W. MAUSS.

VALVELESS ENGINE.

APPLICATION FILED AUG. 5, 1908.

1,037,033.

Patented Aug. 27, 1912.

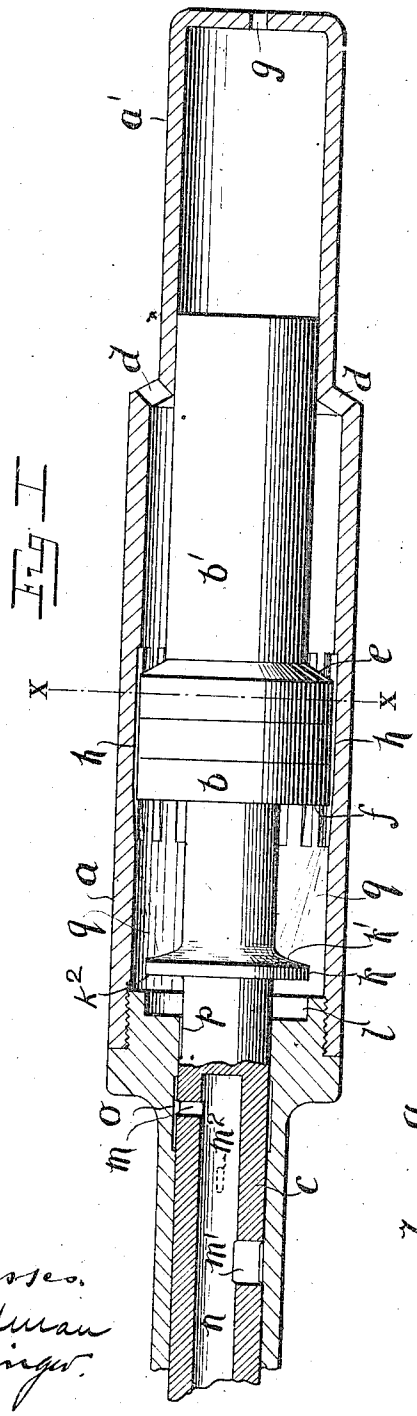

Fig. I

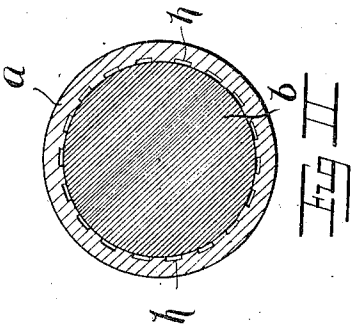

Fig. II

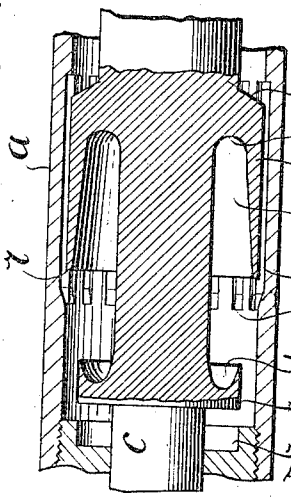

Fig. III

Witnesses.
L. Waldman
C. Singer.

Inventor:
Wilhelm Mauss
by B. Singer
Atty.

UNITED STATES PATENT OFFICE.

WILHELM MAUSS, OF BRACK PAN, TRANSVAAL, ASSIGNOR TO THE KONOMAX ROCK DRILL SYNDICATE LIMITED, OF JOHANNESBURG, TRANSVAAL.

VALVELESS ENGINE.

Specification of Letters Patent. Patented Aug. 27, 1912.

1,037,033.

Application filed August 5, 1908. Serial No. 447,182.

To all whom it may concern:

Be it known that I, WILHELM MAUSS, engineer, of Victoria Falls Power Company, Brack Pan Branch, Brack Pan, Transvaal, a subject of the King of Great Britain, have invented certain new and useful Improvements in Valveless Engines, of which the following is a specification.

The present invention relates to valveless engines and particularly to direct acting valveless engines adapted for rock drilling and other percussive purposes, for pumping, and like operations.

In any valveless engine the relative position of the piston and cylinder is necessarily identical at the moments of admission and cut off of the working fluid and again at the opening and closing of exhaust; and in constructions hitherto proposed, this has resulted in one or both terminations of the stroke of the piston being effected wholly or to a large extent by previously acquired momentum and against a retarding cushion. In percussive engines particularly the effect has been to cushion the blow to such an extent as practically to restrict the employment of the valveless type of engine to the smaller sizes where efficiency is a minor consideration.

