March 31, 1959 A. S. BEECH ET AL 2,879,905

CHARGING OF HOPPERS

Filed July 25, 1957 7 Sheets-Sheet 1

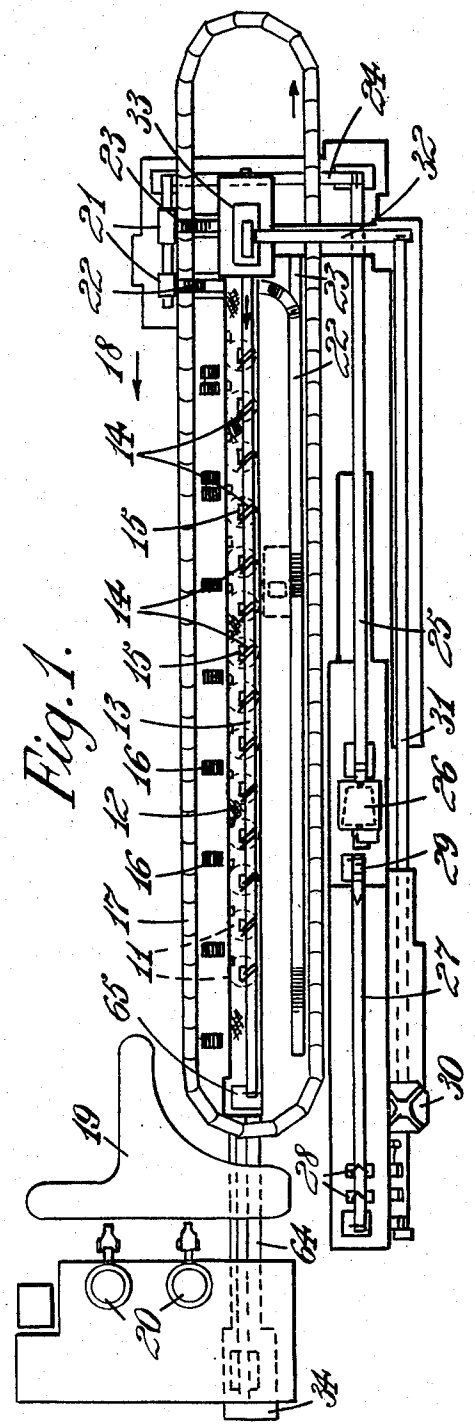


Fig. 1.

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CHARGING OF HOPPERS

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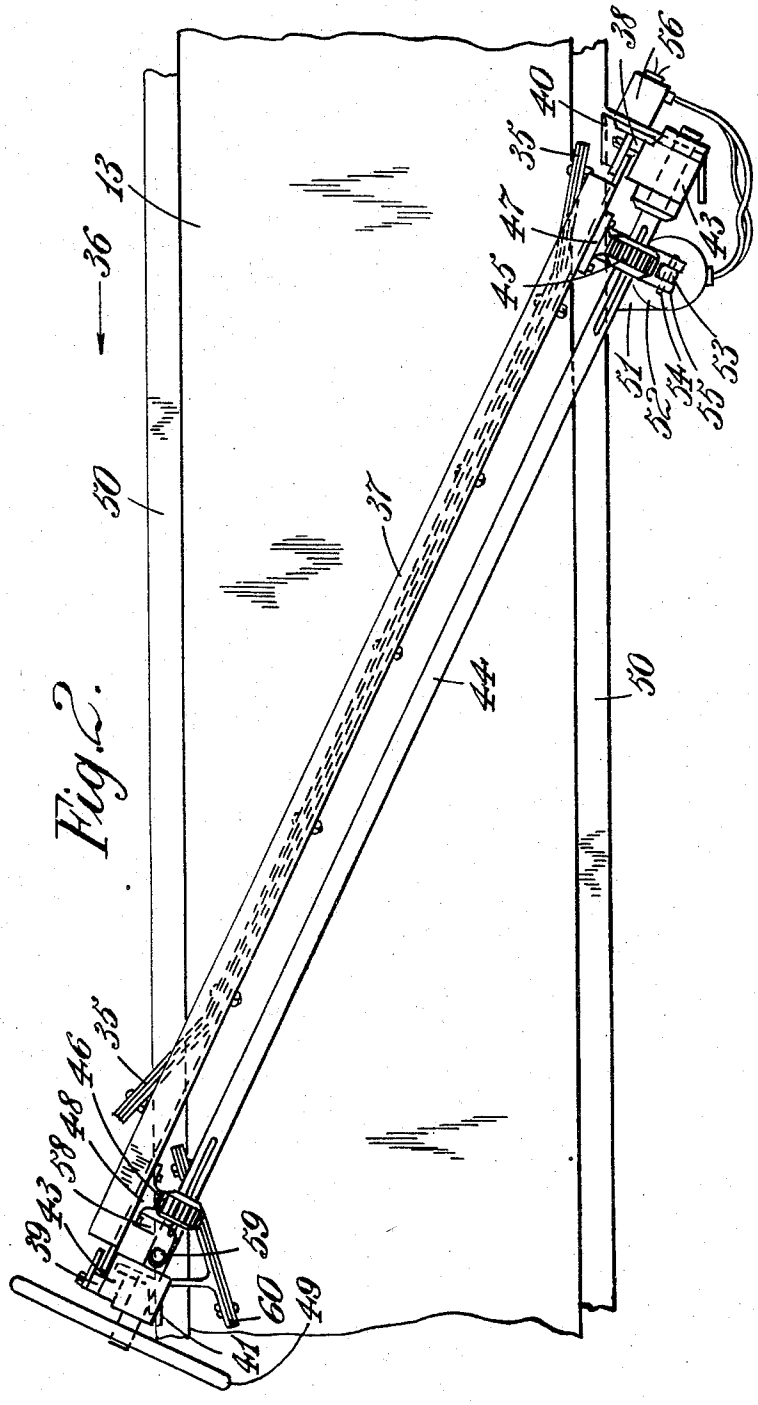


