H. C. BEHR.

PNEUMATIC STAMPING PLANT.

APPLICATION FILED JUNE 30, 1909.

1,034,863.

Patented Aug. 6, 1912.

3 SHEETS—SHEET 1.

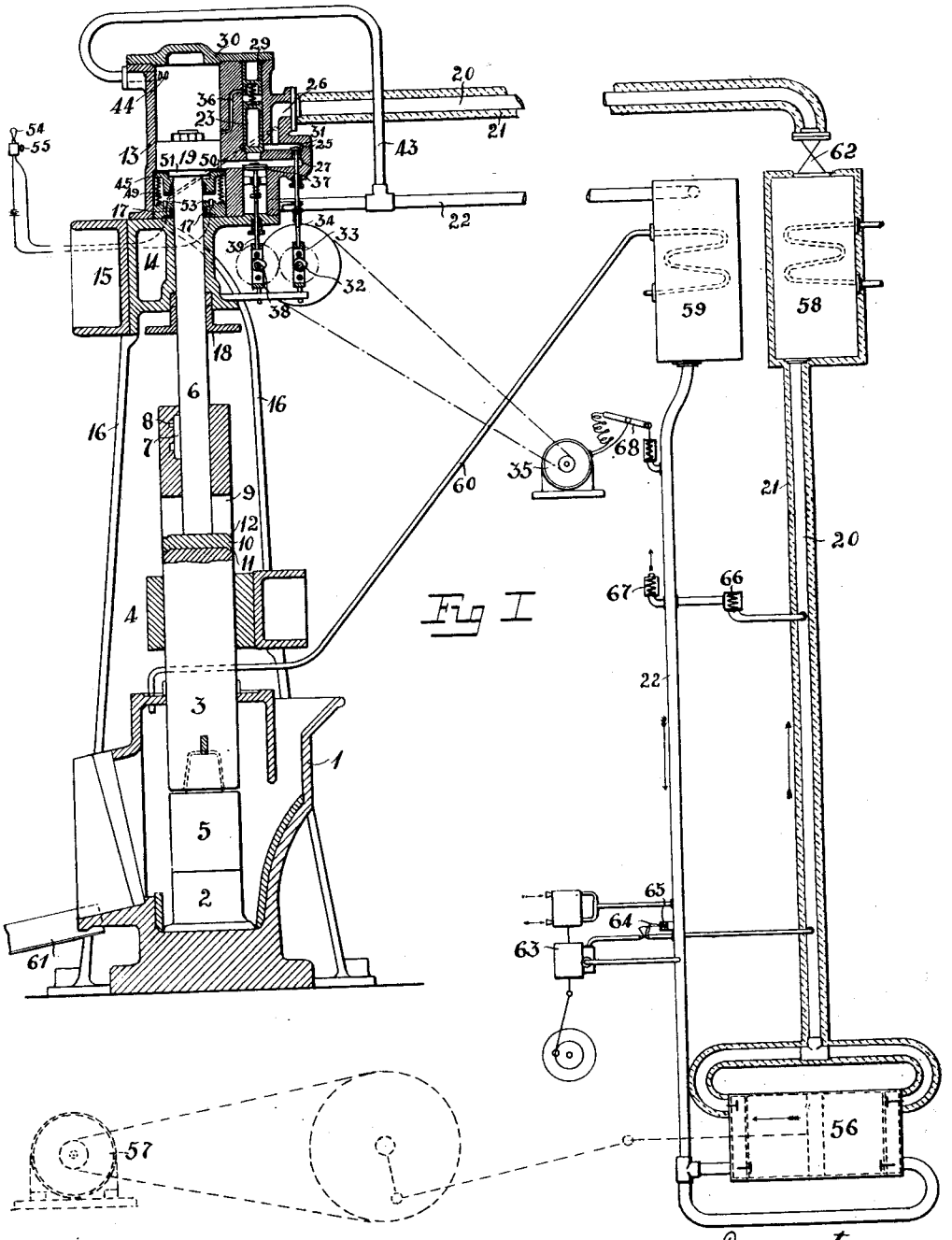

Fig I

Witnesses.
A. Ringer.
H. C. Hunsberger

Inventor
Hans Charles Behr
by B. Singer Atty

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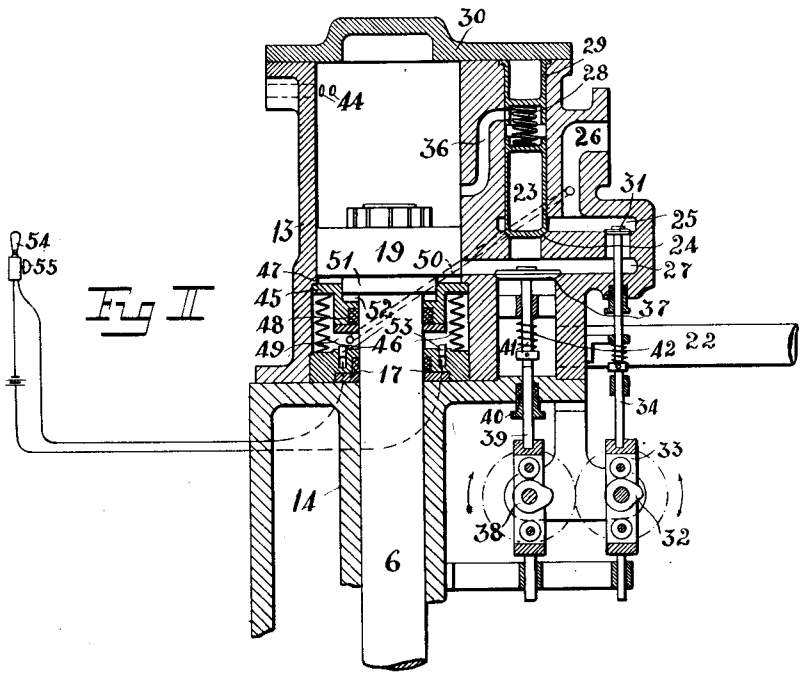

Fig II

Witnesses:
A. E. Singer.
H. C. Hunsberger

Inventor:
Hans Charles Behr
by B. Singer atty.

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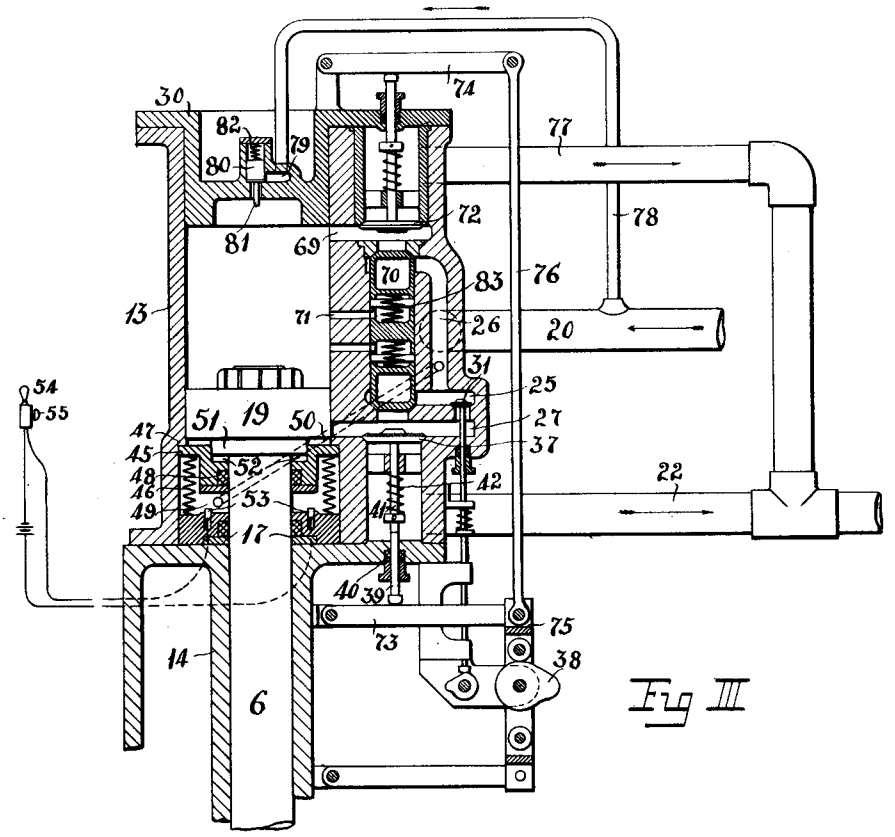

Fig III

Witnesses:
P. E. Singer
H. Himsberger

Inventor:
Hans Charles Behr
by B. Singer atty.

UNITED STATES PATENT OFFICE.

HANS CHARLES BEHR, OF JOHANNESBURG, TRANSVAAL.

PNEUMATIC STAMPING PLANT.