The purpose of the present invention is to overcome such defects, and to approximate to a valve effect in a valveless engine.

In an engine constructed according to the present invention the fluid admitted during the current stroke for effecting the succeeding stroke in the ordinary manner, is caused to assist the current stroke kinetically, or at least is prevented from acting adversely to it for a period after admission, such period in the case of a percussive machine extending until the blow is struck. Further, a novel exhaust arrangement is provided, as hereinafter described, whereby the cushioning due to the usual late or terminal exhaust is decreased without the waste of fluid and power incident to the early complete exhaust sometimes employed.

The invention will be described in detail as embodied in a rock drilling engine of the type in which constant pressure is applied to the rear piston area, and the actuating fluid is caused to operate expansively upon the relatively larger front piston area; but it is to be understood that this is only by way of example and it is not intended thereby to restrict the invention to engines of this constructional type or function.

In the accompanying drawings Figure I is a longitudinal section of a rock drilling engine showing the piston in the position it occupies at the moment the blow is struck; Fig. II is a transverse section on the plane X—X of Fig. I, and Fig. III is a longitudinal section showing a modified form of the piston, a portion of the structure being broken away.

Referring to Figs. I and II, the cylinder is represented by letter *a*, the piston by *b* and the piston rod by *c*. Pressure fluid is supplied constantly through ports *d* and presses uninterruptedly upon the annular rear piston area *e*. Said area *e* is made smaller than the front piston area *f*; in this instance by forming upon the piston *b* a trunk b^1 which works in a correspondingly reduced part a^1 of the cylinder *a*. The rear face of trunk b^1 is relieved of pressure by means of hole *g*.

h, *h*, are slots formed in the cylinder wall by which communication is established, immediately before the completion of the forward stroke, between the rear and the front cylinder spaces, the forward ends of said slots being curved or beveled toward the axis, as shown.

Upon the piston rod *c* is the annular ring *k*, which is made slightly less in diameter than the piston *b*. There are thus three pressure areas, *f*, k^1, and k^2, formed at the front of the piston, two viz. *f* and k^1, of which are in facing opposition and the third k^2 of which is unopposed; while communication between k^1 and k^2 is afforded by the somewhat restricted passage-way formed between the ring *k* and the walls of the cylinder. The faces *f* and k^1 are spaced well apart so that a large dead space occurs in the front cylinder and particularly between said faces, at the completion of the forward stroke; the total such dead space being for example and as shown, equal to one half of the total volume of the front cylinder space when the piston is retracted.

l is a recess in the front cylinder head corresponding in diameter to the ring *k*.

m, m^1, are holes bored from the periphery of the piston rod *c* into the bore *n* thereof, said bore communicating in any suitable manner with the atmosphere, so that upon one or both of the holes *m* or m^1 entering

the front cylinder, the latter will be opened to exhaust.

o is an annular groove formed in the extension of the cylinder head surrounding the piston rod *c*, and *p* is a slot cut in the piston rod periphery, such as to register with groove *o* when the normal forward stroke is exceeded.

The device operates in the following manner. The piston being retracted, pressure fluid admitted through ports *d*, presses upon area *e* and propels the piston forward. Immediately before the blow is struck, communication is established between the cylinder ends by way of the slots *h*, *h*, fluid from the rear thus rushing into the front cylinder as a series of jets *q* moving with great velocity away from the piston face *f*, which, impinging on the face k^1 expend more or less of their kinetic energy in driving the piston forward. When the piston is moving with the requisite velocity, that is half that of the jets, the admitted fluid is deprived of both velocity and pressure and is therefore without action on faces *f* and k^2. Thus in the most favorable instance, admission is followed by a period in which force is exerted on face k^1 but none on *f* and k^2. With a lower piston velocity than that mentioned, more or less backward deflection of the jets occurs and in the extreme case with a comparatively freely moving piston, sufficient pressure may be established on face *f* to balance that on k^1. Such backward deflection however, by obstructing the passageway around ring *k*, delays the movement of fluid to face k^2 and even tends to suck out the fluid trapped in front thereof. In no case therefore is effective pressure adverse to the blow established in front of the piston, for a period after admission, and cushioning is avoided for that period. Upon the blow being struck, high pressure is established uniformly throughout the front cylinder space, areas k^1 and k^2 are in equilibrium, and the area *f* being in excess of the area *e*, the piston returns. During such movement the slots *h* remain open for a short period and continue to supply high pressure fluid to the front cylinder, the velocity of the incoming fluid however being now immaterial, and ineffective to retard the piston owing to the dense fluid already occupying the cylinder. Upon closure of the slots *h* the imprisoned fluid continues to force the piston back by expanding.

