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CUPOLA CONTROL AND CHARGING APPARATUS

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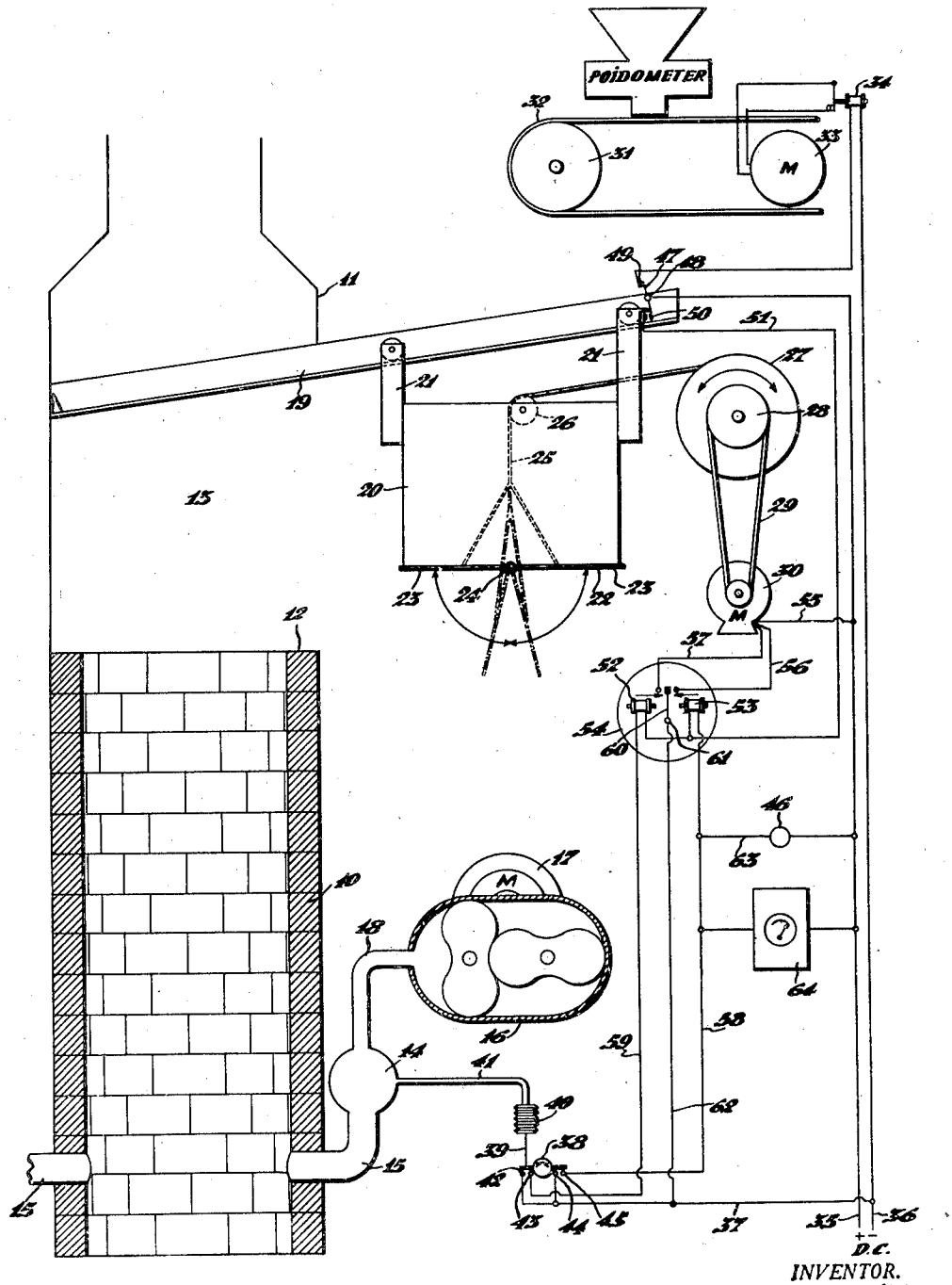

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CUPOLA CONTROL AND CHARGING APPARATUS

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1

This invention relates to an apparatus for indicating when a cupola needs additional charging and for charging it, when necessary, automatically. This is to say that the invention may be used only as a signalling means or only as a charging means, or as a simultaneous signalling and charging means.

