Aug. 8, 1961 W. T. FLEMING 2,995,292

PRESSURE INTENSIFIER

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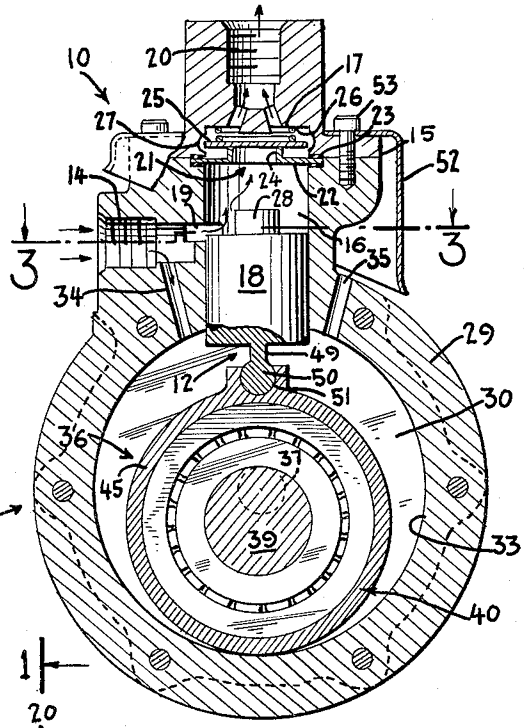


Fig. 1.

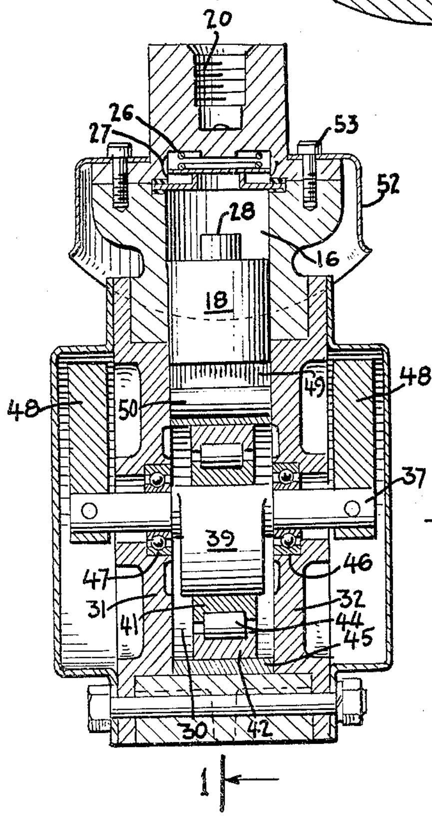
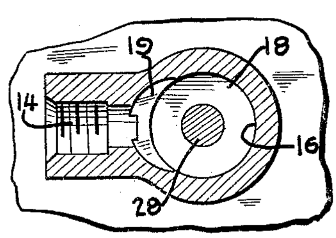


Fig. 2.

Fig. 3.



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PRESSURE INTENSIFIER

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The present invention relates to pneumatic pressure intensifiers, and, more particularly, to pressure intensifiers of the combined compresser-engine type wherein the engine is driven by the source of fluid pressure to be intensified by the compressor.

In many instances, applications for high pressure pneumatic fluid exist where only low pressure fluid is available. This is particularly true in pneumatic applications where pressures of 3,000 to 5,000 pounds per square inch are required and the available air supply has a pressure of about 40 to 100 pounds per square inch. It is desirable under these circumstances to utilize the available low pressure fluid and compress it to the pressure required, in an efficient and inexpensive manner, by an apparatus which is low in cost, is light in weight and has a minimum space requirement.

Heretofore, apparatus designed for this purpose has not been entirely satisfactory for one or more reasons, namely, that the apparatus was costly to manufacture because of complex valving, had excessive weight and space requirements, lacked the desired volumetric efficiency, lacked a sufficient output pressure to input pressure ratio, or required power from a source other than the available fluid under pressure.

Accordingly, an object of the present invention is to provide a pneumatic pressure intensifier which is simple and economical to manufacture.

Another object is to provide such apparatus which utilizes the available low pressure fluid as its power source.

Another object is to provide such apparatus which has a large output pressure to input pressure ratio and thereby is efficient in operation.

Another object is to provide such apparatus which has a small space requirement and is light in weight.

A further object is to provide such apparatus which has a high volumetric efficiency.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

In accordance with the present invention, the foregoing objects are accomplished by providing apparatus for increasing the pressure of a gaseous medium under pressure, for example air, which comprises a compressor including a cylinder bore having an intake port and an exhaust port, a piston mounted for reciprocation in the cylinder bore, and valve means for the exhaust port; a rotary engine operable by gaseous medium under pressure and adjacent the compressor and including a cylindrical chamber having its central axis intersecting the central axis of the cylinder bore perpendicularly and having an inlet port and an outlet port, a piston drum in the chamber, and eccentric means for mounting the drum for rotary movement within the chamber; coupling means for connecting the drum and the piston to cause rotary movement of the drum to thereby effect reciprocation of the piston; and conduit means adapted for connection to a supply of gaseous medium under pressure and in fluid flow communication with the intake port and the inlet port, whereby a portion of the medium supplied is utilized to drive the engine and the remainder thereof is compressed to increase its pressure.

