

March 12, 1968

H. F. WEINERT

3,372,822

LOAD HANDLING APPARATUS WITH VACUUM ATTACHING MEANS

Filed May 27, 1965

4 Sheets-Sheet 1

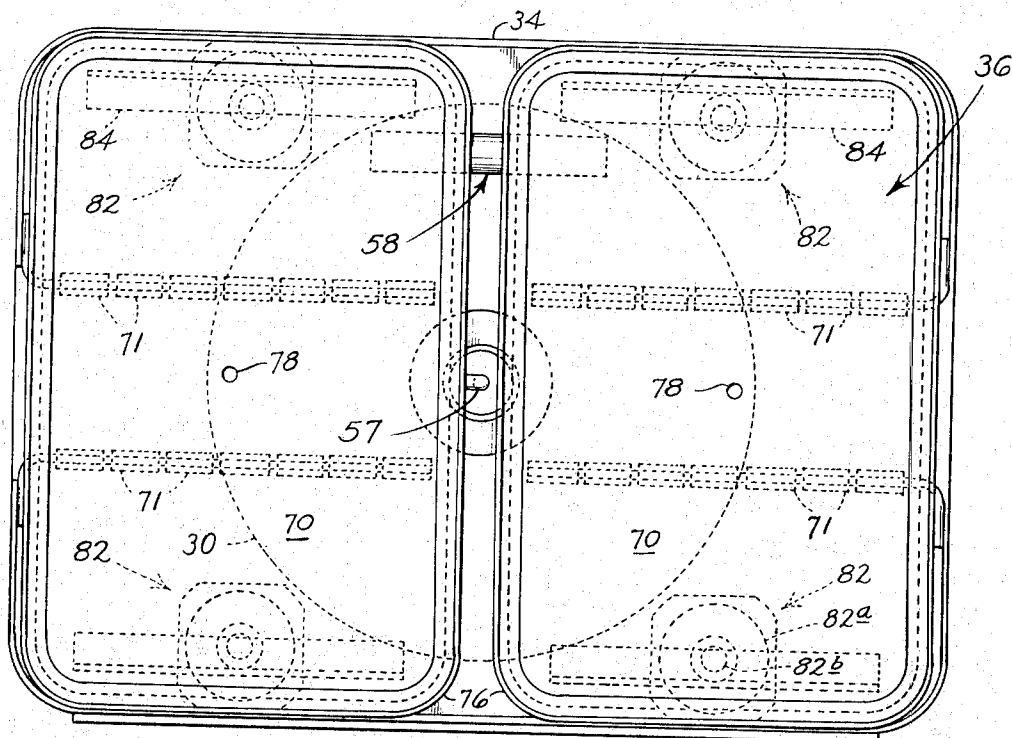


Fig. 3.

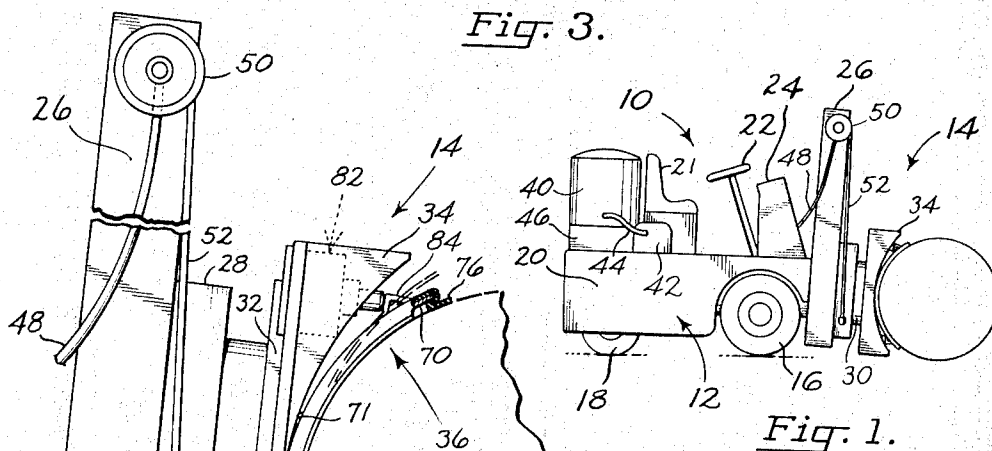


Fig. 1.

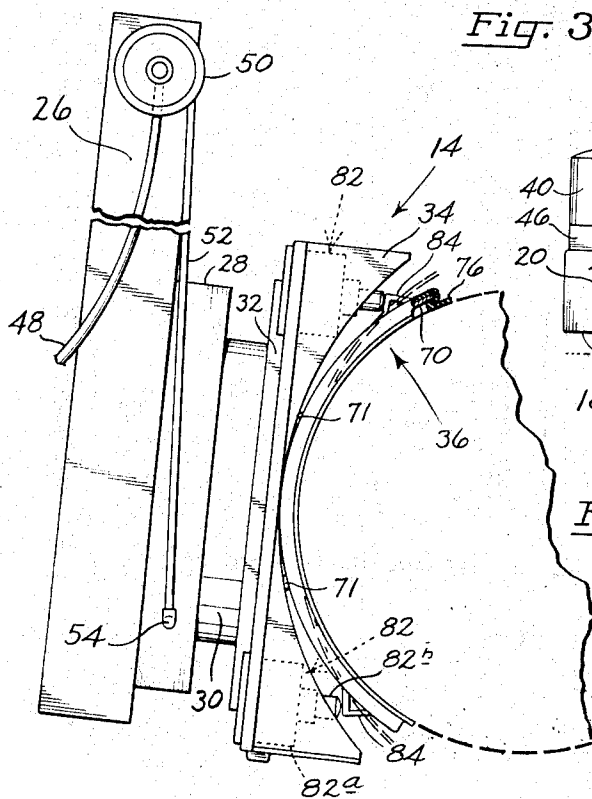


Fig. 2.

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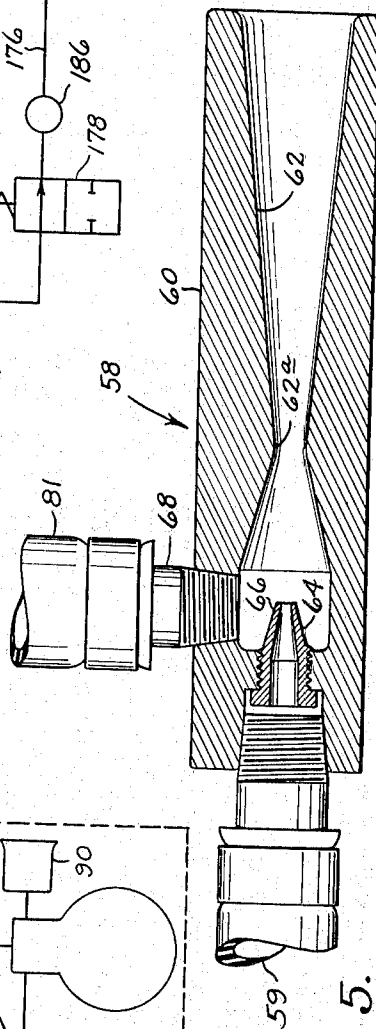
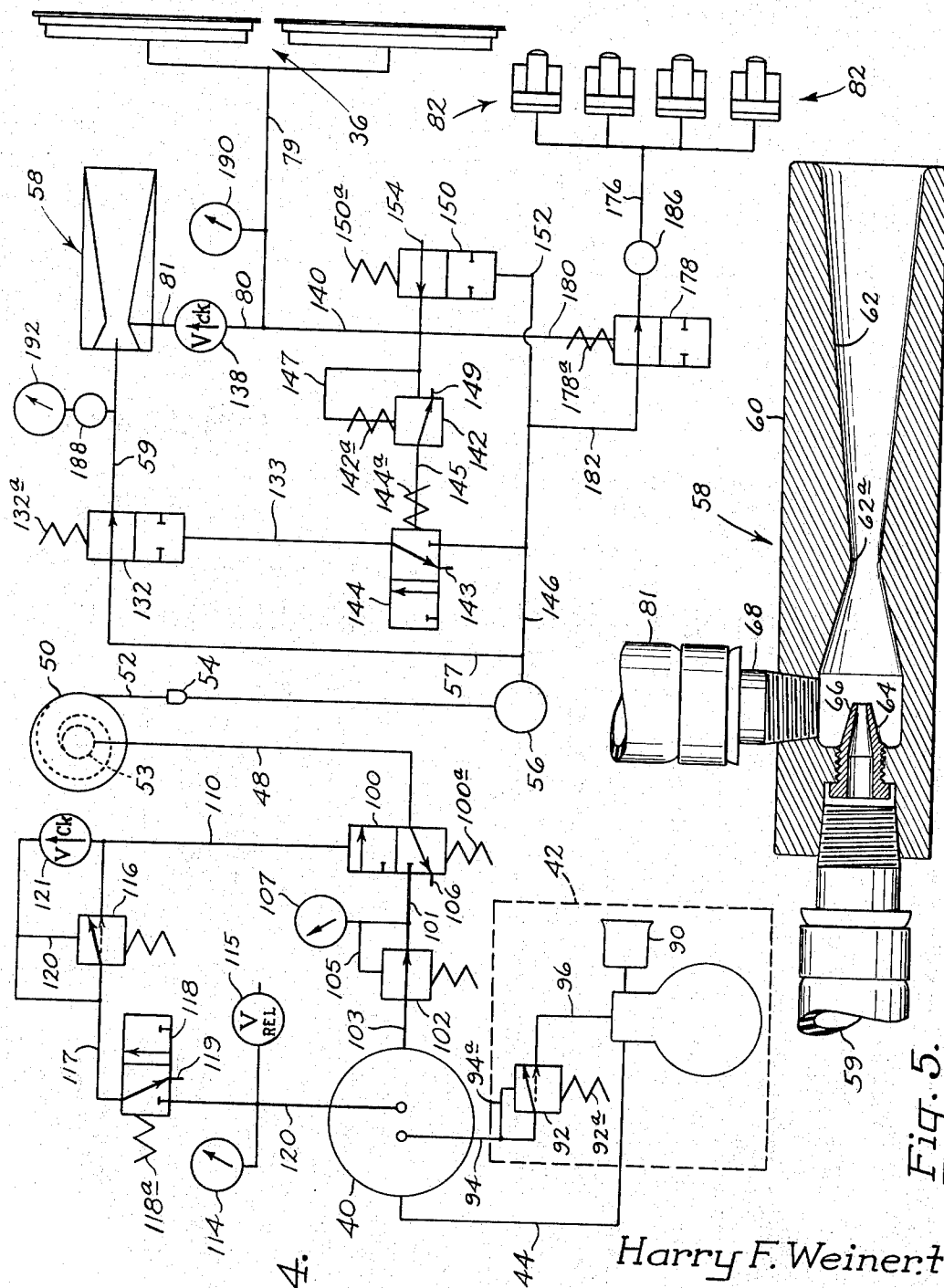
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4 Sheets-Sheet 2