The object of the invention is to provide a means whereby the necessity for additional charging is made evident, so that additional metal, ore or the like may be added at the correct time. As will hereinafter appear, the addition may be made by hand or by automatic means. In either case, the capacity of the cupola can be raised provided that there is prompt obedience to the signal on the part of the crew manning the cupola. In the case of automatic charging, greater efficiency and less labor is an inevitable consequence over the usual operating conditions.

Although this invention may be used on all kinds of metallurgical cupolas and vertical shaft furnaces, it was made with particular reference to the manufacture of mineral wool. In this industry, rock or slag is melted while being carried upon a bed of coke or coal within a cupola. A blast of air is provided from a blower, the latter being usually electrically driven. After the slag is melted or fused, it descends through the fuel bed, is withdrawn from the cupola, formed into one or more streams and drawn into fibers by the force of a steam jet.

The principle upon which this invention is founded is based upon the fact that when the air blast is supplied by a constant displacement blower the resistance to the air blast created by the burden of the cupola results in a difference in pressure which is relative to the amount of burden still remaining. As the charging cycle is completed the pressure differential thus formed decreases due to a reduction of the resistance offered by the burden and is sharply increased upon recharging. The onset of this condition is quite sudden so that it may be sharply detected with the proper instruments. In this invention I have not only provided such instruments but have also utilized their ability to set into motion various other devices to correct the condition that led the detecting device to function. The system is again restored to its previous condition and is ready for another cycle.

In the drawing 10 is a cupola or vertical shaft furnace which is provided with an upper stack 11 which is at a substantial vertical distance from the upper edge 12 of the cupola, thereby leaving an open space 13 which is technically known as

2

a charging section. A bustle pipe 14 encircles the cupola near the bottom and is in communication with tuyères 15 through which air is supplied to the interior of the cupola at a constant rate. A constant displacement blower 16 is driven by an electric motor 17. The blower is connected to the bustle pipe through a duct 18. By this arrangement a definite fixed volume of air is supplied to the cupola regardless of the amount of burden which may be in it at any given instance. The resistance encountered by the blower varies, however, i. e., the more burden within the cupola, the higher the air pressure within the duct 18 and the bustle pipe 14 is required.

Just above the charging space 13 there is a rail 19 which is part of a monorail conveying system. This system comprises the rail and a charging bucket 20 which runs thereon by means of wheeled hangers 21. Since the rail 19 is inclined, its lowest point being at the cupola end, the wheeled hangers 21 are of different lengths so that the bucket 20 is supported vertically and level. A hinged bottom 22 is provided for the bucket, there being two flaps 23 which are hingedly pivoted on a shaft 24. A cable 25 is attached to each of the flaps 23 and runs over a shaft and pulley 26 which is supported by the upper rim of the bucket. The cable parallels the beam 19 and runs over the drum 27 of a winch 28 which is driven through a belt or chain 29 by a motor 30.

Above the rail 19 and just above the point where the bucket comes to rest at the top of its travel, as shown in the drawing, there is a pulley 31 over which a poidometer conveyor belt 32 runs. A poidometer is a convenient device for the continuous weighing of a loaded moving belt, which regulates the load on the belt. This belt is for the purpose of delivering a correctly pre-mixed charge of coke and slag or other material to be loaded to the charging bucket 20. The entire poidometer is driven by an electric motor 33, the circuit of which is controlled by a solenoid switch 34, the rate of delivery of pre-mixed charge composition being co-ordinated with the average charging cycle of the cupola such that the bucket 20 is being filled in the interval of time before the next charge is required in the cupola.

Electric circuit

A two-main supply circuit of which the positive main is 35 and the negative main is 36 powers the electric circuit about to be described. A

negative lead 37 is connected to a mercury switch 38 of the four-wire type. The left end of switch 38 is attached by a chain 39 to an air operated bellows 40. When the bellows is half extended, no contact is made within the glass envelope of the switch. The upper end of bellows 40 is connected by means of a pressure transmitting tube 41 to the interior of the bustle pipe 14 so that the fluid pressure existing within the bustle pipe is transmitted to the interior of bellows 40, to extend that member or to allow its contraction by its own natural resilience. The contacts in switch 38 are respectively from left to right, 42, 43, 44 and 45, it being understood that all such contacts are within the glass envelope of the switch. The circuit is intended to be arranged that when contacts 42 and 43 are immersed in mercury there will be no signal or impulse transmitted to the warning device which may be an electric lamp 46 or to the motor 30 which controls the travel of bucket 20, and therefore the charging of the cupola. When contacts 44 and 45 are immersed it is intended that the motor 30 shall be energized and the lamp 46 lighted.

