

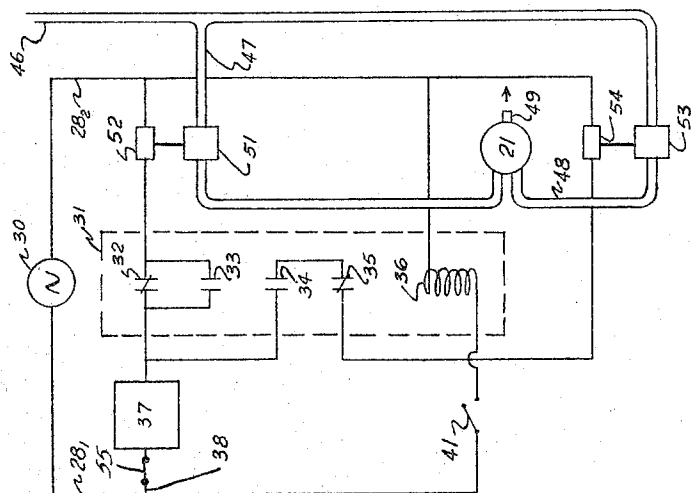
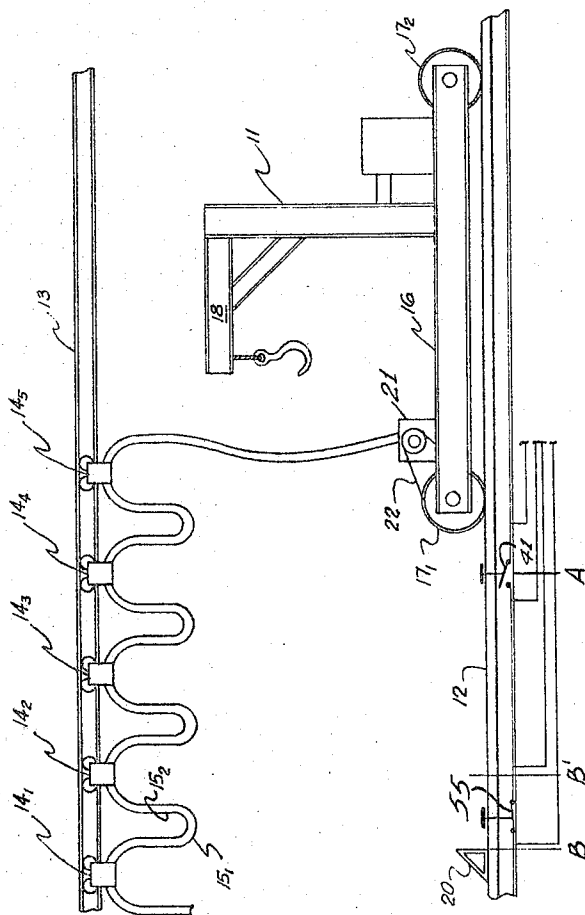
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MATERIAL HANDLING EQUIPMENT

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1

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MATERIAL HANDLING EQUIPMENT

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This invention relates to material handling equipment. More particularly, the invention relates to improvements in pneumatic powered cranes and associated apparatus of a type whereby a crane is automatically moved along a path or tracks, to an operating station, and at said station, accomplishes a delivery or pickup or some other material handling function or functions.

In the automatically programmed operation of a travelling crane along a crane path to a delivery station, means must be provided for termination of the motivating power when a crane approaches or reaches a station. In the case of cranes driven by pneumatic motors, one such mechanism has involved a preliminary trigger, or switching, which upon the approach of a crane to a terminal position, accomplishes a switch of the gas or air supply for the transfer motor from a relatively high volume to a relatively low volume. The theory of such arrangement is that a terminal portion of a crane movement path to a station will be at a relatively low speed so that the final resting position will be achieved with a minimum of shock accompanying the positive stoppage of the crane by a block mechanism, which is generally associated with complete termination of the air to the transfer motor. However, in actual practice such an arrangement has not proven effective. Usually, the momentum of massive equipment, on attaining a traverse speed of several hundred feet per minute, is so great that merely diminishing the rate of flow of processing gas is not enough to decrease the speed to the extent necessary to avoid shock, unless the low rate is commenced so far in advance of the terminal position that the benefits of potential rapid traverse are largely lost. In addition, the normal variation in control pressure of a motivating gas is such that frequent adjustments would be necessary in any case.

The present invention is intended to assure the termination of movement of such a crane, or similar apparatus, with a minor amount of shock. The present invention is intended to circumvent the necessity of frequent adjustment of control apparatus and to provide apparatus for bringing a massive moving carriage to a firm but gentle stop.

