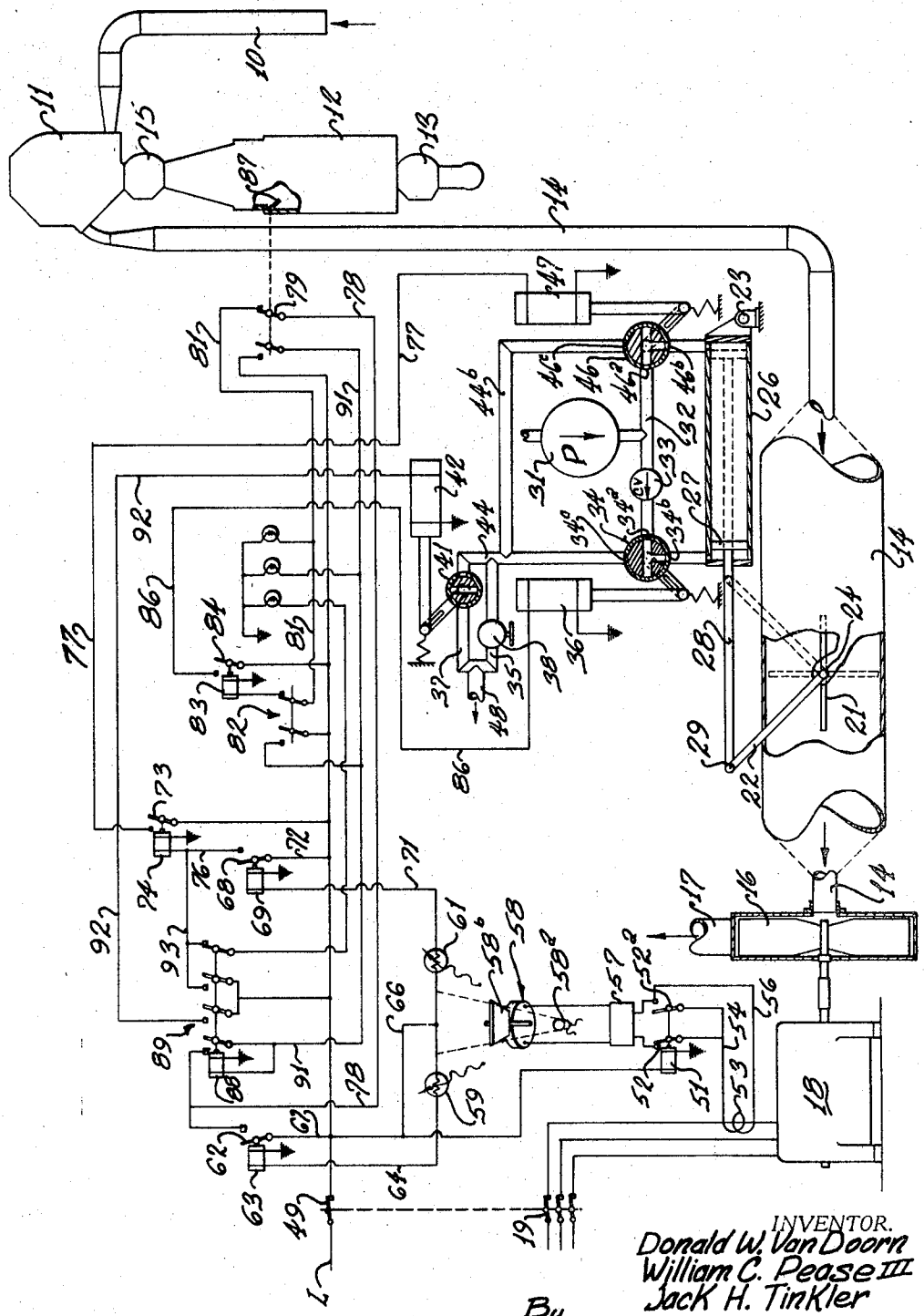
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PROCESS AND APPARATUS FOR CONVEYING MATERIALS PNEUMATICALLY AND INTERMITTENTLY

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PROCESS AND APPARATUS FOR CONVEYING MATERIALS PNEUMATICALLY AND INTERMITTENTLY

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ABSTRACT OF THE DISCLOSURE

Process and apparatus for conserving energy in the operation of centrifugal fans or blowers in which the amount of power required by the prime mover is determined by the amount of material being conveyed, such control being effectuated by automatically decreasing or shutting off the volume of air passed through the fan or blower during periods when a reduced amount or no material is being moved through the system.

