

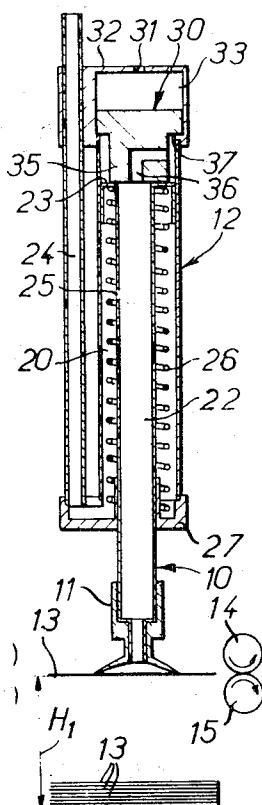
[54] **PNEUMATIC ELEVATOR FOR LIFTING A SHEET OF MATERIAL**[75] Inventor: **Michel Bru**, Chatenay-Malabry, France[73] Assignee: **Ets. J. J. Carnand & Forges de Basse-Indre**, Boulogne, France[22] Filed: **Aug. 6, 1973**[21] Appl. No.: **385,653**[30] **Foreign Application Priority Data**

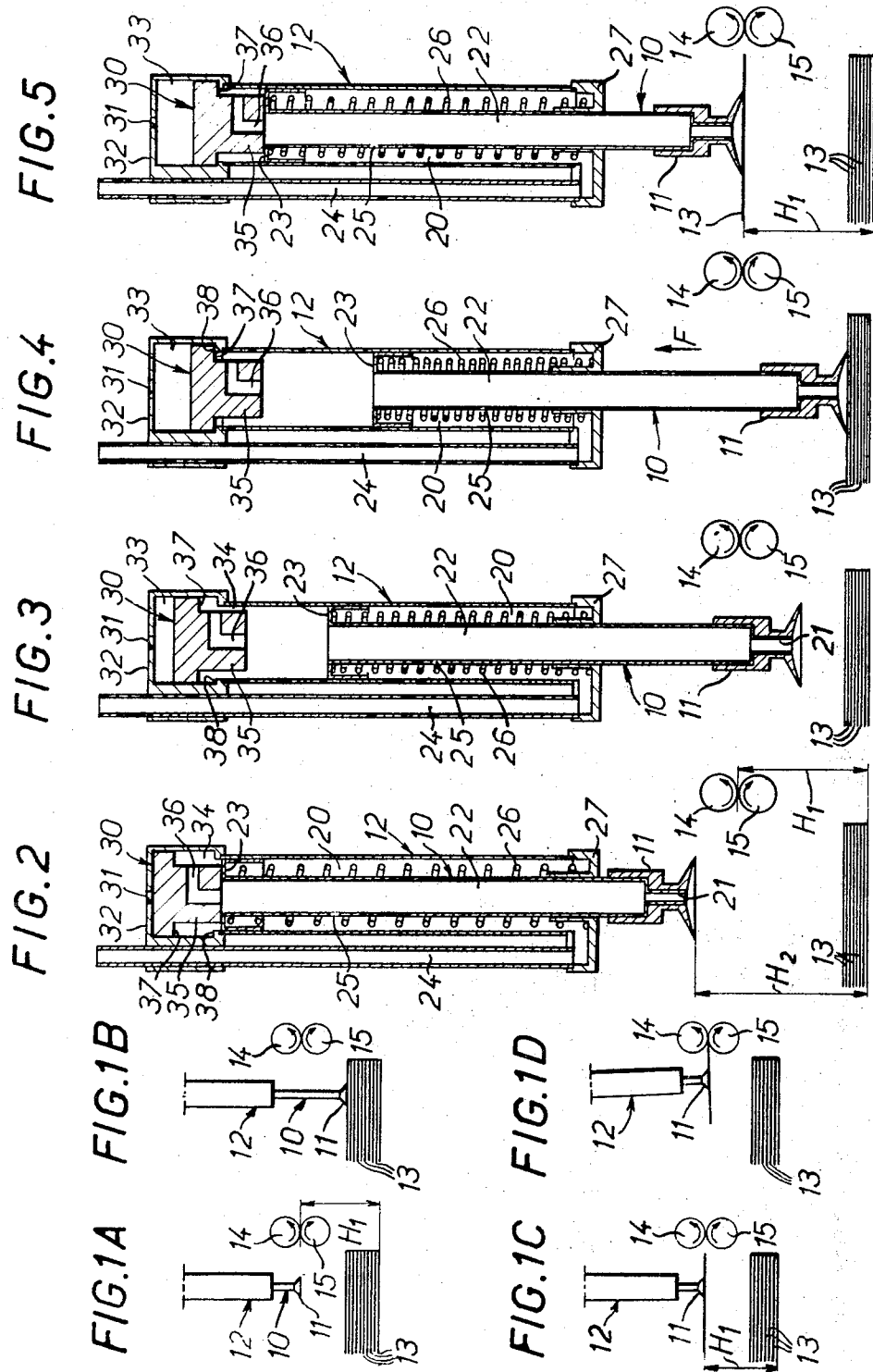
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[52] U.S. Cl. **214/1 BT, 214/8.5 D, 294/64 R**[51] Int. Cl. **B65g 59/04**[58] Field of Search ... **214/1 BS, 1 BT, 1 BV, 1 BH, 214/8.5 D; 294/64 R, 65**[56] **References Cited****UNITED STATES PATENTS**2,247,787 7/1941 Schmidt 214/1 BT
3,050,175 8/1962 Jeddeloh 214/1 BT X**FOREIGN PATENTS OR APPLICATIONS**514,399 7/1955 Canada 214/1 BT
M22,250 9/1956 Germany 214/1 BS*Primary Examiner*—Frank E. Werner*Attorney, Agent, or Firm*—Diller, Brown, Ramik & Wight[57] **ABSTRACT**

