PATENT SPECIFICATION

401,934

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Corresponding Applications in United Kingdom
No. 5924/33 } Dated Feb. 27, 1933
No. 5925/33 } (One Complete Specification Left)

Accepted: Nov. 23, 1933.

COMPLETE SPECIFICATION.

Improvements in and relating to Pistons for Internal Combustion Engines.

We, CENTRA HANDELS- & INDUSTRIE A.-G., of Quaderstrasse, Chur, Switzerland, a Swiss Aktiengesellschaft, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

In the case of two-stroke cycle internal combustion engines, in particular those which work on the Diesel principle, the endeavour is made to keep the combustion chamber as small as possible in order to obtain a high final compression pressure. The piston ring next to the edge of the head of the piston which closes the combustion chamber to the outside is, therefore, arranged as near as possible to the head of the piston, because the annular space between the body of the piston, the cylinder and the piston ring is added to the combustion space between the head of the piston and the cylinder or, in the case when there are several pistons, to the combustion space between these pistons. This annular space is undesirable because the combustion air contained in it cannot be well mixed with the fuel.

The size of this annular space becomes particularly noticeable in the case of internal combustion engines in which several pistons work in one cylinder block on a common combustion chamber since there are then several annular spaces which are in connection with the combustion chamber. Further, in such engines the piston heads are curved or of a roof-like shape in order to keep the combustion chamber small. If, in such engines, the ordinary piston rings which are curved only in one plane are employed, then, owing to the three dimensional curvature of the edge of the head of the piston, the piston ring is situated at the minimum distance from this bottom edge only at a few places and at all other places the distance is considerably greater so that the undesired annular spaces are correspondingly increased in size. The surfaces of these annular spaces at which an accumulation of material takes place therefore become relatively great, and, owing to the action of the hot combustion gases, the body of the piston becomes very hot at these places so that grooves are formed in it and a considerable accumulation of coke occurs in the long pockets thereby produced.

According to the invention, the annular gaps are reduced to a minimum by curving the piston ring adjacent to the head of the piston and the groove provided in the body of the piston for the reception of this ring so as to conform to the curve of the edge of the piston. By thus adapting the ring and its groove to correspond with the three-dimensional shape of the edge of the piston all points, or nearly all points, in the piston ring are located at the same distance from the curved edge of the piston. The undesirable annular spaces between the body of the piston and the cylinder are thereby reduced to a minimum. Therefore, on the one hand, a higher final compression pressure can be obtained which is of considerable importance at a low speed of revolution, for example when starting the engine, and on the other hand the durability of the piston is increased since the area of the surface of the piston head which is exposed to the hot combustion gases at the places where accumulations of material occur is considerably reduced. Further, the accumulation of coke in the pockets is reduced. In the case of internal combustion engines, the pistons of which have roof-like heads and control inlet and outlet ports in the cylinder, a gain in the effective length of stroke of the piston is also obtained by the curved shape of the piston ring.

The assembly and dis-assembly of a piston ring curved in three dimensions is only possible when it is of usual rectangular cross-section if the body of the piston is made in several parts. Part of the head of the piston is then preferably

constructed as a retaining ring which is releasably fixed to the piston and forms together with the piston the groove for taking the curved piston ring. In order to avoid a division of the body of the piston into several parts, the side surface adjacent the head of the piston of the groove provided in the piston may be inclined obliquely outwards and towards the head of the piston, the piston ring being then provided with a corresponding oblique surface. It is then possible to insert the piston ring, if it is slit in the usual manner, in the curved groove and to remove it from the groove by spreading apart its ends without exerting excessive force, since the inclination of the oblique side surfaces allows the piston ring when being dis-assembled to make a certain amount of movement in the direction of the axis of the piston in addition to the expansion movement transverse to the axis.