As indicated, the present invention has for its object, provision for a new and improved means for control of movement of a crane or crane carriage, or similar material handling apparatus, which is to move along a path or trackway by the action of a pneumatic motor, to a final terminal stationary position. The movement is to include a rapid rate segment and a terminal segment, and a final firm but relatively gentle stop. Other objects will appear hereinafter.

The invention will be readily understood from the following description and from the accompanying figures wherein:

FIG. 1 is a schematic elevation of a crane with indicia of the relative positions during the movement sequences to which the present invention is applicable, and

FIG. 2 is a schematic illustration of control mechanism to be associated with a crane or similar apparatus for achieving the objects described.

The improved apparatus of the present invention then is always provided in addition to or with a travelling crane or similar material handling mechanism which is

2

propelled in its travel path by a gas powered motor. Particularly, the present improvement is improved control means for controlling the movement of such a crane assembly toward a predetermined stop or stationary position, and for providing in sequence a rapid movement segment terminated by a substantially complete braking action, this being followed by a short and usually slower movement segment, and finally termination by a positive but relatively gentle stop. The apparatus of the present improvement includes means for "reversing" a high speed gas supply to a crane motor at a change or switch point, for a sufficient period of time to substantially stop the crane travel, and means to re-initiate crane travel in the original direction. By "reversing" is meant that the air or gas supply to the gas motor is fed to a different motor port such that reversed rotation would normally occur under the influence of the gas pressure. The apparatus in which the improvement is provided also includes a terminal gas supply cut-off means for terminating all gas flow to the transfer motor at a point before the crane has reached its terminal position, so that final mechanical stoppage is accompanied with minimum shock.

Referring to FIG. 1, the principal segments of this typical apparatus include a carriage or crane assembly 11, which is a wheeled device running on crane rails 12. An overhead I-beam track 13 provides a support means for travelling blocks 14₁, 14₂, 14₃, 14₄, 14₅. These blocks have festooned therefrom one or more power conduits 15₁, 15₂. Thus, as the crane carriage 11 moves back and forth along the rails 12, the conduits 15 are extended or contracted as the case may be. The conduits can include electrical, pneumatic, or hydraulic lines. The crane assembly 11 includes a frame portion 16, supported on paired wheels 17₁, 17₂. Appropriate lifting mechanism 18, including winch and cable means, are provided in the crane assembly 11. Transfer movement of the crane assembly 11 along the railed path 12 is provided by a pneumatic motor 21, which drives a pair of the crane carriage wheels 17₁, by a belt 22 or similar power transmission means.

Associated with the crane rails 12 is a stop device 20, which represents a terminal stopping point for the crane assembly 11, as it reaches a position necessary for a desired material handling function. Such material handling functions—lifting, lowering, etc.—are conducted while the crane is stationary on the rails 12. In most installations the stop device 20 is one of a plurality of equivalent devices at different locations, and can be positioned in place to actuate or be effective as stop means in response to an automatic programming procedure and associated mechanism.

To illustrate improved functioning provided by the present invention, the crane assembly is to be considered moving along the crane rails 12 toward the stop mechanism 20, at the highest rate of speed at which the motor 21 is capable of providing with the gas pressure provided.

As a forwardly projecting portion of the crane assembly 11 arrives at a pre-selected point A, the power supplied to the pneumatic motor 21, viz., the gas supply is reversed. Thus, the motivating power is utilized as brake means, so that forward movement of the crane is terminated at some intermediate point B'. The final position of the aforementioned forwardly projecting portion of the crane assembly is at B, viz., in contact with the stop mechanism 20.

To move the crane assembly from the intermediate position B' to the final terminal position B requires an additional movement segment, preferably at a relatively low rate, and means to discontinue the motivating power in such a manner that the engagement of the crane assembly

11 with the stop device 20 will be without significant shock.

