Dec. 9, 1969 J. G. LARKHAM 3,482,328

FLUIDISED BEDS

Filed May 24, 1968 2 Sheets-Sheet 1

Fig. 1

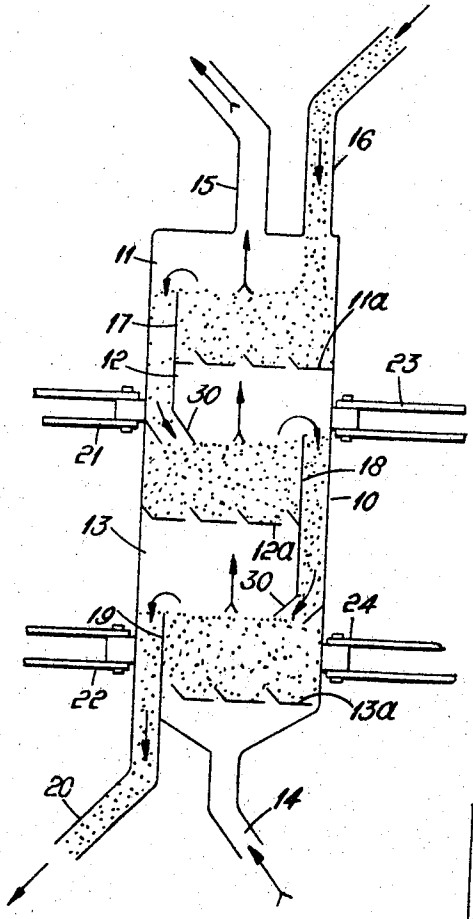
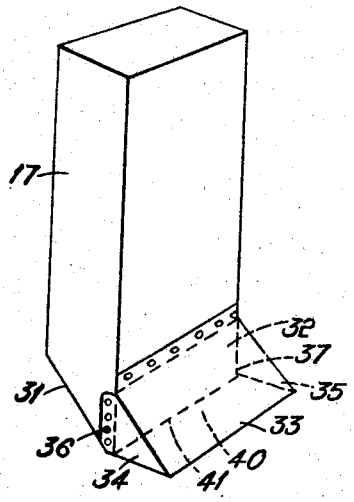


Fig. 2



Dec. 9, 1969 J. G. LARKHAM 3,482,328

FLUIDISED BEDS

Filed May 24, 1968 2 Sheets-Sheet 2

Fig. 3

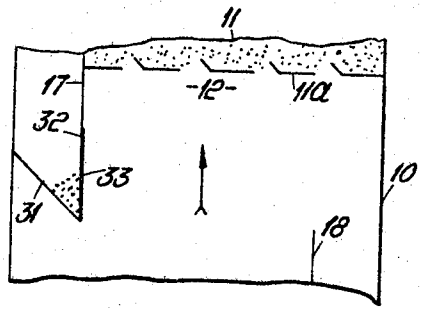


Fig. 4

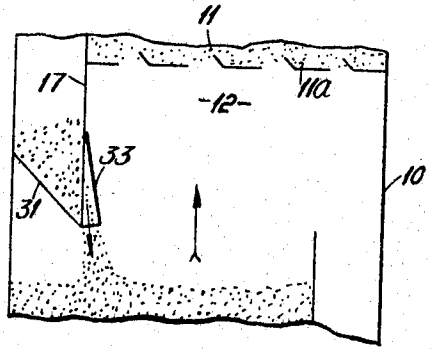
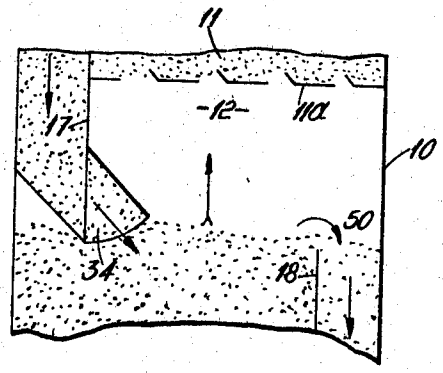


Fig. 5



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3,482,328

FLUIDISED BEDS

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U.S. Cl. 34—57 6 Claims

ABSTRACT OF THE DISCLOSURE

A tower horizontally vibrated and comprising fluidising chambers arranged one below the other with vertical overflow ducts for transferring the fluidised material from one chamber to the next chamber, wherein the outlet from each duct is provided with a pressure-responsive flap valve.

