Oct. 5, 1965 R. C. PENNER 3,210,129

METHOD AND APPARATUS FOR INJECTING MATERIAL INTO FURNACES

Filed March 26, 1963 2 Sheets-Sheet 1

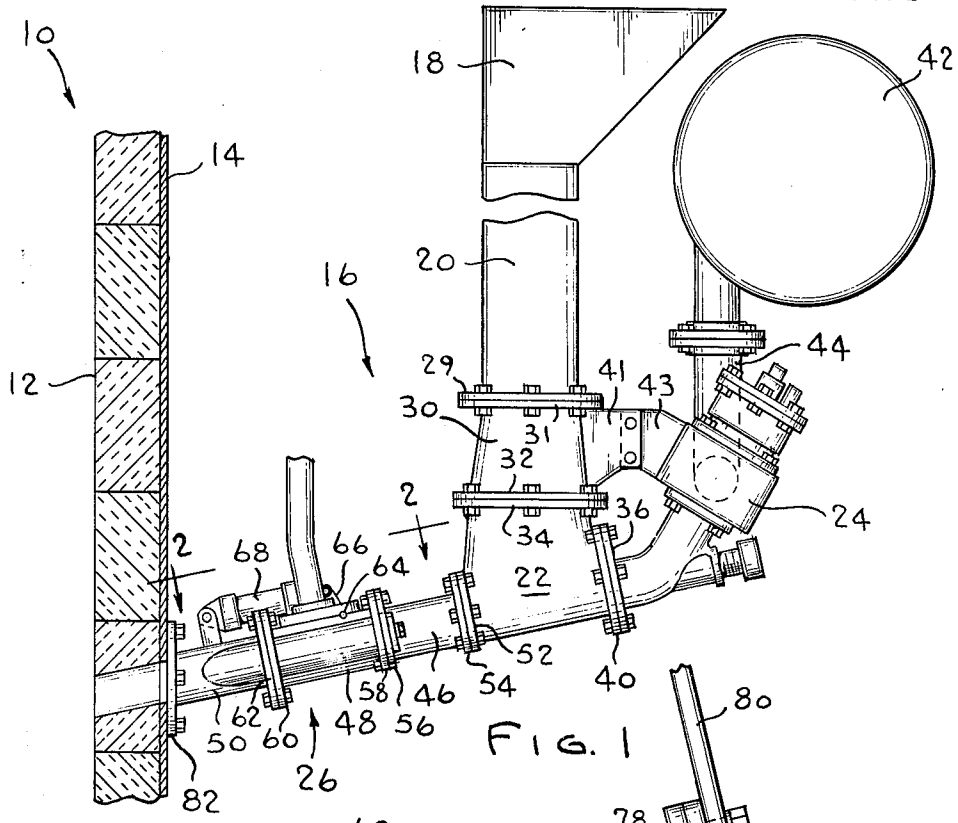


