

[54] **AIR PRESSURE INTENSIFIER**

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[58] Field of Search..... **417/319, 44, 564, 539, 273; 92/60.5**

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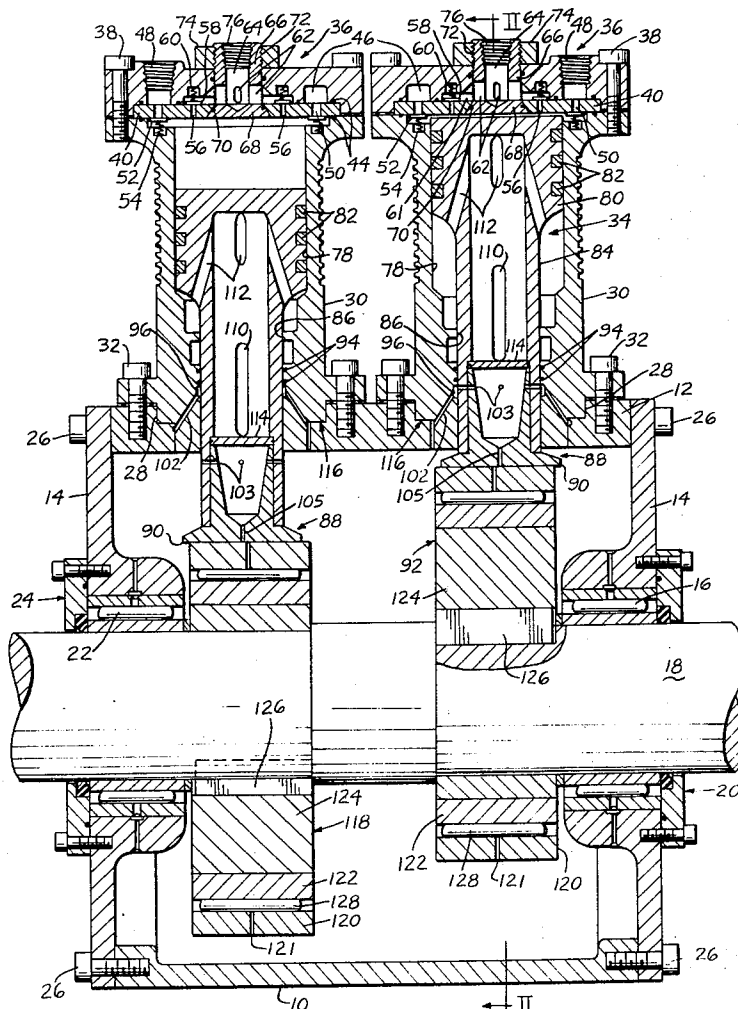
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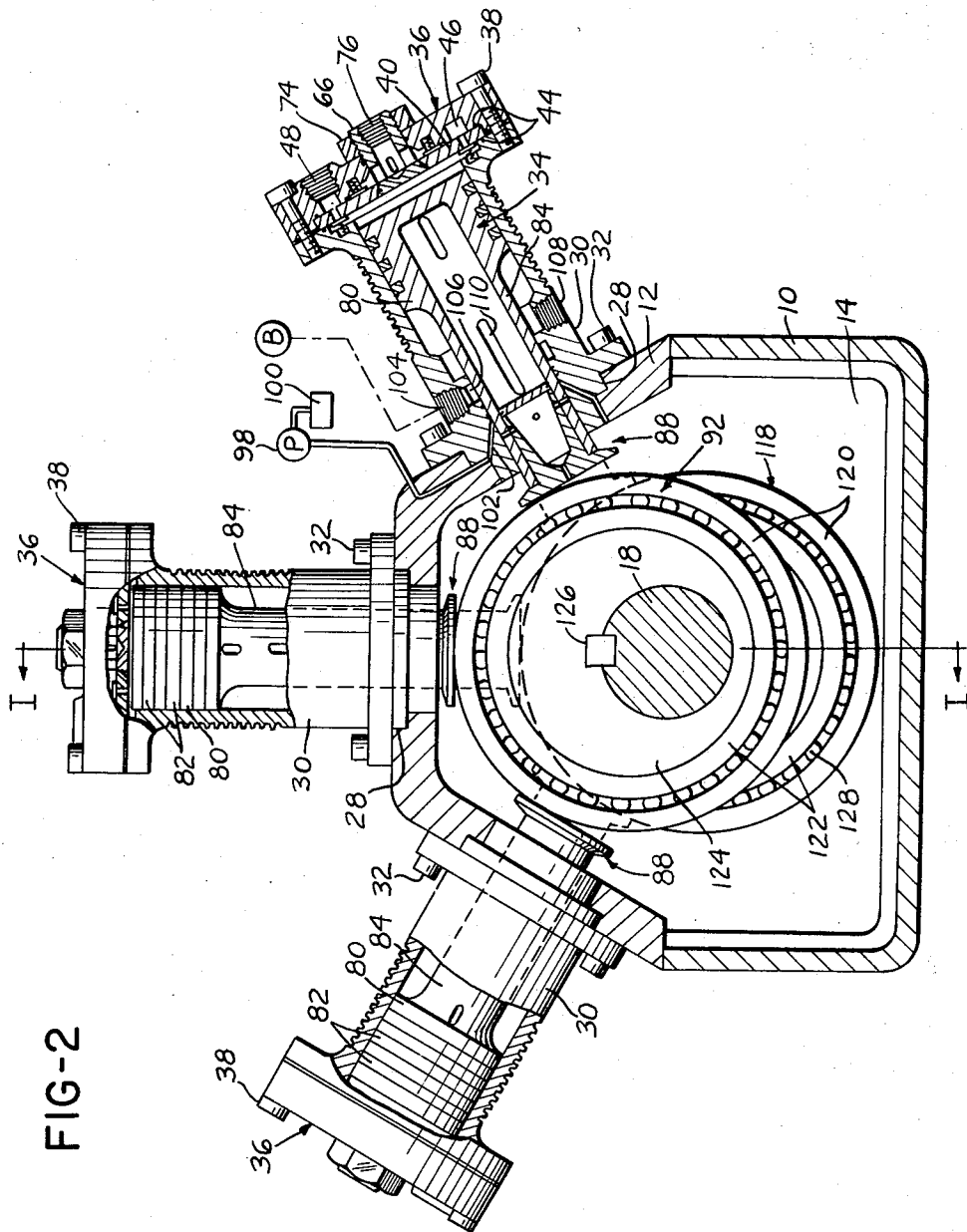
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[57] **ABSTRACT**

