United States Patent

Fuminier

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[54] DEVICE FOR COATING FOUNDRY MOULDS

[72] Inventor: **Claude Fuminier,** Pont-A-Mousson, France

[73] Assignee: **Centre De Recherches De Pont-A-Mousson,** Pont-A-Mousson, France

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[52] **U.S. Cl.** **118/318**

[51] **Int. Cl.** **B05b 13/06**

[58] **Field of Search** 118/317, 318, 254, 416

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Primary Examiner—Henry S. Jaudon

Attorney—M. J. Dlattre-Seguy

[57] **ABSTRACT**

Device for applying liquid coating product to a foundry mould. A coating product projecting apparatus is connected to a product supply vessel through one chamber of a diaphragm pressure exchanger. The other chamber of the pressure exchanger on the other side of the diaphragm is connected to a control fluid supply pipe in which the pressure of the control fluid can be cut off. A flow regulator is inserted in the control fluid pipe and a return pipe connects the projecting apparatus to the vessel.

9 Claims, 5 Drawing Figures

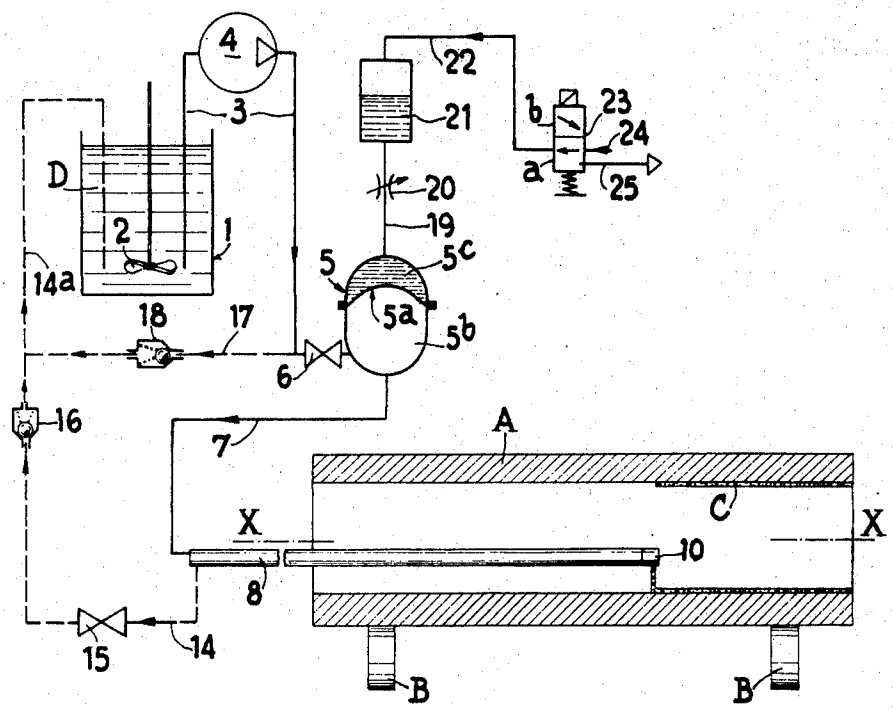


Fig.1

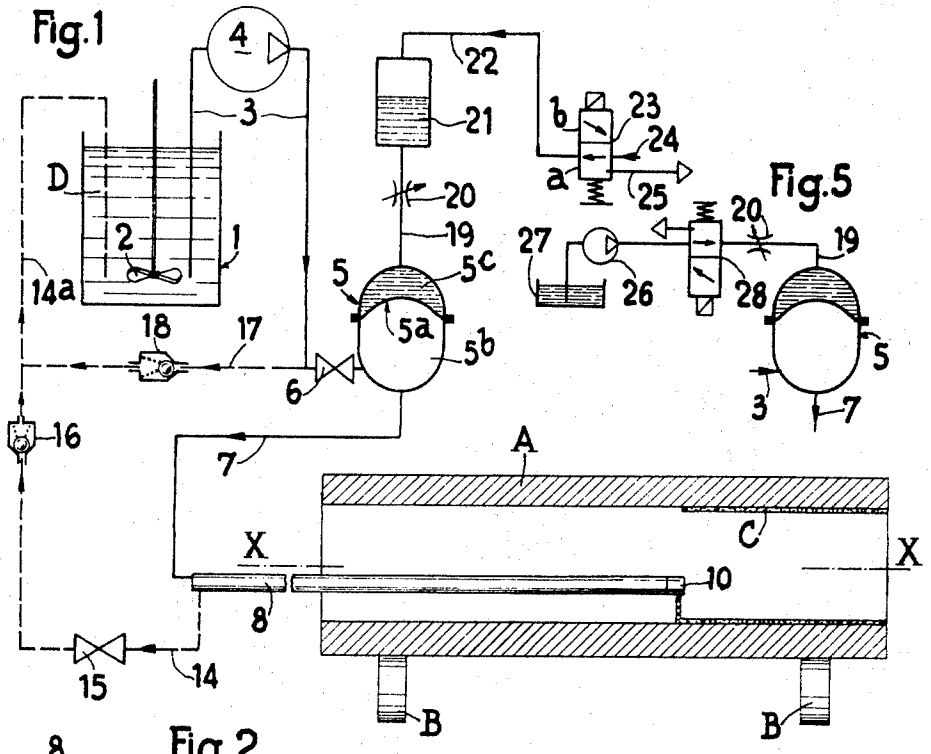


Fig.5

Fig.2

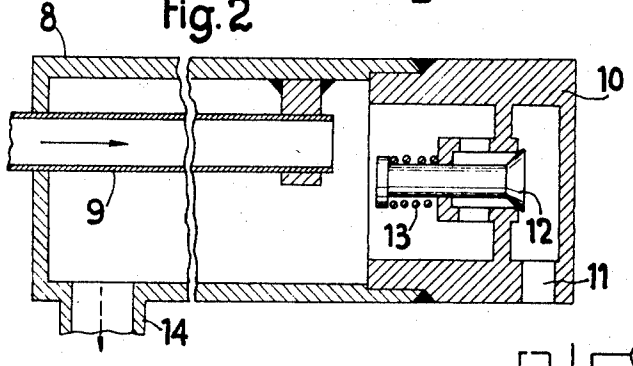


Fig.3

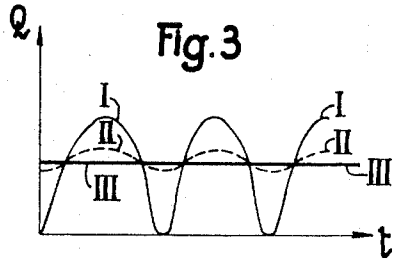
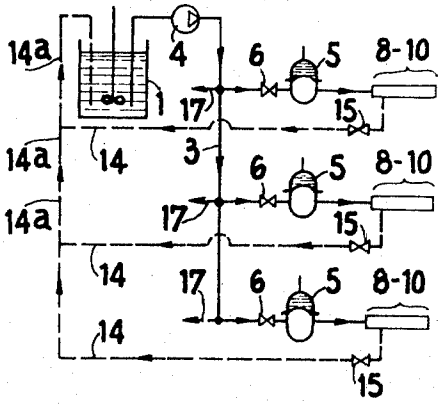


Fig.4



INVENTOR
Claude FUMINIER
By J. Delattre-Segny
Attorney

DEVICE FOR COATING FOUNDRY MOULDS

The present invention relates to the coating of foundry moulds and more particularly to devices for feeding from a supply vessel and spreading over the inner face of a mould or shell a liquid coating product such as a mixture of silica and bentonite in suspension in water.

A coating product of this type always has a tendency to settle. The solid deposits agglutinate into masses or plugs and stop up the supply pipes and the apparatus for projecting the coating product in the mould. This drawback is particularly serious when the projecting apparatus is a spraying gun of the paint spraying type. The known method requires a continuous flow in the distributing pipes and in the spraying gun so as to ensure a constant mixing or agitation of the mixture and thereby avoid stagnation which encourages the decantation and settling of the solid particles.

Some known devices operate with a constant liquid coating mixture supply pressure. Consequently, if the pipes and projecting apparatus are obstructed, the flow diminishes or even stops, the pressure being insufficient to push out the solid deposits. The flow is consequently uneven.

Other devices employ a displacement pump, generally having a diaphragm, for supplying the coating liquid under pressure to the projecting apparatus. The flow is then pulsatory and the liquid product is applied in layers of uneven thickness.