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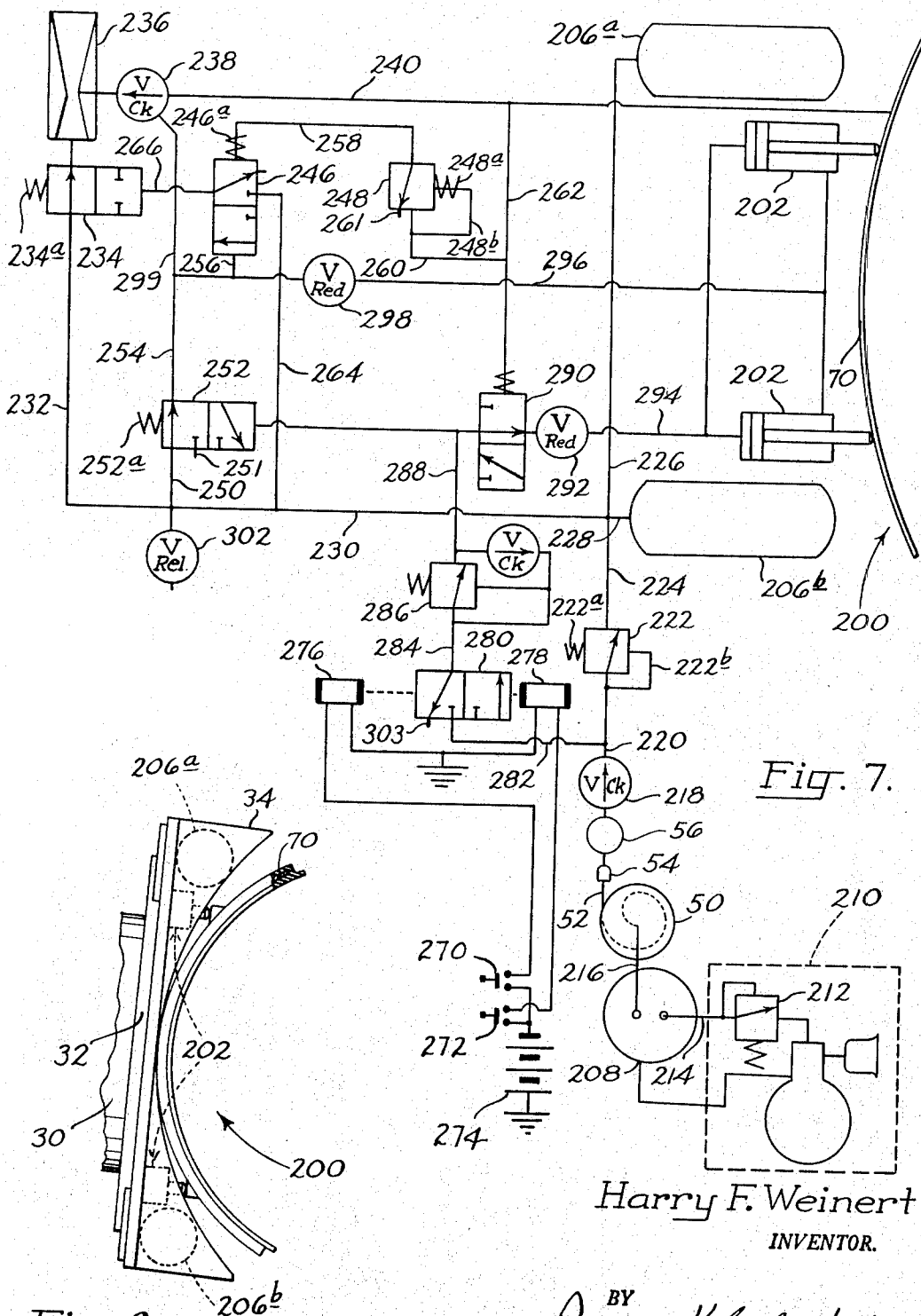
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LOAD HANDLING APPARATUS WITH VACUUM ATTACHING MEANS

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4 Sheets-Sheet 3



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LOAD HANDLING APPARATUS WITH VACUUM ATTACHING MEANS

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4 Sheets-Sheet 4

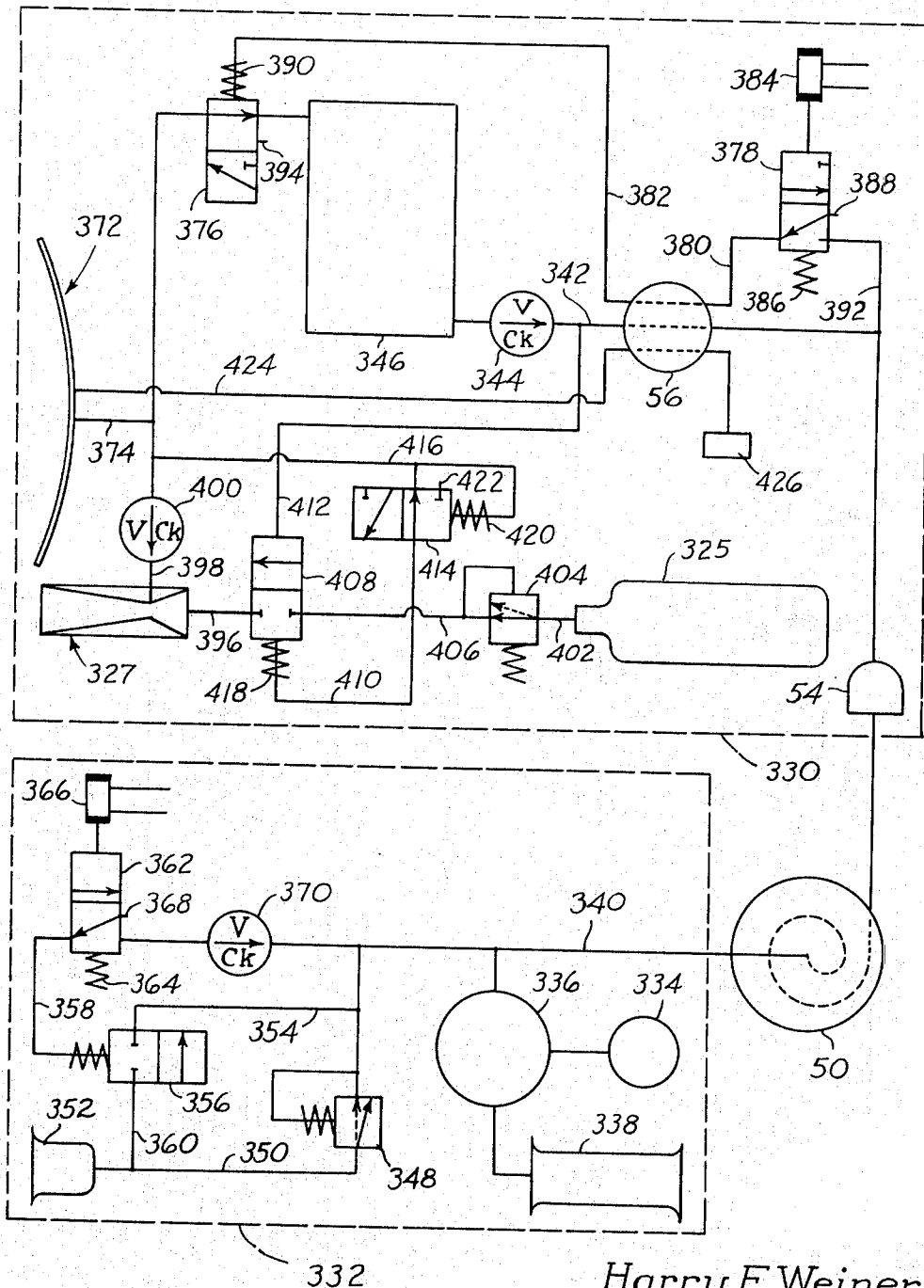


Fig. 8.

