May 26, 1953 G. WATTS 2,639,862

PNEUMATIC ELEVATOR FOR FLOUR MILL STOCKS

Filed June 16, 1950 5 Sheets-Sheet 1

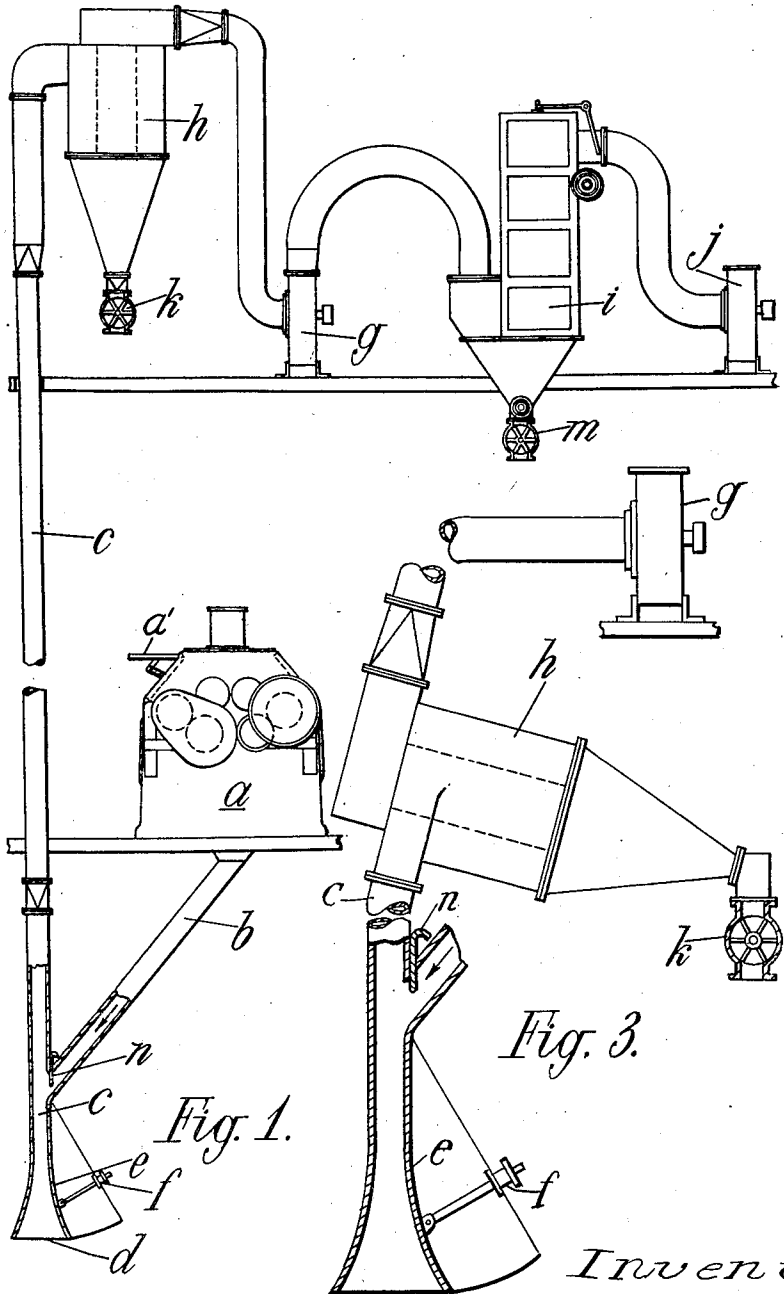



Fig. 1.




Fig. 3.

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PNEUMATIC ELEVATOR FOR FLOUR MILL STOCKS

