Dec. 14, 1937. A. C. STALEY 2,102,389

VALVE MECHANISM

Original Filed July 28, 1932 2 Sheets-Sheet 1

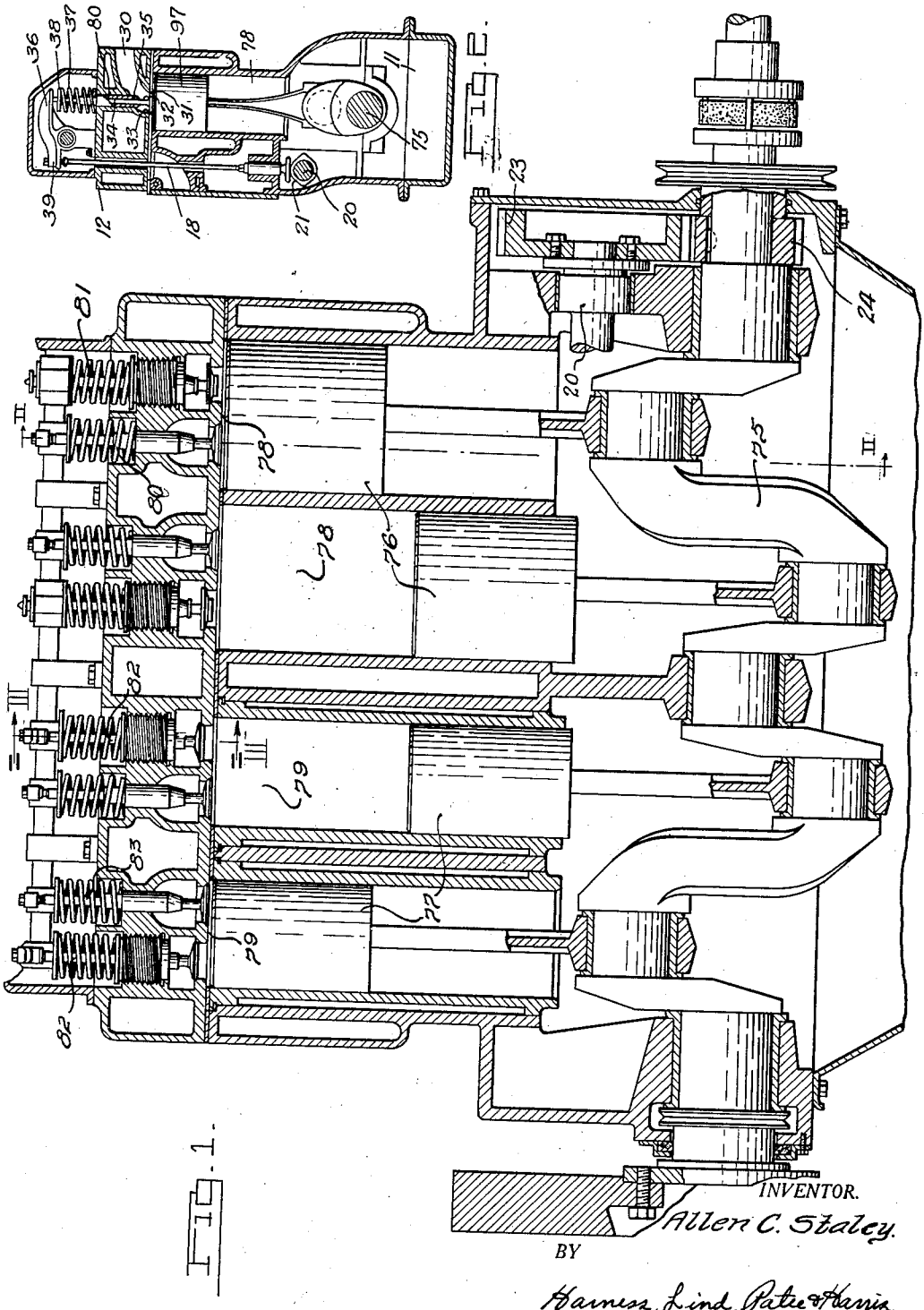


Fig. 1.

Fig. 2.

INVENTOR.
Allen C. Staley.

BY

Harness, Lind, Paten & Harris.
ATTORNEYS.