The object of the invention is to provide a device for coating foundry moulds which is so improved so as to avoid the various aforementioned drawbacks.

The invention provides a device which is of the type which comprises a vessel supplying liquid coating product, a liquid circulating pump, a projecting apparatus, a supply pipe interconnecting the vessel, the pump and the apparatus, and a return pipe from the apparatus to the vessel, wherein there is provided in the supply pipe in series with the pump a diaphragm pressure exchanger which is connected, on one side of the diaphragm, to the vessel and the apparatus and, on the other side of the diaphragm, to a control fluid supply pipe in which the pressure of the control fluid can be turned off, a flow regulator being connected in series in the control fluid pipe.

With this arrangement, the flow of the liquid coating mixture is constant and adjustable. Even in the event of obstructions, the deposits are pushed out by the stream of liquid coating mixture.

According to an important feature of the invention, the projecting apparatus comprises a jet which has a calibrated valve communicating directly with the coating mixture supply pipe and subjected to the opposing action of a closing spring.

Thus, instead of being actuated by an auxiliary fluid as in known projecting apparatuses or guns, the apparatus according to the invention is actuated directly by the liquid coating mixture. The apparatus is consequently much simpler and smaller and this facilitates introduction in small moulds.

Further features and advantages of the invention will be apparent from the ensuing description with reference to the accompanying drawing.

In the drawing:

FIG. 1 is a diagrammatic view of the device according to the invention;

FIG. 2 is a sectional view, to an enlarged scale, of the projecting or spraying apparatus;

FIG. 3 is a diagram showing the curves of variation in the flow Q of the liquid coating product as a function of the time *t;*

FIG. 4 is a diagrammatic view, to a smaller scale than FIG. 1, of the device according to the invention applied to the feeding in parallel of a plurality of spraying apparatuses, and

FIG. 5 is a diagrammatic view of a modification of the control device of the pressure exchanger.

In the drawing some elements or apparatuses of commercially available and known type are shown merely symbolically.

In the embodiment shown in FIGS. 1 and 2, the device according to the invention is adapted to apply a coating product

D, comprising a mixture of silica and bentonite or like product in suspension in water, on the inner face of a centrifugal casting mould or shell A mounted on rollers B so as to produce at least one layer of coating C which protects the liquid metal (for example iron) from an excessively rapid cooling.

As the coating mixture D in the liquid state in a supply vessel 1 settles or forms a deposit to an extent which depends on its composition, this vessel 1 is provided with a rotary propeller-type stirrer or agitator 2 for permanently stirring the mixture.

A supply pipe 3, in which is mounted in series a mixture circulating pump 4, for example of the displacement type, connects the vessel 1 to a pressure exchanger 5.

The exchanger 5 comprises a flexible diaphragm 5*a* which defines two chambers, namely a chamber 5*b* containing the mixture D supplied by the pump 4 since the pipe 3 communicates with the chamber 5*b*, and another chamber 5*c* containing a control fluid which may be oil. Preferably, a diaphragm valve 6 is connected in series in the pipe 3 in the vicinity of the upstream side of the pressure exchanger 5.

There will now be described in turn:

The supply circuit of the projecting apparatus projecting the liquid coating mixture.

The circuit for the return of all or part of the mixture of the vessel 1.

The control fluid circuit for the pressure exchanger 5.

Extending from the chamber 5*b* is a supply pipe 7 connected to a nozzle 8 of the coating mixture applying or projecting apparatus. More precisely, the pipe 7 is connected to a supply pipe 9 (FIG. 2) fixed inside the nozzle 8. The latter has a length corresponding to the length of the mould or shell A. It terminates in a jet 10 having an outlet orifice 11 and a valve 12 which is biased by a calibrated spring 13 to the closed valve position. A return pipe 14, 14*a* for returning all or part of the coating mixture connects the nozzle 8 to the vessel 1. When the valve 12 is open, the tube 9 communicates with the outlet orifice 11. When the valve 12 is closed, there is no communication between the pipe 9 and the orifice 11 and the liquid mixture D can only flow to the return pipe 14, 14*a*. The valve 12 is subjected to two opposed actions, namely that of the liquid mixture D under pressure and that of the calibrated spring 13. The strength of the spring 12 is such that the valve is separated from its seat only when the pressure of the mixture reaches a value higher than a given value *p* defined hereinafter.

