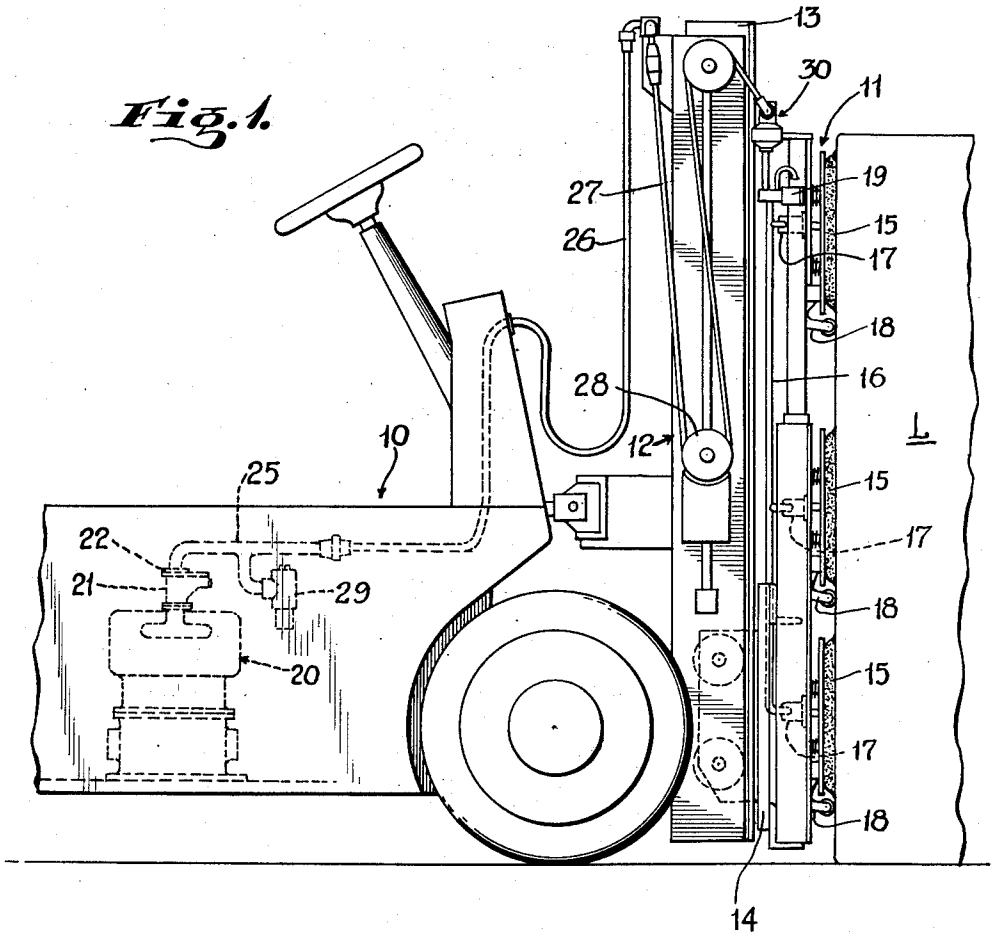
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VACUUM SYSTEM

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Fig. 1.