This invention relates to fluidised beds wherein materials in granular or other flowable form are fluidised by subjecting them to an upwardly flowing stream of gas. Such fluidised beds may be used for example for drying or for moistening the material, for the recovery of solvents, therefrom, and so on.

In particular, the invention may be used to extract nicotine from damp ground tobacco by passing steam therethrough. Such material presents a special problem because it is cohesive and it has therefore been found necessary to vibrate the fluidised bed transversely to the upward flow of steam. If vibration is not carried out, the steam blows holes through the tobacco, forming discrete passages and not disturbing the remainder of the tobacco bed.

Apparatus for the treatment of solids in granular form has already been proposed wherein the solids are fed on to the uppermost of a plurality of horizontal screens in a screen unit which is vibrated both with a vertical movement and with an orbital horizontal movement. Gas is passed upwards through the vibrating screens and withdrawn from the top of the apparatus. The solids are conveyed downwards from screen to screen by ducts, each of which has its inlet at the side of the apparatus and its outlet adjacent the centre of a screen. Each duct has a short vertical intake section followed by a long inwardly-extending section which is inclined slightly below the horizontal. The ducts may be of "valve type construction" to minimise the passage of the gas through them.

Such a prior proposal would not be suitable for dealing with a cohesive material such as damp ground tobacco because the vertical vibration would tend to compact the tobacco making it resistant to penetration by the gas whilst the inclined ducts, if provided with valves to exclude the gaseous upflow, would rapidly become choked by the tobacco. Also, mere screens would not provide the pressure drop in the gas which is required by our invention when applied to thick fluidised beds of cohesive material.

According to the present invention, there is provided apparatus for urging material into a fluidised state and comprising a tower divided by perforated flooring into a plurality of fluidising chambers arranged one below the other, overflow ducting for transferring material under gravity from one chamber to the chamber below it, an inlet for feeding material to the top chamber and an outlet for withdrawal of the material from the bottom chamber, an inlet for gas in the bottom chamber and an outlet for gas in the top chamber, and means for vibrating the material horizontally in the chambers, wherein the overflow ducting is at least substantially vertical, the flooring is perforated to produce a pressure drop in the gas as

it flows upwards through it, and the outlet of each overflow ducting is controlled by a flap valve responsive to the differential pressure of opposing operational pressures in the apparatus.

Preferably, each flap valve when closed is arranged to be urged open by the weight of material and the pressure of the gas in the overflow ducting against the pressure of the gas in the chamber in which the valve is located.

Preferably, each flap valve is rectangular and controls a rectangular outlet in an overflow ducting, the valve being hinged along its top to the ducting and sealed along its sides to the ducting by means of flexible web members.

The invention is illustrated by way of example in the accompanying drawings in which:

FIGURE 1 is a diagrammatic vertical section through apparatus embodying the present invention,

FIGURE 2 is an enlarged perspective view of ducting with a flap valve according to the present invention, and

FIGURES 3, 4 and 5 illustrate the operation of the flap valve of FIGURE 2.

Referring to the drawings and particularly FIGURE 1, a vertical tower **10** comprises three fluidising chambers **11**, **12** and **13** disposed one above the other. There may of course be more than three chambers. The chambers have flooring **11***a*, **12***a*, **13***a* respectively which are perforated to produce an appreciable pressure drop in an upflow of steam through the tower **10** from a steam inlet **14** at the bottom to a steam outlet **15** at the top of the tower, the flow of steam being indicated by feathered arrows. At the top of the tower is a material inlet **16** through which damp ground tobacco, which has been treated with a suitable alkali, is passed into the top chamber **11**.