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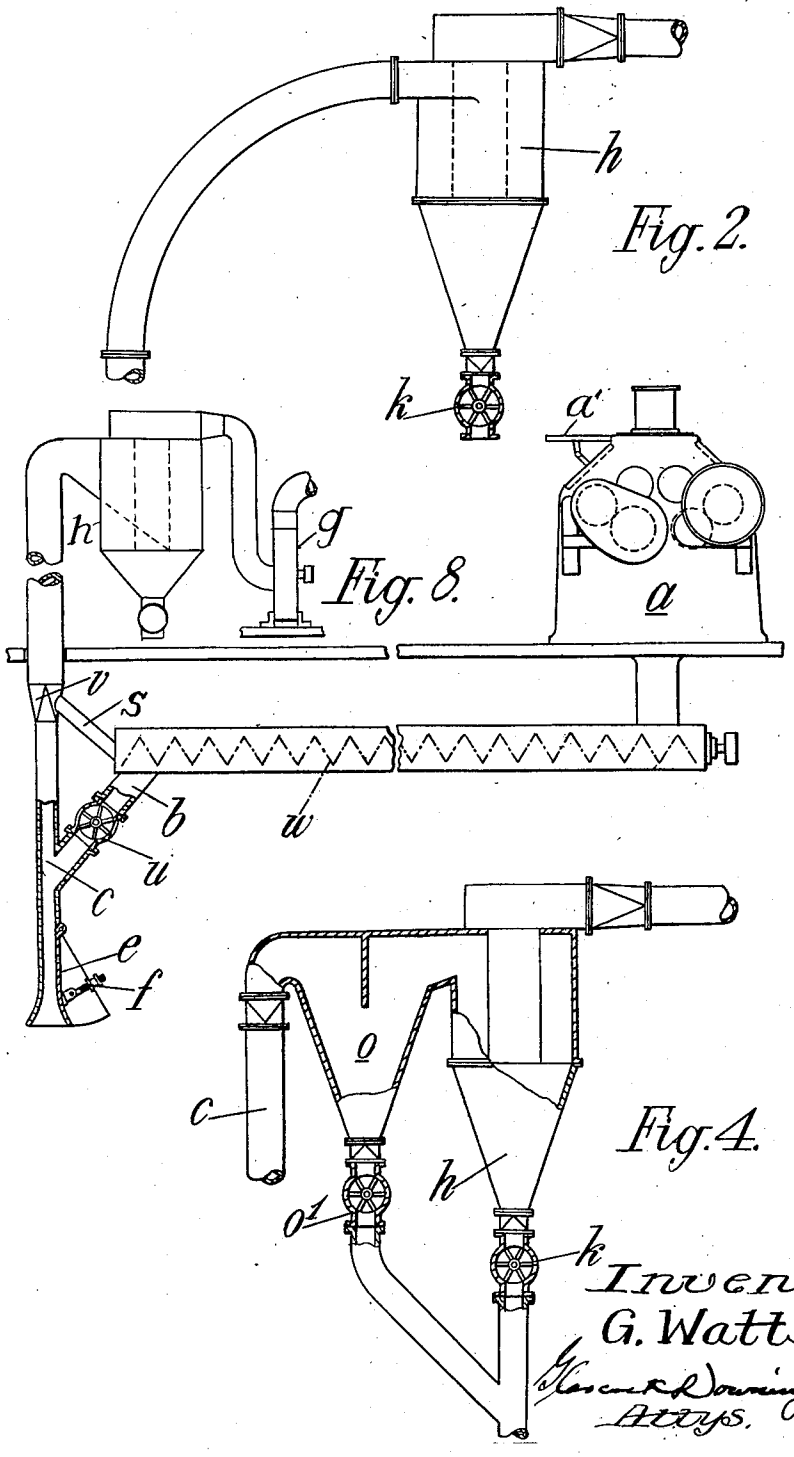



Fig. 2.

Fig. 8.

Fig. 4.

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PNEUMATIC ELEVATOR FOR FLOUR MILL STOCKS

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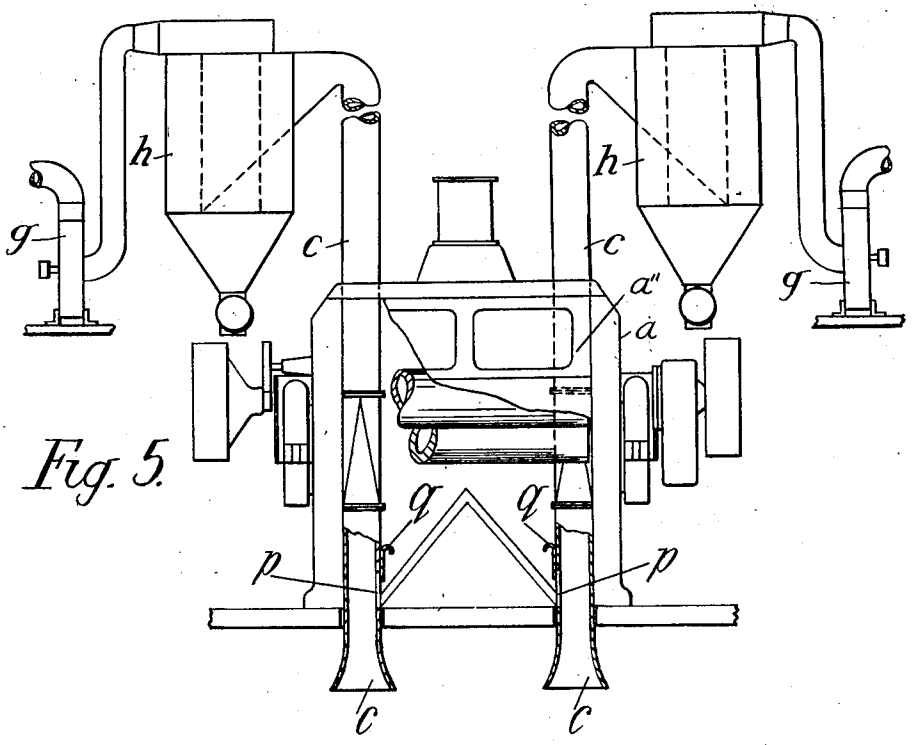



Fig. 5.

