present invention contemplates to use a fairly heavy steel to form the water jacket, and to reinforce the aluminum combustion chamber plate in such sections where increased heat storage is desirable, and to reinforce the aluminum plate in such places where increased sections are not permissible, by connections to the water jacket cover plate so designed to maintain the proper radiation, as far as the combustion is concerned, and to obtain the increased necessary strength by making said cover plate of sufficient strength and suitable design to carry the extra load. We therefore have the heat balanced combustion

chamber plate reinforced by increased sections, to establish heat storage and reinforce where a minimum heat storage is required by connections to a water jacket cover plate, said connections being so designed to maintain same radiation as the plate would have without the reinforcement post. This is done by placing cooling fins on the post.

To illustrate what I mean by heat storage, I show in Fig. No. 1 an iron plate 3/8" thick. The temperatures given are reasonable average temperatures, and are in agreement with co-efficients of heat transfer from gas to metal, and metal to water, also taking into consideration the conductivity factor of the metal. The cast iron plate Fig. No. 1, having a gas at a temperature of 1500° F. on one side, and on that side, the surface temperature will be 310° F. The mean temperature will be 265° F., and the water temperature is taken as 160° F., which is standard in gas engine testing practice. Under such conditions the heat transfer from the gas to the water will be 77,000 B. t. u. per hour per sq. ft. while the heat storage is 1320 B. t. u. at an intake temperature of 100° F.

Fig. No. 2 shows an aluminum plate of the same thickness, and under the same identical condition the heat throughput is 80,900 B. t. u. per hour per sq. ft. The mean temperature is 240° F. The inner surface temperature is 250° F., and the surface exposed to the water is 230° F. The heat storage per sq. ft. is 785 B. t. u.

Comparing the two conditions we have in cast iron, a flow of heat of 310° F. to 220° F. through 3/8", which is a differential of 90° F., while in the aluminum plate we have for the same thickness, only a differential of 20° F., which indicates that the flow in the direction of AA in iron is much slower than in aluminum. In other words all the sections of an aluminum cylinder head will be more uniform. The heat retention capacity of aluminum is much smaller than iron, namely, only 785 B. t. u. per sq. ft. 3/8" thick, while it is 1320 B. t. u. for cast iron. As has been seen before, the heat throughput through aluminum is much greater, and this latter fact would indicate a lower thermal efficiency for the aluminum head. However, looking at Fig. No. 3, which represents a cross section of the charge of an L head motor, we find that space A has a much greater capacity than space B. It stands to reason therefore that the wall section over A is heated much more than the section over B. Since every combustible only ignites when its heat of ignition is reached, section A will burn faster than section B, which causes a secondary explosion in section B, which assumes the proportion of detonation.

I place over section B a greater metal thickness, thereby increasing the heat storage in the metal, giving some heat back to the new charge during compression. The shock wall C having been found by measurements always to be the hottest, is made of a particularly thin section. The exhaust valve region is always hotter than the intake valve region, and I therefore decrease the section over the exhaust valve, and increase same over the intake valve. All of this can be readily determined by taking readings with constantan iron thermal couples embedded into the cylinder head wall. Such readings will only have to be taken once for a specific engine to determine the best cylinder head design.

Actual brake H. P. tests have shown beyond any question that a very material increase in H. P. is obtained with the above described cylinder head design. The drawings show as follows: Fig. No. 4 shows a cross section through the cylinder head AA. Fig. No. 5 shows a plan view of one cylinder and valve chest from the side of the water jacket. Fig. No. 6 shows a plan view of the cylinder head from the combustion chamber side, with the cylinder location indicated by a dotted line. The dimensions in Fig. No. 4 will give the required wall thickness over various sections for an aluminum casting. At No. 1 the wall thickness is $\frac{9}{16}$, at No. 2 the thickness is $\frac{3}{8}$, at No. 3 the thickness is 1/4". In Fig. No. 5 it will be noted that the $\frac{9}{16}$ thickness is carried on from No. 4 to No. 5 and is connected to the stud-bolt bosses 6, 6, and 6. Fig. No. 4 shows reinforcement post No. 7 bracing this relatively weak section against the heavy steel plate No. 8. No. 9 is another reinforcement post also braced against the steel plate No. 8. These reinforcement posts are so calculated in sections, that the increased heat at No. 10 is dissipated by increased area at No. 11. Above dimensions obviously apply to a specific motor only.

In the plan view, the reinforcement posts 7, 9, and 12 are shown. It may be noted that the maximum span between reinforcements is thereby reduced to carry the explosion pressure, without however disturbing the heat balance of the cylinder head. Spark plug boss No. 13 also acts as a reinforcement. It must be remembered that the stud bolts exerting each about 1500 lbs. pressure, and in the particular cylinder head covering 4 cylinders illustrated in Fig. No. 7 there are stud bolts which are more than ample to hold down the entire cylinder head and lend strength to the reinforced sections, each stud bolt being connected by ribs No. 14 to the combustion chamber.

It is of course understood that various metals may be used for the combustion chamber plate, providing the proper heat balance which is different for different engines is taken into consideration. The method of calculating, hereinbefore given, can be used by those versed in the art to design such cylinder heads. The cover plate No. 8 forming the water jacket may be either made from a flat sheet, or may itself be reinforced with ribs, without departing from the invention.

I claim:

1. A cylinder head for internal combustion engine cylinder blocks, said head having a wall constructed to provide any number of combustion chamber wall portions to overlie the cylinders and their respective intake and exhaust valve ports in said block, each combustion chamber wall portion of said head being divided into areas of differential heat transfer capacity, the areas of greater heat transfer capacity being arranged to overlie the hottest portions of the combustion chamber and being of less tensile strength than adjacent areas of lesser heat transfer capacity, a water jacket overlying said wall, and spaced heat conducting means extending through said water jacket and reinforcing said areas of greatest heat transfer capacity, whereby substantially uniform combustion wall strength and temperature during the power stroke of the engine is maintained.

2. A cylinder head for internal combustion engine cylinder blocks, said head having a wall constructed to provide any number of combustion chamber wall portions to overlie the cylinders and their respective intake and exhaust valve ports in said block, each combustion chamber

wall portion of said head being divided into areas overlying the intake and exhaust port regions which are of different tensile strength and heat transfer capacity, and heat conducting means connected to and reinforcing the area of lesser tensile strength and greater heat transfer capacity above the exhaust valve port of the block, whereby substantially uniform combustion wall strength and temperature during the power stroke of the engine is maintained.

3. A head for an internal combustion engine cylinder block, said head having a combustion chamber forming wall overlying the cylinder and intake and exhaust valve ports for said cylinder in said block, said wall being divided into areas of differential heat transfer capacity, the area of minimum heat transfer capacity overlying the cylinder region, the area of maximum heat transfer capacity overlying the exhaust port region, and the area of intermediate heat transfer capacity overlying the intake port area and extending a substantial distance over the center of the cylinder region, and heat conducting means disposed adjacent the centers of certain of said areas of maximum and intermediate heat transfer capacity and reinforcing said areas, whereby substantially uniform combustion wall strength and temperature during the power stroke of the engine is maintained.

ALFRED SCHWARZ.