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VALVE MECHANISM

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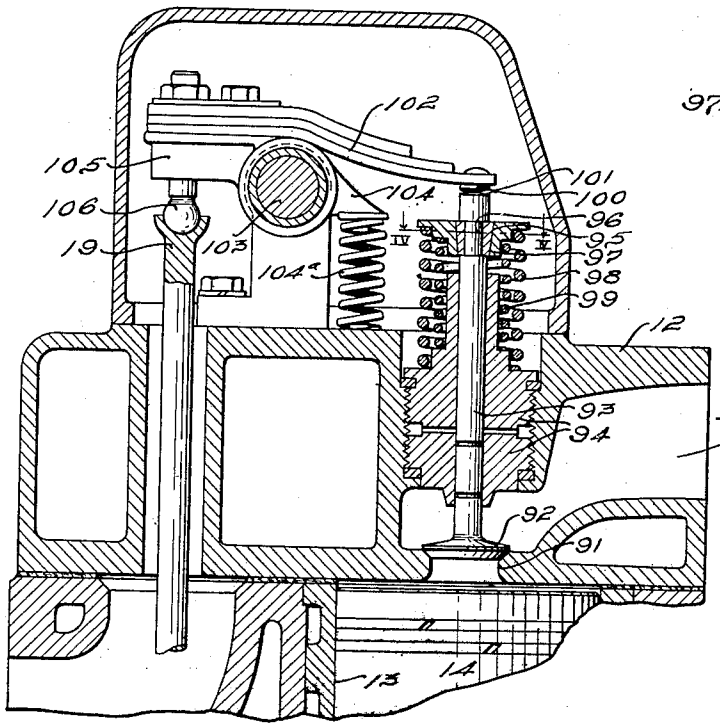


Fig. 4.

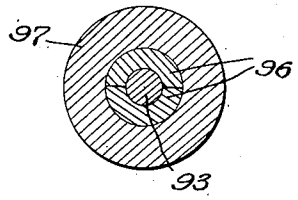


Fig. 3.

INVENTOR.
Allen C. Staley.

BY
Harness, Lind, Pate & Harris
ATTORNEYS.

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UNITED STATES PATENT OFFICE

2,102,389

VALVE MECHANISM

Allen C. Staley, Birmingham, Mich., assignor to Chrysler Corporation, Highland Park, Mich., a corporation of Delaware

Original application July 28, 1932, Serial No. 625,449, now Patent No. 2,011,780, dated August 20, 1935. Divided and this application March 30, 1935, Serial No. 13,823

4 Claims. (Cl. 121—127)

My invention relates to air or gas expanding mechanism of the reciprocating piston type and has particular relation to several novel types of valve mechanism, and several novel combinations of such types, for use in equipment of the character designated, and is a division of my copending application Serial No. 625,449, filed July 28, 1932, which has now issued as Patent No. 2,011,780, dated August 20, 1935.

More particularly, my invention relates to novel types of inlet and exhaust valve mechanism, and to novel combinations thereof for use in air or gas expanding mechanism for use in refrigerating systems.

By my invention, I have provided a mechanically operated valve of the poppet type for use as an intake valve in an air motor in which a cam of normal contour is employed to operate the valve and in which the valve is mechanically closed at the proper time, thus eliminating both of the objections of the aforementioned type of valve.

One of the objects of my invention consists in providing a novel type of valve adapted for use as an exhaust valve of air motors of the reciprocating type which eliminates the objections of both the mechanically operated and the pressure operated valve and retains the advantages of both types.

Another object of my invention is to provide a novel type of intake valve for air motors and expanding machines of the reciprocating type that eliminates the objections to, and retains the advantages of, mechanically operated valves.

A still further object of my invention consists in providing a novel type of valve mechanism in which the effect of the inertia of the valve closing member is eliminated as a factor in the timing of operation of pneumatically operated valves.

An additional object is to provide a combination of intake and exhaust valve mechanism for use in air motors or in expanding machines as used in refrigerator equipment.

For a more detailed understanding of my invention reference may now be had to the accompanying drawings, of which:

Fig. 1 is a longitudinal cross-sectional view of a combined compressor and expander, or air motor, constructed in accordance with my invention and adapted for use in refrigeration systems.

Fig. 2 is a transverse cross-sectional view of the structure illustrated in Fig. 1, the section being taken along the line II—II thereof.

Fig. 3 is a fragmentary transverse cross-sectional view taken along the line III—III of Fig. 1.

Fig. 4 is a horizontal sectional view taken on the line IV—IV of Fig. 3.