This invention relates to a process and apparatus for pneumatically conveying particulate or discrete material such as seed cotton or the like into or through a system.

In this art it is customary to convey seed cotton pneumatically into the gin house and through various machines prior to ginning such as dryers, cleaners, stick removers, etc. The usual source of air for such systems is a centrifugal fan driven by a prime mover, for instance, an electric motor. One of the characteristics of a centrifugal fan is that when there is no load in the system, namely, when no material is being conveyed therethrough, the power required to drive the fan increases. Thus, it literally requires more horsepower to drive such centrifugal fan when it is moving only air than when it is moving the maximum amount of material which the system is designed to move. In the past it has been necessary, when conveying material intermittently or in varying quantities in such a system, to select a prime mover of greater horsepower than required to perform the material conveying work. This is true because, as stated, if the motor is sized only to convey the full load of material, then, during idle periods when air only is being drawn through the system, the load imposed by the fan will exceed the rated horsepower of the motor and damage it. The past practice, therefore, has required the selection of motors for such systems which are larger, more expensive, and which waste considerable amount of energy. Further, in case of an electric motor, such oversized machines increase the connected horsepower and result in lowering the power factor when the motor is not operating near its maximum capability.

In view of all the foregoing the prime objects of our invention are to provide a process and apparatus in which:

(a) The prime mover selected to drive such centrifugal fans or blowers may safely be of a horsepower consistent with that required to move only the material in the system rather than having to be of such horsepower to drive the fan when no material or reduced amounts thereof are being conveyed;

(b) The control over the amount of power required by the prime mover is determined by the amount of material being conveyed, this control being effectuated by automatically decreasing or shutting off the volume of air passed through the fan during periods when a reduced amount or no material is being moved through the system;

(c) Means is provided to shut off air from the fan if the system becomes overloaded with material;

(d) The cost of the system and its cost of operation are materially reduced.

Generally, our invention comprises means effective to sense the presence or absence of material in the system or a decrease therein below a predetermined amount, thereby to otain signals representative of such conditions. Through the medium of such signals we provide means to reduce or substantially exclude inlet air to the centrifugal fan during times of reduced or no load of material in the system, thereby, during such times, reducing the power required to drive the fan. Our improved controls may be used completely to automate such systems, all to the end that our improved process and apparatus may be carried out and operated by workmen of ordinary skill.

Apparatus illustrating the constructional features of our invention and which also may be used to carry out our improved process is illustrated in the single figure of the drawings in which we have shown our invention, wholly diagrammatically, as applied to a portion of a seed cotton conveying system commonly found in a gin house, the air being supplied to the system by a centrifugal suction fan driven by an electric motor.

Referring now to the drawing for a better understanding of our invention we show at **10** the usual telescope suction pipe through which materials such as seed cotton are drawn into the plant as will later appear. That is, from a wagon seed cotton is sucked up through the pipe **10** into a separtor **11** from whence it falls by gravity through a drop seal feeder **15** into a storage hopper **12**. The cotton is delivered from the bottom of the storage hopper **12** through a drop seal feeder **13** from which it then proceeds to other machinery, such as dryers, stick removers, and finally to the gins, none of which are shown in the drawings.

Connected to the separator **11** is a suction conduit **14** which leads as indicated to the inlet side of a suction fan **16** of the centrifugal type. As is understood for such apparatus, the separator **11** in effect separates the air from the cotton. Thus, in line **14** only air is drawn from the separator and thence through the fan, to be exhausted through the exhaust pipe or outlet of the fan indicated at **17**. The fan may be driven by a prime mover such as an electric motor **18**, the motor being under control of a manually operated switch **19**.