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LOAD HANDLING APPARATUS WITH VACUUM ATTACHING MEANS

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Continuation-in-part of application Ser. No. 285,015, Feb. 12, 1963. This application May 27, 1965, Ser. No. 462,785

8 Claims. (Cl. 214—650)

This application is a continuation in part of an application entitled "Vacuum-Operated Load-Handling Apparatus," having Ser. No. 258,015, filed Feb. 12, 1963, now abandoned.

The invention relates to load-handling apparatus, and more particularly to load-handling apparatus including vacuum-attaching means for attaching onto a load to facilitate moving of the load. The invention has particular advantages in connection with an industrial vehicle, such as a lift truck equipped with load-lifting structure for carrying loads transported by the truck.

Vacuum-attaching means in load-handling mechanisms have advantages over other types of load-handling systems. They are relatively compact, light, and can grip a load with less likelihood of damaging it than mechanical loading-handling systems equipped with opposed clamping arms. It is this latter feature which has made devices with vacuum-attaching means particularly advantageous in the handling of goods which can be damaged in transport. One type of article which has been traditionally handled by means of clamping arms comprises rolls of paper, i.e., newsprint, kraft paper, etc. Frequently in handling such a roll, a substantial portion of the roll is damaged thus causing considerable economic loss.

The invention is described below in connection with apparatus for lifting and transporting paper rolls and the like, although it should be understood that by so describing the invention it is not intended to be limited to paper rolls as certain features have more general application.

A general object of this invention is to provide improved load-handling apparatus, with vacuum-attaching means characterized by reliability, simplicity in construction and handling ease. Reliability in a vacuum system is, of course, extremely important. In moving heavy loads with a lift truck, for example, should the vacuum suddenly be interrupted, air leakage through the load and around the means gripping the load could cause the load to be suddenly dropped and endanger personnel and equipment. For a mobile unit such as a truck some form of motor device must be provided to supply the power producing the necessary vacuum, and failure in the operation of this motor device is a major cause of concern in connection with reliable operation.

According to this invention, loading-handling apparatus is contemplated including vacuum-attaching means for attaching to a load wherein a vacuum for operating said vacuum-attaching means is supplied from a vacuum producer powered by a compressed gas. In one modification of the invention, such a vacuum producer is relied upon to supply the vacuum for the vacuum-attaching means only when, by reason of some malfunctioning, the regular source of vacuum for the vacuum-attaching means is cut off. In another modification of the invention such a vacuum producer is relied upon to provide the vacuum during all operating periods.

In load-handling apparatus with vacuum-attaching means, as already indicated it is usual to provide some form of motor device which on operation supplies the power necessary to produce a vacuum. Such a motor device may be utilized to power a compressor producing compressed air, and the compressed air may be employed to actuate a vacuum producer. With this organization, and

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by including a standby tank for storing a volume of compressed air, a vacuum may be maintained in the vacuum-attaching means over a sustained period of time should there be some failure in the motor device and it stops operation. Thus, auxiliary mechanical devices that formerly have been relied upon to insure reliable operation may be dispensed with, such as a standby compressor, vacuum pump, etc. In this connection, it should be pointed out that by storing air under pressure considerable more energy may be stored in a tank of given size than can be stored by evacuating the tank, where atmospheric pressure limits to about 15 pounds the maximum pressure difference obtainable between regions inside and outside the tank.

In vacuum apparatus, frictional resistance to flow in a vacuum line is a significant factor because of the relatively low level of atmospheric pressure. Thus, in vacuum-handling systems any vacuum lines present should preferably have relatively large diameters and be as short as possible, in order to reduce to a minimum inefficiencies due to frictional losses. This invention has for another of its objects the provision of an industrial vehicle with vacuum-attaching means for lifting a load, where the means that actually produces the required vacuum for such vacuum-attaching means is directly adjacent the attaching means, whereby the length of any vacuum conduit necessary may be reduced to a minimum.

In another modification of this invention it is contemplated that an ordinary motor-driven vacuum producer such as a motor-driven vacuum pump may be utilized to provide the vacuum normally relied upon to operate the vacuum-attaching means. To obtain sustained operation in the vacuum-attaching means in the event that the normal vacuum supply is cut off, a tank or other reservoir holding a supply of compressed gas such as nitrogen is provided and the contents of this tank operates an ejector to produce a reserve vacuum supply. The tank and ejector preferably are mounted directly adjacent the vacuum-attaching means. This type of mounting minimizes the chance of any malfunctioning in the means providing the reserve vacuum supply.

Another object of the invention is to provide vacuum-handling apparatus for an industrial vehicle, which includes vacuum-attaching means for attaching to a load, a device for producing the vacuum necessary to actuate such vacuum-attaching means, and a governor controlling operating periods of said device, whereby the device operates intermittently, with the frequency of operation determined by the amount of air leakage occurring in the system. In a specific embodiment of the invention, an audible signal inherent in the operation of the device indicates when proper attachment has been made to a load.

A further object is to provide, in an industrial vehicle, including a truck and load-lifting structure mounted on the truck, the combination of vacuum-attaching means mounted on the load-lifting structure for attaching to a load, means for converting the energy contained in a supply of compressed air into a source of subatmospheric pressure, and means mounted on the truck portion of the vehicle, including an air compressor for supplying air under pressure to the means converting the energy of compressed air into a source of subatmospheric pressure.

Other features, objects and advantages of the invention will become more fully apparent as the following description is read in conjunction with the accompanying drawings, wherein:

FIG. 1 illustrates an industrial vehicle as contemplated herein, with vacuum-attaching means for attaching to a load;

FIG. 2 is an enlarged view of the vacuum-attaching means shown for the vehicle in FIG. 1;

FIG. 3 is a front view of the vacuum-attaching means illustrated in FIG. 2;

FIG. 4 is a schematic view illustrating means (according to one modification of the invention) provided for producing the vacuum necessary to operate the vacuum-attaching means in the vehicle;

FIG. 5 illustrates, on an enlarged scale, an ejector present in the construction;

FIG. 6 illustrates a vacuum-attaching means for attaching to a load, according to another modification of the invention;

FIG. 7 is a schematic view illustrating a modified form of means that may be provided for producing the vacuum necessary to operate the vacuum-attaching means; and

FIG. 8 illustrates yet another modification of the invention, wherein, a vacuum-attaching means for attaching to a load is supplied with a vacuum during regular periods of operation from a motor-driven vacuum pump, and a vacuum producer powered by compressed gas is included to provide a reserve source of vacuum.

Referring now to the drawings, and first of all more particularly to FIG. 1, 10 indicates generally an industrial vehicle, including a motor-driven truck 12, and load-lifting structure 14 mounted on the forward end of truck 12. Truck 12 may be conventional in construction. As shown, the truck includes the usual front and rear lateral support wheels 16 and 18, respectively, and a motor (not shown) within housing structure 20 of the truck and operatively connected to the wheels to drive the wheels. At 21 there is illustrated the usual operator's seat. A steering wheel assembly is indicated at 22, and in front of wheel assembly 22 is a control panel 24, upon which are mounted the usual gauges and control devices for the vehicle.

Load-lifting structure 14 at the front of the truck comprises the usual vertically movably extensible parts of an extensible mast assembly 26, with the usual vertically movable carriage 28 or load-handling component mounted on the extensible parts of the mast assembly for vertical movement therealong. Not shown, but also provided in the vehicle is the usual power-operated means for extending the mast assembly and for shifting carriage 28 up and down thereon.

With reference now to FIGS. 2 and 3, mounted on carriage 28, and carried forwardly thereof, is a rotator indicated at 30, a backing plate 32 fastened to rotator 30, and a mounting 34 secured to the front of backing plate 32. Rotator 30 may take conventional form and includes means (not shown) within the structure whereby the rotator may be revolved or rotated about a horizontal axis extending substantially along the longitudinal midline of the truck. With rotation of the rotator, the backing plate and mounting 34 are also rotated about the same axis. Mounted on mounting 34, and described in more detail hereinbelow, is a vacuum-attaching means 36 for attaching onto a load. With rotation of the rotator, vacuum-attaching means 36 is also revolved, and thus the rotator may be used to invert, or set on its side, any paper roll or the like to which the vacuum-attaching means is attached.