1,034,863. Specification of Letters Patent. Patented Aug. 6, 1912.

Application filed June 30, 1909. Serial No. 505,226.

To all whom it may concern:

Be it known that I, HANS CHARLES BEHR, a citizen of the United States of America, residing at Consolidated Goldfield's Building, Johannesburg, Transvaal, have invented new and useful Improvements in Pneumatic Stamping Plants, of which the following is a specification.

The modern tendency to use continually heavier stamps for ore crushing purposes and to accelerate their rate of operation has shown that the hitherto general method of operating them by means of cams and tappets has reached its practical limit and that progress in the direction indicated necessitates a radically different method of operation. The failure of the cam and tappet device is primarily due to the difficulty of designing the parts of sufficient strength to meet the conditions suggested, the disproportionate augmentation of the shock of first contact between the cam and the tappet, and the speed limit introduced by the pause necessary to prevent "camming." To overcome this difficulty, there has been developed the use as an actuating medium of elastic fluid, that is, for practical purposes, steam or compressed air. The former is wasteful when used in a stamp, and for various reasons is somewhat unsuitable for use in most ore mills, in which environment pneumatic stamps appear to be more suitable and have been used to a limited extent. As hitherto constructed, however, pneumatic stamps have presented serious drawbacks. In that type in which the air is used simply as cushions interposed between the heads of a mechanically reciprocated cylinder and a piston to which the stamp head is attached, owing to the heating of the air, it is imperative constantly to permit some of the heated air to escape at high pressure and to replace it from the atmosphere, thus leading to waste of energy. In the other type of pneumatic stamp which has been proposed, air is taken from the atmosphere, compressed and delivered to the cylinder of the stamp where it does its work and whence it is exhausted back to the atmosphere. In compressing air from atmospheric pressure—especially at high altitudes—to a pressure suitable for practical purposes, by means of a single stage compressor, an amount of heat is made sensible which were it all retained in the air would raise its temperature to such an extent as to render its transmission to and use in the stamp cylinder impracticable. It therefore becomes necessary to use a multi-stage compressor which increases the cost of the plant and introduces mechanical complications; and also to abstract heat from the air which involves the loss of the mechanical work by which it was produced. Again when such cooled air is used in the stamp cylinder, it is impossible to reëxpand it through the same range within which it was compressed, owing to the rapid fall of temperature, and consequent liability to freeze the moisture in the air. Energy is thus lost both in compression and in the exhaust to an extent which renders the method of transmission very inefficient. On the other hand, compressed air offers undoubted advantages as a stamp actuating medium, especially in the manner in which it facilitates and extends the employment of electric, hydraulic and even in certain cases steam power; and it is the purpose of the present invention to provide a pneumatic stamping plant which overcomes the drawbacks indicated above.

The nature of the invention may be indicated generally by describing it as a stamping plant operating upon the dense air system; *i. e.* a system in which the compressor and the engine form a closed circuit, air being exhausted from the engine above atmospheric pressure and forming an artificial dense atmosphere from which the compressor draws. Such a system has already been applied to the actuation of pumps, rock drills and winding engines situated at long distances from the compressor; but its application to a stamping plant is believed to be novel and useful in that it is the only solution hitherto proposed for the practical and efficient actuation of stamps pneumatically.

A practical embodiment of the invention is shown in the accompanying drawings, in which—

Figure I illustrates the complete system, Fig. II is an enlarged detail view of the stamp cylinder shown in Fig. I, and Fig. III a similar view of a double acting cylinder.

Referring to the drawings, 1 indicates a mortar box, 2 the die therein and 3 the stamp head, which passes through the lower guide 4 and carries the usual wearing shoe

5. In the upper end of the head is formed an aperture for the reception of the piston rod 6, to which rod the head is secured by such means as the gib 7 and cotters 8. Below said aperture is formed a transverse slot 9 adapted to receive a number of shims such as 10. Said shims are formed at their lower edges with lugs 11, adapted to cooperate with corresponding depressions 12 formed in the lower face of the slot 9, and on the upper edges of the shims themselves, to prevent lateral displacement of the packing pieces. When working with new shoes and dies the end of the piston rod seats onto the bottom of the slot 9; but as the shoes and dies wear the shims 10 are inserted from time to time as required to maintain the piston rod 6 within its proper range of movement. The piston, or the piston and the parts attached thereto, may be considered a pneumatic working element. It will be understood however that any other suitable connection between the piston rod and the head may be employed, such for example as forming the top of the head as a split nut which screws upon and is suitably clamped to the correspondingly threaded piston rod.

