July 19, 1955 R. C. TENCH 2,713,408

VARIABLE DELIVERY MEANS FOR LOADING CHUTES

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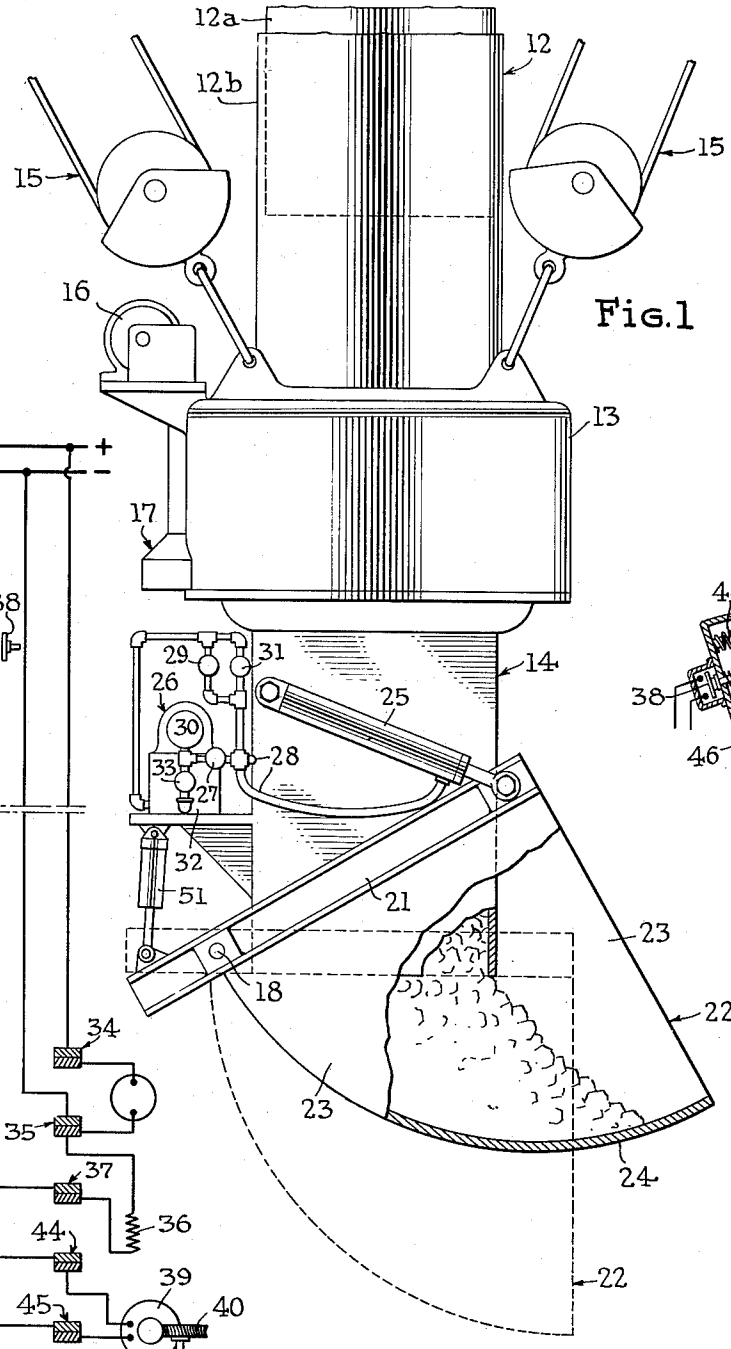