Various constructional embodiments of a piston in accordance with the invention as well as one form of an apparatus for its manufacture are illustrated by way of example in the accompanying drawings, in which:—

Figure 1 is a longitudinal section through an engine in which three pistons constructed in accordance with the invention work in one cylinder block on a common combustion chamber.

Figure 2 is a front elevation of the piston according to Figure 1 on a larger scale.

Figure 3 is a side elevation of the piston shown in Figure 2.

Figure 4 is a perspective view of the piston ring again on a larger scale.

Figure 5 illustrates diagrammatically a piston together with the outlet ports in the cylinder, wherein the piston and piston rings are constructed in the manner hitherto usual.

Figure 6 is a view similar to Figure 5, but showing the piston having a curved piston ring in accordance with the present invention.

Figure 7 illustrates the upper part of the piston partly in section and shows how the piston ring is assembled and dis-assembled.

Figure 8 is a view similar to Figure 7 showing the piston and ring in the assembled condition.

Figure 9 is a section through a part of the piston head according to another form of construction.

Figure 10 illustrates the upper part of the piston shown in Figure 9 on a smaller scale and shows the method of removing the piston ring.

Figure 11 is a plan view of Figure 10.

Figure 12 is a partial vertical section on the line A—B of Figure 11.

Figure 13 is a section through part of the edge of the piston head in a further form of construction.

Figures 14 and 15 show in elevation two further forms of construction of the piston head, and

Figure 16 is a plan of an apparatus for manufacturing the piston and the piston ring.

Referring to the drawings, in the internal combustion engine illustrated in Figure 1, the three pistons 2 work in a cylinder block 1 on a common combustion chamber 3. The pistons 2 drive the cranks 4, the movement of which is transmitted by toothed wheels 5 to a toothed wheel 6. The heads of the pistons 2 are of roof-like shape. Owing to the roof-like surfaces 7 of the heads of the pistons, the line 8 of the edge of the head of the piston (Figure 3) is curved in three dimensions. Each piston 2 is provided with four rings. The piston ring 9 next to the head of the piston is shaped so as to conform to the curve of the edge 8. This piston ring, therefore, is also curved in three dimensions (Figure 4). The three remaining piston rings 10 are of the usual shape and are arranged at right angles to the axis of the piston and are curved only in a plane transverse to the longitudinal axis of the piston.

The combustion chamber of the engine illustrated is composed of the combustion spaces 3 which are left between the roof-like surfaces 7 of the pistons 2 when at their dead points and the narrow pockets 11 (Figure 6) which lie between the body of the piston 2, the cylinder block 1 and the piston ring 9 and are open to the combustion chamber. A comparison of Figures 5 and 6 shows that the annular pockets 11 are considerably smaller when a piston ring 9 which is curved in three dimensions is employed than when an ordinary piston ring 10 (Figure 5) is arranged next to the head of the piston. Nearly all points of the piston ring 9 are at the same distance from the edge line 8 of the piston. The conditions in the combustion chamber for obtaining complete combustion are considerably improved by this reduction in the size of the pockets. Figure 6 also shows that, at the places where the greatest accumulation of material takes place at the head of the piston owing to the roof-like shape, the surfaces exposed to the hot combustion gases at these places are reduced, so that the durability of the head of the piston is increased and the danger of coke adhering in the pockets 11 is reduced.

The inlet and outlet ports 12 which are

provided in the cylinder block 1 and are controlled by the pistons 2 are adapted to conform to the roof-like shape of the end of the piston (Figures 5 and 6). The control of the ports 12 is, of course, primarily effected by the edge 8 of the piston but, owing to the presence of the annular pocket 11, the interior of the cylinder is in connection with the scavenging ports during the compression stroke until the piston ring next to the head of the piston has completely shut off all the scavenging ports.