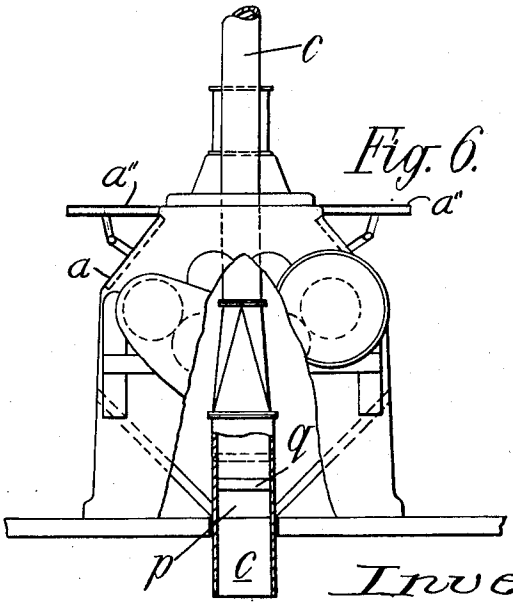


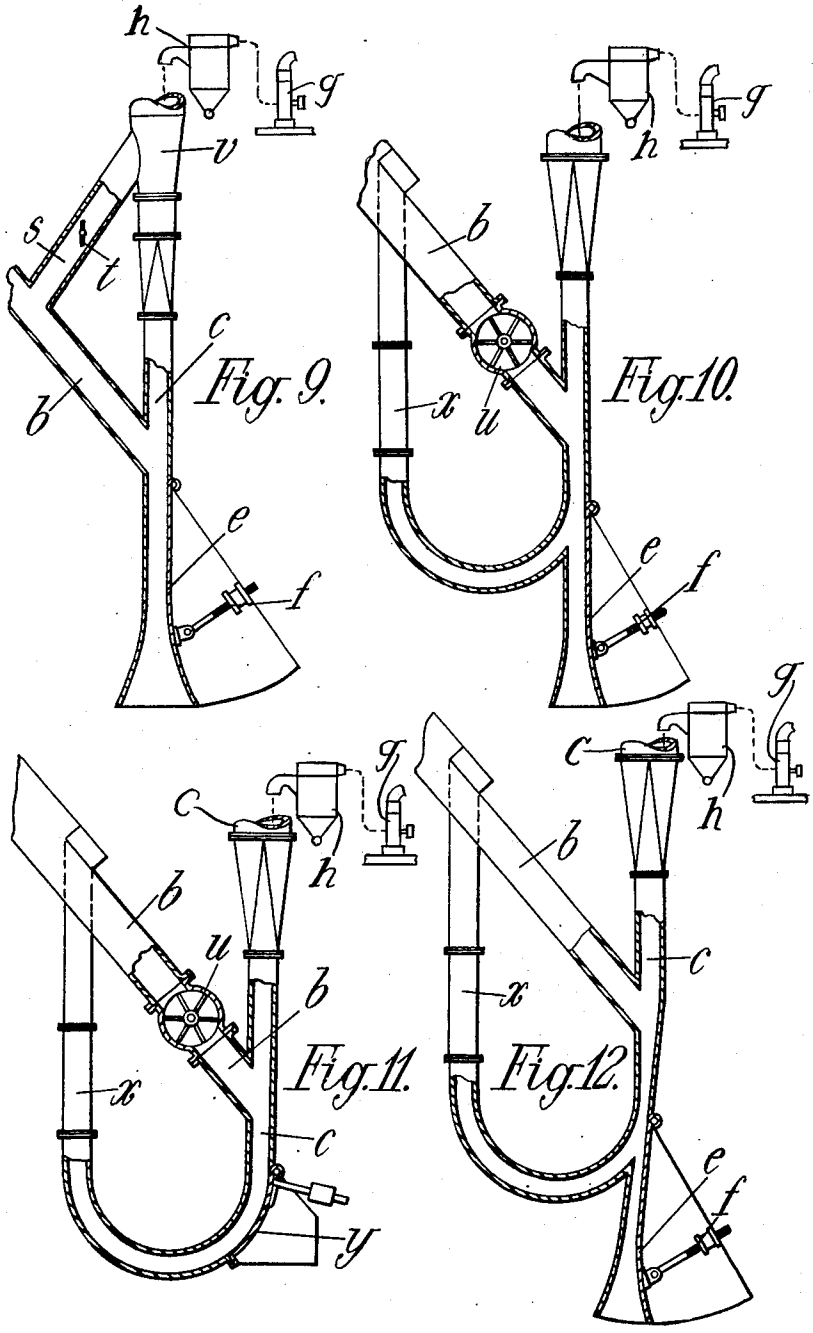

Fig. 6.