According to one modification of this invention, fluid, more specifically air pressure-operated means, is contemplated for producing the vacuum necessary to actuate vacuum-attaching means 36, and a feature of the invention is that such air pressure-operated means for producing the vacuum is mounted directly adjacent vacuum-attaching means 36. A construction is further contemplated whereby the means producing a vacuum is capable of producing sustained attachment with a load, even in the event of motor failure in the truck. These and related features of the invention will now be described.

Referring again to FIG. 1, mounted on truck 12, and to the rear of operator's seat 21, is a receiver or tank 40 for holding a supply of compressed air. Also mounted on truck 12 is an air compressor, portions of which are

shown at 42. The air compressor is operatively connected to the motor of the truck, and driven thereby. Connecting the compressor and tank 40 is a conduit 44, which delivers air compressed by the compressor to tank 40.

With actuation of vacuum-attaching means 36, compressed air travels through valves and conduits within a control box 46 (to be described below), and thence through a pressure hose 48, to the axial center of rotatable reel device 50 including a spool which is mounted on mast assembly 26. A pressure hose 52 is wound about the spool of reel device 50. Referring to FIGS. 1 and 4, hose 52 is connected at one end to hose 48, through a rotary coupling in the reel device (shown diagrammatically in FIG. 4 at 53), and has its other end connected to a swivel fitting 54 mounted on carriage 28. Fitting 54 connects hose 52, through a rotary coupling interposed between rotator 30 and the carriage (shown diagrammatically in FIG. 4 at 56), and conduits 57, 59 with an air-operated ejector 58, mounted on mounting 34 directly adjacent vacuum-attaching means 36 (see FIG. 3).

With reference now to FIG. 5, ejector 58, which may be conventional in construction, comprises a housing 60 provided with a passage 62 extending along the length thereof, such passage being constricted at 62a. Interposed between the connection of conduit or hose 59 with the housing, and constricted portion 62a, is a nozzle 64, which is operable to produce a high-velocity air stream at its tip 66. Projecting out to one side of housing 60 is a pipe section 68.

The ejector works on the Venturi principle, and produces subatmospheric pressure, or a vacuum, in the vicinity of greatest air flow, which is adjacent tip 66 of nozzle 64. In the invention, the ejector constitutes a converter, and is operable to convert the energy contained in a mass of compressed air into a subatmospheric pressure or vacuum source. The ejector is also referred to herein as a pressure fluid or air pressure-operated means for producing a vacuum, and it is important to note that such vacuum-producing means is located in the load-lifting structure directly adjacent attaching means 36.

As best illustrated in FIG. 3, vacuum-attaching means 36 comprises a pair of flexible plates 70, pivotally mounted through pivot connections 71 on mounting 34. The plates are curved, so as to conform approximately to the outside of a paper roll. Along the margins of each plate, a seal 76 is provided, for producing a substantially air-tight seal with the outside of a paper roll. Each plate, within the area bounded by its seal 76, is provided with an opening 78, through which air is evacuated, when actuating attaching means 36. Openings 78 are connected, through conduits 79, 80, 81 (see FIG. 4), to pipe section 68, which, with the ejector operating, constitutes a vacuum outlet or connection.

Pressure fluid-operated means is provided for adjusting the position, more specifically flexing, flexible plates 70, so that their curvature corresponds more closely to the curvature of the outside of a paper roll. Specifically, this means comprises air pressure-operated rams or jacks 82, with cylinder ends 82a secured to mounting 34, and ends 82b engageable with abutments 84 mounted on flexible plates 70. When the rams are extended, the extensible ends move out to increase the curvature of the flexible plates, and on contraction of the rams, the resiliency of the plates causes them to spring out to assume a less curved shape, as indicated by the solid and dashed outline of a plate shown in FIG. 2. The provision of such flexible plates which are deformed in the manner indicated facilitates the making of a good seal. It also enables rolls of different diameters to be handled with equal facility.

A circuit such as may be employed to interconnect the various components so far described is illustrated in FIG. 4. Some of the components illustrated in FIG. 4 have been referred to above and the same reference numerals are used to designate these components. Many of the compo-

nents illustrated in FIG. 4 have been omitted from the other figures, for reasons of clarity.

In FIG. 4, certain valves employed in the circuit are represented by means of rectangular outlines. The zigzag lines outside and connecting with the rectangular outlines of the valves represent springs biasing the spools of the valves. Arrows within the valve outlines illustrate flow paths through the valves.

As shown in FIG. 4, and already discussed, the outlet side of compressor 42 is connected by conduit 44 to tank 40. Air intake to the compressor is through an air filter 90. Also, part of the compressor is a pilot-operated unloading valve 92, connected to tank 40 by a line or conduit 94, and to the usual unloading mechanism in the compressor by line or conduit 96. With less than normal operating pressure in tank or receiver 40, the spool of valve 92 is biased by biasing spring 92a for the valve to the position indicated by the solid arrow for the valve, where conduit 94 is disconnected from conduit 96 and closed off in valve 92. With valve 92 in this position, the compressor operates to supply tank 40 with compressed air. On maximum operating pressure being reached within the tank, the pressure of air in pilot line 94a shifts the spool of valve 92 against the bias of spring 92a, so as to connect conduit 94 with conduit 96 (as shown by the dotted arrow within the rectangular outline representing the valve), which results in unloading of the compressor, and stopping of the supply of compressed air to tank 40. On dropping of the pressure within the tank, the compressor reloads.

Hose 48, which is in the connection of receiver or tank 40 with ejector 58, is connected to the receiver through a pilot-operated three-way valve 100, a conduit 101, a pressure regulator valve 102, and a conduit 103.

Valve 100 (and certain other valves shown schematically in FIGS. 4 and 7) is represented in the drawings by an elongated rectangular outline, divided by a central line into two squares disposed side by side. A spring 100a is illustrated, which is connected to the lower of the two squares in FIG. 4. With this valve (and other valves similarly represented) a spring so illustrated relative to the elongated outline which represents the valve as a whole indicates that the spool of the valve is urged by the spring to a position where flow takes place through the valve as shown within the square to which the spring is connected. This is indicative of the fact that the spring is a compression-type spring, and functions to force the spool within the valve housing toward the end of the housing away from where the spring is located.

A pilot line for valve 100 is shown at 110. Pilot line 110 contains air under pressure, and in the drawings, where such a pilot line with air under pressure is shown attached to a valve, flow takes place through the valve as indicated within the square to which the pilot line attaches, when a sufficiently high air pressure is reached within the line (indicative of the fact that the valve spool is urged in the valve housing in a direction extending away from the end to which the pilot line is connected, under such high pressure conditions).

Thus, the spool of valve 100 is urged by biasing spring 100a for the valve to the position shown, where flow through the valve is as indicated by the arrow in the bottom half of the outline that represents the valve. In this position of the valve, hose 48 is connected to the atmosphere through a conduit 106, and conduit 101 (which extends from the tank), is closed by the valve. With air under pressure in pilot line 110, the spool of the valve is shifted against the bias of spring 100a, to a position where conduit 101 connects with hose 48, so that air under pressure is supplied the hose, as indicated by the arrow in the top half of the outline for the valve.

Pressure regulator valve 102 is a constant pressure outlet valve, and functions to supply hose 48 with air at a uniform pressure, which is reduced from the pressure of air in tank 40. A pilot line for regulator valve 102 is

shown at 105. A gauge for indicating the pressure of air on the downstream side of valve 102 is shown at 107. Assuming, for instance, that an operating pressure of 150 pounds per square inch is selected for tank 40, typically the pressure of air supplied the ejector might be in the range of 80 pounds per square inch. Pilot pressures in line 105 automatically adjust regulator valve 102, so that such a pressure exists on the downstream side of the valve.

Pilot line 110, that operates three-way valve 100, is connected to the tank or receiver through a hold-back valve 116, a conduit 117, a manually-operated three-way valve 118 (which is the "on-off" valve in the construction), and a conduit 120. Biasing spring 118a of valve 118 adjusts the spool of the valve so that flow is as shown by the arrow at the left of the outline representing the valve, i.e., conduits 120 and 117 are disconnected from each other, and conduit 117 connects with the atmosphere through conduit 119. With the spool of valve 118 shifted against the bias of its spring (which is done manually), conduits 120 and 117 are connected (as shown by the arrow at the right of the outline representing the valve) and air under pressure passes from the tank to hold-back valve 116. A pressure gauge is shown at 114, a relief valve is indicated at 115, a check valve is indicated at 121.