The nozzle 8 is made to undergo a to-and-fro movement with respect to the mould A, in a direction parallel to the axis X—X of the latter, during the rotation of the mould, so as to apply the coating C over the entire inner face of the mould. The mould may be fixed in the longitudinal direction and the nozzle movable in the direction parallel to the axis X—X, but it must be understood that the nozzle 8 may be made fixed and the mould A made to undergo a to-and-fro motion.

The circuit for returning the liquid mixture D to the supply vessel 1 comprises the pipe 14, 14*a* leading from the nozzle 8 to the vessel 1. Connected in series in this pipe is a valve 15, preferably of the diaphragm type, in the vicinity of the apparatus 4 or at least in the vicinity of the nozzle 8, and a valve 16 having a calibrated spring. The valve 16 is adapted to create a slight pressure drop so as to allow the filling of the chamber 5*b* when the valve 15 is open.

A return pipe 17 is interconnected between the supply pipe 3 upstream of the valve 6 and the pipe 14, 14*a* and by-passes the projecting apparatus 8–10. It is adapted to ensure the free circulation of the liquid coating mixture when the valve 6 is closed. Mounted in series in the pipe 17 is a valve 18 having a calibrated spring and adapted to create a slight pressure drop and permit the filling of the chamber 5*b* when the valve 6 is open.

The circuit of the fluid controlling the pressure exchanger 5 comprises an oil supply pipe 19 in which is connected a flow regulator 20. The pipe 19 communicates with the upper part of the chamber 5*c* of the pressure exchanger and connects the

chamber 5c to an oil tank 21. An air pipe 22 communicates with the upper part of the oil tank 21. The air pipe can be connected by a distributor slide valve 23 of known type having two positions *a* and *b* to a source of compressed air 24 (position *a*) or to an exhaust pipe 25 communicating with the atmosphere (position *b*). According as the valve 23 is in position *a* (FIG. 1) or position *b*, the air pipe 22, the oil tank 21 and the chamber 5c are put or not put under pressure. The pressure of compressed air is P; this value P is higher than the aforementioned value *p* (for example *p* = three bars and P = seven bars).

The device according to the invention operates in the following manner:

1. At rest, that is to say during the inoperative period when it is not desired to apply a coating C, the valves 6 and 15 are open and the slide valve 23 is in position *b* and connects the air conduit 22 to the exhaust, since this conduit 22 communicates with the exhaust conduit 23.

The liquid mixture circulating pump 4 pumps the liquid mixture partly to the exchanger 5 and partly through the conduit pipe 17. The liquid mixture returns from the pipe 17 to the vessel 1 by way of the pipe 14*a*. The liquid mixture flows from the exchanger 5 through the pipe 7, the pipe 9, the nozzle 8 and the return pipe 14—14*a* to the vessel 1.

The liquid mixture D in the pipe 3, the chamber 5*b*, the pipes 7, 9, 14 and 17 up to the upstream side of the valves 16 and 18 and in the nozzle 8 of the projecting apparatus, is at pressure *p*, whereas in the pipe 14*a* downstream of the valve 16 and in the pipe 17 downstream of the valve 18 the liquid mixture D is at a pressure *p'* which is less than *p*, the pressure drop (*p*—*p'*) being produced by the calibrated valves 16 and 18. It is, moreover, owing to this pressure drop, produced by the valves 16 and 18, that the mixture D is at pressure *p* upstream of the check valves.

The pump and the check valves 16 and 18 are so chosen that the pressure *p* has such value that the force exerted by the mixture D on the valve 12 in the direction for opening the latter, in opposition to the action of the spring 13, is less than the calibrated force of this spring.

However, this pressure *p* must be such as to be capable of urging back the diaphragm 5*a* and the oil towards the tank 21 and filling the chamber 5*b* with liquid coating product D. The pressure *p* must also be such as to be capable of pushing out any plugs of deposit which might have accumulated in the pipes. For example, the pressure *p* can be as already mentioned, of the order of three bars.

With the valve 12 of the projecting apparatus closed, the mixture D flows in a continuous manner in a closed circuit in passing through all the pipes which are thus irrigated so that there is a continuous agitation of the mixture D and settling of solid particles is avoided.