Fig. 2.

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CHARGING OF HOPPERS

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Fig. 3.

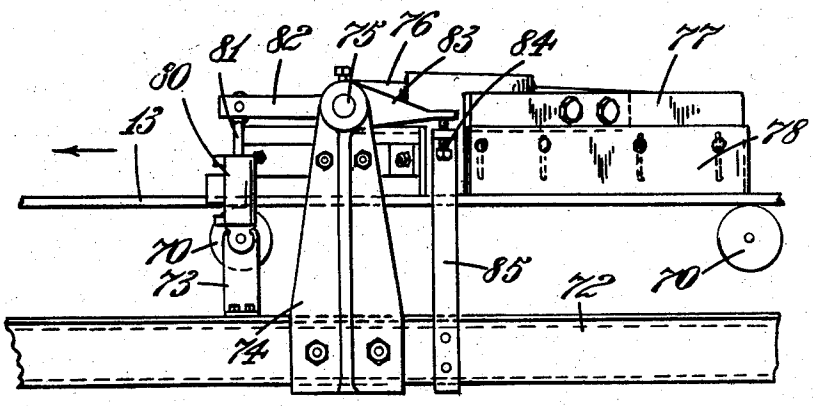
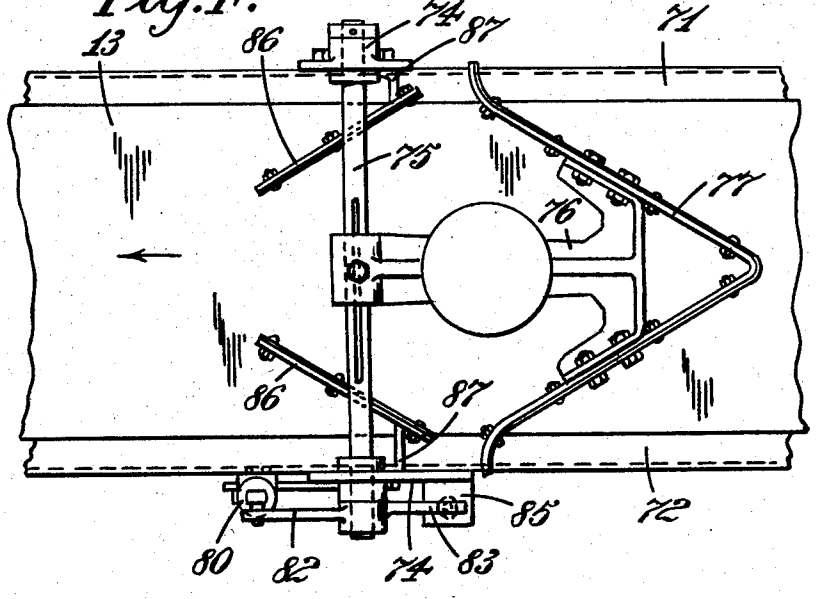


Fig. 4.