Fig. 1

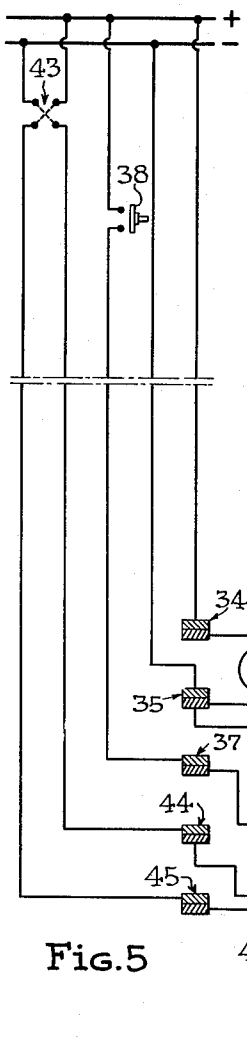


Fig. 5

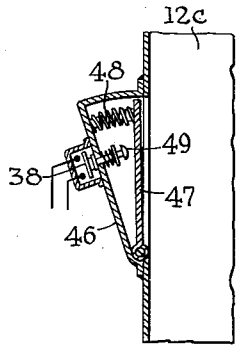


Fig. 6

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VARIABLE DELIVERY MEANS FOR LOADING CHUTES

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Fig.2

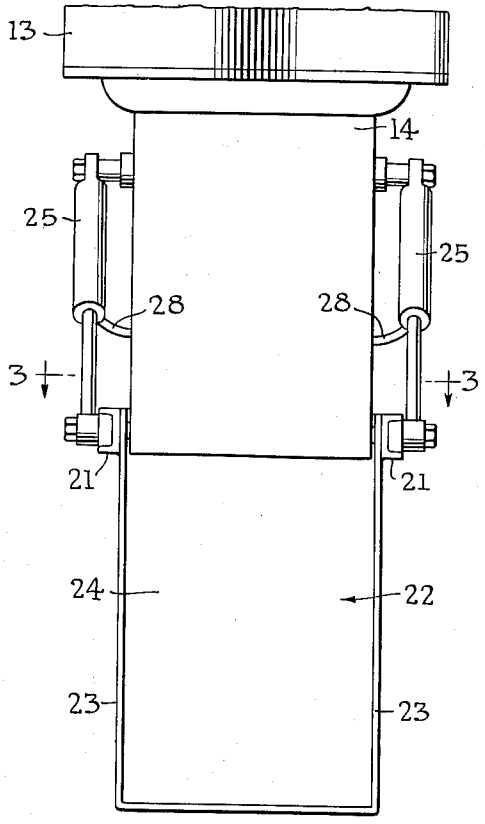


Fig.3

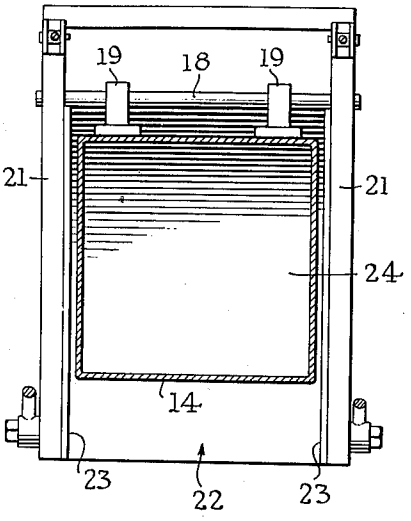
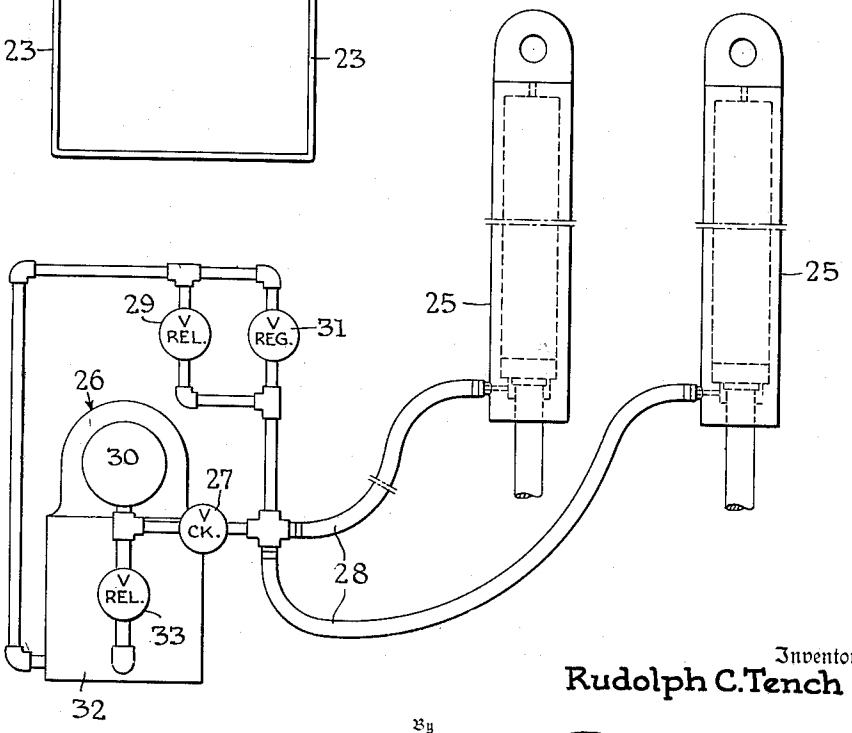