FIG. 1

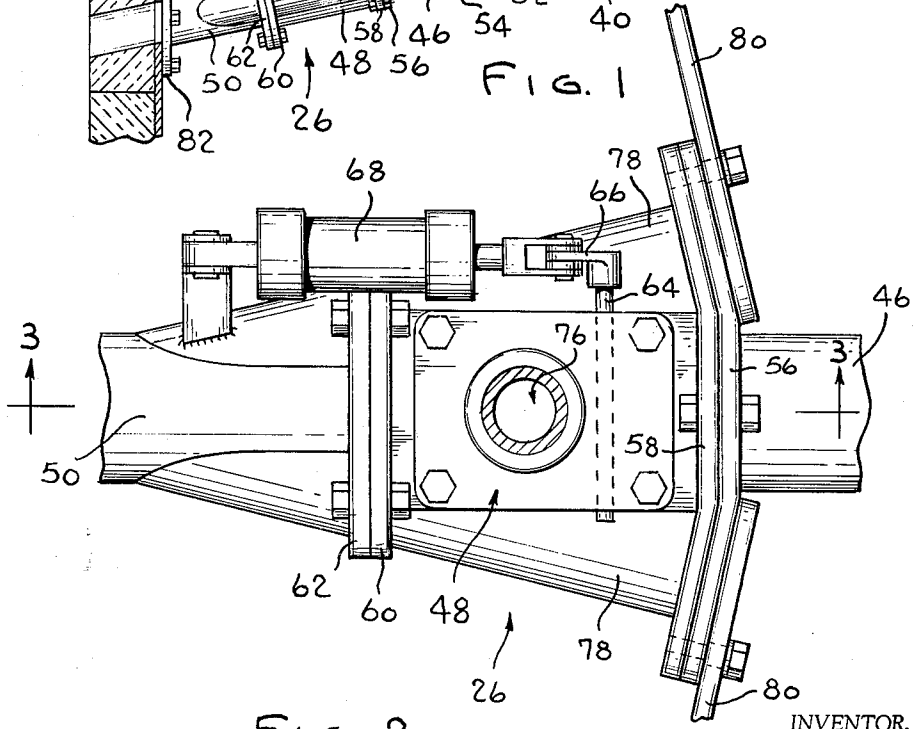


FIG. 2

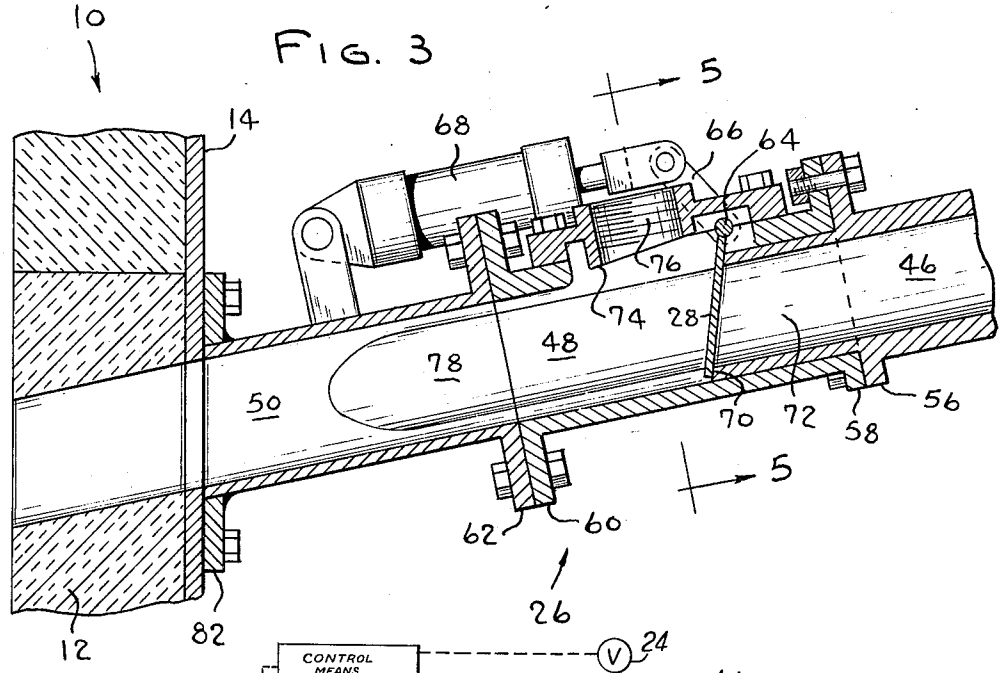
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FIG. 3