Pneumatic elevator for lifting a sheet of material for

introducing it between drive rollers of the type having a tubular piston with a suction nozzle at its distal end displaceable in a cylinder with which it forms an annular space. The piston moves downwards in the cylinder under the force of gravity, its upward movement with the sheet held thereby being assured by a spring. The upward movement is limited by a movable plug to a height corresponding to the position at which the sheet is to be introduced between the rollers. The plug comprising a tubular portion and two laterally extending bearing members. The plug divides the cylinder into three chambers: a first chamber to one side of a first bearing member and the open upper end of the cylinder and communicating with the atmosphere through an air filter to prevent clogging of the chamber, a second chamber to one side of the second bearing member remote from the first bearing member and adapted to communicate directly with the interior of the piston, and third chamber formed about the tubular portion between the first and second bearing members and adapted to be connected to the suction means through the pressure-drop orifice in the tubular portion. The plug acts as valve means for connecting the annular space with the suction means in the upper rest position of the plug and the atmosphere in the lower operating position of the plug. The lifting power of the pneumatic elevator is greatly increased by a substantial reduction in the force exerted upward movement by the spring.

8 Claims, 15 Drawing Figures



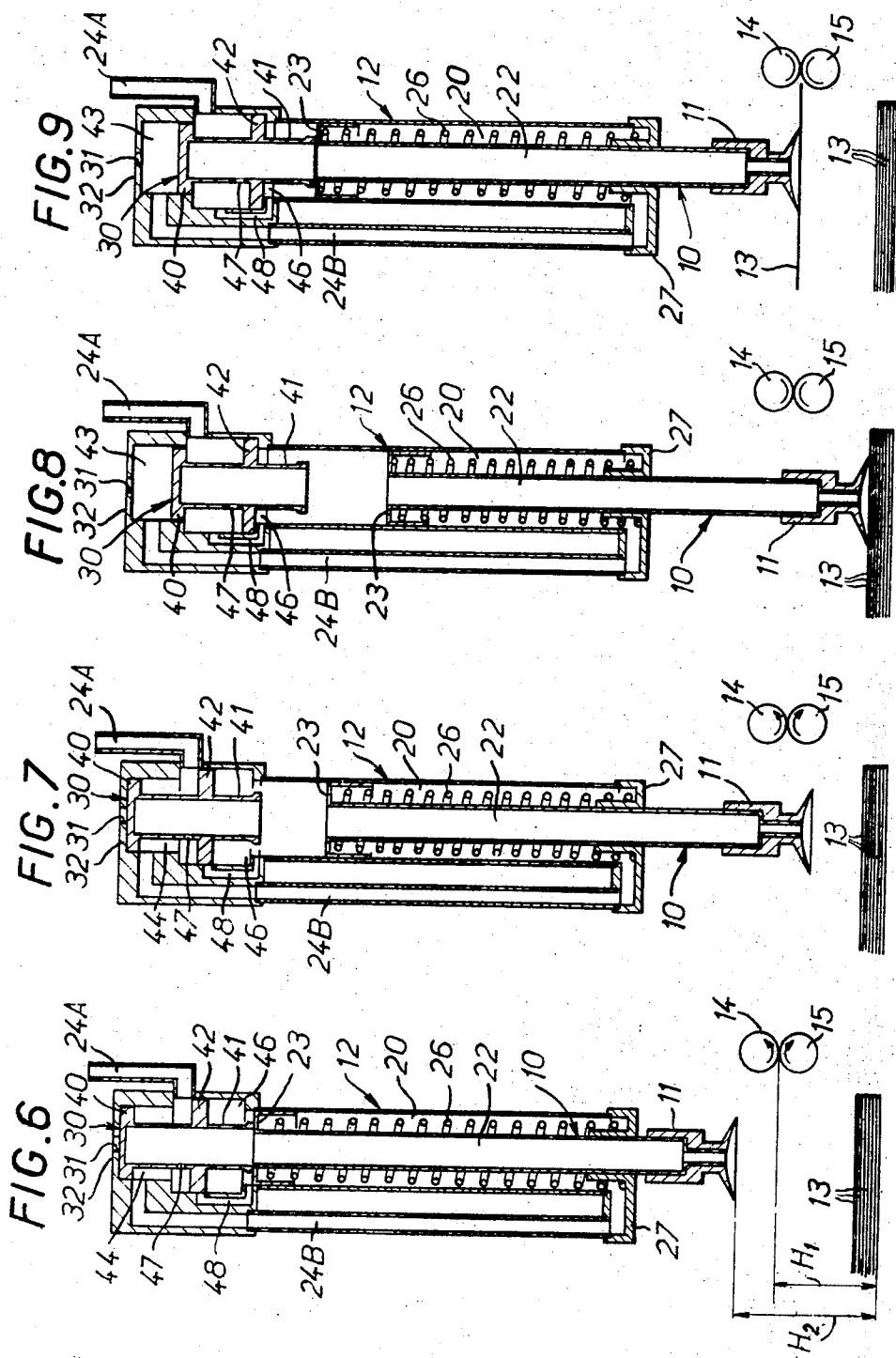


FIG. 10

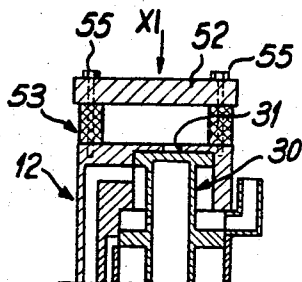


FIG. 12

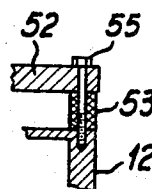
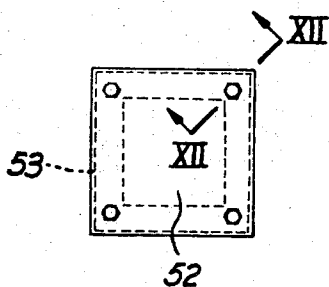


FIG. 11



PNEUMATIC ELEVATOR FOR LIFTING A SHEET OF MATERIAL

The present invention generally relates to pneumatic elevators and more particularly to the application of such pneumatic elevators to gripping and handling sheet material for introducing such material into a processing machine or apparatus.