The specification discloses an air pressure intensifier adapted to be supplied with air at a certain lower pressure and operable to increase the pressure of the air to a predetermined higher pressure. The device has reciprocating pistons driven by eccentrics and employs a cooling medium for cooling the pistons as the device operates. In one modification, the air pressure intensifier is connected in circuit with a source of air under pressure and only operates when the source drops to a certain lower level and turns off when the pressures reaches a predetermined amount.

7 Claims, 5 Drawing Figures





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FIG-3

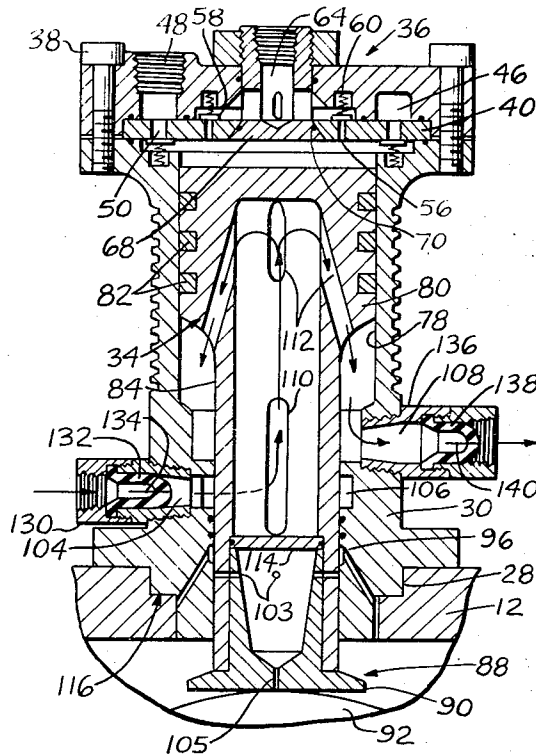


FIG-4

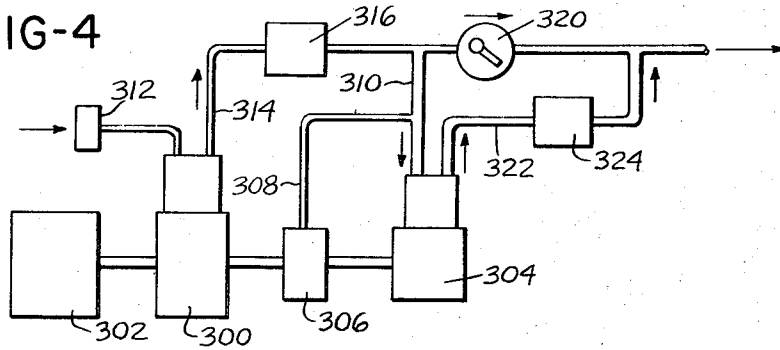
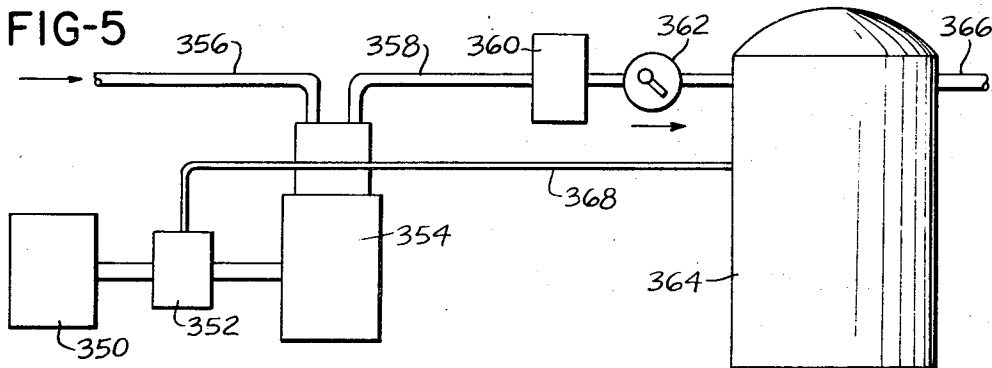


FIG-5



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AIR PRESSURE INTENSIFIER

The present invention relates to an air pressure intensifier and is particularly concerned with a piston type air pressure intensifier and especially one in which the pistons are actuated by eccentrics which move the pistons positively in a working direction, while the pistons are returned by the pressure of the air supplied to the intensifier.

Air compressors, and the like, are well known and, for all pressures above relatively low pressures, are of the piston type. Air compressors are employed for developing pressure on air which can then become an energy source for driving pneumatic tools and the like and for other known purposes.

In many work operations, such as a mining and the like, ever increasing air pressures are desired in order to carry out work operations at a high rate of speed. As drilling motors and hammers and the like are refined in design, and tools are made better, it becomes possible to supply air pressure thereto higher than has heretofore been supplied and thereby increased the work output.

In general, drills and air operated hammers and the like have operated at 100 to 125 pounds per square inch air pressure and, more recently, at 250 pounds per square inch air pressure but these pressures are becoming inadequate for carrying out the work operations at the desired rate of speed and for penetrating extremely hard formations.

With the foregoing in mind, it is a primary objective of the present invention to provide an air pressure intensifier of nominal design operable for receiving air at a certain pressure and for increasing the pressure on the air.

Another object of the present invention is the provision of a piston type air pressure intensifier in which the pistons are positively driven only in the working direction thereof.

Still another object of this invention is the provision of air intensifier which is, at least in part, self cooling.

Still another object of the present invention is the provision of an air pressure intensifier which can be constructed to substantially any size utilizing the same principles throughout.

Still another object of the present invention is the provision of an air pressure intensifier in which the compression, or intensification, ratio can easily be adjusted to meet particular working conditions.