2. In operation, that is, when a mould A is in position for receiving at least one layer V of coating, the valves 6 and 15 are closed and the distributor valve 23 is shifted to position *a* for putting the air circuit 22 under pressure by communication with the pipe 24. The pump 4 is then cut off from the pressure exchanger 5 and the projecting apparatus (8–10) and is made to feed the liquid mixture D in a closed circuit in the pipes 3, 17 and 14*a*. Thus the continuous agitation of the mixture D continues, the pipes are irrigated and settling of solid particles is avoided.

Meanwhile, the pressure exchanger 5 whose chamber 5*b* is filled with the liquid mixture D is subjected to an oil pressure P which is substantially higher than the pressure *p* of the aforementioned period of rest. This pressure P of the oil in the chamber 5c results from the pressure of the compressed air of the tank 21 and of the pipe 22 and is transmitted to the liquid mixture D through the diaphragm 5*a*. It is for example, as already mentioned, of the order of seven bars. The force it exerts is higher than the calibrated force exerted by the valve 12 of the projecting apparatus (ratio between the calibrated force of the spring 13 and the section of opening of the valve). Consequently, the pressure exchanger 5, which operates as an injecting bulb, forces the liquid mixture D through the pipe 7, the pipe 9 and the jet 10. The liquid mixture D at pressure P shifts the valve 12 from its seat and flows in the form of a jet or stream through the outlet 11 and is spread in an even layer C of coating on the inner face of the mould A which is driven in rotation.

The main advantages of the device according to the invention are the following:

Owing to the pressure exchanger 5, which is very simple in construction and operation, there is a regular and adjustable flow of liquid mixture D, governed by the flow regulator 10, through the outlet 11 of the projecting apparatus. In particular, the pressure exchanger 5, in urging the liquid mixture D in the manner of an injecting bulb, replaces a pulsatory displacement pump to advantage in respect of not only a substantial saving in cost but also the evenness of the coating C applied on the mound A. Indeed, in the case of a direct pumping by a pulsatory liquid circulating pump, the coating C is not applied at a regular flow rate but in periodic spurts at the rhythm of operation of the pulsatory pump (consequently the coating has a variable thickness) whereas in the case of the injection by means of the pressure exchanger 5 the flow is even and results in a coating of constant thickness).

This is shown by the diagram in FIG. 3 which represents the variations in flow Q (ordinates) as a function of time *t* (abscissae). The curve I in full line corresponds to the flow obtained with a pulsatory pump. The curve II in dotted line corresponds to the flow obtained with a pulsatory pump combined with a pulsation damper. The flow remains nonetheless pulsatory. The curves I and II are obtained with known devices. The straight horizontal line III represents the constant flow obtained with the device according to the invention.

Owing to the return pipe 17, the mixture D is stirred or agitated and the pipe 3 and the part 14*a* of the return pipe located upstream of the vessel 1, are constantly irrigated in the period of service in which the vessel 1 and the pump 4 are cut off from the projecting apparatus the projecting the closure of the valves 6 and 5. This precludes the formation of occlusions.

Owing in particular to the combination of the pressure exchanger 5 and the oil pipe 19 with the pipe 7, and in particular owing to the fact that the liquid coating pressure is not the same during the inoperative period or period of rest (*p*) and the operative period (P), the pressure difference is employed for directly actuating the projecting apparatus 8–10 by leaving its valve 12 closed or by causing the opening of the valve 12, which result in a considerable simplification of the projecting apparatus with respect to known guns actuated by means of an auxiliary fluid. The jet 10, which is simple and strong, very little sensitive to obstructions and easy to service, advantageously replaces the gun of known type having a needle or regulating point, with or without a spraying effect, in which there are problems of sealing and protection of the mechanism from the liquid coating mixture D. Further, the jet 10 is small and this facilitates its introduction in moulds A of small diameter.

In the event of an obstruction, the pressure *p* of the mixture is ample for unclogging and driving out the deposits which are once again dissolved in the vessel 1.

Owing to the oil flow regulator 20, the flow of the liquid mixture D is adjusted in accordance with the desired thickness of the coating C.