Hold-back valve 116 is pilot-operated through a pilot line 120. With low air pressure in line 120, the biasing spring of the valve adjusts the spool of the valve so as to disconnect conduit 117 from conduit 110, as shown by the solid arrow in the valve outline. With high pressure in line 120, the valve spool is adjusted so that flow is as indicated by the dotted arrow in the outline representing the valve. The function of hold-back valve 116 is to prevent the ejector from being operated, if the pressure of air within tank 40 is below a certain minimum. Thus, even though manually-operated valve 118 is adjusted to feed air under pressure to the hold-back valve, air still is cut off from line 110 (and prevented from actuating valve 100) until a pressure has been reached within the tank sufficient to open the hold-back valve.

Explaining briefly the operation of that portion of the circuit which so far has been described, when the compressor is started, tank 40 begins to fill with compressed air, and this continues until maximum tank pressure is attained. Then unloading valve 92 operates, and the compressor ceases to compress further air. To feed compressed air into hose 48, manually-adjusted valve 118 is actuated, to connect conduit or line 110 with tank 40, which produces adjustment of valve 100 (providing sufficient tank pressure has been reached) through open valve 116. Air under pressure passes into hose 48 through valve 102, at a reduced pressure which is constant, as long as the pressure of air in the tank or receiver is above the regulated pressure of valve 102.

Continuing with a description of the circuit, conduits 57 and 59 (already mentioned) are interconnected through a pilot-operated, two-way valve 132. Valve 132 is a normally open valve, connecting conduits 57, 59 as shown by the arrow in the upper part of the outline representing the valve. Air under pressure, in pilot line 133, adjusts the valve against the bias of its spring 132a, to close the valve. A governor device, to be described, controls the pressure of air in line 133, in such a manner that under normal conditions valve 132 is repeatedly opening and closing producing intermittent operation of ejector 58.

As described earlier, openings 78 in plates 70 of vacuum-attaching means 36 are connected through conduits 79, 80 and 81 with the vacuum outlet of the ejector. Interposed between conduits 81 and 80 is a check valve 138. Connecting with conduits 79 and 80 is a conduit or line 140, which connects with a governor or valve 142. Governor 142 is connected through line 145, to the pilot side of a pilot-operated three-way valve 144. Valve 144 con-

trols flow between pilot line 133 of two-way valve 132, and a conduit 146 connected to conduit 57.

Valve 144 has a pilot line indicated at 145 connected to it which controls its operation. This pilot line normally is a vacuum line, as compared, for instance, to pilot line 110 discussed in connection with valve 100, which normally contains air under pressure. Thus, in the drawings, in the case of three-way valves such as valve 144 that are operated by vacuum, flow takes place through the valve as indicated by the square beyond the square to which the pilot line attaches, when a sufficiently high vacuum is reached in the pilot line (indicative of the fact that the spool of the valve is drawn in its housing toward the end of the housing having the pilot line attached by the suction in the pilot line). With a low vacuum in the pilot line, spring 144a shown for valve 144 biases the spool of the valve to a position where flow takes place as indicated by the square to which the spring is connected, in the same manner as discussed for valve 100 and other valves operated by pilot lines containing air under pressure.

Valve 142 has a pilot line controlling its operation which is a vacuum line. Thus, with the valve and like valves in the drawings, when the spring for the valve (such as spring 142a for valve 142) is the agency positioning the spool of the valve, the arrow within the outline representing the valve indicating flow direction may be thought of as pushed by the spring to an inclined position, such as the position shown in FIG. 4 in connection with valve 142. With vacuum in the pilot line being the agency controlling the valve spool, the arrow within the outline representing the valve indicating flow may be thought of as pulled up by vacuum in the vacuum line to a horizontal position.

With a relatively small vacuum (a pressure only slightly less than atmospheric pressure) existing in vacuum-attaching means 36, valves 142 and 144 have the positions shown, i.e., valve 142 cuts off conduit 140 from pilot line 145 (and connects conduit 145 to the atmosphere through conduit 149), and valve 144 disconnects conduit 146 from line 133 (while connecting line 133 with the atmosphere through a conduit 143). With the valves in this position, air under pressure is cut off from line 133, with the result that valve 132 is open and the ejector is supplied air under pressure and operating.

When a higher vacuum (or lower subatmospheric pressure) is reached in attaching means 36, governor valve 142 is adjusted to a position connecting conduit 140 and conduit 145, because of the higher vacuum in its pilot line 147, with the valve spool in the valve moving against the bias of biasing spring 142a. This results in the introduction of a vacuum to line 145, causing an adjustment of the spool of valve 144 (against the bias of its spring 144a) whereby conduits or lines 146 and 133 are connected. When this occurs, air under pressure is introduced to the pilot side of two-way valve 132. Upon the latter occurring, the spool of the valve is adjusted so as to close off ejector 58 from conduit 57.

Valve 132 remains closed until governor valve 142 closes, which occurs only after the loss of a certain amount of vacuum in attaching means 36. When governor valve 142 closes (after such a loss of vacuum), valve 144 returns to its original position, and line 133 exhausts through valve 144 and conduit 143, which is accompanied with opening of valve 132.

The governor device is included for the purpose of conserving compressed air. It has been noted that vacuums ranging from 13 to 15 inches of mercury, for example, are entirely satisfactory for holding onto the usual load. The governor device thus may be constructed to start the production of a vacuum when the vacuum drops in the attaching means to 13 inches, and to stop the production of a vacuum when the vacuum reaches 15 inches.

The ejector in operation makes an audible sound, which is a useful signal to the operator of the vehicle. Thus,

during operating periods, air escaping from the ejector makes, a distinct "hiss," which the operator of the vehicle can hear. In picking up a load, if a continual sound is noted, this is an indication that a suitable seal has not yet been produced between the attaching means and the load, and it is not safe to move the load. On the other hand, if the sound is intermittent, this indicates that the governor is operating as intended, and that a satisfactory seal has been produced.

Referring again to FIG. 4, a dumping valve is indicated at 150 which is connected through line or conduit 152 to conduit 146 and hose 52. In the absence of air under pressure in hose 52, the valve's spring 150a holds the valve in the open position indicated, where conduit 79 leading to attaching means 36 is connected to the atmosphere through conduit 140, valve 150 and conduit 154. With air under pressure in hose 52 and conduit 152, valve 15 closes, permitting the establishment of a vacuum in means 36. The dumping valve is included to enable a load to be released immediately when the supply of air under pressure to hose 52 is cut off.

Rams 82, previously described and provided for increasing the curvature of flexible plates 70, are actuated by compressed air supplied through a conduit 176. At 178 is indicated a pilot-operated two-way valve provided with a pilot line 180 connecting with vacuum line 140. Spring 178a of the valve normally adjusts the valve to the open position shown, where conduit 176 is connected through the valve to a conduit 182 and conduit 146 containing compressed air. With a vacuum established in means 36, valve 178 is closed, against the bias of its spring, so as to cut off the supply of compressed air to rams 82. Thus, when the truck comes up against a load, and the system started, air under pressure automatically is supplied the rams and plates 70 are flexed, until a vacuum is established, meaning that a seal has been produced. The supply of compressed air is then stopped, and the rams held in their extended position, by the air trapped in the rams.

Completing the description of the circuit, shut-off cocks are indicated at 186, 188. Additional pressure gauges are shown at 190, 192. These components, as well as all the other components that are supplied air through rotatable coupling 56, are mounted on mounting 34 of the load-lifting structure.

Operating of the ejector, or the means producing the vacuum in the load-lifting structure of the vehicle, is started by adjustment of manually-actuated valve 118, to cause air under pressure to be supplied hoses 48, 52. Upon a sufficiently high vacuum being established in the vacuum-attaching means, the ejector cuts off, and remains off, until leakage and seepage through the load reduces the vacuum a predetermined amount. At this time the ejector starts again, and intermittently operates to maintain the desired vacuum. To release a load, valve 118 is adjusted to shut off the supply of air under pressure to valve 100. This results in atmospheric pressure being established in hoses 48, 52, and the conduits connected thereto, through valve 100.

Referring now to FIG. 6, here a load-lifting carriage with attaching means 200 is shown, according to a modification of the invention. In this modification of the invention, means is provided mounted on the carriage for holding a reserve supply of compressed gas, more specifically air. This construction has the advantage of enabling a vacuum to be sustained in the attaching means, even through pressure hose 48 which connects with the compressor on the truck should become cut accidentally or otherwise damaged.

More specifically, and referring to FIG. 6, as in the first embodiment of the invention, 30 indicates a rotator having a backing plate 32 fastened thereto. Secured to the front of the backing plate is a mounting 34. A flexible plate 70 is pivotally mounted in front of mounting 34.

Pressure-operated means, more specifically double-acting rams or jacks 202, are provided which flex plate 70

upon extension of the rams to change its curvature, in the same manner as rams 82 discussed in connection with the first-described modification of the invention. Mounted within mounting 34, in back of plate 70, and to either side of rams 202, are a pair of air pressure tanks 206a, 206b.