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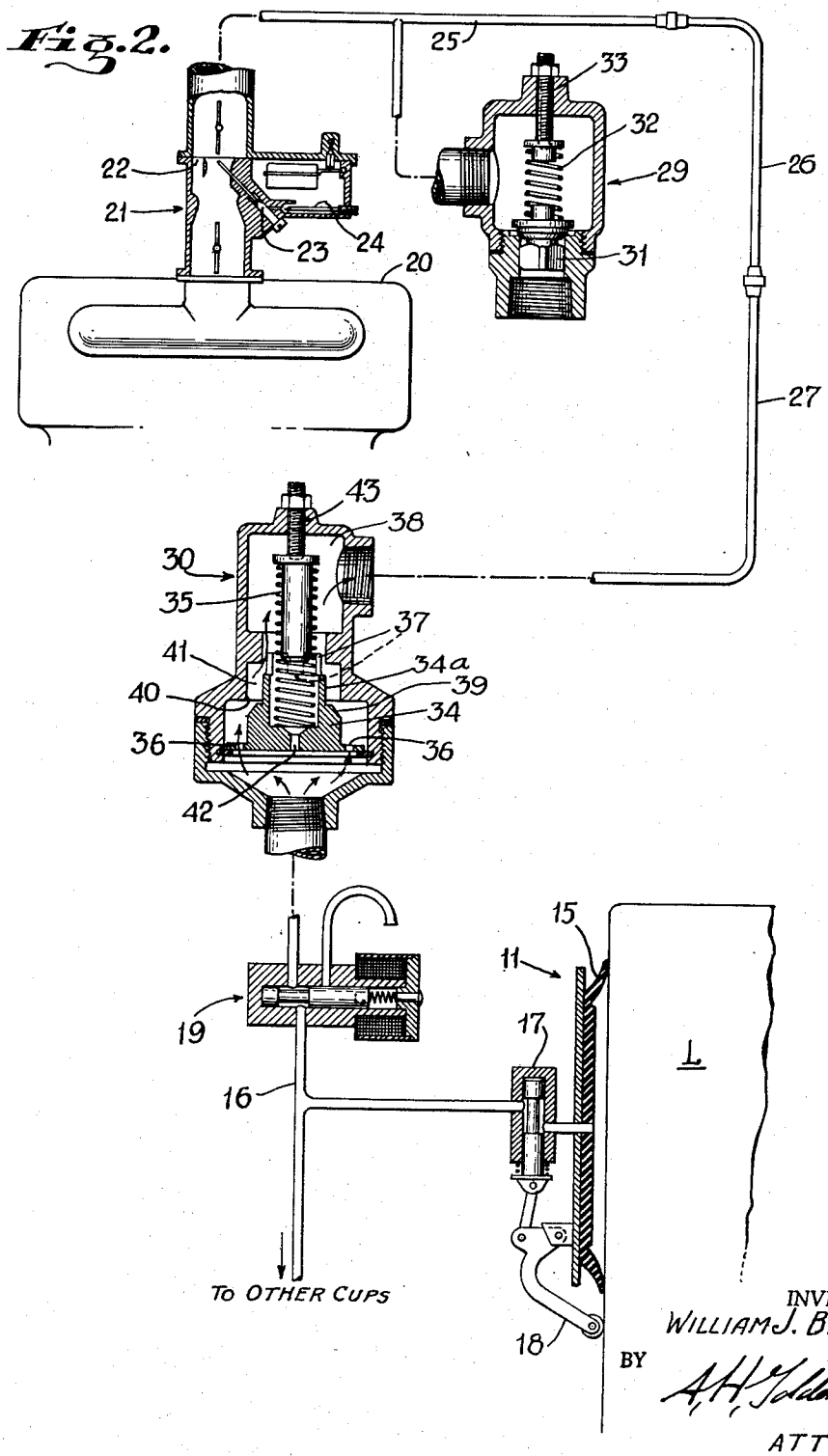
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Fig. 2.



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VACUUM SYSTEM

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9 Claims. (Cl. 230—1)

This invention relates to a vacuum system for vacuum devices, such as vacuum cup load grippers, cement drying devices, vacuum cleaners, or the like.

The invention provides an efficient, dependable, low cost method and apparatus for continuously supplying a large flow of air for creating vacuum or suction for such devices, without the use of a separate vacuum or suction pump for this purpose.

This is accomplished in accordance with the invention by providing an internal combustion engine which will operate efficiently at a particular sub-atmospheric air pressure; connecting the vacuum attachment to the air intake of the engine whereby the large flow of air to the engine for operating the engine may be utilized to create vacuum or suction for the attachment; and maintaining the air pressure between the engine and the vacuum operated attachment substantially at said sub-atmospheric pressure to prevent stalling of the engine. In this manner, vacuum or suction for the vacuum attachment is provided, without the necessity of a separate pump for this purpose.

Other advantages of the invention will become apparent from the following description and accompanying drawing, wherein:

FIG. 1 is a side elevational view of an industrial truck incorporating a vacuum system constructed in accordance with the invention for providing vacuum for vacuum cups of a load gripping attachment; and

FIG. 2 is a schematic view of the vacuum system illustrated in FIG. 1, showing one vacuum cup gripping the load.