13 indicates the engine cylinder, the lower head 14 of which is secured to the girder 15, carried by the frames 16. Said lower head is extended to form the upper guide for the stamp.

The piston rod 6, in passing out of the cylinder is packed internally by a packing device 17 and externally by a common gland 18.

19 is the piston to which the rod 6 is secured and which works within the cylinder 13.

The engine shown in Figs. I and II is single acting, the stamp being raised by compressed air and moving downward mainly by gravity. Referring to these figures, 20 indicates the high pressure supply pipe by which air is conveyed to the engine and which is thickly lagged with a non-conducting coating 21; 22 is the low pressure return pipe. The main inlet valve 23 slides in a bore in the cylinder wall and contacts with a seating 24 to cut off communication between a chamber 25 to which the high pressure inlet port 26 opens, and the port 27 opening into the lower end of the cylinder. Said valve 23 is forced downward by a spring 28 bearing against a cap 29 fitted into the upper end of the valve bore. 30 is the upper cylinder head. 31 indicates a small by-pass valve by which high pressure air is admitted under the main valve 23 to lift the same. Said by-pass valve is actuated by means of a cam 32 which engages a yoke 33 attached to the stem 34 of the valve, said cam being driven off a small constant speed motor 35. 36 indicates a port leading from the cylinder bore to the upper end of the valve 23. The exhaust valve 37 is actuated by a second cam 38 which is geared with or otherwise caused to move in unison with, but in a different phase, from cam 32, Said cam 38 is shaped to give a longer opening to its valve than is cam 32. The spindle 39 passes through the stuffing box 40 and makes contact with, but is separate from, the valve stem 41, so that the valve 37 is capable of lifting independently of cam 38. The valve is forced to its seat by a light spring 42. As already indicated air exhausted by the open valve 37 passes away into pipe 22. 43 shows a connection from the low pressure line 22 to the upper end of the cylinder; its openings 44 in the cylinder being somewhat below the head 30 to permit cushioning in the upper end of the cylinder.

The cylinder 13 is provided with a false lower head 45 resiliently supported upon springs 46. Said head normally seats upon a shoulder 47 so as to close the lower end of the cylinder, and the piston rod 6 is made air tight with it by packing 48. The space 49 under said head is put into communication with the high pressure line 20 by means of a passage 50. On the lower face of the piston 19 is raised the annular projection 51 and a corresponding recess 52 is formed in the upper face of the head 45. The function of this false head is to yield resiliently in case the piston makes too long a downward stroke, owing for example to the stamp head not being adjusted to the wear of the shoe and die. The piston acts on such head through air cushioned in the recess 52, so avoiding shock.

53 indicates a pair of electrical contacts in circuit with suitable signal means such as the lamp 54 and the bell 55. When the false head 45 is depressed by the piston it completes the circuit between said contacts, thereby indicating to the attendant that the stamp requires adjustment.

56 represents a single-stage compressor driven for instance by an electric motor 57. Said compressor takes air from the low pressure line 22 and delivers into the high pressure line 20.

A heater is shown diagrammatically at 58 inserted into the high pressure line 20. Similarly 59 indicates a means for cooling the return air. Such cooling may be effected by means of the mill water, which being thereby warmed and conveyed by a pipe 60 to the mortar box 1 is useful in softening and quickening the amalgam within said mortar box or on the amalgamating plate 61. In other cases cyanid solution may be used as the cooling agent and being thereafter conveyed to the treatment vats its heated state facilitates the treatment of the ore.

It is to be remarked that in actual prac-

tice, one compressor 56 with the heater 58 and cooler 59 would be arranged to actuate a group of stamps, a controlling valve 62 being fitted for each stamp. All the valve gears of a number of stamps would preferably be operated by one motor 35, the cams of the several stamps being arranged to produce the desired order of drop when the stamps work in one mortar box.

For achieving the requisite pressure throughout the system to begin with, and for making up such leakage as may occur through glands and joints, a small auxiliary compressor 63 is arranged to force air drawn from the atmosphere into the low pressure line at the normal pressure existing in the latter. As shown, the auxiliary compressor is driven by air from the high pressure line 20 and exhausts such motive fluid into the low pressure line 22. Its operation is controlled by a valve 64 which is closed by normal pressure of the air in the low pressure line 22 but when the pressure falls below a predetermined point, is opened by a spring 65. Thus so long as said pressure is normal the auxiliary compressor is inoperative, but upon its decrease due to loss of air in the system, said compressor is automatically started.