Fig.4



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VARIABLE DELIVERY MEANS FOR LOADING CHUTES

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3 Claims. (Cl. 193—32)

This invention relates to material handling and will be described as applied to loading chutes such as are used at coal piers to load coal into the holds of ships, barges and the like.

In this class of work changes in the height of the tide, and the rising level of coal in the hold each affect the difference of level between the pier-carried conveyor and the level of discharge. Accordingly, it is known practice to deliver the coal through a shiftable pendant tubular chute which is adjustable in length. A telescopic construction is commonly used. These chutes discharge through various types of sluice, or gate, but so far no automatic means to control the discharge rate and thus keep the chute nearly full of coal has been devised.

As a consequence, the coal frequently is subjected tc a long free fall through the chute, or may be discharged from the chute at considerable velocity. These conditions cause serious degradation in size of the coal and occasion losses which it is the prime purpose of this invention to minimize.

The result is secured by controlling discharge from the lower end of the chute in such a way that the chute is kept nearly filled with a descending column of coal at all times. The construction is such that the coal leaves the chute at the lower end thereof at reasonable velocity, and in a nearly horizontal direction.

To bring about the desired result an arcuate scoop-like discharge guide is hinged to the discharge end of the chute, so that it can swing between a closed position, in which it prevents discharge, to an open position in which it deflects discharge through an angle of about 90°; and so that the pressure of a column of coal above it in the chute urges the discharge guide toward its open position.

Motion of the discharge guide is controlled by hydraulic motors which continually urge the discharge guide in a closing direction with a force which can be determined by adjusting the hydraulic pressure. Sudden motions of the guide can be checked by using a fluid pressure check or by throttling the flow of hydraulic fluid to and from the motors, or by both these means.

For each adjusted length of a chute there is a different hydraulic pressure which will properly balance the pressure of the coal, and so cause the discharge guide to shift and maintain nearly even flow while the chute remains full. The specific weight of the coal also is a modifying factor. Hence, it is necessary to provide means to adjust the hydraulic pressure from time to time.

Provision of satisfactory means to adjust and maintain hydraulic pressure would be relatively simple if the source of pressure fluid could be located on the boom from which the chute is suspended. However, it is impracticable to conduct high pressure hydraulic liquid by a chute-carried conduit, because of the customary swivel mounting of the discharge unit at the lower end of the chute, and because of the risk of mechanical injury.

Hence, as a practical matter, pressure must be developed and maintained by means located below this swivel connection and substantially at the discharge guide whose position is controlled. The swivel joint, as customarily constructed, includes a number of slip rings which

make it possible to transmit electrical energy. Hence, according to the preferred embodiment of the invention, pressure is developed by a displacement pump driven by an electric motor.

It is possible to adopt practically any of various known methods to control the pressure developed by the pump, and several of these will be mentioned.