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PNEUMATIC ELEVATOR FOR FLOUR MILL STOCKS

Filed June 16, 1950 5 Sheets-Sheet 4




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PNEUMATIC ELEVATOR FOR FLOUR MILL STOCKS

Filed June 16, 1950 5 Sheets-Sheet 5

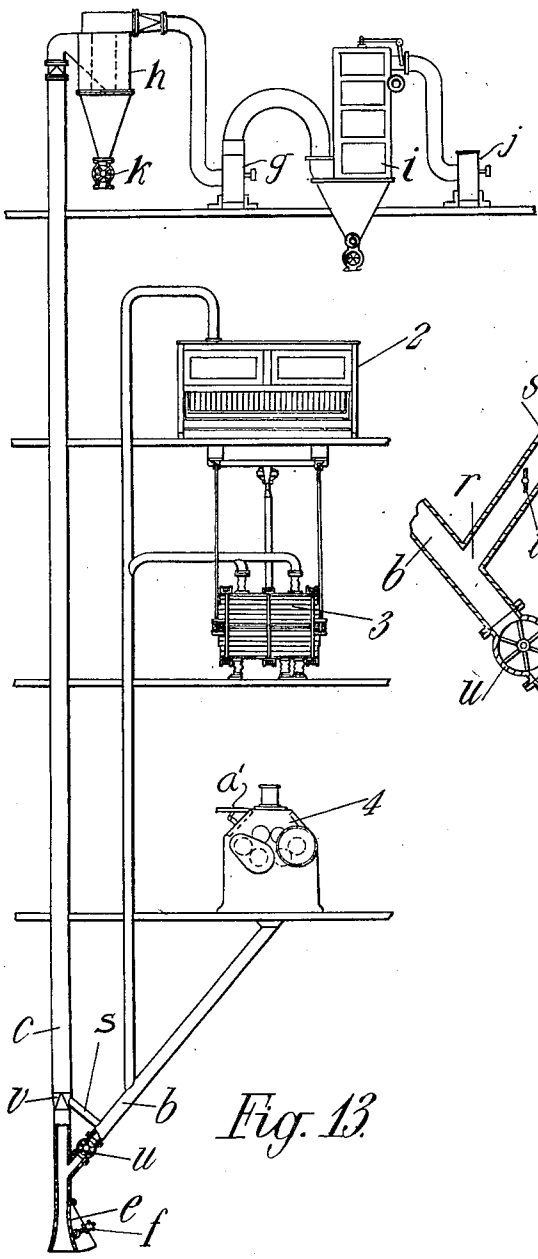



Fig. 13.

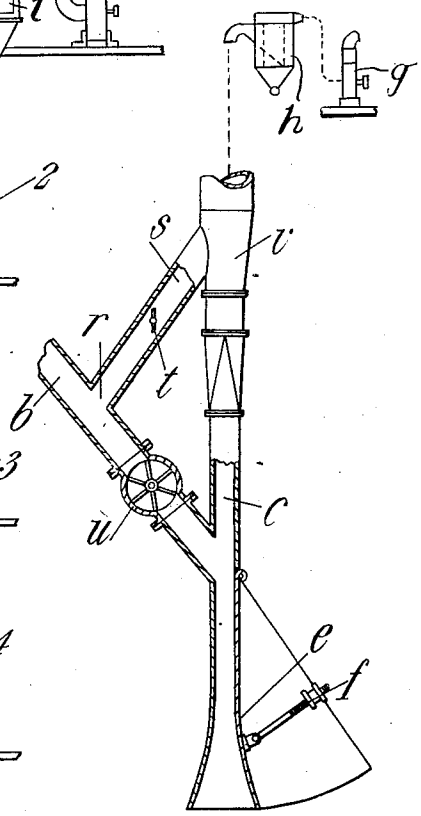



Fig. 7.

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Patented May 26, 1953

2,639,862

# UNITED STATES PATENT OFFICE

2,639,862

## PNEUMATIC ELEVATOR FOR FLOUR MILL STOCKS

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Application June 16, 1950, Serial No. 168,401
In Great Britain July 8, 1949

18 Claims. (Cl. 241—47)

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This invention relates to pneumatic elevators for flour mill stocks (which term includes grain and the products resulting from the milling of grain), where the machine from which the stock to be elevated is obtained needs an exhaustion action to be applied thereto. The air to be exhausted from the machine may enter the latter through the tops or through doors or other inlets provided on the machine.