66 indicates a spring controlled relief valve, which in the event of pressure in the pipe 20 rising above the normal, permits the excess air to pass away to the low pressure line 22. Such increase of pressure might be produced by overspeed of the main compressor 56, or by increase in the amount of heat supplied by the heater 58, or decrease of that abstracted by cooler 59. Generally the leakage from the system will compensate for any increase of pressure in the low pressure part of the system, but as an emergency measure a relief valve 67 may be supplied to relieve such excess pressure.

Overpressure in the return line may also be employed, to actuate a speed regulating device 68 for the motor 35 driving the valve gear; so that the number of drops per minute of the stamps may be varied to suit any variation in speed of the main compressor 56. Owing to the inefficiency of an electric motor when its speed is varied from the normal, it is preferred to regulate the small motor 35 which takes a relatively unimportant amount of current, rather than the large compressor motor 57.

The operation of the above described plant may be stated as follows, it being assumed that both the main and auxiliary compressors have been run for sufficient time for normal conditions to be attained. Air at high pressure is delivered continuously by the compressor 56 into line 20. In passing through the heater 58 it takes up a certain quantity of heat and its volume is increased. Assuming the piston 19 to be at the lower limit of its stroke, the small by-pass valve 31 is momentarily lifted by its cam 32, thereby admitting high pressure air under the main valve 23 which is thus raised against the combined resistance of the low pressure air above it and the spring 28. High pressure air is thus freely admitted under and raises the piston 19. As soon as said piston in its upward travel uncovers port 36, high pressure air passes above valve 23 and by counterbalancing the high pressure beneath said valve, enables spring 28 to close the same. Further admission being thus cut off, the piston stroke is continued by expansion of the air remaining in the cylinder. Immediately when, by reason of said expansion and the momentum of the stamp, pressure under the piston falls below that in the low pressure line 22, valve 37 will open automatically. Cam 38 is so timed that as quickly as possible after such automatic opening of valve 37, spindle 39 rises and retains said valve open during the downward stroke of the piston, permitting it to close immediately before the by-pass 31 re-opens for the next stroke. The use of the free exhaust valve obviates the possibility of the air pressure falling too low during expansion and thus unduly retarding the piston. The air thus being exhausted, the stamp falls by gravity, assisted by the action of the low pressure air above it. Upon its upward stroke the piston may traverse the opening 44 and thereby compress a cushion of air in the upper end of the cylinder, from which it acquires an initial impetus on its down stroke. The provision of said cushion compensates for the gradual loss of weight in the stamp due to wear of the shoe 3, since the less energy there is consumed in lifting the stamp, the more will be available for accelerating the downward stroke. The low pressure air exhausted from the cylinder is conveyed to the cooler 59 where its temperature and consequently its volume are reduced substantially to those originally existing and is then recompressed to undergo a further cycle. Any air lost by leakage is made up by the auxiliary compressor.

It is to be noted in regard to the addition and abstraction of heat to and from the system, that the heat added is utilized in the engine without appreciable loss, within the permissible range of temperature determined by its initial temperature and the ratio of expansion employed. That portion of it which is rejected as low grade heat into the cooling medium is also capable of efficient employment for useful purposes closely related to the stamping of ore; so that the utilization of energy in this manner becomes highly efficient. It may be noted that in a short closed air circuit such as that described, some cooling means is

desirable whether the air is directly heated or not, owing to the fact that as air is not an entirely perfect gas, repeated compressions cause a gradual accumulation of sensible heat in it. The present system permits such heat to be removed without simultaneous loss of pressure and enables it to be applied to useful purposes.

Apart from the added heat and the comparatively small amount which is generated by the imperfection of the air as a gas and which is abstracted by the cooler, and also leakage losses, which the design permits of being kept very low, the only difference in the work of the compressor and that expended by the stamp is that due to the resistance of the moving parts of the stamp and of the valves, ports and comparatively short system of pipes, so that the attainable efficiency of transmission is high. The mechanical efficiency of a good compressor operating under constant conditions is also high so that the total transmission from the primary motor will be very efficient.