Assuming that the pump runs constantly, relief valves may be used to limit the developed pressure, or the pump may be unloaded intermittently by closing its inlet port. In a piston type of pump the pressure developed may be controlled by holding its inlet valve or its discharge valve continuously open, or by varying the effective stroke between zero and a maximum by any of various known expedients. All these are known in the pump art, and some virtually require the use of a small pressure accumulator. A less desirable expedient is to start and stop the pump.

All these schemes fall in the general class of "unloaders" and practically all are susceptible of control by means responsive to the head pressure developed by the pump, in such a way as to maintain that pressure at a selected substantially constant value. Almost any such arrangement known in the pump art can be used.

Maintenance of uniform pressure and the possibility of adjusting from a remote point the pressure so maintained are important characteristics. In attaining these objectives recourse will be had to commercial apparatus so that the controls need be shown only in diagram, and only as to one of many available embodiments, namely, one using adjustable relief valves with a constantly running pump. This is chosen for illustration because it can be shown quite simply.

A preferred embodiment of the invention will be described having reference to the accompanying drawings in which:

Fig. 1 is a side view of the lower portion of a delivery chute equipped with a hydraulically controlled discharge guide, the guide being shown in its chute-closing position in full lines and its chute-opening position in dotted lines.

Fig. 2 is a front view of the discharge guide and the motors which control its position.

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2.

Fig. 4 is a diagram of an hydraulic system suitable for use with the invention.

Fig. 5 is a simplified diagrammatic showing of an electric circuit which may be employed with the invention.

Fig. 6 is a detailed showing of a form of over-load switch which may be used.

As shown in Fig. 1 the loading device comprises a depending chute **12** which is made up of a plurality of tele scoping sections, two of which are indicated at **12***a* and **12***b*. A housing **13** is carried at the lower end of the section **12***b* and contains therein a plurality of slip rings whereby electric circuits may be completed from the top of the chute **12** to the delivery portion **14** which is adapted to rotate relatively to the chute **12** and the housing **13**.

The chute **12** extends downward from a conveyor boom (not shown) and its inclination to the vertical and its length may be adjusted by manipulation of hoists, there being two such hoists indicated at **15**. It will be understood that there are four hoists, two of which are not visible in the drawings.

The delivery portion **14** is swivelled at its upper end to the housing **13** and is arranged to be rotated through an arc of 360° by means of a motor **16** and driving gear train **17**. A shaft **18** is journaled in bearings **19** mounted on the rear face of the rectangular delivery section **14**. Frame members **21** are secured to the outer ends of the

shaft 18 and are fastened to the upper edge of an arcuate delivery gate 22.

The gate 22 comprises vertical side walls 23 and a curved bottom 24. Hydraulic motors 25 are arranged to react between the delivery portion 14 and the members 21. These motors 25 are effective to close the discharge gate 22 against the bias of the granular material descending through the chute 12.

A hydraulic circuit, such as is shown in Fig. 4, supplies pressure fluid to these motors 25 and is controlled by suitable relief valves. An electrically driven pump 26 supplies pressure to the motors 25 through a check valve 27 and flexible lines 28. Also connected to the pump discharge connection are valves 29 and 31 which control a return line to sump 32.

Valve 31 is a motor adjusted regulating valve and is arranged to be adjusted from a point remote to the gate 22 as will be more fully described. The valve 29 is a solenoid operated relief valve effective to unload the pump 26 in the event that the level of granular material in the chute exceeds a predetermined maximum. Also included in the hydraulic circuit is a valve 33 which is a conventional overload relief valve and has a relief pressure setting which is higher than any of the pressures to which the valve 31 may be adjusted.

The electrical circuit used in conjunction with the invention is shown in diagram in Fig. 5. The pump motor 30 is arranged to be supplied with electrical energy from the power lines through slip rings 34 and 35. Solenoid 36 which operates the valve 29 is arranged to be supplied with electrical energy from power lines through the slip rings 35 and 37 under the control of switch 38, the actuation of which will be described.