Still another object of the present invention is the provision of a novel circuit employing a basic source of air under pressure together with an air pressure intensifier in which the intensifier only operates when the pressure of the air supplied by the basic source drops to a predetermined amount.

The foregoing objects of the present invention as well as other objects and advantages thereof will become more apparent upon reference to the following detailed specification, taken in connection with the accompanying drawings in which:

FIG. 1 is a longitudinal section through an air pressure intensifier according to the present invention and is indicated by line I—I on FIG. 2;

FIG. 2 is a transverse section through an intensifier according to the present invention and is indicated by line II—II on FIG. 1;

FIG. 3 is a fragmentary view showing the manner in which valves can be mounted on the cylinders of the intensifier for the self-pumping of cooling air therethrough; and

FIGS. 4 and 5 are examples of circuits in which the intensifier according to the present invention can be employed.

BRIEF SUMMARY OF THE INVENTION

The air pressure intensifier according to the present invention comprises a frame in which a shaft is rotatably mounted. Arranged on the shaft are eccentrics disposed at an angle to each other when viewed from the end of the shaft and mounted on the frame are cylinders in which pistons are reciprocable. The pistons have their one ends engaging the eccentrics in one direction. At the other ends of the pistons, the cylinders in which they reciprocate are closed and have inlet and outlet valves for controlling the flow of air therethrough.

The pistons are arranged in their respective cylinders so that, as the pistons reciprocate, a pumping action is had by means of which cooling air can be drawn into and expelled from the cylinders beneath the pistons, thereby effecting the cooling of the pistons and cylinders during operation of the intensifier.

According to a preferred arrangement of the device, the cylinders, when looking endwise of the drive shaft, are arranged at angles to each other and, when looking at the side of the shaft, are distributed in banks lengthwise of the shaft. Each bank of cylinders and pistons distributed longitudinally of the shaft can thus consist of, say, three pistons and cylinders. Each bank of pistons and cylinders has a respective eccentric on the shaft and the eccentrics are oriented angularly to each other when viewed from the end of the shaft so that the working load is distributed during rotation of the shaft so as to represent a substantially constant load on a driving source of power, such as an internal combustion engine connected to the shaft.

In certain circumstances it is advantageous to put an air pressure controlled clutch between the driving engine and the pressure intensifier which will close only under certain pressure conditions which require operation of the intensifier so that the intensifier is only driven during periods of need, thereby saving wear on the intensifier and also unloading the driving engine during periods when the operation of the intensifier is not required.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings more in detail, in FIGS. 1 and 2 it will be seen that the frame or housing for the air pressure intensifier comprises a lower portion 10 and an upper portion 12. As shown, these portions may be cast but they also may be formed of plates welded together. The lower member 10 is U-shaped and opens upwardly and the upper member 12 consists of the upper half of a generally hexagonal trough-like member so as to have formed thereon three flat regions distributed at angles to each other for mounting the cylinders within which the pistons of the intensifier reciprocate. The marginal edges of member 12 are preferably welded to the edges of member 10 but it is also possible for these members to be bolted together.

At each end of the frame consisting of members 10 and 12 there is mounted a cover plate 14. The cover plate at the right end, as viewed in FIG. 1, has a central bore in which a needle bearing 16 is mounted in which drive shaft 18 is journaled. A retaining ring and seal arrangement at 20 retains the needle bearing in place and also seals against leakage around shaft 18.

The cover plate 14 at the left end of the device has a central bore in which a needle bearing 22 is mounted and a retaining plate 24 closes the aperture in the respective end plate and retains the needle bearing in place therein. The end plates 14, which may be cast members, are held in place on the frame of the machine by cap screws 26.

Each of the aforementioned flat regions on member 12 of the illustrated modification is provided with a pair of longitudinally spaced shouldered bores 28 in which respective cylinders 30 are mounted and which are retained in place on member 12 by cap screws 32. The several cylinders all extend radially of drive shaft 18 and each has reciprocally mounted therein a piston structure 34.