If now piston rings curved in a single plane as heretofore usual are employed (Figure 5) the ports 12 will only be gradually covered by the piston ring nearest to the head of the piston. Figure 5 shows in dotted lines the position of the ring 10 when it begins to cover the ports, whereas the position of the ring in which all the ports are covered is illustrated in full lines. In this case the piston 2 must move through the distance a in its stroke. If a piston 9 which is curved correspondingly to the edge line 8 of the head of the piston is employed (Figure 6), then the piston 2 has only to move through the distance a^1 in order to completely cover the ports and to completely shut off the cylinder space filled with the combustion air. By this means a gain in effective stroke is obtained.

If the piston ring 9 is given a rectangular cross-section (Figures 7 and 8), then an annular part of the head of the piston 2 is formed as a retaining ring 13 and is provided on its underside with an annular step, so that a surface 14 which lies at right angles to the axis of the piston and a cylindrical surface 15 which is parallel to the axis of the piston are formed. This annular step is shaped to correspond to the cross sectional shape of the piston ring 9. On the body of the piston 2 there is also provided an annular step, so that a shoulder 16 which is at right angles to the axis of the piston and a cylindrical surface 17 which is parallel to the axis of the piston are formed. These surfaces 14 and 16 are cut so as to be curved to the same three-dimensional curve as the piston ring 9.

In order to assemble the piston ring 9, this ring is first passed over the body of the piston and the retaining ring 13 is then placed over it. The retaining ring is then fixed to the body 2 of the piston by means of a number of grub screws 18. Thus, the surfaces 14, 15 of the retaining ring 13, together with a portion of the shoulder 16 of the body 2 of the piston form the guide groove for the piston ring 9. The piston ring which is slit in the usual manner can move in this groove with the usual amount of play. To remove the piston ring the screws 18 need only be unscrewed and the retaining ring 13 taken away. The piston ring 9 is then free to be removed. The assembly and dis-assembly of the curved piston ring, therefore, causes no difficulty.

In Figures 9 to 12 is illustrated a form of construction in which the curved piston ring can be assembled and disassembled without the body of the piston being divided into several parts.

In the body of the piston 2 is cut an annular groove 19 which is adapted to conform to the edge 8 of the head of the piston, that is to say it is also curved in three dimensions. In this curved groove, however, the side surface 20 which is nearest the head of the piston is inclined outwardly and towards the head of the piston. The piston ring 9 itself has a cross section which corresponds in shape to that of the groove, that is to say it is provided with an inclined surface 21 which has the same inclination as the surface 20 of the groove 19.

When the curved groove and the piston ring are constructed in this manner the slit ring, by spreading apart its ends, can be passed over the body of the piston 2 and introduced into the groove 19. For removing the ring from the groove the ends of the ring are bent apart in the manner illustrated in Figure 11. At the point b the ring 9 still lies in the groove. While the ends of the ring 9 are still separated as shown, the ring, owing to its curvature in three dimensions, must be able to make a movement not only in a plane at right angles to the axis of the piston 2 but also must be able to make a certain amount of movement in the axial direction of the piston, otherwise easy removal is not possible. This simultaneous movement of the ring at right angles to the axis of the piston and in the axial direction is made possible by the arrangement of the inclined surfaces 20, 21. If, by bending the ring apart in the manner illustrated in Figure 11, the point c of the piston ring 9 is separated from the point d of the piston 2 by the distance c, d in the plane at right angles to the axis of the piston, then the ring 9 must be able to move through the distance e (Figure 12) in the direction of the axis of the piston, in order to be free from the body of the piston. In this manner the ring 9 can be removed without jamming and without being excessively bent apart.

When the curvature of the piston ring 9 is greater, it is advantageous if the side surface 22 of the annular groove 19 which is further from the head of the piston is

also inclined. The opposite side 23 of the ring 9 is then given the same inclination so that the ring has the shape of a trapezium in cross section (Figure 13).

The head of the piston 2 may be curved in three dimensions in various ways. Figures 14 and 15 illustrate some possible forms.