In Fig. 1 is illustrated a combination gas or air compressing and expanding machine adapted particularly for use in a refrigerating system. In this construction, a crankshaft **75** operates two compressor pistons **76** and has connected thereto two expanding machine or air motor pistons **77**. The two pistons **76** move within compressor cylinders **78** which are of larger diameter than the expander or air motor cylinder **79** within which the pistons **77** operate. The compressor cylinders **78** are each provided with an intake valve mechanism **80** similar to that illustrated in Fig. 2, and an exhaust valve mechanism **81**, similar to that illustrated in Fig. 3. The expander or air motor cylinders are each provided with an intake valve mechanism **82**, similar to that illustrated in Fig. 3, and an exhaust valve mechanism **83**, similar to that illustrated in Fig. 2.

The valve mechanisms **80**, **81**, **82** and **83** are operated by valve operating rods **18** and **19** which in turn are operated by a cam shaft **20** provided with four inlet valve operating cams **21** and the same number of similar exhaust valve operating cams (not shown). The cam shaft **20** is driven at half the speed of the crankshaft by means of the gear **23** secured thereon which meshes with a smaller gear **24** mounted on the crankshaft.

In refrigerating systems of this type, it is customary to employ a compressor or compressor cylinder which serves to compress air or other gas, preferably the former, which compressed gas is then carried to an air cooling means, such as a water or air cooled radiator or the like. The compressed gas, now cooled, is in turn admitted to the expander or air motor which reduces the pressure thereof, and the cold air at the reduced pressure is then conducted to the chamber to be cooled, such as a refrigerating chamber, room, or the like. The valve mechanisms **80** to **83** are operated by means of a camshaft **20** driven from the crankshaft **75**, as described in connection with Fig. 1.

In Fig. 2 is shown a cross-sectional view of the compressor inlet valve shown in Fig. 1 which also serves to show the construction and operation of the exhaust valve of the air motor portion shown in Fig. 1. In this construction the valve mechanism is of the usual type employed in internal combustion engines in which an intake manifold passageway **30** communicates with the interior of the cylinder **78** through a valve port **31** which is guarded by a port closing member **32**. The port closing member comprises a valve head **33** which

seats in the valve port 31 and an integral valve stem 34 which extends upwardly through a valve stem guide 35. The upper end of the valve stem 34 is disposed in engagement with a laterally extending projection of a pivotally mounted rocker arm 36. A compression spring 37 surrounds the upper end of the valve stem 34, one end being disposed in engagement with the upper surface of the cylinder head 12 and the other end in engagement with a disc or pin 38 mounted on the valve stem 34. The spring 37 thus tends to hold the valve head 33 in engagement with the seat of the valve port 31. The rocker arm 36 is provided with a second laterally extending projection 39 which is engaged by the valve operating rod 18 in such manner that the cam 21 on the camshaft 20 raises the rod and thereby opens the valve twice during each revolution of the camshaft.

In Fig. 3 is illustrated a valve mechanism which may be employed either as the intake valve mechanism of an air motor or expander, or as the exhaust valve mechanism of a compressor. In Fig. 1, the exhaust valves 81 of the compressor may be identical to the exhaust valve structure shown in my Patent No. 2,011,780 of which this is a division. In this figure I have illustrated the usual cylinder 79 provided with the cylinder head 12 in which is disposed a passageway 90 communicating with the cylinder 79 through a valve port 91 which is guarded by a valve head 92, the latter being provided with an integral valve stem 93. The valve stem 93 moves within any suitable arrangement of valve guide 94. The upper end of the valve stem 93 is provided with a groove 95 in which is fitted a two-part locking collar 96 provided with a conical exterior surface and serves as a seat for a spring collar member 97. The valve stem is surrounded by two coiled compression springs 98 and 99, which together serve to raise the valve head 92 from its seat when no pressure is exerted thereon by the rocker arm.

The valve stem 93 is provided at its top with a curved portion 100 which is engaged by a contacting member 101 mounted upon an end portion of a rocker arm 102. The rocker arm 102 is pivotally mounted upon a pin 103 mounted on the cylinder head 12. The rocker arm 102 is composed of a plurality of leaf springs which serve to provide a resilient engagement between the rocker arm and the valve stem. The rocker arm 102 is provided with an arm 105 on which is mounted an adjustable member 106 which in turn is engaged by the tappet rod 19 and with an oppositely disposed arm 104 which is engaged by a compression spring 104a which serves to raise the arm 102 when the member 19 is in its lowermost position.