A vacuum may be produced in attaching means 200, by means of the apparatus illustrated schematically in FIG. 7. Referring to this figure, a tank 208 is shown (which is mounted on the truck, the same at tank 40) and this tank is supplied compressed air through conduit 214 connecting the tank with an air compressor 210 including an unloading valve 212. The compressor, as in the case of the first modification of the invention described, also is mounted on the truck.

Connected at one end to tank 208 is an air pressure hose 216, which has its other end connected to the center of reel device 50 mounted on mast assembly 26. Pressure hose 52 wound about the spool of reel device 50 is connected through swivel fitting 54, rotary coupling 56, and a check valve 218, to a conduit 220. In this modification of the invention, as in the first modification described, all conduits, valves, the ejector, and other elements or components supplied with air through rotary coupling 56, or actuated by such air, are mounted on mounting 34 directly adjacent plate 70 of the vacuum-attaching means.

Conduit 220 connects with a hold-back valve 222, having a valve spool urged by its biasing spring 222a to a position closing the valve. On a certain minimum pressure being reached in conduit 220, the pressure of air in pilot line 222b for valve 222 adjusts the spool of valve 222 so as to open the valve. With valve 222 open, conduit 220 is connected through a conduit 224, and conduits 226, 228, to tanks 206a, 206b.

Conduit 224 is also connected, through conduits 230, 232 and a normally open, pilot-operated two-way valve 234 (corresponding to valve 132 in the first modification of the invention), to ejector 236. The vacuum outlet of the ejector is connected through a pilot-operated check valve 238 and a conduit 240 to vacuum-attaching means 200, whereby on operation of the ejector a vacuum is produced by the ejector operable to evacuate the concave side of plate 70.

Two-way valve 234 is opened and closed by operation of a pilot-operated three-way valve 246, corresponding to valve 144 in the first-described modification of the invention. Valve 246 in turn is regulated by a governor valve 248, corresponding to valve 142 in the first-described modification of the invention.

Connected to conduit 230 just described is a conduit 250, which connects with a normally open, pilot-operated three-way valve 252. Conduits 254, 256, connect valve 252 to one of two pilot sides provided in valve 246. The other pilot side of valve 246 is connected through a conduit 258 and governor valve 248, and conduits 260, 262, to conduit 240 (the latter conduit being a vacuum conduit with the ejector operating).

Valve 246 is interposed between a conduit 264 connecting with conduit 230, and conduit 266 connected to the pilot side of valve 234. With the spool of valve 246 shifted upwardly against the urging of its biasing spring 246a, conduits 266 and 264 are connected, and with air under pressure in conduit 264, the spool of valve 234 will be shifted against spring 234a so as to close the valve.

Explaining the circuit as so far described, with the compressor operating hold-back valve 222 opens when a certain minimum pressure is attained in conduit 220 and as a result, a surge of air under pressure flows through conduit 224, and to pressure tanks 206a, 206b. At the same time air under pressure also flows through conduit 230 to conduit 232 and the ejector. In order to enable the tanks to fill with air, the ejector must be shut off and this is done by air under pressure flowing through

conduit 250, normally open valve 252, and conduits 254, 256 to valve 246, which air shifts the spool of valve 246 against the urging of its biasing spring 246a whereby the valve opens and conduit 264 is connected to conduit 266. This introduces air to the pilot side of valve 234, with its spool being adjusted so as to close the valve and shut off the ejector from air under pressure.

As will be described below, to produce a vacuum in attaching means 200, the spool of valve 252 is shifted against the bias of its biasing spring 252a to a position disconnecting conduit 250 from conduit 254. When this occurs, the spool of valve 246 returns to the position shown which has the effect of cutting off the supply of air under pressure to the pilot side of valve 234, and as a result valve 234 returns to the position shown with the ejector then being placed in operation.

Governor valve 248 has the same function as valve 142 discussed in connection with the first modification of the invention. When a high vacuum (low subatmospheric pressure) is present in attaching means 200, such is reflected in its pilot line 248b, and the spool of governor valve 248 is adjusted against the bias of its biasing spring 248a to a position connecting conduits 258, 260. This results in a vacuum being produced in conduit 258 (through conduit 260), and the spool of valve 246 shifting to a position wherein conduit 264 is connected to conduit 266, with air under pressure then being introduced to the pilot side of valve 234 causing this valve to close and the ejector to stop. As the vacuum in the vacuum-attaching means decreases, i.e., approaches atmospheric pressure, governor valve 248 returns to the position shown in the drawings, with conduit 258 opening to the atmosphere through conduit 261. The spools of valves 246, 234 return to the positions shown, and the ejector is put back in operation.

Pickup and release switches indicated at 270 and 272 are actuated by an operator to pick up and release a load, respectively. These switches complete a circuit between the battery of the truck, shown at 274, and either pickup solenoid 276 or release solenoid 278, depending upon which switch is actuated. When release switch 272 is closed a circuit is completed to solenoid 278 placing the valve spool of a valve 280 in the position shown where conduit 282 connected to conduit 220 is shut off from conduit 284. With the pickup switch 270 actuated, a circuit is completed to solenoid 276 shifting the spool of valve 280 to a position connecting conduits 282 and 284.

With pickup switch 270 actuated and valve 280 adjusted to connect conduits 282, 284, air under pressure travels from conduit 282 and through valve 280 to a hold-back valve 286 (corresponding to hold-back valve 116 of the first modification of the invention described). With suitable operating pressure existing in the pressure system, valve 286 opens to connect conduit 284 to conduit 288. This results in air under pressure being introduced to the pilot side of valve 252 already discussed, causing the spool of its valve to shift against the bias of its biasing spring and to a position disconnecting conduit 250 from conduit 254, which starts the ejector in the manner already discussed.

As in the first embodiment of the invention discussed, plate 70 is deflected at the start of picking up a load so that its curvature conforms more closely to the curvature of the load. Pilot-operated valve 290 controls the extension of rams 202 producing this deflection of the plate. With the spool of valve 290 positioned as shown, air under pressure will pass from conduit 288 through the valve, a restricting valve 292, and a conduit 294, to one set of ends of the rams with the rams then extending. Air is exhausted from the opposite ends of the rams through a conduit 296, a restricting valve 298, conduit 254, valve 252, and a conduit 251 which opens to the atmosphere (the spool of valve 252 being in a position shifted against its biasing spring when air under pressure is present in conduit 288).

Check valve 238 is a conventional pilot-operated check valve. The valve, when not actuated by its pilot line 299, accommodates flow through the valve in the direction indicated by the arrow only. With air under pressure in its pilot line 299, the valve is urged to an open position, which enables the flow of air through the valve in the opposite direction, or toward attaching means 200.

Valve 302 is a conventional pressure-relief valve, which opens conduit 230 to the atmosphere should excessively high pressures occur therein.

The operation of the modification of the invention illustrated in FIGS. 6 and 7 should be clear. When the compressor on the truck is first started, at first no air can flow into conduit 224. When a supply of air under suitable pressure has built up, valve 222 opens which allows air pressure to flow into tanks 206a, 206b. Air under pressure at the same time flows through conduits 230, 250 to the pilot side of valve 246, with this valve being actuated so as to cut off the ejector, thus to enable the tanks to fill completely with air at a suitable pressure.

To pick up a load pickup switch 270 is actuated to shift the spool of valve 280 to a position connecting conduits 282 and 284. With adequate pressure in the system hold-back valve 286 opens which results in pressurized air flowing through conduit 288, adjustment of valve 252 producing starting of the ejector, and the passage of air under pressure into rams 202 with deflection of plate 70. Upon the plate conforming to a load the vacuum on the concave side of the plate increases, and a vacuum results in line 262 which causes the spool of valve 290 to shift to a position cutting off conduit 294 from 288. This serves to lock the rams in place, with the plate remaining in the deflected position determined by the rams.

When the load is to be released, release switch 272 is actuated causing the spool of valve 280 to return to the position illustrated for the valve. Air under pressure escapes from conduit 284 through valve 280 and conduit 303 which opens to the atmosphere. Valve 252 returns to the position shown, and as a result air under pressure is admitted to conduit 254 and the ejector is shut off. With air under pressure in conduit 254, check valve 238 opens and air is permitted to flow to the concave side of plate 70, with any vacuum on the concave side of the plate being destroyed.

In some applications it may be desirable to utilize the energy stored in fluid or gas under pressure, for the production of a reserve vacuum supply for use in emergencies only, and to rely upon a conventional vacuum pump for the supply of a vacuum during normal operation of the vacuum-attaching means. This can be done very effectively using a construction of the type illustrated in FIG. 8, where a tank or other container 325 containing a volume of nitrogen or other gas under pressure is provided, and the compressed gas in the tank on being released and flowing through an ejector 327 produces a vacuum at the ejector used only when there is malfunctioning in the means normally supplying a vacuum. With such an organization it is possible to insure sustained operation in the vacuum-attaching means for an extended time period, in the event of malfunctioning, in the means normally supplying a vacuum, without having to include any auxiliary motor and pump unit, or other such devices, which are bulky, expensive, and require careful maintenance.