A preferred embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawing forming a part of the specification, wherein:

FIG. 1 is a longitudinal sectional view of the apparatus in accordance with the present invention.

FIG. 2 is a sectional view taken along the line 2—2 on FIG. 1.

FIG. 3 is a sectional view taken along the line 3—3 on FIG. 1 illustrating certain details of construction.

Referring to the drawing in detail, the pressure intensifier in accordance with the present invention generally comprises a compressor **10**, a rotary engine **11**, and connecting means **12** through which the engine drives the compressor. Conduit means **14** provide a common low pressure fluid supply to the compressor and the engine.

The compressor **10** comprises an upper casing **15** having a cylinder or bore **16** therein, a head **17** for closing the upper end of the bore **16**, a piston **18** mounted for reciprocation in the bore **16**, an intake port **19** in the side wall of the bore **16** just above the piston when it is in its lower position (FIG. 1) and in fluid flow connection with the conduit means **14**, an exhaust port **20** in the head **17**, and exhaust valve means **21** positioned in the bore adjacent the exhaust port **20** to control the flow of compressed fluid therethrough.

The exhaust valve means **21** includes a disc-like valve seat member **22** seated in an annular recess **23** formed in the bore **16** and having a tubular upwardly extending portion **24**, a valve disc **25** positioned above the portion **24**, and a spring **26** above the valve disc for urging the same to seat on the tubular portion of the seat member **22**. The bore **16** is fluted adjacent the periphery of the valve disc **25** to form passageways **27** for enabling the fluid flowing through the portion **24** to get past the valve disc when the latter is unseated. A projection **28** on the upper end of the piston **18** is adapted to extend into the tubular portion **24** to obtain maximum compression of the fluid in the bore **16**.

The rotary engine **11** comprises a lower casing **29** having a cylindrical chamber **30** defined by end walls **31** and **32** and a cylindrical side wall **33**, an inlet port **34** in the wall **33** in fluid flow connection with the conduit means **14** and adjacent one side of the bore **16**, an outlet port **35** in the wall **33** adjacent the bore **16** on the opposite side of the bore **16** from the inlet port **34**, a piston drum **36** positioned eccentrically within the chamber **30** and having a smaller diameter than the chamber **30**, and a shaft **37** on which the drum **36** is eccentrically mounted to provide continuous contact between peripheral surface of the drum and the inner side of the wall **33** as the shaft rotates.

The piston drum **36** comprises a cylindrical core section **39** attached to the shaft **37** for rotation therewith; a bearing assembly **40** having an inner race **41** mounted on the core section **39**, an outer race **42** and roller bearings **44** between the races; and an outer cylindrical sleeve **45** mounted on the outer race **42** of the bearing assembly **40** for rotatory movement therewith. The sleeve **45** is dimensioned to contact the end walls **31** and **32** of chamber **30** to provide a fluid seal between the end walls and the edges of the sleeve **45**.

The ends of the shaft **37** extend outwardly of the chamber **30** through openings **46** in the end walls **31** and **32** and bearings **47** are provided in the openings **46** about the shaft 37. Counterweights **48** are attached at the outer ends of the shaft **37** to dynamically balance the rotary piston drum 36 and thus provide smooth operation of the engine.

The connecting means **12** include a depending transverse extension **49** at the bottom of the compressor piston **18** terminating in a cylindrical portion **50**, and a cylindrical socket **51** provided on the piston drum **36** for receiving the portion **50** to provide a pivotal connection between the piston **18** and the piston drum **36**. The connecting means portions **49**, **50** and **51** also are dimensioned to be in fluid sealing contact with the end walls **31** and **32** of the chamber **30** so that a partition is provided in chamber **30** between the inlet port **34** and the outlet port **35**. A truncated, inverted cup-shaped hood **52** is secured to the casing of the compressor **10** by a plurality of bolts **53** and overlies the outlet port **35** of the engine **11** whereby the cool expanded air leaving the port **35** is utilized to cool the compressor.