The setting of the relief valve 31 may be adjusted by the actuation of a reversible motor 39. The gear train 40 driven by the motor 39 shifts the adjusting nut 41 which controls the force exerted by the spring 42 on the valve 31, thereby changing the pressure at which valve 31 will open. The energization of motor 39 is controlled by a reversing switch 43. This switch is preferably located somewhere on the tower from which the conveyor boom extends. As in the case of the motor driven pump 26 and the solenoid 36, electrical energy is supplied to the motor 39 through slip rings 44 and 45. Slip rings 34, 35, 37, 44 and 45 are enclosed within the housing 13.

Fig. 6 shows the apparatus whereby the switch 38 is actuated. The uppermost section of the delivery chute 12, a fragment of which appears at 12c, is provided on its outer surface with a housing 46 which closes an opening through the side of the chute. The switch 38 is mounted in one surface of the housing 46 and is spring-biased to its open position. A plate 47 which is hinged at its lower edge to the section 12c fills the opening from the chute 12 into the housing 46 and is normally biased into a vertical position, as shown in the drawings, by spring 48.

In the event that coal should reach the level of the plate 47, it will be swung from its normal vertical position into a position in which it will contact the actuating member 49 of the switch 38, thus closing the circuit to the solenoid 36 whereby the relief valve 29 will be opened.

The hydraulic circuit is arranged to be mounted on the rotary delivery portion 14, as is shown in Fig. 1. This is the preferred location of the hydraulic circuit, because it is unnecessary to make elaborate provisions to convey the fluid from the stationary chute 12 to the section 14. A fluid check 51 is provided to prevent sudden movement of the discharge gate 22. This same result would be achieved by throttling the flow in the hydraulic circuit.

The operation of the device is probably clear from the description of the apparatus. However, for purposes of complete understanding, the following description of its operation is made.

The chute 12 is adjusted so that it has the desired inclination and so that the discharge guide is at the proper level by manipulation of the hoists 15. The chute 12 is then filled with granular material such as coal. This level to which the chute is filled is chosen so that the free fall of the material from the conveyor into the chute is kept to a practicable minimum, thus keeping the degradation of particle size, because of breakage, to a minimum.

It will be seen that the granular material in the chute 12 biases the discharge gate 22 toward its open position. The hydraulic motors 25 act to oppose this bias, and are adjusted by the setting of the regulating valve 31 to produce a closing bias on the discharge gate 22, thus controlling the opening of the gate 22 so that proper amount of material is maintained in the chute.

The lower end of the chute 12 is always open; the flow of material being arrested by assuming an angle repose beyond which the weight of material in the chute 12 is incapable of pushing the material in the discharge gate. This is an important feature because it enables large pieces of material to pass through the gate, even though the gate 22 may be near the position in which the flow of material will be interrupted.

In effect the hydraulic circuit operates to provide a variable counter-balancing force to oppose the bias of the weight of material in the chute. The ability to change the setting of the regulating valve 31 from a point on the tower is advantageous because it enables an observer who can see the level of material in the chute to make a direct adjustment of the discharge rate from the gate 22 even though it may be hidden from his view.

As stated earlier, the precise form of the control devices and of the hydraulic circuit is a matter of choice, and various control devices and circuits may be used to produce the desired result, i. e. a variable hydraulic force effective to bias the discharge gate toward its closed position.

I claim:

1. In a loading device of the type including a tubular chute affording a confined path for the descent of granular material, a gate hinged at the discharge end of said chute, and angularly adjustable to vary the rate of discharge from said chute between zero and a maximum, the parts being so arranged that the weight of the column of material in the chute biases said gate toward its open position; a counterweighting device for said gate comprising in combination an expansible chamber motor connected to be moved by said gate as the latter moves; and means to supply pressure fluid to said motor to develop therein a selected pressure which resists said bias.

2. The combination defined in claim 1 in which said pressure fluid is a liquid and the means for developing pressure therein comprises an hydraulic circuit including a pump arranged to supply fluid to said motor, and adjustable means to maintain a selected pressure in said motor.

3. The combination with the structure of claim 1 of means operable from a point remote from said gate, for adjusting the fluid pressure effective in said motor.

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