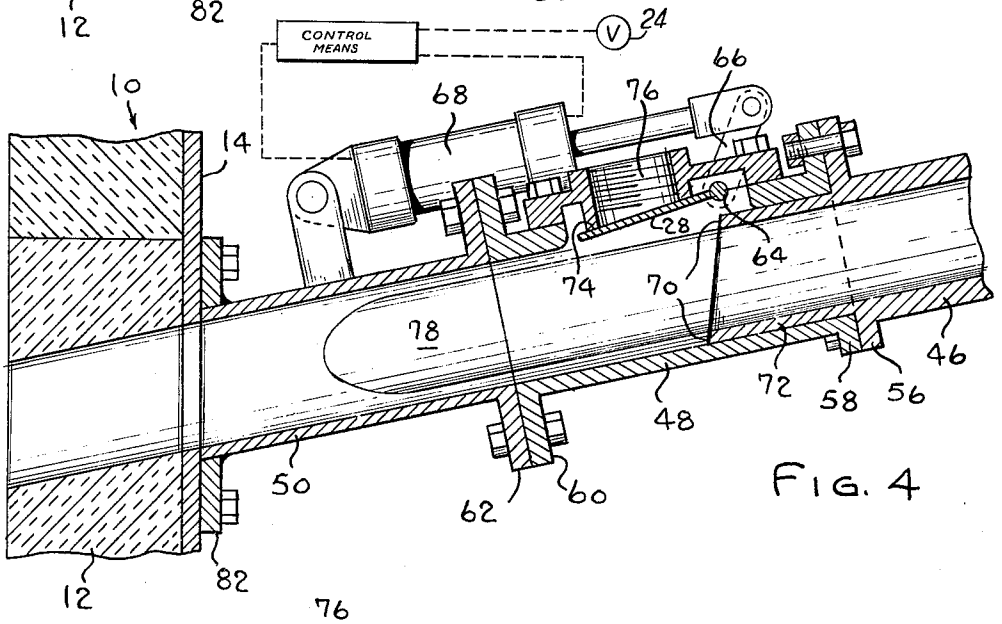


FIG. 4

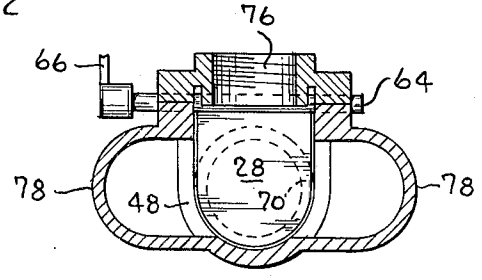


FIG. 5

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METHOD AND APPARATUS FOR INJECTING MATERIAL INTO FURNACES

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9 Claims. (Cl. 302—36)

This invention pertains to an improved method and apparatus for injecting borings, chips and/or other material into cupolas and other types of furnaces for remelting therein.

In particular this invention pertains to chip injectors which are adapted to be secured to a cupola and which utilize pneumatic power to periodically inject a given charge, generally consisting of metallic chips and/or borings, into the melting zone of the cupola. The size of the charge is dependent upon the size of the equipment and upon the amount and duration of the air pressure. The frequency of injection is generally dependent upon the melting rate within the cupola.

The basic components of a chip injector are, a hopper which communicates with a charging chamber for delivery of the chips thereto from which the chips are injected through a delivery pipe into the cupola. For this purpose a supply of high pressure air is provided in the charging chamber at predetermined intervals, the air supply being controlled by means of an air control valve.

A valve is provided in the delivery pipe (between the cupola and the charging chamber) to shield the charge from the radiant heat and hot fumes within the cupola and thus prevent the melting or burning of the chips nearest to the source of heat. In the chip injectors known heretofore, this valve was a simple gravitationally closing flapper or check valve which was pushed open by the charge hitting its one face during the injection and which dropped in the closed position when the air pressure decreased within the charging chamber after the injection. The principal trouble encountered with this valve was that chips or other charge material tended to lodge themselves between the valve and the valve seat or in the valve hinge mechanism thus preventing its full closure. On such occasions flames and/or hot gases entered the charging chamber thereby tending to melt or burn some of the charge and impair the proper operation of the injector. Another problem was created by chips which tended to force themselves against the flapper valve thereby creating a gap between it and its seat which permitted some of the chips to escape, which in turn tended to fuse to the delivery pipe and also impair the operation of the chip injector.

The equipment known prior to this invention required a valve which had to be actuated to close the communication between the hopper and charging chamber during the injection of the charge into the cupola and which had to be opened after the injection to refill the charging chamber for the next charge. This valve prevented the high pressure air from escaping through the standpipe and hopper during the injection of the charge.