The manufacture of the curved piston ring and the guiding groove for it in the body of the piston is preferably effected by means of the machine illustrated in Figure 16. On the chuck 24 of a lathe is fixed a ring 25 which is provided with a guide surface 26 which is curved in three dimensions correspondingly to the edge line 8 of the head of the piston. The tool carrier 27 is provided with the roller 28 which runs on the cam ring 25, and is pressed against the cam ring 25 by means of the spring 29. If now the piston 2, or hollow cylinder from which the piston ring 9 is to be shaped, is clamped in the chuck 24 the tool is guided in such a manner that the groove 19 or the ring 9 is given a curvature which corresponds to the bottom edge line 8 of the piston. By setting the tool carrier into an inclined position, the inclined surfaces 20, 21, 22, 23 of the groove or the piston ring can be formed.

A further advantage of a piston ring curved in three dimensions is that the ring automatically makes movements which prevent the ring from becoming stuck in its groove. As is known, the ring expands to a greater extent than the cylinder, so that, owing to the varying effects of the heat, the places at which the ring is in contact with the walls of the cylinder frequently change. Since a ring which is curved in three dimensions is in contact with its groove along surfaces which lie in a plane inclined to the axis of the piston, the ring, when it expands under the influence of heat, makes movements not only in its peripheral direction but also in the direction of the axis of the piston. A continuous movement of the piston ring in its groove, therefore, takes place.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Piston for internal combustion engines, in particular of the type in which several pistons operate in a common combustion chamber, of which the edge line of the piston head is curved in three dimensions, in which the piston ring nearest to the head of the piston and the groove provided in the body of the piston for the reception of this ring are curved in three dimensions correspondingly to the edge line of the head of the piston.

2. Piston in accordance with claim 1, in which part of the head of the piston is formed as a retaining ring which is releasably fixed to the body of the piston and forms with it the guide groove for the curved piston ring.

3. Piston according to claim 1, in which the side surface nearest to the head of the piston of the curved groove provided in the piston is outwardly inclined, namely towards the head of the piston, and the upper surface of the curved piston ring is correspondingly inclined.

4. Piston according to claims 1 and 3, in which the curved groove and the curved piston ring are of trapezoidal cross section.

5. Piston for internal combustion engines, substantially as described with reference to the accompanying drawings.

Dated the 27th day of February, 1933.