Such a pneumatic elevator is for removing sheets of material one at a time from a stack of sheets, the uppermost sheet of which being at a height below that at which each sheet is released and fed one by one between a pair of driving rollers thereby assuring the introduction of the sheets into a stamping machine.

Pneumatic elevators currently in use for this purpose comprise a tubular piston mounted for movement under the force of gravity to the lower end of the associated cylinder and having a suction nozzle at its distal end, a spring urging the piston upwardly against the force of gravity into contact with an abutment at its end remote from the suction nozzle, the piston defining with the cylinder an annular space adapted to be connected with suction means, the interior of the piston also being adapted to be connected to the suction means through a calibrated pressure-drop orifice.

These pneumatic elevators, usually arranged in a row parallel to the associated drive rollers and in the vicinity thereof, are in addition pivotally mounted about a pivot pin also parallel to said rollers.

In the rest position, the annular space between the piston and the cylinder of such a pneumatic elevator is at atmospheric pressure and the spring associated with the piston maintains the latter at its upper rest position or dead point, at a height substantially the same as the height at which the sheets are introduced between the associated drive rollers.

When the annular space between the piston and the cylinder is connected up to suction means, the piston falls under the force of gravity in opposition to the force of the spring until contact with the sheet to be handled at the top of the pile of sheets.

At this point the interior of the piston is closed off; interior being in communication through a calibrated pressure-drop orifice with the suction means, a partial vacuum is present in the interior of the piston and the spring associated with the piston is then able to assure the upward movement of the piston with the sheet removed from the pile by suction.

When the piston thus urged by the spring is once again in engagement with the abutment defining its upper dead point, the cylinder is pivoted to a position facing the associated drive rollers so that the corresponding extreme edge of the sheet carried by this piston and other similar associated pistons is introduced between said rollers.

The suction means is then cut off so that the piston may free the sheet, which up to then is carried, as the sheet is gripped by said drive rollers.

Such pneumatic elevators have various disadvantages.

First of all, since the upper dead point or rest position of the piston coincides with the height at which the sheets, previously freed by the piston, are introduced between the associated drive rollers, there is an undesirable friction contact between the suction nozzle of the piston and the sheet in motion which may cause rapid wear of the suction nozzle.

This friction contact is much greater especially since the pivotal movement returning the pneumatic elevator to position after the introduction of the sheet between the associated drive rollers is effected in the direction opposite to the forward movement of this sheet driven by the rollers.

Accordingly, the suction nozzles of pneumatic elevators of this type are subject to rapid wear requiring them to be replaced nearly daily.

In order to overcome this problem, it has already been proposed to have the upper dead point or rest point of the piston of such a pneumatic elevator at a height slightly above the height at which the sheet is introduced between the associated drive rollers.

However a deformation of the sheet results in such a case, the sheet bends during its introduction and this deformation is prejudicial to the regularity of its introduction which may cause operating failures such as jamming.

It has also been proposed to form the abutment defining the upper position of the piston by a plug displaceably mounted in the cylinder between an upper rest position and a lower operating or work position in which it maintains said piston in releasing position intermediate its upper rest position and its lower "gripping" position.

In other words, the height at which the piston is adapted to release the sheet is different than the height corresponding to the dead point or rest position.

Thus, as soon as the release of a sheet which had been picked up by the piston, the latter continues its upward movement to the upper rest position, therefore there is no friction between the suction nozzle of the piston and the sheet which released by the piston is driven by the associated drive rollers.

The wear of suction nozzle of the piston is therefore considerably reduced, the replacement of such a nozzle is necessary only every few weeks.

But in all pneumatic elevators known till now, the lifting force for the sheet removed is assured jointly by the return force of the spring associated with the piston and the effect of the partial vacuum present in the cylinder above the piston; and because of this, the partial vacuum effect above piston is reduced by the effect of the same partial vacuum in the annular space between the piston and the cylinder. Accordingly, the lifting force is relatively diminished, and therefore the lifting time for the sheet is relatively long.