The principal object of this invention is to provide a simplier and better chip injector, principally by eliminating the valve between the hopper and the charging chamber, thereby reducing both its manufacturing and maintenance costs, and by improving the design and operation of the flapper valve in the delivery pipe.

In essence, this object is attained by a hopper design which permits the material contained therein to block the escape of the high pressure air therethrough, and by a positively actuated flapper valve which is opened and closed by means independent of the charge and air pressure. The independent actuation of the flapper valve also

permits a greater quantity of chips to be injected per unit of pressure than with comparable size equipment used heretofore, since all of the air pressure is utilized in moving the chips, and no energy is lost in opening the flapper valve.

Thus, another object of this invention is to provide a more efficient chip injector and a more efficient method of chip injection.

A further object of this invention is to provide a chip injector which may be adapted to provide various size charges.

This versatility is attained by removably placing a spacer section between the charging chamber and the flapper valve thereby providing an extension of the charging chamber into which part of the charge delivered from the hopper enters and from which it is injected into the cupola upon actuation of the control valve. By varying the size of the spacer section, the size of the charge may be effectively varied.

Further objects and advantages of the invention will be pointed out in or be apparent from the specification and claims, as will obvious modifications of the single embodiment shown in the drawings, in which:

FIG. 1 is a view of the chip injector in side elevation and a fragment of the cupola shell to which it is attached,

FIG. 2 is a view of the flapper valve section of the delivery pipe in top elevation with parts of the delivery and spacer sections being broken away,

FIG. 3 is a view taken on line 3—3 of FIG. 2 with the flapper valve in a closed position,

FIG. 4 is a view as shown in FIG. 3 with the flapper valve in an open position as assumed during injection of the charge; and

FIG. 5 is a view on line 5—5 of FIG. 3.

Referring to the drawings, FIG. 1 shows a fragmentary section of a cupola side wall **10**, comprised of cupola lining **12** and an external shell **14**, and a chip injector **16** operably secured to the cupola. The basic components of the injector are a hopper **18** and a standpipe **20** by means of which the material to be injected is conveyed to a charging chamber **22**, a pneumatic control valve **24** by means of which high pressure air is introduced into the charging chamber for injecting the charge into the cupola through a delivery pipe **26**, and a flapper valve **28** which closes the delivery pipe during the time intervals between injections.

The hopper **18** is removably secured to or made integral with the standpipe **20**, which for reasons hereafter explained, is of a length of approximately ten feet or more. The standpipe is removably secured to a cast section **30** by means of two mating flanges **29** and **31**. This section in turn is removably secured to the charging chamber **22** by mating flanges **32** and **34**. During operation, the hopper is loaded with chips, borings and/or other material which tend to freely fall down the standpipe and into the charging chamber to form a "stack" of material extending from the bottom of the charging chamber upwardly in the hopper or for at least a substantial distance within the standpipe. The hopper is frequently refilled to always maintain a certain amount of material within the standpipe.

The control valve **24**, preferably a differential type blow valve, is secured to the charging chamber **22** by means of two mating flanges **36** and **40**, and to the section **30** by means of ears **41** and **43**. The valve has an air receiver **42** attached thereto by means of a pipe **44**. Upon actuation of the control valve a steady short blast of air under pressure enters the charging chamber from the air receiver and for its duration forces the bottom portion of the "stack" of material contained in the charging chamber through the delivery pipe **26** into the cupola.

The delivery pipe **26** is comprised of three separate

sections, a spacer section **46**, a flapper valve section **48** and a connecting section **50**.

The spacer section is removably secured by means of mating flanges **52** and **54**, and **56** and **58** to the valve section and charging chamber respectively, and forms an auxiliary charging chamber in that a portion of the material conveyed from the hopper will tend to fill the spacer section and will be injected into the cupola upon actuation of the control valve **24**. By varying the size (length) of the spacer section **46** the size of the charge may be varied, thus providing a certain versatility to the chip injector.

The valve section **48** is secured to the spacer pipe as described above and secured to the connecting section by mating flanges **60** and **62**. This section contains the flapper valve **28** which is pivotally mounted therein by pin **64** and which is fixed to link **66** for actuation by an automatically controlled pneumatic cylinder **68** between the closed position as shown in FIG. 3 and the open position as shown in FIG. 4.