For the Applicants:—
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Fig. 1

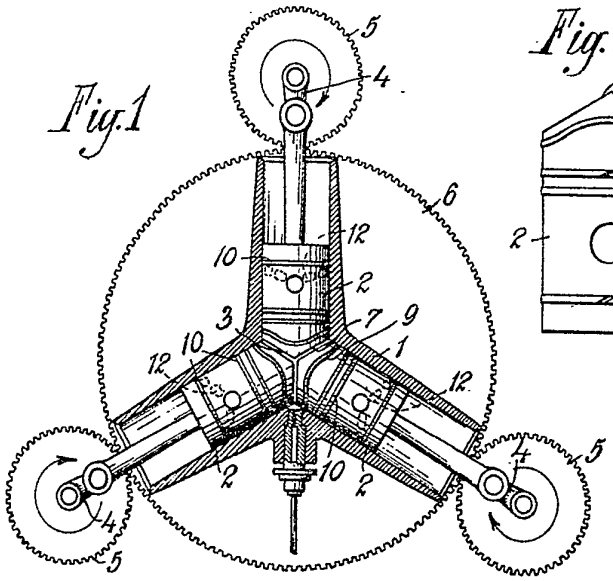


Fig. 2

Fig. 3

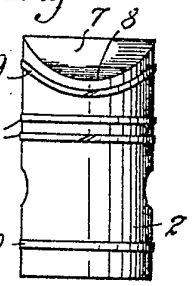


Fig. 4

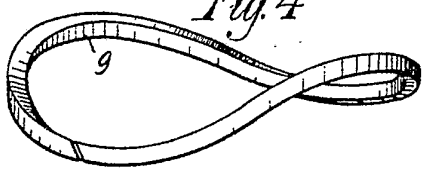


Fig. 7

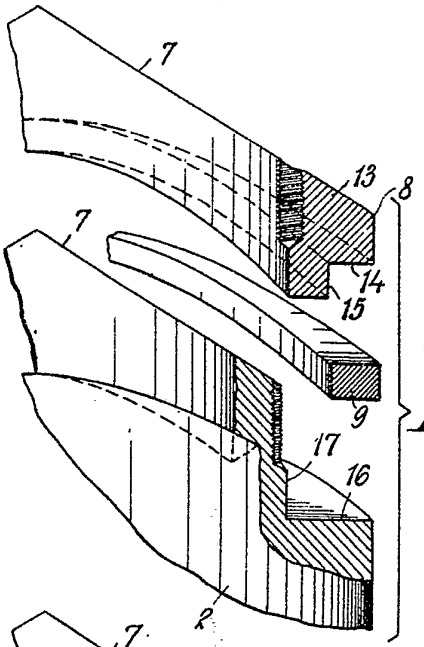


Fig. 5

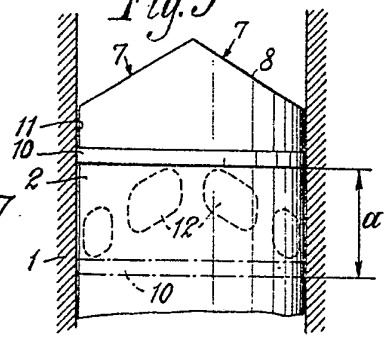


Fig. 6

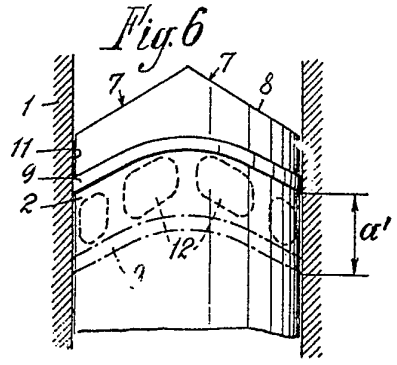


Fig. 8

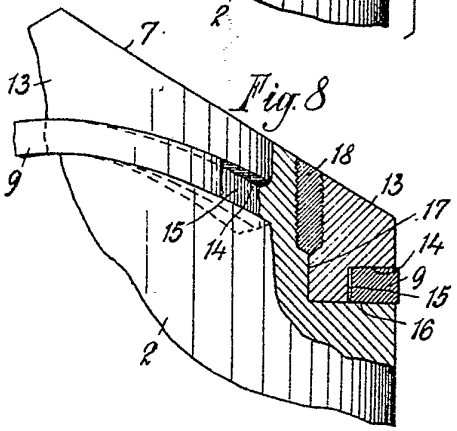


Fig. 9

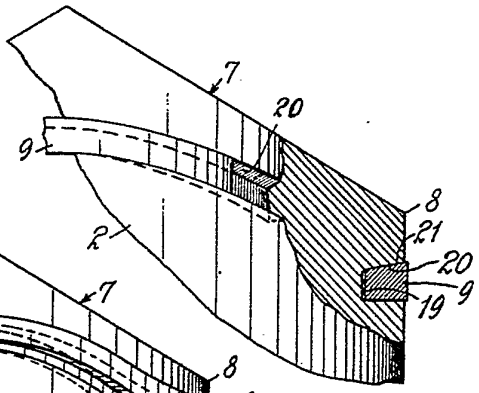