A vertical overflow duct **17** transfers the overspill of ground tobacco from chamber **11** down to chamber **12** below it, whilst a further vertical overflow duct **18** transfers the overspill of ground tobacco from chamber **12** to chamber **13**. Finally, a third vertical overflow duct **19** transfers the overspill of tobacco from chamber **13** to a material outlet **20** provided in the base of the tower, the zig-zag passage of ground tobacco through the tower **10** being indicated by plain arrows. Each of the ducts **17** and **18** is provided at its lower end with a pressure-sensitive flap valve **30** which is urged towards its open position by the weight of ground tobacco in the duct falling upon it and the pressure of the steam in the duct but is urged towards its closed position by the pressure of the steam in the chamber in which the valve is located. In this way the tobacco is passed downwards from chamber to chamber but any appreciable flow of steam is prevented from passing upwards through any of the transfer ducting.

To avoid condensation in the tower **10**, the latter may be fitted with a steam jacket (not shown).

In operation, the tower **10** is filled with damp tobacco to the condition shown in FIGURE 1 so that tobacco fills each of the chambers **11**, **12**, **13** up to the level of the inlet of its overflow duct, say three to four inches above the flooring, while steam is blown upwards through the tower to pass through the bed of tobacco in each of the chambers **11** to **13**. Arms **21**, **22**, **23**, **24** which are pivotally attached to the outer surface of the tower are driven via eccentrics to vibrate the tower **10** in a substantially horizontal plan in order to avoid the formation of blow-holes in the tobacco beds.

The resulting vibration of the tobacco within the chambers **11**, **12** and **13** and the up flow of steam through the tobacco result in fluidisation of the tobacco, further tobacco being fed into the tower **10** through inlet **16** to provide a continuous flow of tobacco through the tower. The steam leaving outlet **15** contains nicotine which can

then be recovered or concentrated in subsequent known apparatus.

Details of the automatic pressure sensitive flap valves **30** are shown in FIGURES 2 to 5. Referring to FIGURE 2, the overflow duct **17** is shown provided at its lower end with an inclined bottom wall **31**, which slopes downwards to a rectangular outlet **32**. The inclination of the bottom wall **31** assists the discharge of the tobacco through the outlet. Hinged to the upper edge of outlet **32** is a rigid flap **33** which is sealed along its opposing sides by means of flexible webs **34, 35** which connect the flap to the side edges **36, 37** of the outlet **32**. The flaps **33** and the webs **34, 35** may be of nylon proofed with nitrile rubber, the flap being three times thicker than the webs in order to obtain the necessary stiffness. The webs have the flexibility of a suitable bellows-like material. In an open position of the flap **33**, as shown in FIGURE 2, an outlet port **40** is defined by the lower side **41** of outlet **32**, the lower edges of webs **34, 35** and the lower edge of flap **33**. In the closed position of flap valve **30**, the flap **33** covers the outlet **32** of duct **17** preventing any appreciable flow of material or gas therethrough. Due to the simple attachment of the flap valve **30** to duct **17**, its operation is controlled on the one hand by the weight of material and the pressure gas within the duct **17** and on the other hand by the pressure of the gas upon its outer surface. Thus the pressures which control the valve **30** are those exerted by the weight of tobacco within duct **17** and the difference in pressure of the steam between chambers **12** and **11**.

Referring now to FIGURE 3 the flap **33** is shown in its closed position in which the webs **34, 35** collapse like a bellows, permitting the flap **33** to seal against the outlet **32** of the duct **17**. In this position, the superior steam pressure in chamber **12** maintains the flap **33** closed and thus the steam is prevented from passing upwardly through the duct **17** so that tobacco is permitted to accumulate within the duct **17**.

As shown in FIGURE 4 sufficient tobacco has accumulated within duct **17** to form a wedge and overcome the pressure on the flap **33** exerted by the steam within chamber **12** and thus the flap **33** is shown partially open to allow tobacco to pass therethrough into the chamber **12**. As soon as the weight of the tobacco within duct **17** is insufficient to overcome the pressure on flap **33** by the steam within the chamber **12** the flap will automatically reclose.