In this particular construction there is normally a considerable pressure in the chamber 90 which exerts a pressure on the upper side of the valve head 92 and serves to hold the valve closed. As the piston approaches the upper end of its stroke, there being but comparatively little clearance between the cylinder head and the piston, the pressure created thereby is sufficient, together with the aid of the springs 98 and 99, to raise the valve head 92 from its seat against the pressure in the chamber 90. When this occurs, the pressure is immediately equalized on both sides of the valve head and the springs 98 and 99 open the valve wide instantly. The upwardly moving valve stem 93 engages the resilient arm 102 and is cushioned thereby, so as to prevent any sharp blows to any part of the valve mechanism, thus eliminating any slowness of movement resulting from the inertia of the valve head and valve stem. It will be apparent that by reason of the force of the springs 98 and 99 being additive to the pressure within the cylinder, the valve will start to open before the pressure in the cylinder equals that in the chamber 90. This small interval of time is sufficient for overcoming the inertia of the valve closing member and its stem so that the valve actually opens at the time when the pressure in the cylinder is equal to that in the passageway 90. When the cam engages the tappet rod 19 it moves the rocker arm 102 downwardly, thus promptly and positively closing the valve through a resilient connection. The rocker arm may be raised immediately thereafter but the valve remains closed because of the pressure in the passageway 90 on the upper side of the valve head being greater than the pressure exerted thereon by the springs 98 and 99, and the valve will remain closed until the piston again reaches the upper portion of its stroke and pneumatically raises the valve, as previously described.

From this description it will be apparent that the air motor intake valve is positively mechanically closed at the desired predetermined point and is pneumatically opened during its normal operation. It will also be apparent that the compressor exhaust mechanism is likewise mechanically positively closed and is pneumatically opened by the differential in pressure on the two sides thereof. In each instance the valve opens without any retardation caused by the inertia of the valve member and instantly opens widely. Also, in each instance, the valve closing member moving upwardly engages at the uppermost portion of its movement a resilient cushioning member which serves to eliminate shocks to the mechanism.

It should also be understood that all the foregoing advantages of the air motor intake valve are obtained in the compressor operation by the correspondingly constructed exhaust valves thereof and that the resulting perfection of timing of compressed fluid discharge from the compressor and intake of such compressed fluid by the air motor results in an obtainment of efficiency which surpasses that of combined air motor and compressor units of conventional structure. By employing an improved valve mechanism of this character and the precise parts of the motor and compressor specified, the system is conditioned, not only to make available the advantages of the fluid compressor exhaust valve operation and the advantages of the improved motor intake valve operation individually, but to so synchronize these related functions as to obtain an efficiency and accommodate speeds of operation far in excess of what could be expected by the individual contributions of the improved motor and compressor constructions, respectively.

Although I have illustrated but one specific form of my invention, it will be apparent to those skilled in the art that my invention is not so limited but that various changes and modifications may be made therein without departing from the spirit thereof or from the scope of the appended claims.

What I claim is:

1. In an air motor having a cylinder provided with a movable piston; valve mechanism including an intake and an exhaust valve, each adapted to be opened and closed, said intake valve being

adapted to be opened by a combined mechanical and fluid pressure differential on opposite sides thereof and to be closed by positive mechanical means.

2. In an air motor having a cylinder provided with a movable piston; valve mechanism including an intake and an exhaust valve each adapted to be opened and closed, mechanical means adapted to close the inlet valve and to retain it in its closed position during a predetermined portion of the piston movement, said valve being adapted to be opened by a combined mechanical and fluid pressure differential on opposite sides thereof during other portions of the piston movement.

3. In an air motor having a cylinder provided with a movable piston; valve mechanism including an intake and an exhaust valve, said intake valve being of the poppet type, each of said valves being adapted to be opened and closed, mechanical means adapted to open and close the intake valve at predetermined points in the travel of the piston and to hold said intake valve closed during a predetermined portion of the piston travel, said intake valve being adapted to be opened by a combined mechanical and fluid pressure differential on opposite sides thereof during other portions of the piston travel.

4. In an air motor having a cylinder and a movable piston, valve mechanism including an intake valve and an exhaust valve of the poppet type, each constructed to be opened and closed, said intake valve being constructed to be opened by a pressure differential on opposite sides thereof and to be closed by positive mechanical means.

ALLEN C. STALEY.