As so far described the system is standard in the art. As will be understood, the operation of the system insofar as the suction from the fan **16** conveying the cotton into the apparatus **11** is concerned is intermittent inasmuch as cotton generally is ginned by wagon loads.

Our invention comprises, as stated, a process and apparatus by which, during times when no cotton is flowing into the system or, when less than a predetermined amount is being drawn thereinto, the volume of air flowing through the line **14** and the fan **16** is reduced, thereby reducing the power required to drive the fan. To this end, we provide in the conduit **144** a plate type valve **21** which may be movable from full open position shown in full lines in the drawings to full closed, dotted line position shown therein. The plate valve is under control of an operating arm **22**, the plate valve being pivotally mounted in the duct **14** as at **24**. While we have shown the plate valve at the inlet line of the fan, the volume of air passing through the fan, and hence the load imposed upon the motor driving the fan, may be controlled by providing such a valve in the fan discharge line.

At **26** we indicate a fluid pressure cylinder which may be either an air cylinder or a hydraulic cylinder embodying a piston **27** and a piston rod **28**. The piston rod **28** is connected at **29** by means of a pin to the end of the arm **22**. The cylinder in pivotally mounted, as indicated at **23**, to allow the cylinder to tilt as the piston rod rotates the arm **22**. Fluid under pressure from a source indicated at **31** is applied continuously through a line **32** to one port **46***a* of a three-way valve **46**. The source **31**

also applies fluid under pressure to the input side of a check valve 33, and thence to one port 34*a* of another three-way valve 34. The conduits between the ends of the cylinder and the valves 34 and 46 are flexible.

Valve 34 is controlled by means of a solenoid 36. A port 34*b* of valve 34 is connected to the left hand end of cylinder 26 as shown in the drawing. The third port 34*c* of valve 34 opens into line 44. Similarly valve 46 is controlled by a solenoid 47. Port 46*b* of valve 46 is connected to the right hand end of cylinder 36, while port 46*c* is connected by line 44*b* to line 44. Lines 35 and 37 connect line 44 to the exhaust line 48. A needle valve 38 in line 35 serves to restrict the flow of fluid from line 44 to exhaust, and thus controls the speed at which the piston 27 moven in the cylinder 26. A two way valve 41 in line 37 is spring biased to closed position whereby, when valve 41 is closed, the exhausting fluid passes through valve 38. A solenoid 42 is provided to control valve 41, as will later appear.

From what has so far been described, it will be seen that the position of the piston 27 within the cylinder 26 and consequently the setting of the valve 21 is determined by the several valves and the piping arrangement described. Thus, to move piston 27 to the right as viewed in the drawing valve 46 is operated, permitting the fluid in the right end of the cylinder to flow through line 44*b* and 44, through the regulating valve 38, line 35 and thence out through the exhaust line 48, while fluid under pressure from the source 31 flows through line 32 and valve 34 to the left end of the cylinder. The valve 41 is actuated only when it is desired to move the piston 27 to the right rapidly, thus rapidly to close the plate valve 21, as will later be described. Assuming that the piston 27 is in its righthandmost position and it is desired to open the plate valve, valve 34 is operated, permitting the fluid in the left end of the cylinder to flow through line 44, through regulating valve 38, line 35 and thence out through the exhaust line 48, while fluid under pressure from the source 31 flows through line 32, and valve 46 to the right end of the cylinder.

We will now describe the control circuits for the mechanism which we have already described. First, it will be noted that there is a switch 49 which is gang connected to the switch 19. A time delay relay 51 is actuated by the closing of switch 49, after a few seconds delay and closes the contacts 52 and opens a contact 52*a*. Thus the control circuit is not affected by the high current drawn by the motor when it is starting.

At 53 we show a transformer, the secondary leads of which are indicated at 54 and 56. Thus, the amount of current flowing in the leads 54–56 depends upon the amount of current being drawn by the motor 18, and hence is representative of the load being imposed upon the motor.