As previously outlined, the novel combination of the present invention utilizes means associated with the crane, which are responsive to attainment of a position of a part of the crane at point A, said means providing for a short period of "reverse" application of gas to the motor 21. Hence, the same "prime-moving" force as has been applied to achieve rapid movement of the crane toward the stop device 20 is applied in the exact reverse direction. It is then apparent that in those cases in which the momentum during the approach toward point A, has been unusually rapid because of unusually high air pressure, can be resisted by application of air pressure of the same magnitude in the reverse direction. Similarly, if the air pressure has fallen below a set point, then the momentum attained in approaching point A will be diminished, and similarly the braking action, resulting from reversing the air to the motor, will be less severe. In other words, the means provide a built-in factor to compensate for irregularly or improperly controlled air pressure in the supply to the traversing motor 21. The reverse air pressure initiated at A for the purpose indicated, is maintained for a discrete but short period of time, sufficient to effectively stop, or substantially stop, traversing movement of the crane assembly. It will be clear to one skilled in the art that the exact positioning of point A and the duration of the reverse application of air pressure, can be varied according to the size of the traversing motor 21, the nominal air pressure supplied thereto, the mass of the crane assembly 11 and other perceptible factors. Generally, for illustrative purposes, in the case of a crane which weighs 12,000 pounds, and is powered by a traversing motor utilizing 80 cubic feet per minute of air at a normal pressure of 90 pounds per square inch, the duration of reverse pressure of air, is of the order of 2 seconds. Following this interim period of reverse application of air pressure, so that the traversing movement of the crane is substantially eliminated or at least drastically curtailed, air pressure is applied for forward movement, i.e., in such a manner that the motor 21 again drives the crane assembly toward the stop mechanism 20. In the preferred embodiment, such air is supplied at a drastically reduced rate, in effect, only enough to overcome the inertia and frictional drag of the crane assembly 11.

As the crane assembly 11 achieves engagement of some point, slightly before actual engagement of the crane assembly with the stop positioning device 20, the final application of air is terminated, so that the crane assembly "coasts" into final position and is engaged by the stop or registration means 20, without significant shock.

As already mentioned, FIG. 2 illustrates typical circuitry and means for association with the apparatus illustrated in FIG. 1 for accomplishing the operative functions of the invention. Thus, the apparatus illustrated by FIG. 2 includes electrical and pneumatic lines and circuitry control devices for achieving the reverse power supply to an air motor driving a crane carriage, in response to attainment of a particular position.

Referring more specifically to FIG. 2, principal elements of the apparatus include a switch means 41 and a relay 31, the contacts thereof to be mentioned later herein. An equally important segment of the powering and control apparatus includes the air supply line 46 and the air motor 21. Valves 51 and 53 are provided in branches 47 and 48 of the air supply line to the pneumatic motor 21. Power to the electrical circuitry is supplied from a conventional source 30, to branch leads 28₁, 28₂.

The branch line 47 feeds air to the motor 21 for movement in a "forward" direction, and the second branch line 48 supplies air to the motor 21 through a port resulting in rotation of the motor in a "reverse" direction.

The relay mechanism 31 is of a conventional type including a solenoid coil 36 and four contacts 32, 33, 34, 35, actuated concurrently by movement of the armature (not

shown) of the solenoid. The contacts are of different character. Thus, contacts 32, 34 are instantaneous acting whereas contacts 33, 35 are delayed action. Such a relay mechanism 31 is well known in the art and may be obtained commercially (Square D Company, Model RG-14D) as a timing relay with a dial having one pole normally open, one pole normally closed, and an adjustable time range of 0.2 seconds to 3 minutes. Starting mechanism 37 is schematically shown, this indicating merely associated circuitry or programming devices to close a circuit with lead 38 thus initiating circuitry for driving the crane in a forward direction.

The switch 41 is normally open and is positioned at point A of FIG. 1, an appropriate point along the path of a crane travel, so that it is mechanically closed by contact with some projection or operative mechanism associated with the carriage.

The valves 51, 53, for control of flow to the air motor 21 are of the normally closed type. Solenoids 52, 54, individually associated with the valves, provide for opening the valves upon energizing.

The interrelation of the several segments of the apparatus will be clearly understood by description of the operating sequence starting from the situation represented by FIG. 2 as described below. The circuitry represents the position of the switches associated with the relay 31 when the crane mechanism is moving in a forward direction. Thus, the motor 21 is operated by air supplied through branch conduit 47, valve 51 being opened owing to operation of the solenoid 52. The solenoid 52 is energized by current flowing through the relay, by reason of closure of the contact 32.