After a certain proportion of the rearward stroke has been effected, the relatively small hole *m* enters the cylinder and exhaust therefrom thus begins. The rate of exhaust through said hole *m* however is so restricted that when the machine is working normally the pressure retained in the cylinder is, in conjunction with the acquired momentum of the piston, sufficient to carry the latter to the full length of the rearward stroke, when the relatively large hole m^1 enters the cylinder and exhaust is completed. The pressure on area *e* then drives the piston forward again to make the working stroke, during part of which hole *m* remains open and discharges a further quantity of fluid, thereby minimizing compression of fluid in the front cylinder. When working with low pressures or when the drill is clogged, complete exhaust may be effected through hole *m*, resulting in shortening of the stroke of the machine.

A wider range of variation in the length of the stroke, and enhanced rapidity of reversal when making short strokes may be procured by interposing one or more additional exhaust holes, such as m^2 between holes *m* and m^1, the size of said intermediate hole or holes being preferably proportional to its or their position in the series. It will be evident that such a series of separate holes may be replaced by a tapered exhaust slot.

In the event of the drill being too far from the rock when fluid is turned on, the piston is cushioned by the ring *k* entering the recess *l* and compressing the fluid therein. When said ring *k* has penetrated sufficiently far into the recess for the momentum of the piston to be reduced to safe limits, slot *p* opens into groove *o*, thus exhausting the fluid compressed in recess *l*, through hole *m* and into the piston rod bore *n*. By this means the pressure on face *e* is enabled to retain the piston at the forward limit of its stroke until the machine has been properly advanced to its work.

In the modified construction of the piston shown in Fig. III, the forward peripheral edge *r* of the piston is carried forward, so as to bring the fluid jets *q* in close proximity to the impact ring *k*, the adjacent front part of the piston being undercut as at *s* in order to maintain the requisite distance and dead volume between faces k^1 and *f*. This figure also shows the face k^1 recessed for the purpose of enhancing the effectiveness of the jets, and keeping for a time the fluid thereof from passing beyond ring *k*.

What I claim, and desire to secure by Letters Patent is:—

1. In a valveless engine, the combination of a cylinder, a piston providing a forwardly directed pressure face, means for admitting actuating fluid into the front of the cylinder to reverse the piston, said means causing said fluid to enter jet-wise and in a direction away from the aforesaid piston face upon which it subsequently acts by pressure, and means whereby the forward action of the piston is increased after the actuating fluid has entered the space in front of the cylinder.

2. In a valveless engine, the combination

of a cylinder, a piston providing an outwardly directed pressure face, and a piston rod, means for admitting actuating fluid into the cylinder to reverse the piston, said means causing the actuating fluid to enter jet-wise and in a direction away from the aforesaid piston face, and exhaust means controlled by the movement of the piston rod.

3. In a valveless engine, the combination of a cylinder, a piston providing a forwardly directed piston face, means for admitting actuating fluid to the cylinder, said means causing the actuating fluid to enter jet-wise and in a direction away from the aforesaid piston face, and means whereby the energy of the actuating fluid admitted into the forward part of the cylinder is utilized for assisting the forward stroke.

4. In combination, a cylinder, a piston, a piston controlled inlet for the front cylinder space, said inlet being opened by the piston immediately prior to completing its forward stroke, and being so located that a large dead-volume remains in the front cylinder space upon the completion of the forward stroke, means whereby the incoming fluid is directed into said space and away from the adjacent front piston area, and means in front of the piston acted upon by the pressure of said incoming fluid for assisting the forward stroke.

5. In a valveless engine, a cylinder, a piston reciprocable therein, means for admitting fluid into an end of the cylinder during the current stroke to effect the succeeding stroke by pressure in said end, said means causing the fluid to enter jet-wise, and a surface associated with the piston upon which said fluid impinges to propel the piston kinetically during the current stroke.

6. In combination, a cylinder, a piston having its front pressure area greater than its small rear pressure area, means for supplying actuating fluid constantly to said rear area, slots *h* in the cylinder wall, a piston rod and a ring *k* thereupon.

7. In a valveless engine, a cylinder, a piston and piston rod, said piston rod being provided with a surface upon which the actuating fluid admitted during the current stroke to effect the succeeding stroke by pressure impinges to propel the piston kinetically during the current stroke.