Likewise when the bucket 20 is at the top of its travel on the inclined beam 19, it is intended that the solenoid switch 34 shall close the circuit of motor 33, thereby causing the poidometer 32 to deliver material which will be dumped over pulley 31 and dropped into bucket 20. Closing of the circuit for motor 33 is accomplished by a spring pressed make and break switch 47 which is in series with the positive main 35 from its pivot 48 to its upper contact 49. By its lower contact 50 it is in series with a third lead 51 which runs to the left hand one 52 of a pair of solenoids, the other being 53 which are part of a double solenoid switch 54. When the upper contact of switch 47 is closed, the lower one is also closed, and vice versa.

The motor 30 is connected by a lead 55 to main 35 and to the right hand solenoid of switch 54 by a lead 56. The left hand solenoid is connected to the motor by a lead 57, the three leads being necessary for the two-directional operation of the motor. Solenoid 53 is connected with contact 45 by a lead 58. Solenoid 52 is connected with contact 43 by a lead 59. A movable contact arm 60 which is pivoted at 61 is connected by a lead 62 to lead 37. A lamp 46 is connected between lead 58 and main 35 by a lead 63. A recording instrument 64 adapted to record a log of the operation of the cupola, may be connected between lead 58 and main 35.

Operation

As the pressure existent in the bustle pipe 14 decreases, due to fusion and withdrawal of the cupola burden, the bellows 40 contracts, thereby activating (tipping) the mercury switch 38 in such a manner as to make contact with the leads 44 and 45, thereby activating the solenoid 53 and signal lamp 46. Activation of solenoid 53 then starts motor 30, unwinding cable 25 and allowing bucket 20 to traverse rail 19 by gravity until the bucket 20 reaches the lowermost point of travel. Thereupon the bucket 20 is caused to stop while the cable 25 continues unwinding, thereby allowing bucket doors 23 to open so that the bucket deposits its contents within the cupola 10.

Upon deposition of the charge in the cupola 10, sufficient pressure is created within the bustle pipe 14 due to the increased resistance offered by the new charge to the air flow supplied by the blower 16. Thereupon the bellows 40 expands to tip the mercury switch 38, breaking contacts 44 and 45 and making contacts 42 and 43 which energize solenoid 54. This operation reverses motor 30 and winch 28, closing the doors of the bucket 20 by lifting them with cable 25 and pulls the bucket up the rail 19 to its original position. There it breaks contact 50, interrupting the circuit supplying the solenoid 54 while closing the contact 49 and energizing the solenoid switch 34 to close it. Motor 33 is then energized which drives poidometer 32, carrying a new weighed charge of proportioned slag, coke or other materials across pulley 31 and deposits this charge in the bucket 20. The cycle is now complete and is again set into operation when the pressure in the bustle pipe 14 decreases.

From the foregoing, it is now evident that the discovery of the sudden air-pressure drop in the cupola when the charge of slag and fuel is exhausted has been utilized to provide automatic means for ascertaining the condition and automatically recharging the cupola. The invention eliminates much of the loss of time consequent upon depending upon the skill of the operator alone in detecting the condition. This was for the most part done by observation of the volume of molten slag delivered from the bottom of the cupola. This involved a very substantial lag in time before the condition became apparent to the operator. It was impossible to get any reliable indication by looking into the cupola from the charging deck since the flames made it impossible for the operator to go close enough for a view into the charged zone.

I claim as my invention:

1. In combination, a cupola of the metallurgical type having tuyères, a constant displacement type blower arranged to deliver a blast of air into said cupola through said tuyères, pressure responsive means arranged to detect a change in the pressure of the blast of air, an electrical circuit associated with said pressure responsive means, a second electrical circuit operatively interconnected with the first, an electric cupola charging means associated with said second electrical circuit, and means for controlling the second electrical circuit from the first electrical circuit in response to actuation of said pressure responsive means whereby said charging means may be actuated in response to a drop in the pressure of the air blast.