Each cylinder has a shouldered lower end part relatively closely fitting the respective bore 28 and a circumferential flange, or laterally extending lugs, through which bolts 32 pass. At the outer end of each cylinder a cylinder head 36 is mounted and is retained in place by cap screws 38 extending through the cylinder head and threaded into a peripheral flange on the outer end of the respective cylinder. Between each cylinder head 36 and the outer end of the respective cylinder there is confined a valve plate 40 which is sealed at the outer periphery thereof by the O rings 44.

Each cylinder head 36 includes an annular passage 46 opening to the upper face of the respective valve plates and including at least one port 48. Port 48 represents the inlet port for the cylinder and annular passage 46 represents the inlet passage through which air is supplied to the interior of the cylinder. Distributed about plate 40 and in communication with channel 46 are ports 50 and on the cylinder sides of ports 50 are valve discs 52 pressed toward plate 40 by respective springs 54. Discs 52 and springs 54 form check valves opening from channel 46 into the cylinder.

Also distributed circumferentially about plate 40 on a smaller radius are outlet ports 56, which on the side facing away from the interior of the respective cylinder are engaged by discs 58 which are pressed toward plate 40 by respective springs 60. Discs 58 and springs 60 form outlet check valves through which the high pressure air discharge from the respective cylinder passes. The downstream ends of ports 56 communicate with a central chamber 61 in the cylinder head and therefrom via ports 62 with a central passage 64 in a plug member 66 which forms an outlet fitting for the cylinder.

Plug member 66 has a conical inner end 68 seated in a correspondingly shaped central aperture in plate 40 and sealed thereto by O rings 70. The opposite end of plug member 66 is externally threaded at 72 for receiving a retaining nut 74 and internally threaded at 76 for receiving a conduit. The provision of plug like fitting 66 fixedly clamps valve plate 40 to the cylinder head and also reinforces the central portion of plate 40 against deflection due to the high pressure standing on the upper face thereof.

Turning now to the cylinders 30, each thereof is tubular and has a bore extending completely therethrough with the portion of the bore nearest the cylinder head as at 78 being enlarged for receiving the piston head 80 of the respective piston 34. Piston head 80 carries piston rings 82 for sealing against leakage along the piston head. Extending toward the center of the device from piston head 82 is a push rod portion 84 which is reduced in diameter from the diameter of piston head 80 and which slidably fits in the reduced diameter portion 86 of the lower end of the cylinder. At the extreme inner end of reduced diameter portion 84 there is mounted a shoe member 88 which has a flat enlarged lower end part 90 adapted to engage the periphery of a respective eccentric 92 mounted on drive shaft 18.

The push rod portions 84 of the pistons are sealed in reduced diameter portion 86 of the cylinder by conventional seal rings 94. Lubrication is supplied to the push rod portions by an annular passage 96 formed in the cylinder beneath the rings 94 and which is connected with the outlet side of an oil pump 98 which draws oil from a sump 100, and which may be the sump in member 10. The pump 98 operates substantially pressure free because channel 96 is connected by a conduit 102 directly with the sump inside the frame of the device. The supply of oil however maintains the push rod portions can adequately lubricated as they reciprocate in the pistons.

Lubricants can also enter pistons via passages 103 and will flow downwardly therein and out passages 105 and lubricate the pertaining shoe member.

A particular feature of the present invention is to be found in the provision of a first port 104 in the cylinder wall within the range of the reduced diameter portion 86 of the cylinder and which communicates with an annular passage 106, and the provision of another port in the cylinder at 108 which communicates with large diameter portion 78 of the cylinder beneath the head 80 of the piston and the reduced diameter portion 86 of the cylinder.

Still further, the tubular push rod portion 84 of the piston is provided with elongated slot means 110 in the lower portion thereof and with the angularly disposed passages 112 in the upper portion thereof which lead from beneath piston head 80 up to directly underneath the closed end of the working end of the piston head. The ports 104 and 108 are employed for circulating coolant through the cylinder and piston.

It will be appreciated that a supply of coolant fluid, such as cool air, to port 104 will enter channel 106 and then be supplied through slot-like ports 110 to the inside of the tubular push rod 84 of the piston. The cooling fluid will then flow in the piston toward the closed working end thereof and will then flow outwardly through the passages 112 into the space underneath the piston head and will then exit from the piston via port 108.