8. In a valveless engine, a cylinder, a piston structure comprising a piston having a rear pressure area to which fluid pressure is applied constantly, and having its front pressure area greater than said rear area, an inlet to the front end of the cylinder, said inlet being opened prior to completion of the forward stroke and being so located that a large dead volume remains in the front cylinder space upon the completion of the forward stroke, means causing retardation of the action of the fluid so admitted upon the front piston area, said inlet being closed during the rearward stroke whereby the remainder thereof is effected expansively, and exhaust means controlled by the movement of the piston structure.

9. In a valveless engine, in which fluid is worked expansively, restricted exhaust means adapted to be opened during the latter part of the expansion stroke and during the initial part of the return stroke and full exhaust means opening upon completion of a full expansion stroke.

10. In a valveless engine, a cylinder, a piston having three pressure faces, two of which are in facing opposition and widely separated so as to form between them a large dead space, means for admitting actuating fluid between said opposing faces, and means whereby such fluid is subsequently conveyed to the unopposed face to exert pressure thereon.

11. In a valveless engine, a cylinder, a piston having three pressure faces, two of which are in facing opposition, and means for admitting actuating fluid between said opposed faces, a permanently open passage-way or space being afforded for conveying fluid from between the opposed faces to the unopposed face, said space being so restricted that the establishment of pressure on the latter face is delayed.

12. In a valveless engine, a cylinder, a piston having three pressure faces, two of which are in facing opposition, and widely separated so as to form between them a large dead space, means for directing actuating fluid onto one of the opposed faces to assist the current stroke kinetically, and a permanently open passage-way or space being afforded for conveying fluid from between the opposed faces to the unopposed face.

13. A piston structure, comprising a large front member *b*, a smaller rear member b^1, a piston rod and a ring *k* thereon, the front face of the larger piston member being under cut, substantially as described.

14. In a valveless engine, a cylinder, a piston, a piston rod, exhaust means associated with the piston rod, means at the forward end of the cylinder for cushioning the blow of the piston, and means whereby communication is afforded between said last mentioned means and said exhaust means.

15. In a valveless engine, the combination of a cylinder, a piston, means for admitting actuating fluid to reverse the piston, a piston rod having a tubular bore, an exhaust port communicating with said tubular bore for effecting a partial exhaust of the actuating fluid from the interior of the cylinder, and an additional exhaust port for effecting the complete exhaust of such actuating fluid.

16. In a valveless engine, the combination of a cylinder, a piston, a piston rod having a

tubular bore, a ring on said piston rod, an exhaust port communicating with said tubular bore for effecting the exhaust of the actuating fluid from the interior of the cylinder, a recess in the front end of the cylinder adapted to receive said ring and serve as a cushioning means therefor, and a passage in said piston rod whereby communication is afforded between said recess and said tubular bore.

17. In a valveless engine, a cylinder, a piston having three working pressure faces, two of which are in facing opposition, means for admitting actuating fluid between said opposed faces one of said pressure faces being so arranged that during a portion of the stroke it receives the full force of the incoming actuating fluid, and a permanently open passage-way for conveying fluid from between the opposed faces to the unopposed face, said passage-way being so restricted that the establishment of pressure on the latter face is delayed.

18. In a valveless engine, a cylinder, a piston structure comprising two members one of which is provided with one working pressure face, and the other of which is provided with two working pressure faces, one of said last named pressure faces and the pressure face of said first named member being in facing opposition, means for admitting actuating fluid between said opposing faces, and a passage-way whereby such fluid may be subsequently conveyed to the unopposed face to exert pressure thereon.

19. In a valveless engine, a cylinder, a piston structure consisting of two members one of which is of less diameter than the other, said piston structure having three working pressure faces, two of which are in facing opposition, means for admitting actuating fluid between said opposed faces, and a permanently open passage-way for conveying fluid from between the opposed faces to the unopposed face to exert pressure thereon.

20. In a valveless engine, a cylinder, a piston structure comprising two members, one of said members having one working pressure face said pressure face being hollowed out, and the other of said members having two pressure faces, one of said latter pressure faces and the pressure face of said first named member being in facing opposition, means for admitting actuating fluid between said opposed faces, and a passage-way whereby such fluid is subsequently conveyed to the unopposed face to exert pressure thereon.

In testimony whereof I affix my signature in the presence of two witnesses.

WILHELM MAUSS.

Witnesses:
W. HILLMAN VINCENT,
J. WARREN VENNING.