In the modification shown in FIG. 4, a plurality of projecting apparatuses having a projecting nozzle 8 and a jet 10 are connected in parallel in the supply pipe 3. Owing to the invention, it is possible to employ a single liquid mixture circulating pump 4 and as many pressure exchangers 5 as there are projecting apparatuses 8–10 (the cost of a pressure exchanger 5 is much less than that of a pump 4). In the known method, if each projecting apparatus 8–10 is to have a mean flow, varying about a constant value, there would be required as many pumps 4 as there are projecting apparatuses since it is not possible to divide into equal parts the flow of a simple pump by means of known devices (throttles) owing to the deposit of

solid particles which modify the flow characteristics of the devices.

According to the modification shown in FIG. 5, instead of the oil filling the chamber 5c of the pressure exchanger 5 being taken (as shown in FIG. 1) from a tank 21 under a pressure controlled or not controlled by compressed air, it is directly furnished at high pressure by a pump 26 which draws the oil from a tank 27 through a distributor slide valve 28 having two positions similar to the distributor valve 23. The flow regulator 20 is optional if the flow from the pump 26 is suitably regulated. The oil of the exchanger 5 can thus be connected to the exhaust by the valve 28 in the position of rest or supplied at high pressure p to the pipe 19 with a flow controlled and rendered even by the regulator 20 or the pump 26. The pressure P may exceed 7 bars. The mixture distributing circuit operates in the same manner as the circuit shown in FIGS. 1 and 2.

In another modification, the jet of the projecting apparatus may deliver the liquid coating mixture directly by way of an annular orifice between the valve 12 and its seat, the outlet orifice 11 being dispensed with. In this case, the valve 12 can be disposed radially or obliquely with respect to the longitudinal axis of the nozzle 8, for example in the same way as the orifice 11 of the embodiment shown in FIGS. 1 and 2.

Moreover, note that there may be provided instead of calibrated valves 16 and 18, pipes 14 and 17 having portions of reduced diameters or adjustable throttles.

Further, the projecting apparatus may be completed, in the known manner, by provision of a pipe supplying air for spraying the liquid mixture D and a chamber of cooling water. However, the overall size would be increased in this case.

The device according to the invention is applicable to the coating of stationary foundry moulds or shells as well as to centrifugal casting moulds or shells.

Having now described my invention what I claim and desire to secure by Letters Patent is:

1. A device for coating a foundry mould, said device comprising a vessel supplying a liquid coating product, a coating product circulating pump associated with said vessel, a projecting apparatus for projecting the liquid coating product onto said mould, a product supply pipe connecting an element of two elements consisting of said vessel and said pump to said projecting apparatus, a first return pipe connecting said projecting apparatus to said vessel, a diaphragm pressure exchanger inserted in said supply pipe in series with said pump, said exchanger having a diaphragm and a first side of said diaphragm connected to said vessel and to said apparatus and a second side of said diaphragm connected to a control fluid supply pipe, means for cutting off pressure of the control fluid in said control fluid supply pipe, and a flow regulator connected in series in said control fluid pipe.

2. A device as claimed in claim 1, wherein said projecting apparatus comprises a jet having a closing valve and directly communicating by way of a pipe with said product supply pipe, and a calibrated closing spring for biasing said valve to a closing position.

3. A device as claimed in claim 1, comprising a valve in said first return pipe.

4. A device as claimed in claim 1, comprising a calibrated valve connected in series in said first return pipe.

5. A device as claimed in claim 1, comprising a second return pipe by-passing said projecting apparatus and connected in parallel between said product supply pipe and said first return pipe, and a valve for cutting off said second return pipe at will from said pressure exchanger.

6. A device as claimed in claim 5, comprising a calibrated valve connected in series in said second return pipe.

7. A device as claimed in claim 1, comprising a tank of fluid having an upper part, an air pipe for supplying air under pressure communicating with said upper part of said tank and a distributor valve for putting said air pipe selectively in communication with a source of air under pressure and in communication with an exhaust pipe.

8. A device as claimed in claim 1, comprising a slide valve associated with said control fluid supply pipe and capable of putting said control fluid supply pipe selectively in communication with a second pump supplying fluid under pressure and with a discharge orifice.

9. A device as claimed in claim 1, for the purpose of simultaneously applying liquid coating product on a plurality of moulds, comprising a plurality of said projecting apparatuses associated with their respective pressure exchangers connected in parallel with said coating product circulating pump.

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