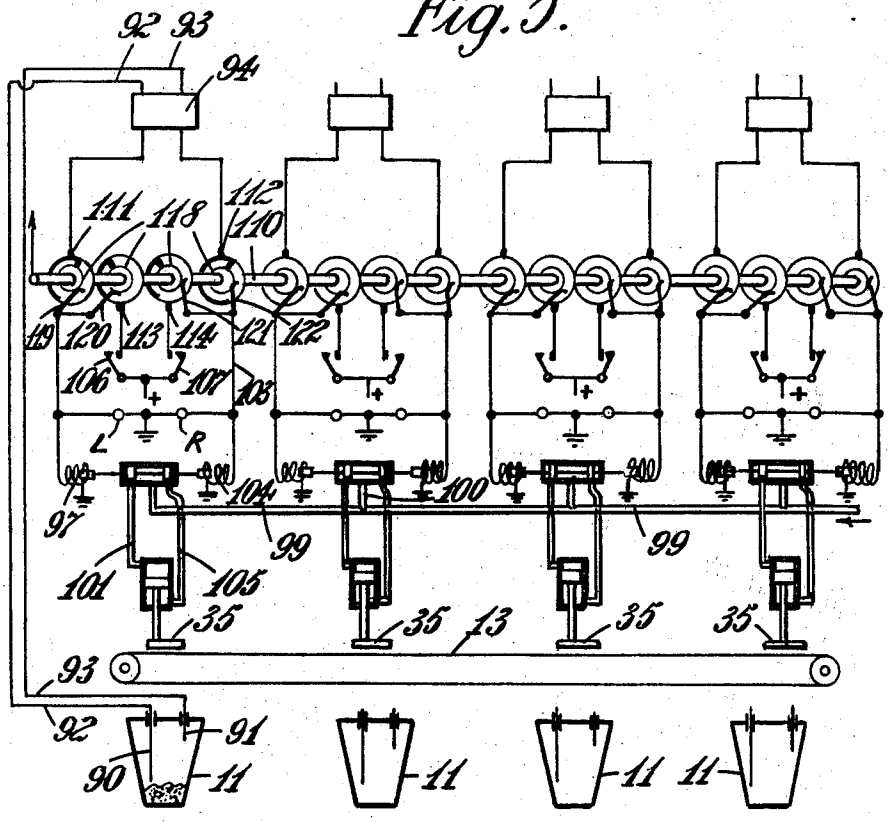


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CHARGING OF HOPPERS

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Fig. 5.

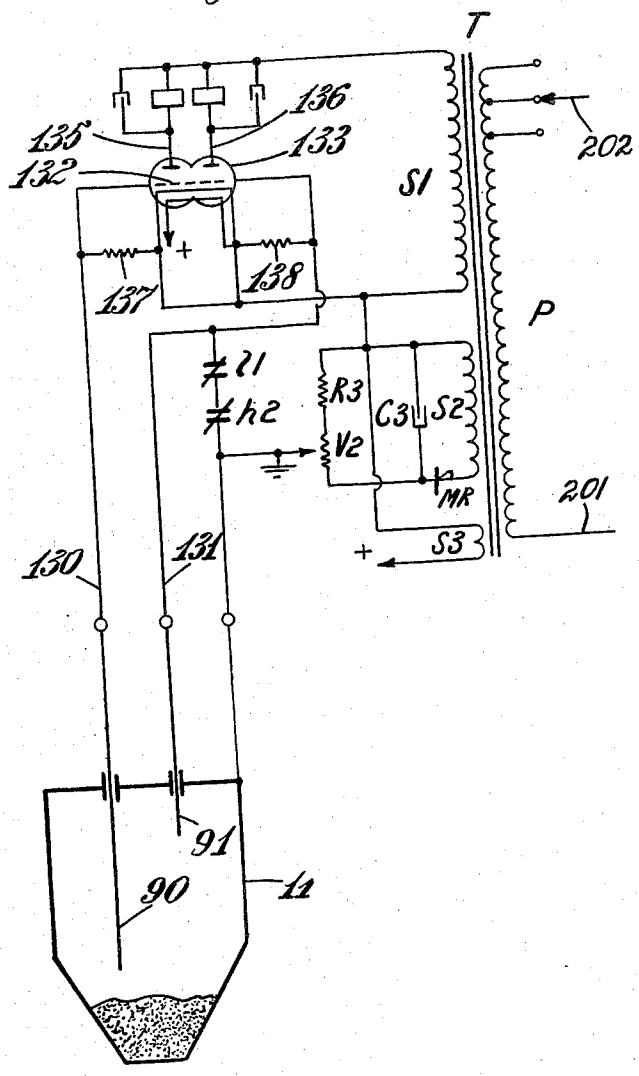


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CHARGING OF HOPPERS

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Fig. 6.