As the crane attains proximity to a terminal stopping point (as in reaching point A in FIG. 1), switch 41 is closed, immediately energizing coil 36 and actuating the armature of the relay solenoid, which immediately opens instantaneous contact 32 and closes time delay contact 33 after the pre-set time delay period, and also closes instantaneous contact 34 and opens time delay contact 35 after the pre-set time delay period. It is immediately seen that this change in circuitry will energize the solenoid 54 of valve 53 and de-energize solenoid 52 of valve 51, thus causing immediate flow of air to the motor in a manner to cause reverse direction. It will be understood that flow is not actually occurring until the motor 21 stops and would reverse if the air pressure supplied through branch 48 were continued. In other words, the effect of the reversal above described is to apply air pressure in the reverse direction, rather than a substantial degree of air flow, thus utilizing the motor for braking purposes. The duration of the electrical circuitry energizing solenoid 54 is determined from the setting of the time delay mechanism associated with the time delay contacts 33, 35. These time delay switches are of conventional type, and the time delay in both should be identical, and is, preferably, controlled by a unitary delaying mechanism. In any event, after expiration of the appropriate time delay, contact 33 closes and concurrently contact 35 opens, thus re-establishing air pressure through branch line 47 to the motor, causing forward movement. Upon attainment by the carriage or of approximate attainment of, the terminal position, the forward circuitry established by mechanism 37 is terminated, owing to switch means 55 associated with attainment of the final position. Incidental to attainment of the terminal position is a re-opening of switch 41, resetting it for the next cycle. This also restores, of course, the armature of the relay 31 to the position corresponding to the contact position shown in FIG. 2.

It will be understood that the above described circuitry can be associated with movement of the crane in either direction toward a terminal position, by appropriate supplemental switching means, not shown.

To further illustrate apparatus for specific application, in an installation wherein a crane assembly weighing

5

about six tons was employed, the air traverse motor was a Gardner-Denver motor. The air supply was at, nominally, 90 pounds gauge pressure, which provided maximum travel rate after movement of several feet. In this installation, the point A was located approximately 6 feet from the final stop at point B. A final position switch was located approximately 2 inches from the final stop point B, for discontinuing any air pressure to the motor. In practice, the duration of reverse air flow or pressure application, accomplished by the circuitry and contact means illustrated by FIG. 2, required about two seconds, and in this time the movement of the crane carriage was essentially fully terminated. Upon expiration of the time delay relay period, and reinstatement of full line air pressure in the forward direction, the crane carriage approached point B at a relatively slow rate. The entire movement, from point A, after engagement of the first position switch 41 to the final stopping point B was about four seconds. In this embodiment, the reinstated air flow in the forward direction, following the braking action of the motor, was at a restricted rate, by means of restriction valve in the air line (not shown) which was automatically actuated during this portion of the cycle.

Many variations of the control circuitry and mechanism described above can be made by one skilled in the art without departing from the principles of our invention.

We claim:

1. In a crane mechanism or the like of the type which is moved on a railed path to at least one definitive terminal position by a reversible pneumatic motor driving means having at least one first pneumatic feed port for operation in one direction and at least one second feed port for operation in a direction opposite to said one direction, an apparatus for assuring attainment of said terminal position in a substantially shock-free manner comprising, in combination,

- (a) a pneumatic feed supply means for operation of said pneumatic motor driving means,
- (b) a first switch means attached to said railed path at a point approaching said at least one terminal position for actuation by said crane mechanism in passing,
- (c) a controllable-time switching means responsive to said first switch means for supplying pneumatic feed to reverse said reversible pneumatic motor driving means for controllable period of time, and
- (d) a second switch means attached to said railed path at a point between said first switch means and in

6

close proximity to said at least one terminal position for actuation by said crane mechanism in passing for terminating pneumatic feed from said pneumatic feed supply means.

2. In a crane mechanism or the like of the type which is moved on a railed path to at least one definitive terminal position by a reversible pneumatic motor driving means having at least one first pneumatic feed port for operation in one direction and at least one second feed port for operation in a direction opposite to said one direction, an apparatus for assuring attainment of said terminal position in a substantially shock-free manner comprising, in combination,

- (a) a pneumatic feed supply means for operation of said pneumatic motor driving means,
- (b) a first pneumatic supply conduit having a first supply valve means connecting said at least one pneumatic feed port and said pneumatic feed supply means,
- (c) a second pneumatic supply conduit having a second supply valve means connecting said at least one second feed port and said pneumatic feed supply means,
- (d) a starting means for opening said first supply valve means,
- (e) a first switch means attached to said railed path at a point approaching said at least one terminal position for actuation by said crane mechanism in passing,
- (f) an adjustable time switching means responsive to said switch means for closing the open normally closed first supply valve means and opening said second normally closed valve supply means for an adjustable period of time and then reopening said first supply valve and closing said second supply valve, and
- (g) a second switch means attached to said railed path at a point between said first switch means and in close proximity to said at least one terminal position for actuation by said crane mechanism to close said first supply valve.

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