Referring to the drawings and in particular to FIG. 1, a vacuum system constructed in accordance with the invention is shown applied to a conventional lift truck 10 for the purpose of providing vacuum or suction for a vacuum cup type load gripping attachment 11. While the invention is described hereafter with reference to such an attachment, it will be appreciated that the invention may be utilized for other types of vacuum attachments or accessories, such as vacuum cleaners, cement drying attachments, etc.

The lift truck 10 is of conventional construction and includes stationary or primary uprights 12 which are mounted on the truck frame, secondary uprights 13 which are mounted for vertical movement on the primary uprights 12, and a load carriage 14 which is mounted for vertical movement on the secondary uprights 13. The vacuum cup load gripping attachment 11 is mounted on the load carriage 14, so that a load gripped by the attachment may be raised and lowered.

The particular attachment 11 illustrated in the drawings is of the general type shown in United States Patent No. 2,942,745, and includes a plurality of vacuum cups 15 for gripping a load. As best shown in FIG. 2, each cup 15 is connected to a common manifold 16 through a normally closed valve 17. The valve 17 is opened to connect the cup 15 to the manifold 16 through movement of a sensing lever 18 by contact of the outer end of the lever with the load as the cup 15 is moved against the load. By this arrangement, only those cups which actually engage the load are connected to the source of vacuum. As also shown in FIG. 2, the manifold 16 is provided with a solenoid operated valve 19 which may be

actuated to connect the manifold 16 with atmospheric air pressure to simultaneously release the vacuum on all the cups 15 to release the load gripped by the cups.

In handling a load L, truck 10 is maneuvered to bring the vacuum cups 15 in contact with the surface of the load. As each cup 15 contacts the load, the sensing lever 18 associated with each cup is pivoted through contact with the load to open the valve 17 to connect the cup with the source of vacuum through the manifold 16 so that the vacuum cup grips the load. The load carriage 14 then may be elevated to lift the gripped load from the floor to permit the load to be transported by operation of the truck. The load may be released by relieving the vacuum on the vacuum cup 15 by actuation of the solenoid operated valve 19.

In accordance with the invention, vacuum is provided for the attachment 11 by providing an internal combustion engine which will operate efficiently at sub-atmospheric pressure, e.g., at 16 inches of Hg; connecting the air intake of the engine with the vacuum attachment whereby the large volume of air which is drawn through the air intake of the engine during operation of the engine may be utilized to create vacuum or suction for the attachment; and maintaining the air pressure between the air intake and the attachment substantially at said sub-atmospheric pressure, to prevent stalling of the engine due to air starvation or excessive air.

In the drawings, the internal combustion engine is shown at 20 suitably mounted on a convenient part of the truck 10. The engine 20 is of conventional construction and, as best shown in FIG. 2, includes a conventional carburetor 21 having an air intake 22, an injection nozzle 23 through which fuel is injected into the carburetor and mixed with air entering the carburetor through the air intake 22, and a needle valve 24 which is adjusted so that the flow of fuel to the carburetor is such that the engine will operate at the sub-atmospheric air pressure.

The air intake 22 of the carburetor 21 is connected to the manifold 16 of the attachment 11 by means of a pipe 25 and flexible hoses 26 and 27, so that the large volume of air drawn through the air intake 22 of the carburetor 21 for operating the engine is available for creating vacuum or suction for the vacuum cup attachment 11. As shown in FIG. 1, the hose 27 may be reeved around a weighted, sliding reel 28, so that slack in the hose 27 is taken up as the attachment 11 is raised and lowered with the carriage 14.

The air pressure between the air intake 22 and the manifold 16 of attachment 11 is maintained substantially at the sub-atmospheric pressure to which the engine 20 is adjusted by means of a bypass valve 29 and a metering valve 30.

The bypass valve 29 is connected to the pipe 25 and admits air to the air intake 22 to prevent stalling of the engine 20 by air starvation in the event that all the vacuum cups 15 are closed off by the valves 17 or are covered by the surface of a non-porous load.