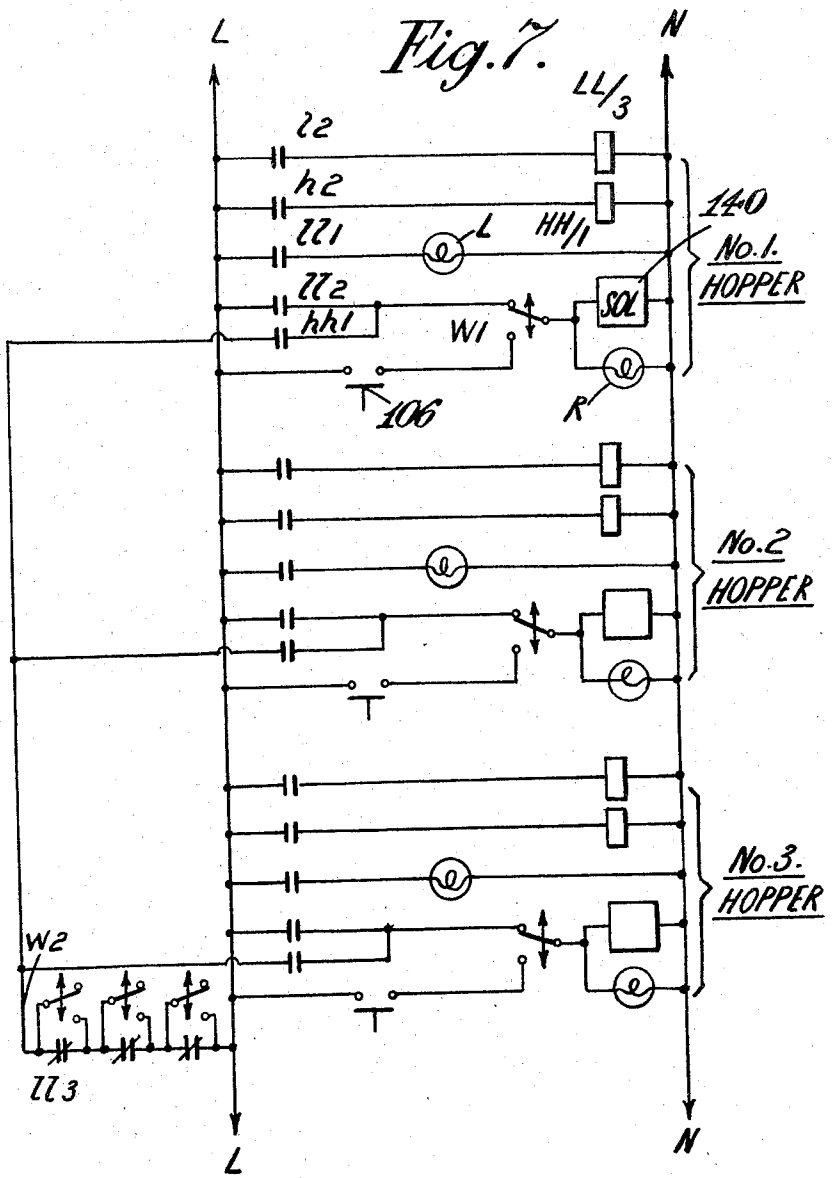


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CHARGING OF HOPPERS

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Fig. 7.

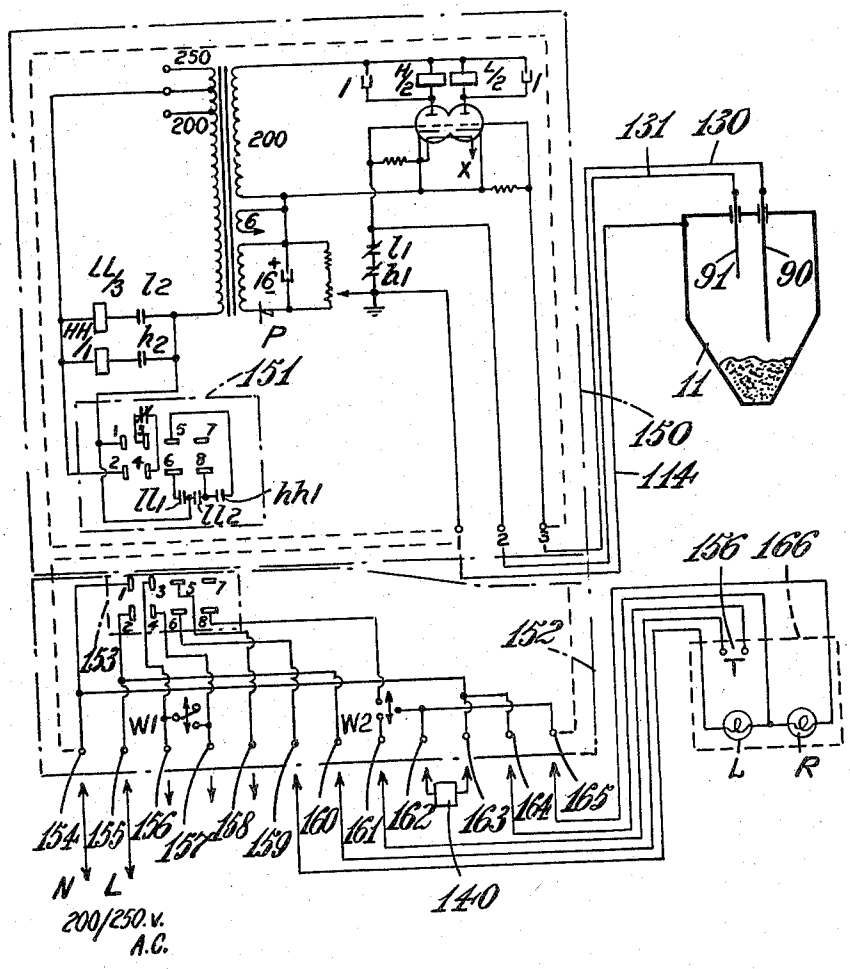


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CHARGING OF HOPPERS

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Fig. 8.