Fig. 10

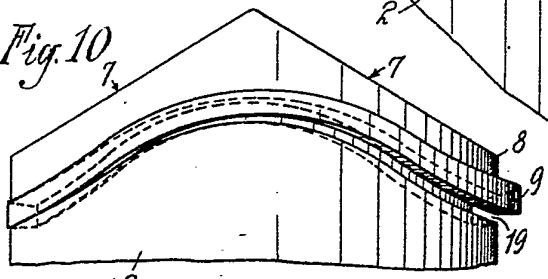


Fig. 12

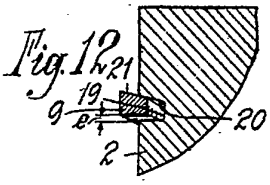


Fig. 11

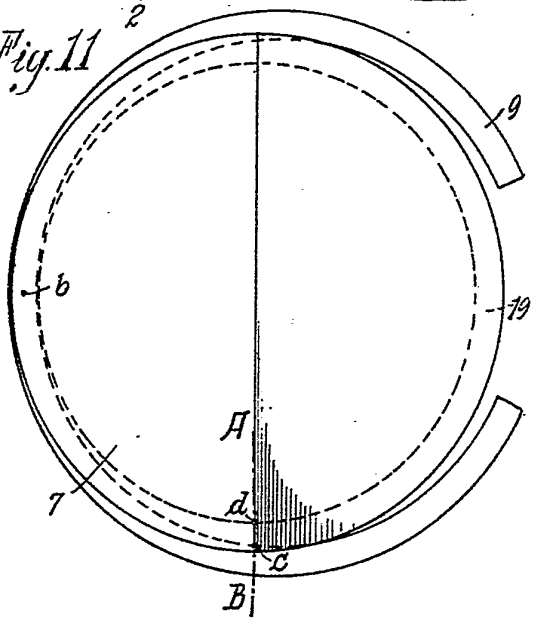


Fig. 13

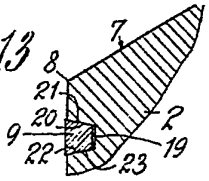


Fig. 14

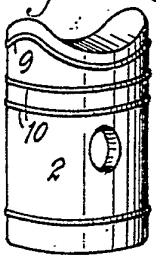


Fig. 15

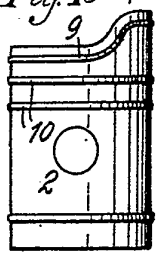
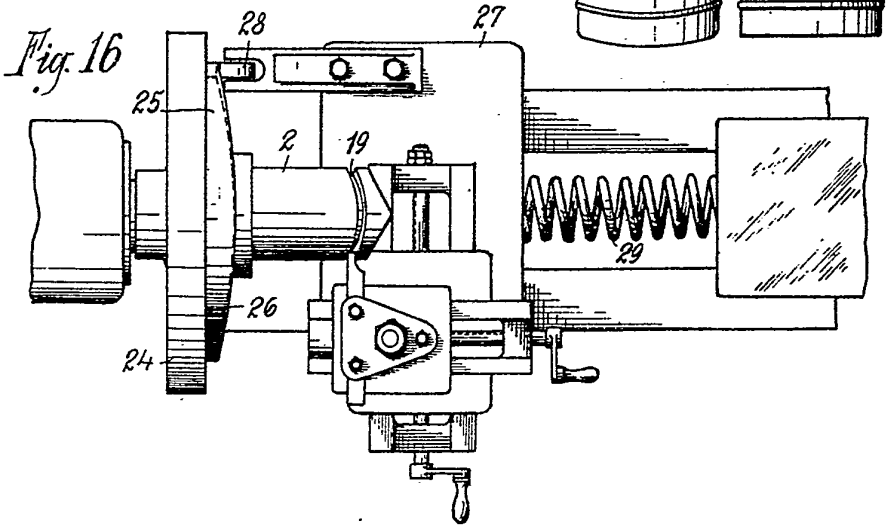


Fig. 16



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401,934 COMPLETE SPECIFICATION

