

Aug. 30, 1960

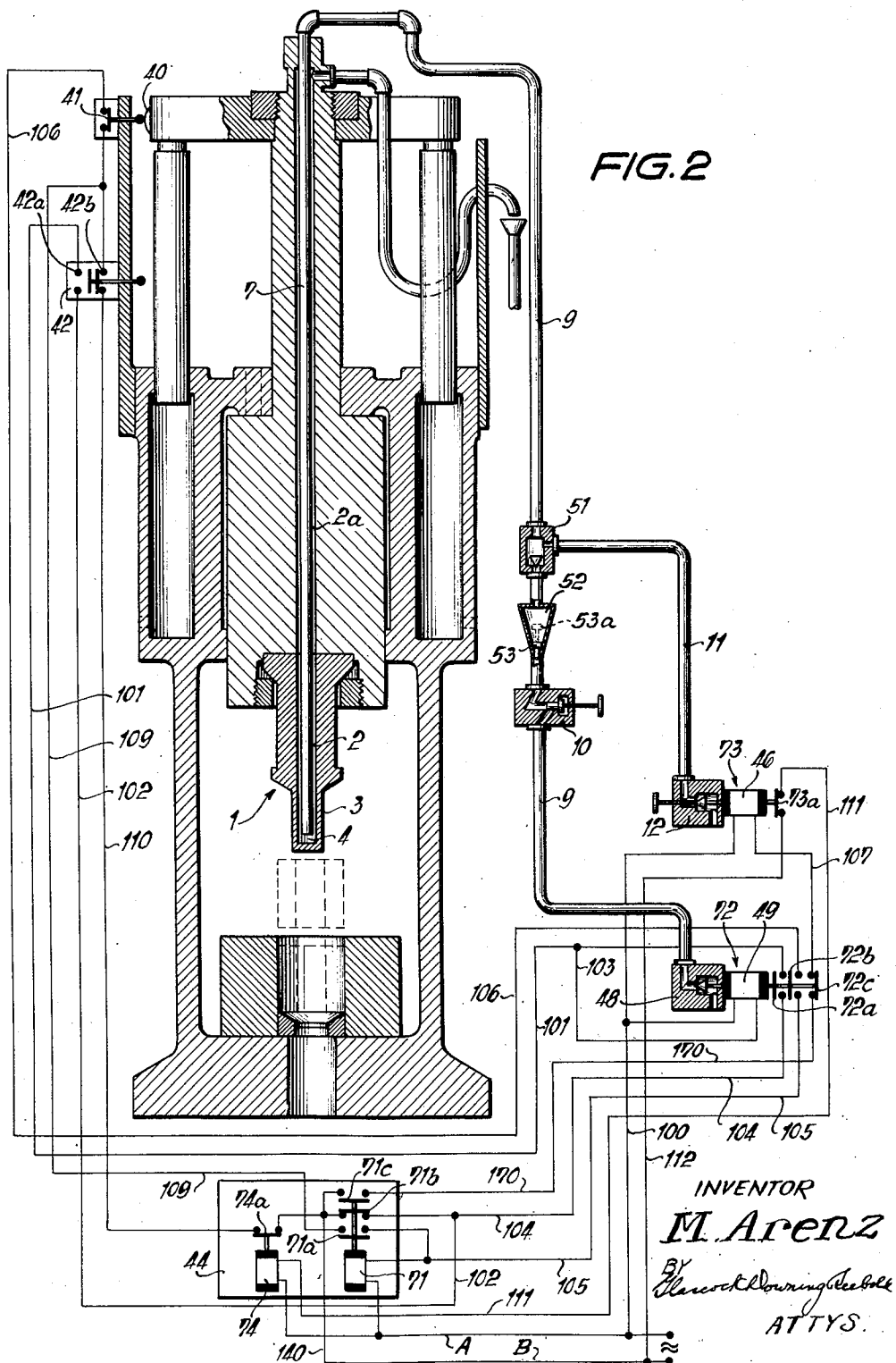
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IMPROVEMENTS IN CONTROLLING THE COOLING OF A HOLLOW
MANDREL IN A METAL EXTRUSION PRESS