United States Patent Office 2,879,905 Patented Mar. 31, 1959

2,879,905

CHARGING OF HOPPERS

Austin Sidney Beech and Thomas Spencer, Leighton Buzzard, England, assignors to Foundry Equipment Limited, Leighton Buzzard, England, a British company

Application July 25, 1957, Serial No. 674,093

Claims priority, application Great Britain July 27, 1956

4 Claims. (Cl. 214—17)

This invention comprises improvements in or relating to the charging of hoppers.

In sand-conditioning plants for foundries it is customary, for the purpose of feeding moulding sand to moulding machines in particular, to have a long distribution belt over the machine which carries sand to a series of hoppers, one above each machine. The sand is diverted into each hopper in turn by a plough mechanism, which is operated by a man who walks along a walkway beside the belt and ploughs sand in whenever more sand is required in the hopper, so that all hoppers are kept filled.

It is an object of this invention to eliminate the need for having an operator to manipulate these ploughs and also to make sure that all the hoppers are kept charged with sand, so that there is no delay at the moulding machines due to lack of sand being available.

According to the present invention, apparatus for controlling the distribution of pulverulent material from a conveyor into a hopper comprises a probe or probes in the hopper, an electrical relay device connected to the probe or probes, plough means above the conveyor for diverting pulverulent material thereon into the hopper and means under the control of the electrical relay device for operating the plough so that if the sand level in the hopper sinks below the probe or probes, the plough is actuated automatically to direct sand into the hopper, while if the sand level rises, the plough is actuated to diminish or discontinue the delivery of sand to the hopper.

Electronic relay devices may be used for the relay device referred to.

Conveniently, there are two probes at different levels in the hopper, one to control the upper limit of the amount of sand and the other to control the lower limit.

Preferably, the plough is operated by a pneumatic device which is controlled by a solenoid-operated air valve, the solenoid being under control of the electronic or other relay device.

By employing a control of this kind on a series of hoppers fed from a single conveyor and having an appropriate circuit for interconnecting the automatic controls of the various hoppers, a complete foundry sand delivery system may be automatically controlled.

Preferably, an indicator light or other signal is arranged for each hopper to show to the person responsible for the running of the plant which hopper is being filled or emptied at a given time.

Furthermore, an overriding manual switch may be provided which may be used for affording an alternative circuit in which the hoppers may be individually hand-controlled, for example by push-buttons connected to the electrical circuit, if desired.

The following is a description by way of example of one form of plant in accordance with the invention:

Referring to the accompanying drawings,

Figure 1 is a diagrammatic plan of part of a casting plant;

Figure 2 is a plan to an enlarged scale of part of a conveyor belt and of an automatically-operable plough located above it;

Figure 3 is a side elevation of an alternative form of plough and part of a conveyor belt;

Figure 4 is a plan of the parts shown in Figure 3;

Figure 5 is a schematic diagram of electrical and pneumatic connections; and

Figures 6, 7 and 8 are further connection diagrams.

Referring to Figure 1, which shows the relevant parts of the plant in plan, a series of hoppers shown in dotted lines at **11** beneath an elevated walk **12** is provided for a line of moulding machines which are arranged in the usual manner below the hoppers. Beside the walk **12** is a conveyor belt **13** and above the conveyor belt at each hopper station there is disposed a plough **14** so mounted that it can be raised and lowered and that if lowered it will divert foundry sand from the conveyor belt **13** into an opening **15** leading to the hopper below.

It should be explained that the moulding machines are arranged beside closing tables **16** from which completed moulds are transferred to a mould conveyor **17** which moves in the direction indicated by the arrow **18**. Moulds are taken past a casting station indicated diagrammatically at **19**, after having been poured at the casting station from ladles hung on a casting conveyor and fed from cupolas **20**.

After casting, the moulds on the conveyor are carried through the plant over a sufficient distance to allow the castings to set and the sand is then knocked out of the moulds on knock-outs **21** at the other end of the plant. From the knock-outs the moulding boxes are carried by return-box gravity conveyors **22**, **23**, to a position behind the hoppers **11** where they can be easily transferred to the moulding machines for re-use. Sand from the knock-outs is carried by a transverse conveyor belt **24** and a second belt **25** to a rotary screen **26** and thence by an elevator **29** and another belt **27** to openings **28** above a storage hopper where the sand is collected. From the storage hopper, sand is delivered to a sand mill **30** whence it is taken by an inclined belt **31** and an elevated transverse belt **32** to a hopper **33** below which is a disintegrator delivering on to the belt **13**. New sand is kept in a hopper **34** from which it is delivered by a belt **64** which runs below the moulding machine and also collects spillage of sand therefrom. Overflow from the end of belt **13** drops into a hopper **65** and thence to belt **64**. The belt **64** delivers to the sand from the knock-outs and is conveyed by belts **24**, **25** into the circuit for use.

Castings from the knock-outs **21** are of course removed and dealt with in the usual way.