In operation, low pressure fluid from the common supply flows from the conduit means **14** through the ports **19** and **34** into the compressor bore **16** and into that portion of chamber **30** on the inlet side of the partition formed between the ports **34** and **35**. The drum **36**, by having fluid under pressure acting only on its left or inlet side, is forced toward the right (as viewed in FIG. 1) thereby causing its core section **39** and shaft **37** attached thereto to rotate in a counterclockwise direction. The sleeve **45** is restrained from rotation with core section **39** by its pivotal connection to the piston **18** and thus is displaced vertically and horizontally, maintaining its contact with the wall **33** as the core section **39** rotates within bearing assembly **40**. The point on the inner side of wall **33** at which the peripheral surface of the sleeve **45** is in contact therewith moves continuously in a counterclockwise direction as the core section **39** rotates.

As the core section **39** rotates through 180° from the position shown in FIG. 1, the vertical movement of the sleeve **45** is transmitted through the connecting means **12** to move piston **18** upwardly and effect a compression stroke. As the piston starts its compression stroke, it covers and seals off the intake port **19** to confine the low pressure fluid in the bore **16** for compression. As the piston nears the end of its compression stroke, the pressure of the fluid in the bore **16** overcomes the resistance of spring **26** and lifts the valve disc **25** from its seat portion **24** thereby allowing the fluid to leave the bore **16** and flow through the passageways **27** to the exhaust port **20**. When the unit is started, the spring **26** supplies a positive seating force to the valve disc as a back pressure is being built up.

When the core section **39** has completed its revolution, the piston **18** is returned to its starting position for the next cycle.

The fluid issuing from the outlet port **35** of the engine **11** flows up under the hood **52** and around the compressor **10** spilling out on the side of the compressor opposite the port **35**. Since this fluid, in driving the engine, has done work, it has been cooled and, therefore, cools the compressor as it flows past.

With apparatus of the type described, it has been found that low pressure air of 50 pounds per square inch having a flow rate of 20 standard cubic feet per minute can be boosted to the very high pressure of about 2,500 pounds per square inch with a flow rate of approximately 2 standard cubic feet per minute, with the engine developing a speed of 5,500 revolutions per minute.

From the foregoing description, it will be seen that the present invention provides an improved and novel apparatus for providing a source of very high pressure fluid by increasing the pressure of available low pressure fluid.

As various changes may be made in the forms, construction and arrangement of the parts herein, without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in any limiting sense.

I claim:

1. Apparatus for increasing the pressure of a gaseous medium under pressure comprising in combination a casing, said casing including a lower portion formed with a cylindrical chamber having a curved side wall and flat end walls and an upper portion formed with a cylinder bore of a diameter equal to the distance between said flat end chamber walls and having a closed upper end, said bore extending downwardly into said lower casing portion intersecting said curved chamber wall and having a central axis perpendicularly bisecting the central axis of said chamber; a piston mounted for reciprocation in said cylinder bore; a rotary piston positioned in said chamber; eccentric means for mounting said rotary piston for rotary movement within said chamber; a coupling member rigidly attached to the lower end of said piston and having a cylindrical portion on the lower end thereof; means on said rotary piston providing a cylindrical socket receiving said cylindrical portion of said coupling member whereby rotary motion of said rotary piston effects reciprocating motion of said reciprocating piston; inlet port means for said cylindrical chamber provided in said casing adjacent one side of the intersection of said chamber and said bore; outlet means for said chamber provided in said casing adjacent the other side of said intersection; said coupling member having a width equal to the diameter of said reciprocating piston whereby said coupling member and said reciprocating piston seal said inlet port from said outlet port; intake port means for said bore provided in said casing intermediate the ends of said bore; exhaust port means for said bore provided in said casing in communication with the upper end of said bore; pressure operated spring biased valve means at said exhaust port; conduit means in said casing extending from the outer surface thereof including means for connecting a supply of gaseous medium under pressure thereto; passageway means connecting said conduit means and said inlet port for conducting gaseous medium under pressure to said chamber to drive said rotary piston; and passageway means connecting said conduit means and said intake port for conducting gaseous medium under pressure into said bore to be compressed by the upward motion of said reciprocating piston, said intake port being positioned to be sealed off by said reciprocating piston when it moves upwardly, thereby confining the fluid in said cylinder bore for compression.

2. Apparatus according to claim 1, wherein an inverted cup shaped hood of greater horizontal dimensions than said upper casing portion is mounted on said upper casing portion at a level adjacent the said end wall of said bore, said casing is provided with an external opening positioned inwardly of the periphery of said hood, and passageway means is provided in said casing connecting said outlet port to said opening for directing expanded gaseous medium into the volume enclosed by said hood, the lower edge of said hood being slanted upwardly from adjacent said opening to induce the expanded gaseous medium issuing from said opening to flow around and cool said upper casing portion.

3. Apparatus according to claim 1, wherein said means for mounting said rotary piston includes a shaft extending through said casing and having its ends positioned outwardly of said casing, eccentrically mounted weights are mounted on each end of said shaft to counter balance the rotary piston, and a cover secured to said casing is positioned over each of said weights.

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