In order to overcome this drawback and thus increase the overall production rate, it has already been proposed to associate with the pneumatic elevator a control valve adapted to connect the annular space between the cylinder and the piston either with the suction means or with the atmosphere.

The connecting of the annular space with the atmosphere occurs upon lifting and therefore during the lifting, only the suction effect in the cylinder above the piston intervenes, there being no partial vacuum in the annular space about the piston. The lifting force is then considerably increased.

In known pneumatic elevators of this type, the associated control valve is arranged outside the associated cylinder and connected thereto through various tubes.

Consequently, during the connecting of the elevator with the suction means, the suction means must evacuate the tubes connected to the elevator beforehand

which is prejudicial to the operating time of the elevator and therefore the work or production rate.

An object of the present invention consists in a pneumatic elevator of the type described above, advantageously without these drawback.

The pneumatic elevator according to the invention adapted for the handling of sheet material comprises a cylinder, a tubular piston mounted for movement under the force of gravity to the lower end of the cylinder and having a suction nozzle at its distal end, a spring urging said piston against the force of gravity towards the upper end of said cylinder, said piston defining with said cylinder an annular space adapted to be connected to a suction means, the interior of the piston also adapted to be connected to suction means, a plug mounted for displacement in the upper end of said cylinder between an upper rest position and a lower operating position at which it limits the upward movement of the piston, said plug defining two chambers in the cylinder, a first chamber rotatively remote from the piston communicating with the atmosphere, a second chamber relatively close to the piston communicating with the interior of the piston, the plug acting as valve means being adapted to connect the annular space between the piston and the cylinder with the suction means in the upper position of the plug and with the atmosphere in the lower position of the plug.

This results in a considerable reduction of the necessary connecting tubes and in turn an appreciable reduction in the operating time of the associated elevator.

Further features and advantages of the invention will become apparent from the description which will follow by way of example with reference to the accompanying schematic drawings, in which:

FIGS. 1A, 1B, 1C, 1D illustrate the operation of the conventional type of pneumatic elevator;

FIG. 2 is an axial sectional view of improved, and for the most part, known pneumatic elevator provided with a movable plug acting as stop means for the piston;

FIGS. 3-5 are view similar to FIG. 2 showing the operation of the improved pneumatic elevator;

FIGS. 6-9 are views similar to those of FIGS. 2-5 respectively for the pneumatic elevator according to the invention;

FIG. 10 is a detail view in axial section of an alternative embodiment of the pneumatic elevator according to the invention;

FIG. 11 is an elevation view of the embodiment of FIG. 10, and

FIG. 12 shows a detail view in axial section along the line XII-XII in FIG. 11.

A conventional pneumatic elevator comprises a tubular piston 10 provided with a suction nozzle 11 at its lower end and movable in a cylinder 12, for taking sheets 13 one by one from a pile and introducing these sheets one at a time between drive rollers 14, 15 rotatably mounted in opposed directions.

According to the usual technique, the suction nozzle 11 of the piston 10 has its upper dead point or rest position (FIG. 1A) at H1, the height substantially at which the sheet 13 are introduced between the rollers 14, 15.

From its dead point or rest position shown in FIG. 1A, the piston 11 is able to drop until it comes in contact with the uppermost sheet 13 in the pile (FIG. 1B), then rises carrying with it the sheet by means of

suction (FIG. 1C) until once again it reaches the upper rest position where the sheet is at the height H1.

The cylinder 12 is then slightly rocked about an axis parallel to the rollers 14, 15 which enables the introduction of the sheet between the rollers, and once this sheet is released by the piston 11, it is driven by the rollers 14, 15.

In practice, there is a row of cylinders 12 arranged parallel to the corresponding edge of the sheet 13, but for the purpose of simplification and clarity only one of these cylinders is shown in the drawings.