The signals from the transformer 53 are impressed upon the input side of an amplifier 57, the output of which controls the operation of a meter relay 58. While various forms of such relays may be used, we prefer to use an optical type in which a light source 58*a* is adapted to be shaded, at times, by a shutter 58*b*. Located in position to receive light from the source 58*a* are photoresistors 59 and 61. As illustrated, when the shutter is in the midrange position, the resistors 59 and 61 both receive light from the source 58*a* and both are conductive.

At 62 we illustrate a switch, under control of a relay 63. One side of the relay coil 63 is connected by a line 64 to the output side of the resistor 59. Also, power is supplied to the input sides of the resistors 59 and 61 through a line 66, connected to the line L through switch 49. Therefore, end for purposes later to appear, whenever light is falling on the resistor 59 relay 62 is energized and its switch 62 is opened. The contact arm 62 of the switch is connected by a line 67 to the power line L.

In a manner quite similar to that just described, we illustrate another switch 68 under control of a relay 69 which has one side of its coil connected by a line 71 to the output side of the resistor 61. Thus, when light from the source 58*a* is falling on resistor 61 coil 69 is energized, holding the switch 68 open. Current is supplied to the switch arm 68 from a line 72, in turn from line L through switch 49.

At 73 we show a switch under control of a solenoid 74, one side of the coil of the solenoid 74 leading through a line 76 to a contact adapted to be engaged by switch 68 when coil 69 is deenergized.

As will be seen, when more than a predetermined amount of current is drawn by the motor 18, as for instance when there is no cotton or less than a predetermined amount in the system, the shutter 58 moves to the right as shown in the drawing, shading resistor 61. The resistance of resistor 61 goes up, as is customary for such devices, in effect operating as a switch, deenergizing coil 69. This permits switch arm 68 to move to the right as viewed in the figure, connecting line 76 to the power line L through line 72. This energizes coil 74, moving contact arm 73 to the left. Through line 77 solenoid 47 is energized, moving valve 46 to a position to exhaust through line 44 some of the fluid in the right hand end of the cylinder 26. This moves the plate valve 21 toward closed position.

Assuming now that the piston 27 has moved to the right in cylinder 26, moving plate valve 21 either fully closed or more to a closed position than shown, and that cotton once again commences to flow. The motor 18 now will draw less current because there is less air to pull through the system. Under these circumstances the shutter 58*b* moves back to a position permitting light to pass from 58*a* to the resistor 61, whereupon relay 69 will be energized, relay 74 will be deenergized and valve 46, due to the spring return, will move to its original position. Therefore, the piston 27 remains where it was when light last commenced to fall upon resistor 61.

Assuming now that the piston is in a righthandmost position from that shown in full lines, namely, where most of the air, but not all of the air is excluded from the inlet of the fan 16, and that cotton now is again supplied through the conduit 10. This will cause the motor to require less current because it is moving less air, whereupon the shutter 58*b* moves to the left, shading resistor 59. The shading of resistor 59 causes relay 62 to drop thus connecting line 78 to the power line L, through a switch 79, through a line 81, a manually operable switch 82, the coil of a solenoid 83, which incidentally controls a switch 84. As shown, deactivation of coil 63 activates coil 83, closing switch 84, thereby supplying current through a line 86 to the solenoid 36 which controls valve 34. Activation of solenoid 36 moves valve 34 to a position to exhaust through line 44 some of the fluid in the left hand end of the cylinder 26, thus to move the plate valve 21 toward open position.

It will be noted that the switch 79 is a double prong switch and that it is operated by a baffle 87 disposed in the hopper 12. Thus, when the hopper 12 becomes full of cotton to the extent that the baffle 87 is moved, switch 79 is moved from the position shown to the lefthandmost position. This opens line 81 and effectively prevents the "low" side of the pressure system from being operative.