In the closed position the flapper valve is forced by the cylinder **68** against a seat **70** which is formed by the slanted end of an extended portion **72** of the spacer section **46**. In the open position the flapper valve is removed from the path of the charge passing through the delivery pipe and is forced against an auxiliary seat **74** to close a wind box opening **76** in the section side wall through which cooling air is delivered to the delivery pipe from the wind box (not shown) during the time intervals between charging.

The valve section is also provided with two sidewardly extending portions **78**, **78** in which peephole apertures are provided which may be opened by handles **80**.

The connecting section **50** is secured to the cupola side wall **10** by means of a curved mounting flange **82** which abuts against and conforms to the curvature of the cupola shell. This section may be secured to the cupola by either studs welded to the shell which are engaged in corresponding apertures in the flange or by welding the flange **82** to the shell **14**.

Operation

First the hopper is loaded with chips, borings or other material thereby filling the charging chamber **22** and at least a portion of the spacer section **46** to form a "stack" of charging material extending from the charging chamber into the standpipe. After the filling, the chip injector is ready for operation.

Before injection of the charge into the cupola, the flapper valve **28** is held against the seat **70** thereby positively closing the delivery pipe and shielding the charge contained in the spacer section **46** and the charging chamber **22** from exposure to radiant heat and hot fumes from the cupola. Also, at this time cooling air is delivered from the wind box to the cupola side of the flapper valve through opening **76**.

Just prior to actuation of the control valve **24** for delivery of high pressure air, the cylinder **68** is actuated to pivot the flapper valve away from seat **70** and against the auxiliary seat **74** thereby fully opening the delivery pipe and closing the wind box opening **76**.

After the flapper valve is opened, the control valve **24** is actuated to deliver a steady short blast of high pressure air into the charging chamber **22** which, for its duration, forces the material contained in the charging chamber **22** and spacer section **46** through the delivery pipe **26** into the cupola in a free mass of discrete particles. The duration of the blast in practice is controlled by an automatic electric timer (not shown) and may last up to one or two seconds. During this charging, some of the pressure in the charging chamber will expand upwardly through the chips in the standpipe, and depending upon the amount of chips in the standpipe will momentarily surge them upwardly.

Because the flapper valve has been opened before the charging blast commences, the chips are free to move through the delivery pipe immediately upon initiation of the air blast, and therefore the upward surge in the standpipe is relatively minimal, as compared to the surge which would result should the flapper valve be opened by the air blast. It is also of note that by opening the flapper valve independently of the air blast, substantially all of the compressed air energy is utilized in injection of the material into the cupola. In the chip injectors used heretofore, the initial air blast forced the chips within the charging chamber against the flapper valve with such a momentum, that the charge entered the cupola as a briquette type slug, as compared to dispersed separate particles injected with the device embodying the present invention. Also, by removing the flapper valve from the path of the charge prior to its injection, attrition of the valve is substantially minimized.

A short time interval after the control valve **24** has been closed, the cylinder **68** is actuated to pivot the flapper valve **28** against the seat **70** and close the delivery pipe. The time interval between the cessation of delivery of compressed air and the closing of the flapper valve permits the pressure in the charging chamber to drop to normal, and the air under pressure in the standpipe to escape through the delivery pipe. The positive closure of the flapper valve, after this interval, effectually blocks any dribble of chips after the injection cycle or any splatter of chips that may result from the chips descending from the hopper. In chip shooters used prior to the invention, this dribble or splatter from the descent of the chips caused difficulties because the chips tended to force a gap between the flapper valve and its seat and produce a splatter of chips on the cupola side of the valve where they would fuse to the delivery pipe and impede or block the delivery of the charge.

It should be apparent to those skilled in this art that the frequency of actuation of the control valve and the actuation as well as timing of the opening and closing of the flapper valve can be provided and varied by electrical as well as other control means, such as timers, limit switches, etc.