Improved and, for the most part, known construction of such a pneumatic elevator will now be described in detail with reference to FIGS. 2-5; such a pneumatic elevator also has a tubular piston 10 displaceably mounted in a cylinder 12, defining an annular space 20 therewith.

A suction nozzle 11 is provided at the distal end of piston 10 and has a passage 21 in communication with the interior 22 of the piston 10; a radial flange 23 closing off the annular space 20 is carried at the inner end of the tubular piston 10 remote from the suction nozzle.

The lower end of the annular space 20 is in communication with a tube 24 adapted to be connected to suction means of any type (not illustrated).

Moreover, the annular space 20 communicates with the interior 22 of the piston 10 via calibrated pressure-drop orifice 25 formed in the wall of the piston 10.

A spring 26 is arranged in the annular space 20 and bears against the inner end 27 of the cylinder 12 urging the tubular piston 10 upwardly by bearing against the flange 23 fixed to the piston.

A plug 30 movably mounted at the upper end of the cylinder 20 acts as a stop means for limiting the upward movement of the tubular piston 10.

The plug 30 is displaceable in the cylinder 12 under the force of gravity the plug defining two chambers in the cylinder, a first of which is relatively remote from the piston and communicates with the atmosphere through a hole 31 in the upper end 32 of the cylinder 12.

In the illustrated embodiment, the first chamber is effectively eliminated at the upper dead point or rest position shown in FIG. 2 and is more clearly seen at 33 in FIGS. 3-5. The plug 30 defines in the cylinder a second chamber 34 which communicates with the interior 22 of the piston 10.

In the illustrated embodiment, the chamber 34 is at least in part formed annularly about a portion of reduced section 35 in the plug 30 and in the rest position communicates with the interior 22 of the piston 22 via an elbow passageway 36.

Owing to the presence of this portion of reduced section 35, the plug 30 has a support shoulder 37 adapted to cooperate with the support shoulder 38 provided in the cylinder 12 for this purpose.

In the rest position shown in FIG. 2, the annular space 20 between the piston 10 and the cylinder 12 is in communication with the atmosphere. Under the force of the spring 26, the piston 10 is in the upper rest position in abutting contact with the plug 30 which, too, is in its upper rest position in abutting contact with the upper closed end 32 of the cylinder 12.

In this rest position, the suction nozzle 11 is at H2 above the position H1, at which the introduction of a sheet 13 between the rollers 14, 15 may be effected.

It will now be assumed that the annular space 20 is connected by the tube 24 to associated means (FIG. 3). Whereupon there is a partial vacuum in the annular space 20; there is also a partial vacuum in the interior 22 of the piston 10 and in the chamber 34 thereabove, but this partial vacuum is smaller by the fact that the interior 22 of the piston 10 is only in communication with the annular space 20 through the calibrated pressure-drop orifice 25.

The different features of the pneumatic elevator, in particular the sections of the cylinder 12, piston 10 and orifice 25, the weight of the piston 10 and spring force, are chosen so that under the force of gravity acting on the piston 10, taking into account the above-defined partial vacuum, the piston 10 is displaced vertically downwardly against the spring 20 which it compresses (FIG. 3).

At the same time, the movable plug also moves downwards, owing to the force of gravity acting thereon and the fact that the chamber 33 thereabove is in communication with the atmosphere and the chamber 34 therebelow is under a partial vacuum (FIG. 3).

The downward movement of the piston 10 continues until the suction nozzle 11 comes into engagement with the uppermost sheet 13 of the pile therebelow (FIG. 4).

From the above operation, the interior 22 of the piston 10 is closed off and therefore a partial vacuum is created therein which is equal to that in the annular space 20. The spring 26 is chosen so that, taking into account the different sections of the annular space 20 and the interior 22 of the piston in which the partial vacuum is present at this time overcomes the combined weight of the piston and the sheet 13 carried thereby by a sufficiently large margin to assure the lifting the combination in the predetermined direction of lifting F (FIG. 4).