It will be appreciated that this supply of cooling air will maintain the cylinder and the piston cool and, in particular, will directly cool the hottest part of the piston which is the upper working end thereof. The supply of cooling air to ports 104 may be accomplished by way of a blower, indicated at B in FIG. 2, or it may be, as will be seen hereinafter, supplied by a self-pumping action.

Each piston has a disc 114 which closes the tubular push rod at the upper end of the respective shoe member 88.

It will be seen that the pistons normally engage the shouldered portions in the bores 28 and it will be appreciated that if it is desired to change the pressure ratio of the intensifier, the cylinders could be removed and spacing washers inserted between the shoulders on the cylinder and the shoulders on the bore in the frame as at 116, and thereby modify the spacing between the upper end of the piston and the plate 40 when the piston is in its outermost position and, thus, effectively change the compression ratio.

As will be seen in FIGS. 1 and 2, the intensifier might have two banks of cylinders and pistons in axially spaced relation with each bank consisting of three pistons and cylinders disposed angularly relative to each other. It will also be appreciated that eccentric 92 pertaining to the first bank of cylinders is displaced 180° from eccentric 118 pertaining to the second bank of cylinders.

The working load on drive shaft 18 thus distributed throughout the 360° of rotation thereof, thereby making for a smooth application of the driving load to a driving engine connected to the drive shaft. Such an engine is schematically indicated in FIG. 1. Each cylinder bank could, of course, have more or fewer cylinders and there could be one or more banks of cylinders.

According to the present invention each of the aforementioned eccentrics 92 and 118 is in the form of an antifriction bearing. Each eccentric has an outer race 120 engaging the respective shoes in the inner ends of the pertaining bank of pistons and an inner race 122 which is fixedly mounted on a respective eccentric member 24 keyed to shaft 18 by a key 126. Antifriction elements 128 are interposed between the races as shown in FIG. 2. The eccentric arrangement substantially eliminates friction between the eccentrics and the shoes of the pistons and permits the assembly to run in a highly efficient manner. Outer races 120 have passages 121 formed therein to admit lubricant to the space between the bearing races.

As will be seen in FIG. 3, each port 104 in a respective cylinder can be provided with an inlet valve 130 which has a resilient valve member 132 therein with a slit 134 which will permit the flow therethrough to the right, but prevent flow therethrough to the left. Similarly, each port 108 is provided with an outlet valve 136 having therein a resilient member 138 with a slit 140 which will permit the flow through the valve toward the right only.

By the provision of these valves in ports 104 and 108 of each cylinder, each piston becomes a self-pumping arrangement and pumps its own coolant fluid therethrough as the intensifier operates. Obviously, the inlet valves could be connected to a pressure manifold supplied by a blower arrangement and cooling air could thereby be forced through each cylinder if so desired. In this last mentioned case, the outlet valves could be eliminated.

The cylinders and pistons are constructed of a suitable materials which will run together and the cylinders, furthermore, are finned in order to assist in the dissipation of heat therefrom.

The entire structure is simple and inexpensive to fabricate and construct and can readily be serviced and maintained. It will be noted that, it is quite a simple matter to remove one or both of the cover plates 14 from the frame and to remove the entire shaft together with its eccentrics without disturbing the remainder of the assembly. Similarly, a cylinder and its piston can be removed independently from the others without interfering with the other parts of the intensifier. Thus, the assembly and servicing and repair of the intensifier according to the present invention is quite simple and can readily be accomplished by ordinary workmen with ordinary tools.

FIGS. 4 to 5 shown exemplary circuits in which an intensifier according to the present invention can be used. In FIG. 4, a compressor, say, a compressor adapted to deliver 100 to 150 pounds pressure per square inch is indicated at 300 and is driven by an engine 302. The engine is also arranged for driving an intensifier according to the present invention indicated at 304. The intensifier is connected with the engine output shaft by way of a clutch 306 which is operated into closed and opened position by a pilot line 308 which is connected to conduit 310 leading to the inlet side of intensifier 304.