It is known that whilst the pneumatic system for the purpose indicated has many advantages, it involves heavy power consumption due to the large volume of air which has to be dealt with and the high velocity which has to be imparted to the air, due to the employment of horizontal pipes with bends, to prevent chokes in the pipe system and to keep the stock in contact with the surface of the pipe system mobile.

The object of the present invention is to provide an improved pneumatic elevator system or arrangement in combination with a mill grinding machine to be exhausted and in which the volume of air necessary to carry the stock can be materially reduced as can also the velocity of the air requisite to keep the stock mobile.

The invention consists in a pneumatic system for flour mill stock from a machine or machines into which air is drawn by the pneumatic system so that the machine is exhausted and the stock aerated, comprising a vertical or substantially vertical pipe (to the top of which suction is applied) into which the stock is delivered by gravity at a point above the bottom of said pipe, the said bottom being either open or opening if the suction fails, so as to allow stock to fall out of the pipe and not block the same when the suction fails, the top of the pipe leading to separators for stock and dust.

The invention further comprises the arrangement in which the air travelling with the mill stock to the elevating pipe is separated from the stock and delivered separately into the elevating pipe either above or below the point at which the mill stock enters such pipe.

The invention further comprises the arrangement in which the separated air enters the bottom of the elevating pipe through a normally closed connection and forms the sole elevating air, the said connection opening to permit discharge of stock from the connection when the suction fails.

The invention further comprises the arrangement in which a rotary air seal is provided in the pipe delivering the mill stock into the elevating pipe.

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The invention further comprises the arrangement in which one or more elevating pipes pass through the machine from which stock and air are withdrawn, the internal base of the machine directing the stock into the elevating pipe or pipes.

The invention further comprises the arrangement in which a mechanical conveyor delivers the aerated mill stock from the machine to a feed pipe leading to the vertical or substantially vertical elevating pipe.

The invention further comprises the arrangement in which a control valve is situated in the pipe for separated air.

The invention further comprises the arrangement in which the bottom open end of the elevating pipe is adjustable in cross sectional area to control the volume flow of air into the pipe for stock elevating purposes.

The invention further comprises the arrangement in which the elevating pipe is free from bends or ledges for about 15 feet from the point where the elevating air is admitted thereto.

The invention further comprises the arrangement in which the top of the elevating pipe delivers tangentially into a cyclone separator having its axis horizontal or substantially so.

Referring to the accompanying explanatory drawings:

Figure 1 is a general view of an elevating system for flour mill products arranged in one convenient form in accordance with this invention.

Figures 2, 3 and 4 show varying dispositions of the dust separator of the system shown in Figure 1.

Figures 5 and 6 are views taken at right angles to one another with certain parts cut away, showing a modification in which the elevating pipes pass through the machine from which products are to be elevated.

Figures 7–12 show various modified arrangements for delivering the mill stock and air into the elevating pipe.

Figure 13 shows an elevating system in accordance with this invention applied to several machines one of which delivers its product into the elevating pipe together with its exhaust air, the exhaust air from the other machines assisting in the elevation of the said product.

In Figure 1, *a* indicates a roller mill, the stock from which is delivered, along with air drawn into the roller mill through suitable inlet means particularly adjustable doors *a'*, into a feed spout *b*, which delivers the aerated stock into the elevating pipe *c*. The latter is preferably a plain

vertical pipe for a vertical distance of at least 15 feet, in some cases the vertical length may be as much as 100 feet, from its open base *d* where air to elevate the stock enters the system. One side *e* of the elevating pipe below the delivery end of the feed spout *b* is movable and adjustable in its movement by the screw and nut device *f* to regulate the area for the inflow of air into the system.

There is a medium pressure fan at *g* which draws the air and stock from the elevating pipe *c* into the cyclone type separator *h* and delivers the air which is lightly laden with dust from the cyclone *h* to the separator *i* which may have textile filters therein. There is a low pressure exhaustion fan at *j* which exhausts the separator *i*. The stock separated from the air in the cyclone *h* is discharged through the rotary air seal at *k*. The solid material separated from the air in the separator *i* is discharged through a rotary air seal at *m*.

The area for the flow of stock from the feed spout *b* into the elevating pipe *c* can be varied by the slide valve *n*. This valve and the adjustable side *e* of the elevating pipe can regulate the ratio of elevating air to the air drawn into the pipe *c* along with the stock from the machine *a*.