Concomitantly, the plug 30 moves from its upper rest position to its lower operating position (FIGS. 4 and 5) at which it is held by the shoulder 37, the latter being in engagement with the shoulder 38 of the cylinder 12.

The weight of the movable plug per se is chosen so that, taking into account the force due to the partial vacuum in the difference spaces, it stops the lifting movement of the piston 10 when the latter comes once again into abutting contact therewith (FIG. 5).

By the fact of the previous downward movement of the movable plug 30, the suction nozzle 11 and the sheet 13 held thereby are in this abutting position of the piston with the plug 30 at H1 which enables the introduction of the sheet between the rollers 14 and 15.

In a known manner, the cylinder 12 is then swung about a pivot parallel to the rollers for enabling the introduction of the sheet 13 therebetween, the communication between the annular space 20 and the associated suction means is then cut off.

The sheet 13 is then freed by the piston 10 and grasped by the drive roller 14, 15 (operation not shown).

Concomitantly, and because the annular space 20 is once again at atmospheric pressure, the spring 26 is able to overcome the forces acting up to then in opposition to the complete lifting of the piston, the lifting or the upward movement begins again and continues until

the piston 10 returns to its rest position as shown in FIG. 2.

Accordingly, the suction nozzle 11 does not remain in contact with the sheet 13 once the latter is driven by the rollers 14, 15.

The cylinder 12 of course returns at the same time to its vertical rest position by pivoting.

By way of example, numerical values will be given for such a pneumatic elevator.

1. spring force: 1,000 gms
2. cross section of the cylinder: 12 cm²
3. cross sectional area of the annular space between the cylinder and the piston: 9 cm²
4. cross section of the movable plug: 18 cm²
5. suction rate: 500 gms/cm²
6. piston weight: 300 gms
7. effective weight of the sheet to be lifted: 300 gms

8. weight of movable plug: 100 gms

In this example the partial vacuum in the piston 10 during its fall or descent is 100 gms/cm², and the lifting force provided by the piston is 1,900 gms.

In the embodiment of the invention illustrated in FIGS. 6-9, the movable plug 30 acts as a control valve means movably mounted in the upper end of the cylinder 12.

The movable plug has a first bearing member 40 extended towards the piston 10 by a tubular portion 41. The tubular portion carries at its mid-section a second bearing member 42.

The plug 30 thus defines three chambers in the cylinder: a first chamber 43 between the upper end 32 of the cylinder 12 and the bearing member 40 which in the upper rest position FIG. 6 of the illustrated embodiment is effectively nonexistent but is clearly apparent in FIGS. 8 and 9. The chamber 43 communicates with the atmosphere through hole 31 formed in the top end 32 of the cylinder 12. A second chamber 46 located below the bearing member 42 and adapted to communicate directly with the interior 22 of the piston 10. A third chamber 44 is formed annularly about the tubular portion 41 of the plug 30 between the bearing members 40 and 42 thereof.

The third chamber 44 is adapted to be connected by a tube 24 A to the associated suction means. The third chamber 44 is connected via tube 24 B with the annular space 20 between the piston 10 and the cylinder 12 at the lower end of the cylinder. The third chamber 44 is also in communication with the interior 22 of the piston 10 via calibrated pressure-drop orifice 47 formed on the tubular portion 41 of the plug 30 between the bearing members 40, 42.

The piston 10 is not provided with any calibrated pressure-drop orifice. In the illustrated example, a passageway 48 is provided in the cylinder 12 for possible communication between the second and third chambers 46 and 44 described above.

In the rest position shown in FIG. 6, the tubes or conduits 24 A and 24 B are in communication with each other and the passageway is closed off by the bearing member 42 of the plug 30.

When the conduit 24 is connected to the associated suction means, the piston 10 falls in the manner described above; the plug 30 also, as above, falls at the same time (FIG. 8).

However, in the lower operating position of the plug 30 (FIG. 8), the bearing member 40 cuts off all com-

munication between the conduits 24A and 24B, and consequently the annular space 20 between the cylinder 12 and the piston 10 is at atmospheric pressure via conduit 24B and the hole 31 formed in the upper end 32 of the cylinder 12.