Referring now to FIGURE 5 the flap **33** is shown fully open, permitting the optimum flow of tobacco through duct **17** and into chamber **12**. In this position the lower edges of the webs **34, 35** enter the tobacco within chamber **12**. Thus the tobacco within chamber **12** effectively forms a seal around the outlet port **40** and prevents any appreciable flow of steam therethrough into the duct **17**. It will be noted that the lower edge of the duct outlet **32** is substantially level with the inlet **50** to the duct **18** which is of course the transfer duct from chamber **12** to chamber **13**. This feature helps to keep the flap **33** open and so promote a constant flow of tobacco through the duct **17**. It will be appreciated that during normal operating conditions of the apparatus, the positions of each valve **30** should remain substantially as shown in FIGURE 5, with each flap **33** open to its maximum extent to permit a maximum through-flow of tobacco.

Should one of the transfer ducts, e.g. duct **17**, become starved of tobacco the level in the chamber **12** will tend to fall, the weight of the tobacco within duct **17** will decrease and the flap valve will commence to close under the pressure of the steam within chamber **12**. The position illustrated in FIGURE 4 may then be reached. Complete closure of the valve **30** may ensue, but if not, little steam will pass upwards through the nearly closed valve and the apparatus can automatically reprime and restart itself once the supply of tobacco is available at the inlet to the apparatus. One advantage of the webbed flap valve is that it does not become clogged by the damp cohesive tobacco. Thus there is no need to prime the apparatus by hand, nor to control operation of the valve according to the level of material in each of the chambers, and also there is no need to control flow of material in accordance with the flow of steam, as this will all be done automatically. The apparatus is not of course limited to the treatment of tobacco by steam.

In a modification of the apparatus, each valve **30** is operated automatically by control apparatus which is sensitive to pressures existing in the tower. Thus for example a flap valve could be actuated by mechanism sensitive to pressures within the duct **17** and the chamber **12** without permitting the pressures themselves to control directly the operation of the valve. Again, operation of the valve could be controlled according to pressures existing elsewhere in the tower as required.

The particular form of the valve illustrated need not be employed and any suitable shape of exit can be used. Two outlets may be formed in opposing sides of the duct **17** instead of a single outlet from the front, in which case the bottom wall **31** would be V-shaped with its apex pointing upwards so as to divide the flow of tobacco and direct it to one or other of the outlets.

What I claim is:

1. Apparatus for urging material into a fluidised state and comprising a tower divided by perforated flooring into a plurality of fluidising chambers arranged one below the other, overflow ducting for transferring material under gravity from one chamber to the chamber below it, an inlet for feeding material to the top chamber and an outlet for withdrawal of the material from the bottom chamber, an inlet for gas in the bottom chamber and an outlet for gas in the top chamber, and means for vibrating the material horizontally in the chambers, wherein the overflow ducting is at least substantially vertical, the flooring is perforated to produce a pressure drop in the gas as it flows upwards through it, and the outlet of each overflow ducting is controlled by a flap valve responsive to the differential pressure of opposing pressures in the apparatus.

2. Apparatus according to claim **1**, wherein each flap valve when closed is arranged to be urged open by the weight of material and the pressure of the gas in the overflow ducting against the pressure of the gas in the chamber in which the valve is located.

3. Apparatus according to claim **2**, wherein each flap valve is rectangular and controls a rectangular outlet in an overflow ducting, the valve being hinged along its top to the ducting and sealed along its sides to the ducting by means of flexible web members.

4. Apparatus according to claim **3**, wherein each overflow ducting has an inclined bottom wall which slopes downwards to the outlet.

5. Apparatus according to claim **1**, wherein the bottom of the outlet of each overflow ducting is level with the inlet of the overflow ducting in the same chamber.

6. Apparatus according to claim **3**, wherein at least one flap valve has its flap and web members made of nylon proofed with nitrile rubber, the respective thicknesses of the flap and the web members being such that the flap is rigid whilst the web members are flexible.

References Cited

UNITED STATES PATENTS

1,550,992	8/1925	Trump	34—10
1,611,098	12/1926	Borner	34—33
2,639,973	5/1953	Fritz.	
3,079,222	2/1963	Reeve.	
3,161,483	12/1964	Morris.	
3,266,788	8/1966	Jukkola	34—10

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