In FIG. 8, which also is in schematic form, the dashed outline 330 encloses those elements of the construction which are mounted on the load-lifting structure of the industrial vehicle, and the dashed outline 332 encloses those elements which are mounted on the truck portion of the vehicle. In an organization where compressed gas in a container is relied upon for a reserve vacuum supply, there is an advantage in having the tank or container which holds the gas mounted on the load-lifting structure, as indicated in FIG. 8, since this minimizes the chance of any damage occurring to any fluid line or con-

duit operatively interposed between the tank and the vacuum-attaching means, a factor contributing to reliability in operation.

Considering now in more detail the structure shown in FIG. 8, in this modification of the invention a motor 334 mounted on the truck drives a vacuum pump 336 also mounted on the truck. Pump 336 discharges into a muffler 338. The intake or suction side of the vacuum pump is connected to a vacuum hose 340, and this hose extends to a reel device 50, whence it is connected through swivel fitting 54 and rotary coupling 56 to a conduit 342 on the load-lifting structure which communicates through a check valve 344 with a vacuum storage tank 346 mounted on the load-lifting structure.

Also connected to the suction or intake side of the vacuum pump is a relief valve 348, which is normally closed, but which opens on a certain level of vacuum being reached on the suction side of the pump, to connect the intake of the pump through a conduit 350 and an air filter 352 to the atmosphere. Connected to the intake side of the vacuum pump together with the relief valve, through line or conduit 354, is a normally closed two-way valve 356 functioning as an unloading valve. On opening of the valve by a vacuum being introduced to its pilot line 358, the circuit connecting the pump to the vacuum storage tank on the load-lifting structure of the vehicle is bypassed, enabling the pump to run unloaded, with air from the atmosphere flowing to the intake side of the pump through filter 352, conduit 360, and the unloading valve.

Controlling operation of the unloading valve is a three-way valve 362 having a biasing spring 364 and operated by a solenoid 366. With solenoid 366 deenergized (which is the state of the solenoid when a vacuum is being supplied to the vacuum-attaching means), spring 364 adjusts valve 362 to the position shown in FIG. 8, where pilot line 358 of valve 356 connects to the atmosphere through port 368. On energizing of solenoid 366 (which is done when a vacuum is cut off from the vacuum-attaching means), valve 362 is adjusted against the bias of spring 364 to connect pilot line 358 for the unloading valve through check valve 370 to the suction or intake side of the vacuum pump, whereby a vacuum results in pilot line 358 and the unloading valve opens, to unload the vacuum pump.

Mounted on the load-lifting structure is vacuum-attaching means 372, which may be similar to the attaching means described in connection with the other modifications of the invention, and which is provided with the usual opening through which air is evacuated when actuating the attaching means, such opening being connected through conduit 374 and valve 376 to vacuum-storage tank 346 already described as mounted on the load-lifting structure. Valve 376 is a two-way, pilot-operated valve controlling the supply of vacuum to the vacuum-attaching means, and the valve's operation in turn is controlled by pilot-control valve 378, connected through line 380 and rotary coupling 56 to pilot line 382 for valve 376.

Control valve 378 is a solenoid-operated, three-way valve, and with its solenoid 384 deenergized, its spring 386 adjusts the valve to the position shown for the valve where pilot line 382 connects with the atmosphere through valve 378 and port 388. With pilot line 382 connected to the atmosphere, spring 390 of valve 376 biases the valve to the position shown, to connect vacuum-attaching means through conduit 374 to the vacuum storage tank, whereby a vacuum is supplied to the attaching means, and it is in condition to pick up and hold a load. With energizing of solenoid 384, pilot-control valve 378 is adjusted against the bias of its spring 386 to connect pilot line 382 through valve 378 and line 392 to the vacuum hose. This results in a vacuum in pilot line 382, causing adjustment of valve 376 whereby the vacuum in the storage tank is cut off, and the vacuum-attaching means is connected to the

atmosphere through port 394. This enables the vacuum-attaching means to release a load.

Considering now the reserve vacuum supply used in the event that there is malfunction in the vacuum pump or associated structure, ejector 327 already described operates upon gas under pressure flowing therethrough from conduit 396 to produce a vacuum in conduit 398, which is supplied to vacuum-attaching means 372 through check valve 400 and conduit 374. A valve system is provided for the controlling ejector whereby it operates only at such times that there is a vacuum in conduit 374 simultaneously with atmospheric pressure in conduit 342, which is the condition that exists when the vacuum-attaching means is attached to a load and for some reason there is failure in the means supplying a vacuum to tank 346.

Describing this valve system, more specifically, tank 325 containing a supply of compressed gas such as nitrogen is connected to the ejector through conduit 402, pressure-regulating valve 404, conduit 406 and pilot-operated two-way valve 408. Valve 408 has two pilot lines indicated at 410 and 412, respectively. Pilot line 412 connects to conduit 342 and thus is sensitive to pressure conditions in the principal vacuum-supply circuit. Pilot line 410 communicates through a governor valve 414 (corresponding, for instance, to governor valve 142 already discussed), when such valve is in the position of adjustment shown, with a line 416 connected to conduit 374.

With a vacuum in pilot line 412, which reflects a vacuum in conduit 342 and hose 340, and normal operating conditions, biasing spring 418 for valve 408 and pilot 412 together function to maintain valve 408 in the position of adjustment shown (even though there should be a vacuum in pilot line 410), wherein the ejector is cut off from gas under pressure in tank 325. In the event, however, that atmospheric pressure is present in line 412, and a vacuum is present in line 416 (indicative of malfunctioning in the normal vacuum supply circuit at such time as the attaching means is attached to a load), the vacuum in line 416 is transmitted through valve 414 to pilot line 410, and the pressure in pilot line 412 overcomes the biasing of spring 418, whereby valve 408 is adjusted to connect conduits 396 and 406 so as to produce operation of the ejector.

As in the first modification of the invention, during emergency operation when the ejector is relied upon to supply the vacuum, the ejector operates intermittently, to conserve the supply of compressed gas. When the vacuum in attaching means 372 reaches a certain level, this is reflected in pilot line 416, and governor valve 414 is adjusted against the biasing of its spring 420 to connect pilot line 410 to the atmosphere through port 422, and the supply of compressed gas to the ejector is cut off. On the vacuum in attaching means 372 dropping to a certain level, spring 420 of the governor valve adjusts the governor valve so as to return it to the position shown, where pilot line 410 is connected to line 416, and this results in valve 408 being adjusted to a position again connecting lines 406 and 396.

Line 424 connected to the vacuum-attaching means is connected to a vacuum switch 426, and this switch may be used to actuate a suitable indicator for showing the pressure conditions in the vacuum-attaching means.

Explaining generally how the construction shown in FIG. 8 operates during normal operating periods, the vacuum pump evacuates the vacuum-storage tank on the load-lifting structure, and this vacuum-storage tank in turn provides a source of vacuum through valve 376 and conduit 374 to the vacuum-attaching means. Solenoids 366 and 384 are operated together, and during picking up of a load the two are deenergized, whereby a vacuum is transmitted to the attaching means through valve 376 and unloading valve 356 is shifted to a position cutting off the bypass to the vacuum pump. When not lifting a load, the two solenoids are energized, pilot control valve 378 then, by producing a vacuum in pilot line 392, shutting off the

supply of vacuum to the vacuum-attaching means, and the unloading valve at this time providing a bypass to the intake of the vacuum pump. At such time as a vacuum exists in the vacuum-attaching means, and such vacuum is below the level necessary to actuate the governor valve, and atmospheric pressure exists in pilot line 412 (indicative of malfunctioning in the main vacuum supply), then the ejector is placed in operation to provide a reserve vacuum supply for the vacuum-attaching means.

From the description it will be noted that a number of novel concepts have been incorporated into the construction. For one thing, by using a fluid such as gas or air under pressure as a means for producing a vacuum (be it a primary source of vacuum for the attaching means or an auxiliary source to be used in reserve only), a considerable amount of energy may be stored in a relatively small receiver or tank. This, as noted, has advantages when the tank is mounted on the truck portion of the industrial vehicle, or is particularly advantageous when the tank is mounted on the load-lifting structure.

The use of a compressed gas for operating an ejector to provide a reserve supply of vacuum for emergency use eliminates the need for standby pumps, motor drives, etc., to obtain reliability. Where an air compressor through an ejector provides the vacuum normally used in handling loads, a tank may be filled with compressed air using such air compressor to provide the compressed gas needed. Where, however, as in the last modification of the invention discussed, the normal vacuum supply is produced by a vacuum pump, this invention contemplates the inclusion of a reservoir or tank on the vehicle containing compressed gas where such tank is filled by means separate from the vehicle.

By providing for intermittent operation in the ejector, an audible signal results which positively informs the operator if a proper seal has been obtained, and it is unnecessary to relay on a gauge or signal light on the truck which might malfunction. The intermittent operation also serves to conserve the supply of compressed gas by minimizing its use.