The compressor at 300 draws air in through a conduit 312 and expels air through a conduit 314 and via a cooler 316 to a discharge conduit 318 which has therein a check valve 320 opening away from compressor 300. Upstream from check valve 320, conduit 310 is connected to conduit 318 so that the pilot line 308 monitors the pressure at the inlet side of intensifier 300. When this pressure is above a predetermined amount clutch 306 is opened and when the pressure is below a predetermined amount the clutch closes.

The intensifier discharges through a conduit 322 and a cooler 324 to conduit 318 downstream from check valve 320. The provision of clutch 306 permits engine 302 to be unloaded and permits intensifier 304 to rest idle when the high pressure that can be produced by the intensifier 304 are not required.

In FIG. 5, engine 350 drives through clutch 352 to intensifier 354. Intensifier 354 receives a supply of air at, say, 100 to 125 pounds per square inch via an inlet conduit 356 and discharges the air at increased pressure via a discharge conduit 358 and through a cooler 360 and a check valve 362 into a receiver tank 364 which is connected by a conduit 366 with a point of use. The clutch 352 is piloted into open and closed positions by air pressure conducted thereto by a pilot line 368 connected to tank 364.

By the disclosed arrangement, the intensifier only runs when the pressure in the tank drops below a predetermined level and stops running when the pressure reaches a predetermined maximum amount. The intensifier thus runs only when the pressure in tank 364 drops below a predetermined amount and remains idle at other times. This substantially reduces wear on the intensifier and also unloads engine 350 so that it can run idle when it is not necessary to supply air to tank 364.

In both of the circuits described, the engine is provided with automatic throttle control means of a known type to maintain the engine speed substantially constant. If desired, an electric motor could be used as a driver if power therefor is available.

Modifications can be made within the purview of the appended claims.

What is claimed is:

1. An air pressure intensifier comprising: a housing, a shaft rotatable in the housing and having eccentric means thereon, cylinder means connected to the housing and substantially coplanar with said eccentric means and perpendicular to the axis of said shaft means, inlet means and outlet means in the end of said cylinder means which is remote from said housing, piston means reciprocally mounted in said cylinder means, shoe means on the piston means operatively engaging said eccentric means for reciprocation of said piston means in said cylinder means upon rotation of said shaft, check valve means in said inlet means opening toward said cylinder means, check valve means in said outlet means opening away from said cylinder means, each said piston means having a larger outer end forming the piston portion thereof and a smaller tubular part extending from the piston portion into the housing and forming the pushrod portion of the piston means, said piston portion being hollow and communicating with the inside of said pushrod portion and having a closed outer end, said shoe means closing the end of said pushrod portion adjacent said eccentric means, each said cylinder means having a shouldered bore with a larger outer part receiving said piston portion and a smaller inner part receiving said pushrod portion, a cavity in said smaller port of said cylinder means opening toward said pushrod portion and a first port leading from the cavity to the outside of said cylinder means, a second port leading from the larger

part of said cylinder means adjacent said smaller part to the outside of said cylinder means, slot means in said pushrod portion communicating with said cavity, and passage means in said piston means leading from the underside of the closed end of said piston portion of the outer surface of said piston portion at the juncture of said piston portion and said pushrod portion.

2. An air pressure intensifier according to claim 1 which includes seal means in said smaller part of said cylinder means between said cavity and said housing.

3. An air pressure intensifier according to claim 1 which includes conduit means leading to the surface of said pushrod means on the housing side of said seal means for the supply of lubricant thereto.

4. An air pressure intensifier according to claim 3 which includes passage means leading from the eccentric end of said shoe means to the outer surface of said pushrod means for the supply of lubricant from said conduit means to the bottom of said shoe means.

5. An air pressure intensifier according to claim 4 which includes a disc member sealingly mounted in said pushrod means between the inner end of said shoe means and said slot means.

6. An air pressure intensifier according to claim 1 which includes check valve means connected to said first port opening toward said cylinder and check valve means connected to said second port opening away from said cylinder.

7. An air pressure intensifier according to claim 1 which includes a supply of cooling air connected to said first port.

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