The metering valve 30 is connected between the end of the hose 27 and the manifold 16 and meters the air from the attachment 11 to the air intake 22 to prevent excessive flow of air to the carburetor and stalling of the engine 20 in the event that the vacuum cups 15 are not in full contact with the load, or the load is of such porosity as to allow excessive flow of air through the cups. By positioning the metering valve 30 between the hose 27 and the manifold 16, the long lengths of hoses 26 and 27 serve as a vacuum storage. A vacuum storage tank can, of course, be connected in the line between valve 29 and valve 30 if desired.

As best shown in FIG. 2, the bypass valve 29 is a simple pressure operated valve and includes a valve member

31 which is normally held closed by a spring 32 to prevent the flow of air at atmospheric pressure through the valve to the pipe 25 and air intake 22 of the carburetor 21. If the pressure between the air intake 22 and the manifold 16 of the attachment 11 decreases below that to which the engine is adjusted, the valve member 31 opens against the pressure of the spring 32 to admit air to the air intake 22 to prevent stalling of the engine by air starvation. The force exerted by the spring 32 and, therefore, the pressure differential at which the valve member 31 opens, may be adjusted by a screw 33.

The metering valve 30 includes a piston 34, normally held in the position shown in FIG. 2, by a spring 35. In this position of the piston 34, air may pass from the manifold 16 through small ports 36 in a peripheral flange of the piston, through slots 37 in the inner end of the piston into a chamber 38 of the valve, and to the hose 27, to maintain the vacuum or suction on the cups. If the cups are only partially covered by the load, or the load is of high porosity, so that there is a large flow of air from the cups, the high rush of air through the ports 36 creates a pressure differential between the outer end of the piston 34 and the inner chamber 38, causing the piston 34 to move inwardly of the valve against the pressure of the spring 35 until the inner surface 39 of the peripheral flange of the piston 34 engages a seat 40 in the valve body to close off flow of air through the ports 36. In this manner, an excessive flow of air to the air intake 22 of the carburetor 21, which would otherwise cause stalling of the engine, is prevented. During this inward movement of the piston 34, air is trapped in a chamber 41 in the valve body by a reduced portion 34*a* of the piston 34 to provide a dashpot effect which slows down or causes slight time delay in the inward movement of the piston 34 to allow time for balancing of the air-fuel mixture in the carburetor. A small opening 42 in the end of the piston 34 permits the piston to return to its original position when the flow of air from the cups decreases to that required for operation of the engine. The pressure exerted by the spring 35 and, therefore, the pressure differential at which the valve operates may be adjusted by means of an adjusting screw 43.

From the preceding description, it can be seen that by continuous operation of the internal combustion engine 20, a large flow of air at sub-atmospheric pressure is available for creating vacuum or suction for operation of the attachment 11, without providing a separate vacuum or suction pump for this purpose. Adjustment of the carburetor 21 of the engine 20 during operation of the engine, to prevent stalling of the engine as the demands of the vacuum attachment 11 for air varies, is not necessary, as the valves 29, 30 maintain the air to the carburetor 21 at substantially the pressure to which the engine is adjusted to operate effectively. Thus, a very dependable source of vacuum or suction is provided for operating the attachment.

While one embodiment of the invention has been shown and described, it will be appreciated that this is for the purpose of illustration and that changes and modifications may be made therein without departing from the spirit and scope of the invention.

I claim:

1. The method of supplying air at sub-atmospheric pressure to a vacuum device by means of an internal combustion engine operable at a particular sub-atmospheric pressure comprising,

connecting the vacuum device with the air intake of said internal combustion engine whereby the large volume of air drawn through said air intake may be utilized to create vacuum for said vacuum device,

operating the engine whereby a large volume of air is drawn through the air intake of the engine, and

automatically maintaining the air pressure between the vacuum device and the air intake of said engine substantially at said particular sub-atmospheric air pressure to prevent stalling of the engine.