One form of plough suitable for use according to the present invention above the belt **13** is shown in plan in Figure 2 and consists of a plough blade **35** which extends across the belt **13** at an acute angle to the direction of belt travel indicated by the arrow **36**. The plough **35** is mounted on a frame **37** supported in vertical guides **38**, **39** so as to be able to move up and down. The guides **38**, **39** are supported by brackets **40**, **41** from the frame work of the plant and the brackets also carry bearings **42**, **43** for a pinion shaft **44** which carries pinions **45**, **46** meshing with vertical racks **47**, **48** on the frame **37** which carries the plough blade **35**. On the pinion shaft **44** at one end is a hand-wheel **49** and by rotation of the hand-wheel the plough blade may be moved up and down at will.

Also secured to the framework **50** of the plant there is a bracket **51** for an air cylinder **52** having a ram **53** which is connected by a pin **54** to a rack-operating lever **55**. The rack-operating lever at its other end is jointed to the rack **47** and intermediately it has a pivot on the bracket **51** located immediately below the shaft **44**. The

air cylinder 52 is double-acting and the result of operating it up or down is to move the rack 47 down or up correspondingly. As the rack 47 is in mesh with the pinion 45 and is connected through the pinion shaft 44 with the pinion 46 and rack 48, the plough is compelled to move up and down at each end under the impulse of the air cylinder 52 to an equal extent. The air cylinder 52 is actuated by a solenoid valve of known type 56 carried on the bracket 40 and electrically-operated by relay apparatus as hereinafter described.

Attached to the rack 48 is a bracket 58 which is bent so as to overlie the shaft 44 and carries an adjustable stop-screw 59. This limits the depth to which the plough blade 35 can be lowered, so that while it will sweep off sand from the belt 13 some other sand will go on beneath it. A small auxiliary plough 60 tends to sweep the sand back from the margin of the belt after it has passed the plough 35.

Instead of employing a diagonal plough such as is shown in Figure 2, a V-plough can be employed as shown in Figures 3 and 4. In this case the belt 13 is supported on rollers 70 above frame-members 71, 72. The rollers are supported on brackets 73 and the plough is mounted on brackets 74 secured to the frame-members 71, 72. The brackets 74 support a rock-shaft 75 and on the rock-shaft is a bracket 76 supporting a V-plough 77. When the plough 77 is lowered so that its skirt 78 touches the belt 13, as shown in Figure 3, it delivers sand on both sides of the belt 13 and the openings to pass sand down to the hoppers 11 need to be provided below both sides of the belt, or else to be large enough to receive from both sides of the belt the streams of sand which are pushed off by the plough.

Ordinarily a plough of this kind is provided with a counterweight on the rock-shaft 75 on the opposite side of the shaft to that occupied by the plough 77. According to the present invention, instead of the counterweight being so located and used to balance the weight of the plough, one of the brackets 73 is used to support an air cylinder 80, the piston rod 81 of which is pivoted to the arm 82 to a lever secured to the rock-shaft 75 outside one of the brackets 74. The lever has a second arm 83 which extends on the other side of the bracket 74 and is engaged by an adjustable setscrew 84 on a bracket 85 standing up from the frame-members 72. The setscrew 84 regulates the nearness with which the plough skirt 78 can approach the belt 13. The cylinder 80 determines the raising and lowering of the plough and is controlled by an electromagnetic valve similar to the solenoid valve 56 shown in Figure 2. Behind the plough 77 small fixed deflectors 86 overlie the belt and serve to push back toward the centre of the belt any sand which has passed beneath the plough skirt 78. The deflectors 86 are supported by brackets 87.

It is now necessary to describe the electrical control circuit. Referring to Figure 5, this shows diagrammatically the general disposition of the controls. In Figure 5 there are shown four of the hoppers 11 only. In each hopper there are two electrical probes 90, 91, the probe 90 being set in the hopper at a height which corresponds to the minimum depth of sand which it is desired to maintain in the hopper, and the probe 91 being set at a height which corresponds to the maximum height of sand. The two probes 90, 91 are connected respectively by lines 92, 93 to a relay box 94 which may contain electronic or other relays. Each of the probes 90, 91 is large enough to make contact with an appropriate area of sand in the hopper to actuate the relays, bearing in mind that moist sand acts as an electrical conductor but is of poor conductivity. The actual construction of the relay box 94 forms in itself no part of the present invention, such devices being well known in themselves. The construction is such however that if the sand level in the hopper falls to that of the lower probe 90, a signal will be sent out by line 95 and thence by connections about to be described, to a line 96 which is connected to a solenoid winding 97 to a solenoid-operated air valve 56. The air valve is connected to a supply line 99 by a branch 100, and if the solenoid 97 is energized the air valve moves to the left as shown in the figure and connects air pressure to a line 101 leading to the air cylinder 52 of the plough 35. This lowers the plough and commences delivery of sand to the hopper 11. The upper probe 91 is so connected to the relay 94 that upon the sand reaching the level of the upper probe 91, an impulse is sent by the relay box 94 to line 102 and thence to line 103 and solenoid winding 104. This operates the valve 56 to admit air to the pipe 105 and lift the plough.