At the same time, the bearing member 42 of the movable plug 30 opens the passageway 48 which at that moment in turn effects direct communication between the suction means and the interior 22 of the piston 10, the calibrated pressure-drop orifice 47 is thus short-circuited by the passageway 48. An accelerated evacuation of the space above the piston 10, via chamber 46, results.

From these two factors: connecting the space 20 with the atmosphere and the accelerated evacuation of the space above the piston, there results a substantial reduction in the forces opposing the force for upward movement exerted by the spring 26 for assuring the lifting of the piston 10 and the sheet 13 carried thereby (FIG. 9).

In practice, the lifting force F of the piston 10 is thus increased to 6,400 gms and therefore is very much greater than previously obtained.

Moreover, it appears to be advantageous to filter the air which is to pass through the hole 31 into the chamber 43 above the plug 30, or in other words, to connect the chamber 43 with the atmosphere through an air filter.

Indeed, if the air is laden with dust, the chamber is shortly clogged up which may cause the jamming of the plug 30.

According to an alternative embodiment illustrated in FIGS. 10-12, the cylinder 12 is provided at its upper open end with at least one hole 31, as in the previous embodiment, superpositioned by a cap 52, a filter 53 disposed annularly about the hole 31 sandwiched between the cap 52 and the upper end of the cylinder. The sandwiched air filter 53 may be formed as a ring of felt.

The threaded rods arranged peripherally and discretely join the cap 52 to the cylinder 12, the rods 55 pass through the filter 53 for securing the latter in place.

The present invention is of course not limited to the embodiments described and illustrated hereinabove, but encompasses all alternatives, modifications and variations within the scope of appended claims.

What I claim is:

1. Pneumatic elevator for handling sheet material of the type including a cylinder, a tubular piston mounted for movement under the force of gravity to the lower end of the cylinder and having a suction nozzle at its distal end, a spring urging the piston towards the upper end of the cylinder against the force of gravity, the pis-

ton defining with the cylinder an annular space adapted to be connected to suction means, the interior of the piston also being adapted to be connected to suction means, a plug movably mounted at the top of the cylinder between an upper rest position and a lower operating position at which it acts as an abutment for limiting the further upward displacement of the piston, the plug defining two chambers in the cylinder, a first chamber relatively remote from the piston and communicating with the atmosphere, and a second chamber relative close to the piston and communicating with the interior of the piston, the plug providing valve means adapted to connect said annular space with the suction means in the upper position of the plug and with the atmosphere in the lower position of the plug.

2. Pneumatic elevator according to claim 1, wherein the movable plug is provided with a tubular portion extending towards the piston and having a calibrated pressure-drop orifice.

3. Pneumatic elevator according to claim 2, wherein the cylinder has a passageway which is closed off by the movable plug in its upper position and short-circuits the calibrated pressure-drop orifice in its lower position.

4. Pneumatic elevator according to claim 3, wherein the plug has two bearing members, the first chamber being defined to one side of a first bearing member remote from the second bearing member and communicating with the atmosphere, the second chamber being located to one side of the second bearing member remote from the first bearing member and adapted to communicate directly with the interior of the piston, and a third chamber formed about the tubular portion between the first and second bearing members and adapted to be connected to the suction means and communicating with the interior of the piston through the pressure-drop orifice.

5. Pneumatic elevator according to claim 4, wherein the passageway for short-circuiting the calibrated pressure-drop orifice extends between the second and third chambers.

6. Pneumatic elevator according to claim 1, wherein an air filter is arranged between the first chamber and the atmosphere.

7. Pneumatic elevator according to claim 6, wherein the cylinder is opened at least in part at its upper end, a cap superpositioning the open upper end of the cylinder, the air filter being of annular configuration and sandwiched between the open upper end of the cylinder and the cap.

8. Pneumatic elevator according to claim 7, further comprising rods connecting the cap to the cylinder extending through the air filter.

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