It is also within the contemplation of this invention that the flapper valve **28** is held in the closed position against seat **70** by a pneumatic cylinder which presses the flapper valve against the seat and which is disengageable therefrom prior to the actuation of the control valve **24**, whereupon the flapper valve is moved to an open position by a spring. After the injection of the charge, the cylinder again will engage the flapper valve and force it against the bias of the spring into engagement with the seat **70**. In this variation the speed of opening the flapper valve would not be dependent upon the actuation speed of the cylinder since upon disengagement of the cylinder from the valve, the latter could snap to the open position at a faster speed than the speed of the cylinder.

Although but one embodiment of the present invention has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

I claim:

1. A chip injector for injecting charging material into a furnace comprising,

a charging chamber adapted to hold charging material therein prior to its injection,

a delivery pipe in communication with said charging chamber and the inside of the furnace,

normally closed valve means in said delivery pipe for shielding the material in said charging chamber from the heat within the furnace,

means for intermittently supplying high pressure air to said charging chamber to thereby cause the air to convey the material contained in said charging chamber through said delivery pipe and into the furnace,

means independent of said high pressure air in said charging chamber for opening and closing said valve means thereby permitting substantially all of said high pressure air to be utilized for conveying said material in the charging chamber into the furnace, and control means to maintain said valve in the open position for a time interval which is longer than the time interval during which said means for supplying high pressure air does supply such air to said chamber.

2. A chip injector for injecting charging material into a furnace comprising,

a chamber in communication with the inside of the furnace and adapted to hold the charging material to be injected therein,

a normally closed valve located between the material in said charging chamber and the inside of the furnace to prevent the material from being subjected to heat and hot gases from the furnace,

means for intermittently supplying high pressure air to said chamber to convey material contained therein into the furnace,

means independent of said high pressure air in said chamber for opening and closing said valve thereby permitting substantially all of said high pressure air to be utilized in conveying the material into the furnace, and

conduit means in communication with said chamber for delivering charging material to said chamber and for confining the material to form a stack which extends from said chamber into said conduit means to thereby cause the material to prevent substantial escape of said high pressure air through said conduit means during the supplying of said high pressure air to said chamber.

3. A method of injecting charging material into a furnace by a chip injector having a charging chamber in communication with the inside of the furnace and having a valve operable to close the communication, comprising the steps of,

supplying the charging material to the charging chamber while the valve closes the communication between said charging chamber and the inside of the furnace,

opening said valve,

supplying high pressure air to said charging chamber after said valve has been opened to inject the charging material into the furnace,

stopping the supply of said high pressure air, and

closing said valve.

4. A method according to claim **3** wherein said valve is closed after the supply of said high pressure air has been stopped.

5. A method of injecting charging material into a furnace by a chip injector having a charging chamber in communication with the inside of the furnace and having a valve operable to close the communication, the chip injector also having a standpipe in communication with the charging chamber and adapted to be filled with charging material to be injected into the furnace, comprising the steps of,

delivering the charging material to the standpipe and charging chamber,

actuating the valve between said charging chamber and the inside of the furnace to open the same,

supplying high pressure air to said charging chamber after the actuation of said valve to inject the material into the furnace,

maintaining sufficient material in the standpipe to block material escape of said high pressure air through said standpipe,

stopping the supply of said high pressure air, and

closing said valve.

6. A method according to claim **5** wherein said valve is closed after the supply of said high pressure air has been stopped.

7. A chip injector according to claim **1** wherein said control means cooperates with said valve to maintain said valve in an open position before and after said means for supplying high pressure air has ceased supplying such air.

8. A chip injector according to claim **2** including control means for actuating said independent means to maintain said valve in the open position for a time interval longer than the time interval during which said means for supplying high pressure air to supply such air to said chamber.

9. A chip injector according to claim **8** including a pipe in communication with and located between said charging chamber and the inside of the furnace, and a port in said pipe having valve seat means on the inside of said pipe, said port being adapted for the delivery of cooling air to said pipe, said port being maintained open to deliver such cooling air when said valve is in its normally closed position and said valve cooperating with said seat to close said port when said valve is moved to its open position.

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