The air valve 56 is also connected to two push-buttons 106, 107, the button 106 being capable of sending an impulse to the line 96 and lowering the plough, and the button 107 capable of connection to the line 103 and raising the plough. The push-buttons may be disposed in a pendant connection hung on an electrical flexible wire above the walk 12 beside the conveyor belt 13. Each plough has a corresponding pendant push-button switch. Moreover, the push-button switch contains connections to indicator lights L (green) for lowering the plough and R (red) for raising it. The indicator lights are shown as connected to the solenoid circuits but they can be actuated by limit switches on the ploughs if desired. The effect of this is that an operator can if he wishes actuate the ploughs by means of push-buttons but it is desirable that the electronic relay automatic control should in that case be disconnected.

For this purpose, an overriding control switch 110 is provided, which is shown diagrammatically as a drum controller having various positions in which it can be set. In one position it connects all the electronic relay circuit connections 95, 102 to the solenoid leads 96, 103 of the air valves 56. In a second position the electronic leads 95, 102 are disconnected and the push-buttons 106, 107 are connected respectively to the leads 96, 103. In a further series of positions the electronic controls are reconnected to the solenoids, all except one pair in each position. One of the electronic circuits 95, 96 (relating to one plough) is isolated and disconnected and the push-buttons are connected up. Thus, this particular plough can be hand-operated independently of the position of the other ploughs in the circuit.

In operation, the ploughs are set so that those nearest to the entering end of the belt do not touch the belt. This is effected by adjusting the stop-screws 59. The last plough however can touch the belt and intermediate ploughs may occupy intermediate positions. Assuming the hoppers are all empty when current is first switched on, all the lines 95 will be energised and all the ploughs will be lowered as far as the stop-screws 59 permit. The ploughs nearest to the entering end of the belt will get a full delivery of sand first and the hoppers at this end will fill up. As soon as any hopper is full its plough will be lifted and this leaves more sand to go on to the remaining hoppers. After a time all the hoppers will be filled and all the ploughs lifted. Thereafter, immediately any one hopper falls below the level of the lower probe 90, its plough will be lowered automatically and sand will be directed into it until it is refilled.

This operation however may leave one or more of the hoppers at the outgoing end of the belt starved, while other hoppers are being filled and hence the overriding control switch 110 may need to be used. If any one hopper becomes too empty the operator can move the switch 110 to a position where that hopper can be unfilled and he can lower each plough by means of the push-button 106 while all the other ploughs are lifted, or if not lifted are prevented by their stop-screws 59 or 84, as the case may be, from taking all the sand ahead of the plough of the hopper which is empty. The switch 110 is shown as a drum controller having brushes 111, 112 connected to the leads 95, 102 and brushes 113, 114

connected to push-buttons **106, 107** respectively. The brushes **111** to **114** inclusive rest on interrupted metallic segments on the various segments **115, 116, 117, 118** on the various sections of the drum controller, and the interrupted metallic segments are connected to slip rings **118** on which bear brushes **119, 120, 121, 122** of which the first pair are connected to the line **96** and the second pair to the line **103**. By appropriately disposing the lengths of the conducting segments on the drum, the various operations described can be effected.

In the instance shown there are only four hoppers and the controller has six positions. Obviously a larger or smaller number of hoppers can be arranged for, but where the number of hoppers is large the overriding control switch **110** becomes unnecessarily complicated and is moreover inconvenient to operate because it necessitates the operator moving too far along the walk **12**. Therefore the electronic circuits shown in Figures 6 to 8 have been devised.

Figures 6, 7 and 8 show another arrangement of switchgear which is preferred to that of Figure 5.

Figure 6 shows the relay connections to a single hopper with probes **90, 91**. The probes are connected by lines **130, 131** to the grids **132** of a valve **133**. When the hopper is empty and current is switched on the grid will be at the potential of cathode **134**, through resistances **137, 138**. The valve will be conductive and energise both the low relay **L2** (through anode **135** from probe **90**) and high relay **H2** (through anode **136** from probe **91**). The relays **L2, H2** in turn energise the electromagnetic relays **LL3** and **HH1** respectively (shown in Figure 7), through contacts *l2, h2*. There is a single solenoid **140** for actuating the plough air-cylinder **52**, the solenoid **140** having a spring return. The solenoid **140** is energised by either relay **LL3** or **HH1**, through contacts *ll2* and *hh1* respectively, provided the double-pole switch **W1, W2** is in the "automatic" position (i.e. the position shown in Figure 7). Energising the solenoid **140** puts the plough **35** down. Consequently the hopper begins to fill. If this were all, the hopper would go on filling until the upper probe **91** is in contact with damp sand, whereupon both grids (low or high probe grids) become negative and valve **133** cuts out. Therefore the plough lifts and feeding ceases to that hopper.

However it is better to arrange that all hoppers first fill to the lower probe **90** and then are further fed up to the level of the upper probe **91**.