It will be noted that the pipe *c* is free from bends or the like which might cause stock to lodge therein below the level of the feed spout where the valve *n* is situated, so that should the air flow fail due to fan failure, the stock will drop out of the pipe *c*; therefore on restoration of the air flow, there will not be any blocks in the system which will have to be cleared before normal operation recommences.

Instead of the elevating pipe *c* being connected to the cyclone *h* by a right angle bend as in Figure 1, it may be so connected by a bend of relatively slight curvature as shown in Figure 2 so as not to unduly retard the flow through the bend.

The cyclone *h* may as shown in Figure 3 have its axis slightly inclined to the horizontal; or it may be horizontal in order to eliminate the bend in the connection from the pipe *c* to the cyclone.

There may be an expansion box at *o* between the top of the elevating pipe *c* and the cyclone *h*. This is shown in Figure 4. This eliminates the possibility of stock accumulating in the horizontal pipe forming the inlet to the cyclone and causing chokes. The material discharged through the rotary seal $o^1$ below the expansion box *o* may be caused to join that discharged from the cyclone through the rotary seal *k* through pipe *k'*.

In the stock elevating and machine exhaustion system shown in Figures 5 and 6, the elevating pipes *c* pass through the machine *a* which is shown as a roller mill. The doors *a''* provide air inlets and the pipes *c* each have an aperture *p* therein controlled by slides *q* through which stock, with air exhausted from the machine, pass into the elevating pipes. The interior of the base of the machine is inclined and arranged as hoppers as shown to guide the stock into the apertures *p*. The elevating system is otherwise the same or similar to what is shown in Figure 1.

In the modification shown in Figure 7, the air which is drawn into the feed spout *b* along with the stock separates from the latter at *r* and passes separately into the elevating pipe *c* by the branch *s* which may have a control valve *t* thereon. The flow of mill stock into the elevating pipe is through the rotary seal *u* which will be turned at a controlled rate. The elevating pipe is enlarged at *v* where the air enters from the branch *s*.

In Figure 8, the flow of mill stock from the machine *a* into the downwardly inclined feed spout *b* is through a conveyor *w* revolved by suitable means. The exhaustion air from the machine separates from the stock and enters the elevating pipe *c* by the branch *s* as in Figure 7.

Figure 9 is similar to Figure 7, but the rotary seal in the feed spout *b* is omitted.

In the Figure 10 arrangement, the air which separates from the stock in the feed spout *b* is taken by a separate pipe *x* to a point in the elevating pipe below the discharge mouth of the feed spout *b* and assists in elevating the stock entering the pipe *c* from the feed spout.

In the Figure 11 arrangement, the air separated from the stock, which is as in Figure 10, delivered into the elevating pipe *c* by the pipe *x* below the discharge mouth of the feed spout *b*, constitutes the only air for elevating the stock, there being a normally closed connection between the pipe *x*, and the base of the elevating pipe *c*. In order, however, to allow stock to discharge from the base of the pipe *c* should the suction fail due to the fan *g*, Figure 1, going out of action, a hinged flap *y* is provided on the lower side of the bend at the base of the pipe *c*. This flap is held closed by the suction during normal working but opens, if the suction fails, due to the pressure of the stock which accumulates in the base of the pipe *c*. The flap is suitably counterweighted to maintain it normally closed.

In the Figure 12 arrangement, air is admitted to the bottom of the elevating pipe as in Figure 10, but no rotary seal is fitted in the pipe *b*.

Figure 13 shows several machines being exhausted from one pneumatic elevating pipe *c*. There is a sieving machine **2** on the top floor, a plansifter **3** on the middle floor and a roller mill on the bottom floor. Each machine is exhausted to the feed spout *b*. The air exhausted from the sieving machine and plansifter does not contain the stock dealt with by such machines but is used to assist in the elevation of the stock from the roller mill. Air which separates from the stock enters the elevating pipe *c* by the branch *s*. There is a rotary seal at *u* in the feed spout as in previous figures.

By the aforesaid arrangements not only is it possible to reduce the resistance of the system in some cases to about half that customary in known pneumatic elevating systems but also to reduce the air quantity in some cases down to about 80%, so that the power required is reduced to about a third. Furthermore, if for any reason the air supply to the elevator fails, the stock delivered into the vertical pipe is discharged through the open bottom of the latter on to the mill floor and does not choke the system. In addition a very efficient exhaust is obtained on the roller mills, thus maintaining a very clean atmosphere at the machine. Further the heat created by the rolls in the roller mill is removed by the air used in elevating the stock. In addition, during the time the stock is in contact with the air, it is cooled to within a few degrees of the temperature of the ele-