2. In a combination of the class described,

an internal combustion engine,

a vacuum device,

conduit means connecting said vacuum device with said internal combustion engine whereby air supplied to said internal combustion engine to support combustion in said engine flows from said vacuum device, and

a pressure responsive bypass valve operable by a predetermined decrease in the pressure in said conduit means to supply air to said internal combustion engine when insufficient air is supplied through said vacuum device whereby to prevent stalling of said internal combustion engine.

3. In a combination of the class described,

an internal combustion engine,

a vacuum device,

conduit means connecting said vacuum device with said internal combustion engine whereby air supplied to said internal combustion engine to support combustion in said engine flows from said vacuum device, and

pressure responsive valve means operable by a predetermined increase in the air pressure in said conduit means to prevent excessive flow of air to said engine from said vacuum device whereby to prevent stalling of said engine.

4. In a combination of the class described,

an internal combustion engine,

a vacuum device,

conduit means connecting said vacuum device with said internal combustion engine whereby air supplied to said internal combustion engine to support combustion in said engine flows from said vacuum device, and

a pressure responsive bypass valve operable by a predetermined decrease in the presence in said conduit means to supply air to said internal combustion engine when insufficient air is supplied through said vacuum device whereby to prevent stalling of said internal combustion engine, and

further pressure responsive valve means operable by a predetermined increase in the air pressure in said conduit means to prevent excessive flow of air to said engine from said vacuum device whereby to prevent stalling of said engine.

5. In a combination of the class described,

an internal combustion engine operable at a particular sub-atmospheric air pressure,

a vacuum device,

conduit means connecting the air intake of said engine with said vacuum device whereby the large volume of air drawn through said air intake for operating said engine may be utilized to create vacuum for said vacuum device, and

pressure responsive valve means operable by air pressure within said conduit means to maintain the air pressure within said conduit means substantially at said particular sub-atmospheric pressure whereby to prevent stalling of said engine.

6. In a combination of the class described,

an internal combustion engine operable at a particular sub-atmospheric air pressure,

a vacuum device,

conduit means connecting the air intake of said engine with said vacuum device whereby the large volume of air drawn through said air intake for operating said engine may be utilized to create vacuum for said vacuum device, and

a pressure responsive bypass valve operable by a predetermined decrease in the air pressure in said conduit means below said particular sub-atmospheric air pressure to supply air to said air intake when the

air from said vacuum device is insufficient to support operation of said engine.

7. In a combination of the class described,
an internal combustion engine operable at a particular sub-atmospheric air pressure,
a vacuum device,
conduit means connecting the air intake of said engine with said vacuum device whereby the large volume of air drawn through said air intake for operating said engine may be utilized to create vacuum for said vacuum device, and
pressure responsive metering valve means operable by a predetermined increase in the air pressure in said conduit means above said particular sub-atmospheric air pressure to prevent excessive flow of air from said vacuum device to said engine whereby to prevent stalling of said engine.

8. In a combination of the class described,
an internal combustion engine operable at a particular sub-atmospheric air pressure,
a vacuum device,
conduit means connecting said vacuum device with said internal combustion engine whereby air drawn through said conduit means to support combustion in said engine may be utilized to create vacuum for said vacuum device,
a pressure responsive bypass valve operable by predetermined decrease in the air pressure in said conduit means below said particular sub-atmospheric air pressure to supply air to said internal combustion engine when insufficient air is supplied through said vacuum device to support operation of said internal combustion engine, and

pressure responsive metering valve means operable by a predetermined increase in the air pressure in said conduit means above said particular sub-atmospheric air pressure to prevent excessive flow of air from said vacuum device to said engine whereby to prevent stalling of said engine.

9. The method of supplying air at sub-atmospheric pressure to a vacuum device by means of an internal combustion engine operable at a particular sub-atmospheric pressure at the carburetor comprising the steps of,
connecting the vacuum device with the carburetor of said internal combustion engine whereby the large volume of air drawn through said air intake may be utilized to create vacuum for said vacuum device,
operating the engine whereby a large volume of air is drawn through the carburetor of the engine, and
automatically maintaining the air pressure between the vacuum device and the carburetor of said engine substantially at said particular sub-atmospheric air pressure to prevent stalling of the engine.

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