2. In combination with a cupola of the metallurgical type having tuyères, a constant displacement type blower arranged to deliver a blast of air into said cupola through said tuyères, a bellows arranged to detect a substantial change in the pressure of the air blast, an electric circuit including a switch actuated by said bellows whereby an electrical impulse is sent through said circuit when the pressure of the air blast drops below a predetermined value, and electrically actuated means responsive to said impulse for charging the cupola and thereby causing the restoration of the cupola to a condition in which the pressure of the air blast will be above the aforesaid predetermined value.

3. In combination with a cupola of the metallurgical type having tuyères, a constant displacement type blower connected thereto, a motor for driving same, a bustle pipe encircling the cupola, an air pressure transmitting pipe having one end in operative connection with said bustle pipe, an extensible bellows operatively connected to the outer end of said pressure transmitting pipe,

an electric switch of the mercury four-wire variety operatively connected to said bellows, an electric circuit operatively connected to said switch and said bellows, an electric motor, a power circuit connected to said motor, a two-way relay connecting the first mentioned electric circuit and said power circuit, a winch operatively connected to said motor, a charging bucket, a monorail system inclined by extending to said cupola a charging bucket on said monorail, a cable connecting the operating mechanism of said bucket with said winch whereby upon the closing of the mercury switch in response to a contraction of said bellows the relay energizes the motor to drive said winch, unwind said cable, thereupon allowing said charging bucket to traverse down the incline of said monorail system; a poidometer over the topmost portion of said monorail system, an electric motor driving said poidometer, a relay controlling said motor and a limit switch mounted substantially at the topmost point of traverse of said bucket whereby when said switch is closed by the incidence of said bucket thereupon the last mentioned relay is actuated to set the poidometer into operation.

4. In combination with a cupola of the metallurgical type in which the blast is furnished by a constant volume blower and in which the air is injected through a bustle pipe, a pressure transmitting pipe communicating with the interior of the bustle pipe, an extensible bellows at the end of the transmitting pipe and operatively connected thereto; a tiltable mercury switch having at least four contacts arranged to be tilted by the action of said bellows, an electric circuit responsive to the tilting of said switch, an electric motor, a pulley connected thereto, a reversible connection for said motor included in said electric circuit, a cable adapted to be wound by said motor, a charging bucket of the bottom opening type adapted to be pulled by said cable to move the bucket and to be discharged by slackening of the cable, an overhead rail for the traverse of said bucket, said rail being mounted in a slanting position to provide a downhill path to the cupola, a make and break contact included in the circuit and mounted substantially at the top of the rail, a poidometer mounted over the top of the bucket and rail at substantially the topmost position that said bucket assumes, a motor for said poidometer, said motor and said previously mentioned pulley-driving motor being so connected in the circuit that said poidometer motor will operate to discharge material into said bucket while the latter is at rest at the top of its travel on the rail and the pulley-driving motor is at rest.

5. In combination with a cupola of the metallurgical type, a constant displacement blower connected to said cupola and connected to force a blast of air through a charge therein, pressure responsive means arranged to detect a change in the pressure of the blast of air delivered from said blower to said cupola, an electrically operated means for charging said cupola, and an electrical circuit actuated by said pressure responsive means to control said charging means, whereby said charging means is actuated in response to a drop in the pressure of the blast of air.

6. In combination with a cupola of the metallurgical type, a constant displacement blower connected to said cupola and adapted to force a blast of air through a charge therein, a bellows arranged to detect a change in the static pressure of the blast of air delivered therefrom, an electrically controlled means for charging said cupola, and an electrical circuit actuated by said bellows to control said charging means, whereby the charging means is actuated in response to a drop in the pressure of the blast of air.

7. In combination with a cupola of the metallurgical type having tuyères, a constant displacement type blower arranged to deliver a blast of air into said cupola through said tuyères, a bellows arranged to detect a change in the static pressure of the blast of air, automatic means for charging the cupola, and means associated with said bellows for actuating said charging means to charge the cupola in response to a drop in the pressure of the air blast.

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