vator, thus rendering the stock in good condition for sifting. It is found also that infestation of the stock is eliminated due to the high velocity air stream which prevents breeding of the insects. It is therefore clear that the present invention provides a pneumatic conveying system for handling flour stocks for use in a flour mill, the system comprising conduit means that provide a downwardly extending gravitationally influenced inlet that receives processed stock and air to be conveyed. In the specific form illustrated in Figure 13, this inlet further receives exhaust air from other stock treating apparatus such as a sieving machine 2 and the plan sifter 3. This exhaust air of these machines assists in the elevation of processed stock flowing into the inlet from the roller mill 4. A vertically disposed elevating conduit is provided and the gravitationally influenced inlet communicates with this conduit. Air current inducing means communicate with the elevating conduit and are operative to establish an air current that conveys stock and air downward through the gravitationally influenced inlet and upwardly through the elevating conduit. Specifically the air current inducing means constitutes a fan connected to the outlet of a separator, usually a cyclone separator. A by-pass conduit is provided that communicates between the downwardly extending inlet and the vertical conduit, the latter point of communication being in axial spaced relation with respect to the juncture of the downwardly extending or inclined inlet and the vertical conduit. Air is separated from processed stock and passes through this by-pass conduit and into the elevating conduit independently of the stock. From a specific standpoint, as applied to some of the modifications disclosed, the elevating conduit terminates in an open lower end beneath the juncture of the inlet therewith. This open lower end includes a movable portion and means mounting the same for adjusting movement so that the cross-sectional area of this lower end can be varied in order to regulate air flow in the system.

What I claim is:

1. In combination with a mill for grinding mill stocks including grinding elements and inlet means for stock and air, a substantially vertical elevating pipe, means providing communication between the mill and the pipe so that ground stock can flow into the pipe, said elevating pipe including an upper end, air current inducing means communicating with the upper end of said pipe for exhausting said mill and simultaneously elevating ground stock through said pipe, said pipe extending through said mill and terminating therebeneath in an open lower end, said mill having means defining a hopper-shaped enclosure including an inclined bottom, and said pipe having an opening therein adjacent the inclined bottom and communicating therewith and through which opening ground stock flows into the pipe.

2. A pneumatic conveying system for handling flour stocks for use in a flour mill comprising a substantially vertically extending elevator conduit, said conduit having upper and lower ends and the lower end being open, conduit means providing a downwardly extending gravitationally influenced inlet for receiving processed stock and air to be conveyed, said conduit means communicating with the elevator conduit above the lower end for delivering processed stock directly to said vertical conduit, air current inducing means communicating with the upper end of said elevating conduit for simultaneously drawing a current of air and processed stock downwardly through the conduit means, and into the said elevator conduit to provide a lifting current to elevate stock vertically upward through said elevator conduit, and throttle means embodied with the lower end of said elevator conduit below the juncture of said inlet therewith to vary the cross-sectional area thereof and thereby the flow of air thereinto.



3. A pneumatic conveying system for handling flour stocks for use in a flour mill comprising a substantially vertically extending elevator conduit, said conduit having upper and lower ends and the lower end being open, conduit means providing a downwardly extending gravitationally influenced inlet for receiving processed stock and air to be conveyed, said inlet communicating with the elevator conduit above the lower end for delivering processed stock directly to said elevator conduit, air current inducing means communicating with the upper end of said elevator conduit for simultaneously drawing a current of air through the inlet and into the lower end of said elevator conduit to convey stock and air downwardly through said conduit means, into said elevator conduit and to provide a lifting current to elevate stock vertically through said elevator conduit, throttle means embodied with the lower end of said elevator conduit below the juncture of said inlet therewith to vary the cross-sectional area thereof and thereby the flow of air thereinto, and means controlling communication between said elevator conduit and said inlet to cooperate with said throttle means to regulate the ratio of elevating air to the air drawn into said elevator conduit along with the processed stock coming from the mill.

4. The combination as defined in and by claim 3 and a cyclone separator having tangentially arranged inlet and outlet means, said air current inducing means communicating with said outlet means and said inlet means substantially directly communicating with the upper end of said vertical conduit.

5. The combination as defined in and by claim 4 and in which said cyclone separator is disposed with its axis at least substantially horizontal.

6. A pneumatic conveying system for handling flour stocks comprising, in combination, a first machine for treating stock, means comprising a separating apparatus located above said first machine and including an inlet and an outlet, a fan connected to said outlet to withdraw air therefrom, a substantially vertical conduit connected to the inlet of said separating apparatus and extending below said first machine, a conduit connected to the outlet of said first machine and extending downwardly to connect with said vertical conduit at a junction below said first machine to provide a gravity feed therefrom to said vertical conduit, additional stock treating apparatus located above said first machine, and means forming air exhaust connections between said additional stock treating apparatus and said last-mentioned conduit whereby said fan aided by gravity induces the flow of stock and air from said first machine, through said conduits to said separating apparatus and continuously exhausts air from said machine and said apparatus.