At 88 we show a relay coil which controls a gang of switches indicated generally by the numeral 89. The coil 88 is connected by a line 91 to power through the switch 79 when switch 79 is moved from the position shown to a lefthandmost position in response to movement of the baffle 87. The closing of switch 89, in part, supplies current through a line 92 to the solenoid 42, opening a two-way valve 41. Also, current is supplied through line 93 to the solenoid coil 74, closing switch 73, and supplying current through line 77 to the solenoid 47, operating valve 46. Therefore, immediately that the hopper becomes full of cotton, at least full enough to throw switch 79 from

the position shown to its lefthandmost position, solenoid **47** operates valve **46** and solenoid **42** opens valve **41**. This immediately and quickly exhausts the pressure from the righthandmost side of the cylinder, while pressure applied through valve **34** moves the piston **27** to the right, closing the plate valve **21**. This stops delivery of cotton through the suction tube **10**.

We provide means for manually operating the system, which in effect, through the switch **82**, cuts out the "low" side of the pneumatic system. Thus, when the switch **82** is moved to the lefthandmost position from that shown in the drawings, it will be apparent that this has the same effect as does the shifting of switch **79** from the position shown to the lefthandmost position. That is to say, operating switch **82** or switch **79** opens both valves **46** and **41**, exhausting the pressure from the righthandmost end of the cylinder. Thus, by provision of the manual switch **82** an operator may immediately shut down the system to prevent the drawing in of additional material, if that is desired.

From the foregoing it will be apparent that we have devised an improved process and apparatus for pneumatically conveying material through a system. Our invention is particularly characterized by the fact that with its use one may select a prime mover for a pneumatic conveyor fan which bears a real relationship, powerwise, to that actually required to move the material as distinguished from that required to operate in overload conditions, as when no material is being moved. Further, we thus decrease the total connected power, and maintain, on an average, a better power factor.

While we have described our invention as being particularly adapted for use in conveying seed cotton in a gin house, it will be apparent to those skilled in the art that it may have utility in connection with many types of pneumatic conveying systems. Furthermore, it may have utility in connection with those systems wherein the material itself actually moves through the blower or suction fan as distinguished from being separated from the conveying air stream as we have illustrated.

While we have shown our invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and we desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

We claim:

1. The process of conserving power required by a prime mover driving a centrifugal fan used pneumatically to convey varying amounts of materials in a system comprising,

(a) supplying power to the prime mover of a magnitude adequate to convey a predetermined maximum amount of the material fed into the system, and

(b) maintaining the flow of air through the fan in an amount corresponding to decreases of material flow below said predetermined amount thereby to reduce the power requirement of the prime mover during times when less than said predetermined maximum amount of material is being conveyed.

2. The process of conserving power required by a prime mover driving a centrifugal fan used pneumatically to convey varying amounts of materials in a system comprising,

(a) sensing the power input to the prime mover, thereby to obtain signals representative of said power input, and

(b) utilizing the signals obtained in (a) above to vary the amount of air passed through the fan, in relation to the amount of material being conveyed, whereby when less than a predetermined amount of material is being conveyed the amount of air passed through the fan is reduced thereby reducing the power required to drive the fan.

3. In apparatus for pneumatically conveying varying quantities of materials in a system,

(a) a fan connected to the system and disposed to move material-conveying air therethrough,

(b) a prime mover operatively connected to the fan,

(c) valve means associated with the fan and disposed to control the amount of air passed therethrough,

(d) power means operatively connected to the valve for changing its position thereby to control the volume of air passed through the fan,

(e) means to sense the load imposed upon the prime mover, and

(f) means responsive to said sensing means to energize the power means thereby to move the valve to a position to reduce the volume of air being passed therethrough upon an increase in the load on the prime mover and to increase the volume of air passed therethrough upon a decrease in the load on the prime mover.

4. Apparatus as defined in claim **3** in which the prime mover is an electric motor, said means set forth in (e) of claim **3** being a current transformer associated with the input leads to the motor, and the means in (f) of claim **3** comprising circuits and controls effective to cause the power means to set said valve in accordance with the power requirement of the motor as determined by the output of the transformer.

5. Apparatus as defined in claim **4** in which the system is provided with a storage hopper into which the material is delivered, and means associated with the hopper effective through said controls and circuits to energize the power means upon the presence in the hopper of a predetermined amount of material, whereby said valve is moved to a position substantially to shut off the air flow through the fan and thus prevent overloading the system with material.

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