In Fig. III the air engine is shown double acting, air from the high pressure line being consumed to force the stamp downward. The construction is generally similar to that of Figs. I and II, and the same reference numerals apply, with the differences noted hereunder. A cylinder port 69, main inlet valve 70, cut off port 71, and exhaust valve 72 are provided for the upper end of the cylinder similar to those described for the lower end. Both exhaust valves 37 and 72 are operated by the cam 38, by means of the pivoted levers 73 and 74, the former of which is connected directly to the yoke 75 and the latter indirectly by means of the link 76. Exhaust valve 72 opens to a branch 77 of the low pressure line 22. The branch 43 shown in Fig. I leading from the low pressure line 23 to the upper end of the cylinder is done away with and in lieu thereof, a branch 78 is taken from the high pressure line 20 to a chamber 79, communication of which with the upper end of the cylinder is controlled by a by-pass valve 80 having a stem 81 which projects into the path of the piston 19. Said valve 80 is held to its seat by a spring 82 sufficiently strongly to obviate its lifting by fluid pressure. The method of operation in the upper end of the cylinder may be exactly similar to that described in connection with the lower end except that the by-pass valve 80 is operated by the piston itself instead of by an independent cam. The action might however be modified if desired, by causing the upper exhaust valve 72 to close early so as to produce compression in the upper cylinder end sufficient to open the main inlet valve 70 directly, the spring 83 of said valve being so adjusted that the valve will be forced open by a pressure somewhat less than that of the high pressure line. The by-pass valve 80 may in this case be retained to serve as an emergency device which would come into action in case the compression failed, for any reason, to reach the requisite point.

From the foregoing description it will be seen that the application of the dense air system to the actuation of stamps presents a number of advantages. As compared with other devices of a similar nature, it will be seen that a given difference between the inlet and exhaust pressures may be attained without the disadvantage of excessive variation of temperature in the air which occurs when the same effective operating pressure is obtained by compressing air from atmospheric pressure, and which tends both to over-heat the compressor and to freeze up the stamp cylinder. A single stage compressor may thus, in the present system, be used efficiently and with small friction losses; while full expansion is possible in the stamp cylinder. Moreover owing to the small change of volume relatively to pressure, the expansion or compression part of the stroke is relatively small, the bulk of the stroke being pure displacement, leading to more uniform effort both in the compressor and in the stamp cylinder. For the same reason also the volume of air necessary to transmit a given power is relatively smaller, so that the plant is correspondingly more compact. A further important feature is the ease with which heat may be applied directly to perform work; while the possibility of cooling the exhausted air before recompression enables cumulative heating of the air by repeated compression to be more economically obviated, than in stamps of the pneumatic cushion type.

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

1. In combination, a pneumatic motor comprising a cylinder and piston, an air compressor, a high pressure conduit for conveying high pressure air from the compressor to the motor, a low pressure conduit for conveying exhaust air from the motor to the compressor, said motor, compressor and conduits forming a closed circulatory system in which the air moves in a uniform direction, distributing valve mechanism interposed between the cylinder and the conduits for admitting air from the high pressure conduit to propel the piston and exhausting air from the cylinder into the low pressure conduit to permit the return of the piston, and a separate motor for actuating said distributing valve mechanism.

2. In combination, a fluid actuated motor, a source of supply of working fluid, a fluid actuated main inlet valve controlling communication between the source of supply

and the motor, an auxiliary valve for controlling the opening of the main valve, and a separate motor for operating the auxiliary valve.

3. In a fluid actuated motor the combination with valve mechanism including a main induction port, a main inlet valve controlling the same, an independently operated auxiliary valve for admitting pressure to one end of the main valve to open to the same and means controlled by the piston of the stamp for admitting pressure to the other side of the valve to cause cut off of the incoming air.

4. In an expansively operating fluid actuated motor, fluid admission means operated and controlled independently of the moving member of said motor, and cut off means controlled by said moving member.

5. In combination, a fluid actuated motor, an air compressor, conveying means forming with said motor and the compressor a closed circulatory system, distributing valve mechanism controlling admission to and exhaust from the motor, a separate motor for actuating said valve mechanism, and means governed by pressure in the system for controlling said last named motor.

6. In a fluid actuated motor including a cylinder and piston, distributing valve mechanism including an exhaust valve adapted to exhaust fluid from the cylinder to permit return of the piston and capable of opening automatically by difference of pressure, means for holding said valve in the open position and means independent of the motor for actuating said last named means.

7. In combination, a cylinder including a cylinder head, a piston, and signal mechanism including a contact device projecting inwardly from the cylinder head and adapted to be moved upon abnormal movement of the piston to actuate a signal.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HANS CHARLES BEHR.

Witnesses:
H. H. OLDROYD,
WESLEY E. JOHN.