SHEET 1

2 SHEETS
SHEET 2

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1

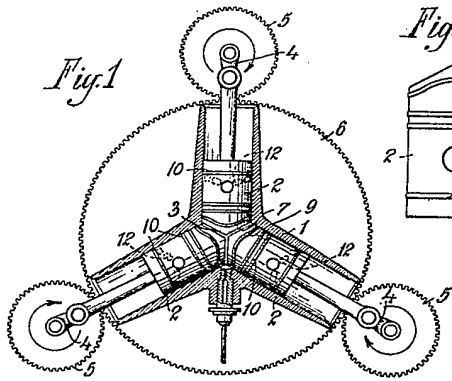

Fig. 2

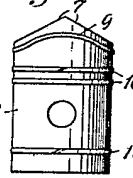

Fig. 3

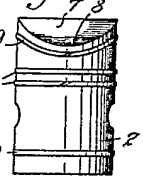

Fig. 4

Fig. 7

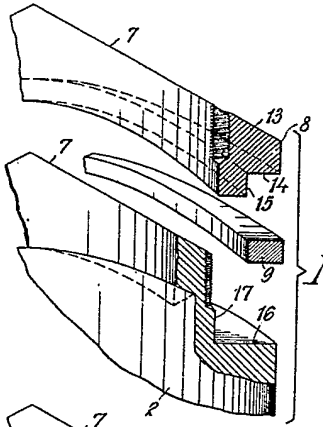

Fig. 5

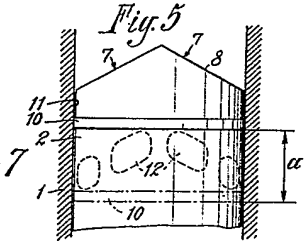

Fig. 6

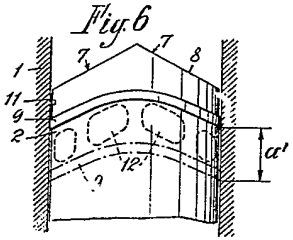

Fig. 8

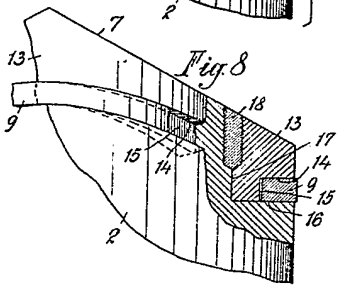

Fig. 9

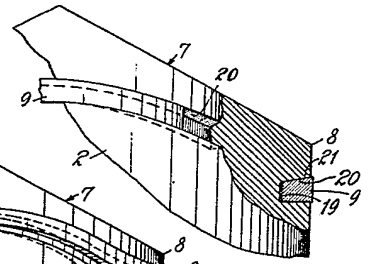

Fig. 10

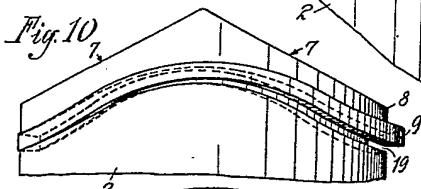

Fig. 11

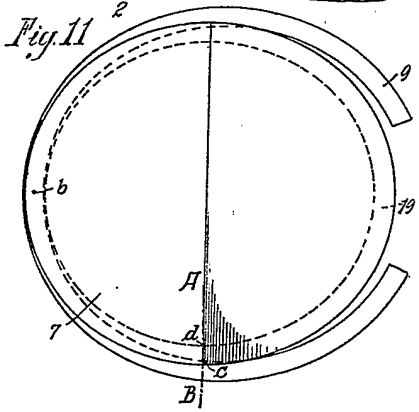

Fig. 12

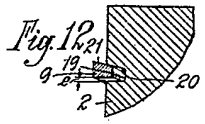

Fig. 13

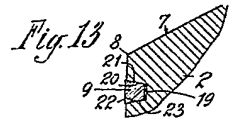

Fig. 14

Fig. 15

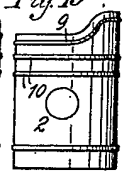

Fig. 16