In Figure 6, the transformer T has a primary winding P which is supplied with alternating current at say 200–250 volts by leads **201, 202**. The lead **202** can be applied to various tappings in accordance with the supply voltage. The transformer has three secondary windings of which the winding S^1 supplies the grids circuit of the valve **133** at about 200 volts. The winding S^2 supplies a rectifier circuit comprising a half-way rectifier MR, a capacitor C^3, a fixed resistance R^3 and a variable resistance V^2 which are connected up in the usual way for a rectifier and supplies rectified current which passes through a low voltage secondary winding S^3 (about 6 volts) to a terminal marked +. As can be seen in the part of the figure close to the filament of the valve, this current is connected to the valve filament. The same appears in Figure 8.

To this end the general connections of each hopper are as in Figure 8. The hopper **11** is connected by the lines **130, 131**, and earth line **141** to a 3-way terminal block on an electronic chassis **150** indicated by a chain line. The electronic chassis comprises the same connections, and similarly lettered, to those shown in Figure 6. The outgoing connections from this are led to an eight-way connecting plug indicated by chain line **151**. In the bottom of the box containing the chassis **150** there is a terminal block **152** having a flying lead to an eight-way socket (indicated by chain line **153**) which fits on to the plug **151**. On the terminal block **152** are terminals **154, 155** to an A.C. supply, say at 200–250 volts 50 cycles per second. There are three more terminals **156, 157, 158** to which reference is made hereinafter and then terminals **159** to **161** and **164** to **165** are connected to the hand-operation push-button and "L" and "R" lights, arranged on a pendant **166** or as a wall switch.

Of the terminals **156, 157, 158**, No. **156** of the electronic chassis of the first hopper is connected to No. **158** of the same chassis. No. **157** of every chassis except the last is connected to No. **156** of the following chassis of the series. On the last chassis it is connected to No. **155**. Nos. **158** on all chassis are connected together.

With the connections so arranged, when the first hopper fills with sand to the level of the lower probe **90**, line **130** is de-energised, this de-energises L2, LL3, and contacts *ll1* and thence by way of terminal **159** the low-level red lamp L. The solenoid on the plough was energised (along with contacts *ll1*) by contacts *ll2*, via terminals **162, 163** which go to the plough solenoid. It is therefore now de-energised and the plough lifts. The contacts *ll3* close on the chassis of hopper No. 1. This connects together contacts **156, 157** on this chassis and makes the plough circuit operative for hopper No. 2, which then fills up to the level of its probe **90** and then passes the impulse to hopper No. 3. This is repeated until all hoppers are filled to the lower level. When all *ll3* contacts are closed, all plough solenoids are energised through *ll3* contacts in series and each *hh1* contact, and the hopper begin to fill further, up to the level of probes **91**. As each hopper fills to the upper level, the grids connected to probes **91** become negative and each in turn de-energizes its relay H2 and its plough solenoid.

If the double switch W1, W2 on any chassis is thrown over to the "hand" position, that chassis can operate by hand, without interfering with the choice of "hand" or "automatic" for the others. In this position the *ll3* contacts are by-passed, so providing continuity to the other chassis for the automatic sequence, and the button **106** can be utilised to operate the solenoid for the chassis which has been turned to "hand."

Moreover in this position of switch S1 the eightway plug **151** can be unplugged from socket **153** and the electronic chassis **150** removed for replacement or repair.

We claim:

1. Apparatus for controlling feed of pulverulent material comprising in combination a plurality of hoppers, a conveyor above the hoppers, ploughs above the conveyor at stations such that each plough can if lowered direct material into one of the hoppers, air motors for raising and lowering each plough, an electromagnetically controlled valve for controlling each air motor, probe-electrodes at two different heights in each hopper, relay means connected to each probe-electrode, means connecting the relay means to the electromagnetically controlled valves to cause the valve to move to admit air to the air motor to lower the plough when the lower probe-electrode is clear of material in the hopper and to raise the plough when the lower probe-electrode is reached by material in the hopper, means to limit movement of said ploughs as to the degree to which they can be lowered so that the second or any later ploughs can be lowered nearer the belt than the first or earlier ploughs, and means whereby when all the lower probe-electrodes have been reached by material in the hoppers the electromagnets are re-energized to cause the air valves to lower the ploughs and so fill the hoppers to the level of the upper probe-electrodes, which thereupon cause the ploughs to be raised above each hopper as it is filled.

2. Apparatus as claimed in claim 1 wherein the means provided to limit the movement of each plough are adjustable so that the various ploughs can be set, each at a height suitable for its position in the series.

3. Apparatus as claimed in claim 1 wherein each lower probe-electrode is so connected to the corresponding relay device that when clear of sand the relay actuates the air

valve to lower the plough of that hopper to deliver sand to the hopper and when so actuated it prevents other hoppers ahead of it in the series from receiving sand.

4. Apparatus as claimed in claim 1 having an indicator signal for each hopper arranged to show to the persons responsible for the running of the plant which hopper is being filled or emptied at a given time.

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