In an organization where an ejector supplies the vacuum normally used, and the ejector is operated with compressed air supplied by a compressor located on the truck, relatively small diameter compressed air lines may be utilized to transfer the product of the compressor to the ejector without frictional losses being a problem. This enables the ejector to be mounted on the load-lifting structure remote from the compressor or other means producing the compressed air. The length of any vacuum conduit required to transmit vacuum from the ejector to the vacuum-attaching means may be minimized, thereby reducing frictional losses in the vacuum conduit. Relatively small diameter compressed air lines offer additional advantages over vacuum lines of larger diameter, since in extending from the truck to the load-lifting structure they offer less visual obstruction to the truck operator who must watch the load through the attaching apparatus.

It should be noted that the valves directly controlling air flow to the ejector in the first modification of the invention (by way of example, valve 132) are normally open, such making the system fail-safe. In other words, should any of these valves malfunction, or should tubing rupture, the loss of pilot pressure to the valve will not cause the valve to close inadvertently.

The electrical circuit in the embodiment of the invention illustrated in FIG. 7 is fail-safe for the reason that valve 280 is a momentary contact solenoid-operated valve, i.e., if one of its solenoids is energized momentarily, its valve spool shifts to the position dictated by the solenoid, and the spool stays in this position until such time as the other solenoid is energized. Thus, a failure in the electrical circuit does not, by itself, produce any change in valve 280.

While an embodiment of the invention has been described, variations are possible without departing from the

invention. It is intended to cover all modifications and variations that would be apparent to one skilled in the art, and that come within the scope of the appended claims.

I claim:

1. In an industrial vehicle, including a truck and load-lifting structure movable relative to the truck mounted on said truck,
 - vacuum-attaching means for attaching to a load mounted on said load-lifting structure,
 - power-supply means for supplying the power to actuate said vacuum-attaching means whereby the latter is placed in operative, load-attaching condition,
 - said power-supply means including mechanism operatively connected to said vacuum attaching means mounted on said truck providing the principal source of power during operating periods for actuating the vacuum-attaching means, and
 - storage mechanism mounted on said load-lifting structure operable to store energy, with such stored energy constituting a reserve source of power for actuating said vacuum-attaching means when the mechanism on said truck for any reason becomes inoperable.
2. In an industrial vehicle including a truck and load-lifting structure movable relative to the truck mounted on said truck,
 - vacuum-attaching means for attaching to a load mounted on said load-lifting structure,
 - a reservoir for holding a supply of gas under pressure mounted on said load-lifting structure together with said vacuum-attaching means,
 - vacuum-producer means mounted on said load-lifting structure operated by gas under pressure and including an inlet for the supply of such gas thereto and a vacuum supply connection wherein a vacuum is produced on operation of the producer means,
 - conduit means on the load-lifting structure connecting said reservoir and said inlet of the vacuum-producer means whereby gas under pressure in the reservoir may be used to operate the vacuum-producer means,
 - conduit means connecting on said load-lifting structure said vacuum supply connection of the vacuum-producer means and said vacuum-attaching means, whereby when gas under pressure in said reservoir operates the vacuum-producer means the latter operates said vacuum-attaching means, and
 - means on said truck operatively connected to said vacuum-attaching means for operating the attaching means independently of said vacuum-producer means.
3. In an industrial vehicle including a truck and load-lifting structure movable relative to the truck mounted on the truck,
 - vacuum-attaching means for attaching to a load mounted on said load-lifting structure,
 - a vacuum conduit connected to said attaching means for supplying the attaching means with a vacuum,
 - means mounted on the truck connected to the vacuum conduit for supplying the vacuum conduit with a vacuum,
 - a reservoir mounted on the load-lifting structure for holding a supply of gas under pressure,
 - an ejector mounted on the load-lifting structure including a vacuum supply connection wherein a vacuum is produced on the flow of gas through the ejector and an inlet for supplying gas under pressure to the ejector,
 - conduit means connecting said vacuum supply connection with said vacuum-attaching means, and conduit means connecting said reservoir and the inlet of said ejector,
 - at least one of said conduit means including means operable to start said ejector upon a loss of vacuum in said vacuum conduit.

4. In load-handling apparatus including vacuum-attaching means,
 - a motor-driven vacuum producer,
 - vacuum conduit means connecting the vacuum producer and the vacuum-attaching means whereby a vacuum to operate said attaching means is supplied by said vacuum producer, said conduit means including valve means for controlling operating periods of said vacuum-attaching means, and
 - means for operating said vacuum-attaching means responsive to a loss of vacuum in said vacuum conduit means,
 - said means comprising a reservoir for holding gas under pressure, an ejector operated by the flow of gas therethrough including an inlet connected to said reservoir to enable the supply of gas to the ejector from said reservoir and a vacuum supply connection wherein a vacuum is produced on operation of the ejector, and conduit means connecting said vacuum-supply connection with said vacuum-attaching means.
5. In load-handling apparatus including a framework and a load-handling component mounted on the framework for movement relative to the framework,
 - vacuum-attaching means operated by a vacuum for attaching to a load mounted on said load-handling component,
 - a primary power supply means mounted on said framework operatively connected to said vacuum-attaching means for supplying power to actuate said vacuum-attaching means whereby the latter is placed in operative load-handling condition,
 - a secondary power supply means operatively connected to said vacuum-attaching means mounted on said load-handling component, operable to store energy, for supplying by the release of such energy power to actuate said vacuum-attaching means whereby the latter may be placed in operative load-handling condition in the event said primary power supply means a operatively cut off from said vacuum-attaching means,
 - said secondary power supply means being operatively connected to said vacuum-attaching means by means causing said secondary power supply means to actuate said vacuum-attaching means automatically on said primary power supply means being operatively cut off from said vacuum-attaching means.
6. In an industrial vehicle including a truck and a load-lifting structure movable relative to the truck mounted on said truck,
 - vacuum-attaching means for attaching to a load mounted on said load-lifting structure,
 - a motor-driven vacuum producer mounted on said truck,
 - vacuum conduit means connecting the vacuum producer and the vacuum-attaching means whereby a vacuum to operate the attaching means is supplied by the vacuum producer, said conduit means including valve means for closing said conduit means, and
 - means mounted on said load-lifting structure for operating the vacuum-attaching means in the event of loss of vacuum in said vacuum conduit means,
 - said means comprising a reservoir for holding gas under pressure, an ejector operated by the flow of gas therethrough including an inlet connected to the reservoir and a vacuum supply connection wherein a vacuum is produced on operation of the ejector, and conduit means connecting the vacuum supply connection with said vacuum attaching means.
7. In an industrial vehicle including a truck and load-lifting structure movable relative to the truck mounted on the truck,
 - a vacuum-attaching means for attaching to a load mounted on said load-lifting structure,
 - primary power supply means operatively connected to said vacuum-attaching means for supplying power to

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actuate said vacuum-attaching means whereby the latter is placed in operative load-handling condition, said primary power supply means being mounted on said truck,

a secondary power supply means operatively connected to said vacuum-attaching means mounted on said load-lifting structure, operable to store energy, for supplying by the release of such energy power to actuate the vacuum-attaching means whereby the latter is placed in operative load-handling condition in the event said primary power supply means is operatively cut off from said vacuum-attaching means,

said secondary power supply means being operatively connected to said vacuum attaching means by means causing said secondary power supply means to actuate said vacuum-attaching means automatically on said primary power supply means being operatively cut off from said vacuum-attaching means.

8. In an industrial vehicle including a truck and load-lifting structure movable relative to the truck mounted on the truck, vacuum-attaching means for attaching to a load mounted on said load-lifting structure, a reservoir for holding a supply of gas under pressure mounted on said load-lifting structure, a converter mounted on the load-lifting structure operable to convert the energy of compressed gas into subatmospheric pressure for operating said vacuum-attaching means, a conduit connecting on said load-lifting structure said reservoir and said converter whereby compressed gas in the reservoir is operable to

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actuate the converter, conduit means connecting said converter and said vacuum-attaching means whereby sub-atmospheric pressure produced by the converter operates the vacuum-attaching means, and means on the truck operatively connected to the vacuum-attaching means for operating the vacuum-attaching means independently of compressed gas contained in said reservoir.

References Cited

UNITED STATES PATENTS

1,505,626	8/1924	Debaecker	244—65
2,578,220	11/1951	Billner	294—65
2,893,581	7/1959	Cushman.	
2,899,088	8/1959	Corbin.	
2,999,715	9/1961	Firestone	294—64
3,008,747	11/1961	Lytle	294—64
3,039,623	6/1962	Sehn et al.	294—64
3,089,723	5/1963	Fortson et al.	
3,139,204	6/1964	Olson.	
3,181,563	5/1965	Giffen	294—64
1,434,623	11/1922	Nichols	212—38
2,934,086	4/1960	Blatt.	
3,104,125	8/1963	Garlinghouse	294—88 X
3,219,380	11/1965	Carliss	294—64
3,260,391	7/1966	Horton	294—65 X

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