7. The combination as defined in and by claim 6 in which there is a pipe connected to said last-mentioned conduit at a point intermediate its ends and in turn connected to said vertical con-

duit at a point above said junction so that air from said machine and said apparatus may separate from stock in said last mentioned conduit and may by-pass said junction.

8. The combination as defined in and by claim 6 in which the additional stock treating apparatus comprise a plansifter and a sieving machine located one above the other.

9. A pneumatic conveying system comprising, in combination, a milling machine for treating stock, means comprising a separating apparatus located above said milling machine and including an inlet and an outlet, a fan connected to said outlet to withdraw air therefrom, a substantially vertical conduit connected to the inlet of said separating apparatus and extending below said milling machine, a second conduit connected to the outlet of said milling machine and extending downwardly to connect with said vertical conduit at a junction below said milling machine to provide a gravity feed from said milling machine to said vertical conduit for the flow of stock and air, additional stock treating apparatus located above said milling machine, a pipe connected to said last-mentioned conduit at a point intermediate its ends and in turn connected to said vertical conduit at a point above said junction, air exhaust conduit means connected between said additional stock treating apparatus and said second conduit and communicating with the latter at an area rearwardly of the point of communication of said pipe with said second conduit so that air is exhausted in said additional apparatus and assists the conveying of stock, and a rotary seal located in said second-mentioned conduit between said pipe and said junction so that air separates from the stock in said second conduit and by-passes said junction.

10. Pneumatic conveying system for handling flour stocks for use in a flour mill comprising conduit means providing a downwardly extending gravitationally influenced inlet for receiving processed stock and air to be conveyed, a vertically disposed elevating conduit, said inlet communicating with said conduit, air current inducing means communicating with said conduit and operative to establish an air current to convey stock and air downward through said conduit means and upward through said elevating conduit and a by-pass conduit communicating at one end with said conduit means and at its other end with said elevating conduit at a point in axial spaced relation with respect to the juncture of said conduit means and said elevating conduit so that air may be separated from the stock passing through said conduit means and passed into said elevating conduit independently of the stock.

11. A conveying system as defined in and by claim 10 in which the elevating conduit terminates in an open lower end beneath the juncture of the inlet therewith, including a movable portion and means mounting the same for adjusting movement to vary the cross-sectional area of said lower end for regulating air in-flow into the system.

12. Pneumatic conveying system for handling flour stocks for use in a flour mill comprising conduit means providing a downwardly extending gravitationally influenced inlet for receiving processed stock and air to be conveyed, means providing a separating zone above said inlet and including an inlet for stock and air, a stock outlet and an air outlet, a vertically disposed elevating conduit communicating at one end with the inlet of said separating zone and having a vertical extent sufficient to dispose its other end beneath said conduit means, said conduit means communicating with said elevating conduit at an area spaced from the lower terminus of the vertical extent of the elevating conduit, air current inducing means communicating with the air outlet of the separating zone and operative to establish an air current to convey stock and air downward through said conduit means and upward through said elevating conduit, and a by-pass conduit communicating at one end with said conduit means and at its other end with said elevating conduit at a point in axial spaced relation with respect to the juncture of said conduit means and said elevating conduit so that air may be separated from the stock passing through said conduit means and passed into said elevating conduit independently of the stock.

13. The combination as defined in and by claim 12 in which the separating zone is constituted by a cyclone separator including means providing a large expansion chamber and said separator having a substantially vertical inlet leading to said chamber and said elevating conduit communicating directly with said vertical inlet.

14. A conveying system as defined in and by claim 12 in which the elevating conduit terminates in an open lower end beneath the juncture of the inlet therewith, including a movable portion and means mounting the same for adjusting movement to vary the cross-sectional area of said lower end for regulating air in-flow into the system.

15. A pneumatic conveying system as defined in and by claim 12 in which a mechanical conveyor is arranged in advance of said downwardly extending gravitationally influenced inlet.

16. A conveying system as defined in and by claim 12 in which said by-pass conduit communicates with the elevating pipe above the point of communication of the downwardly extending gravitationally influenced inlet therewith.

17. A conveying system as defined in and by claim 12 in which said by-pass conduit communicates with the elevating pipe below the point of communication of the downwardly gravitationally influenced inlet therewith.

18. A conveying system as defined in and by claim 17 in which said branch conduit separates air flowing from said stock through said inlet and delivers the air to the vertically disposed elevating conduit beneath the point of entrance of stock thereinto so that the separated air constitutes the elevating air and said vertical conduit including means providing a normally closed opening therein subjacent the point of entrance of stock thereinto, said means including a flap opening upon cessation of suction to permit egress of stock therethrough.

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