Filed Nov. 18, 1957

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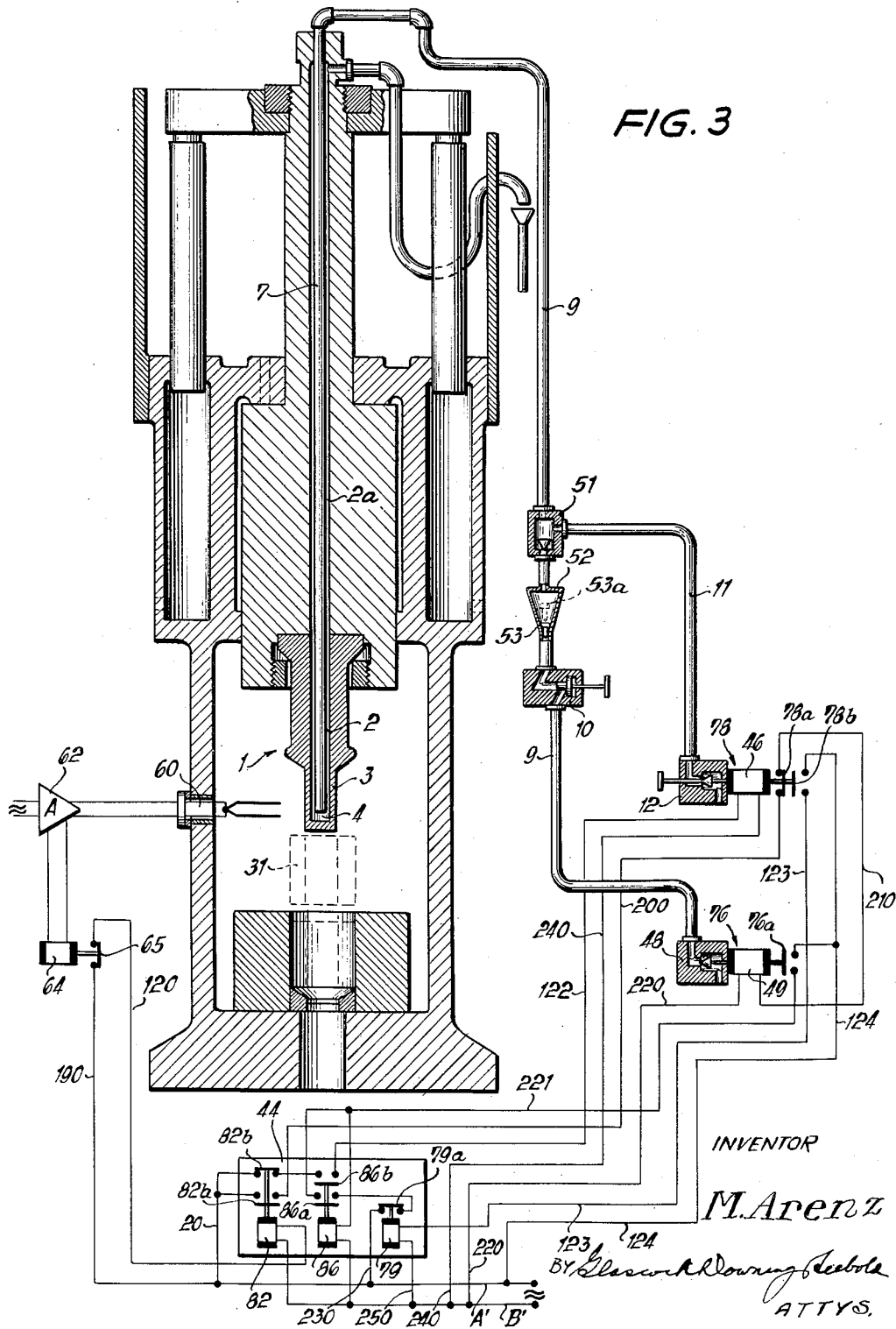


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IMPROVEMENTS IN CONTROLLING THE COOLING OF A HOLLOW MANDREL IN A METAL EXTRUSION PRESS

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Filed Nov. 18, 1957, Ser. No. 697,087

Claims priority, application Germany Nov. 24, 1956

4 Claims. (Cl. 207—16)

This invention relates to a method of controlling the cooling of the hollow mandrel of a steel or metal extrusion press, and to apparatus for performing the same.

When extruding metals, such as brass, steel and the like, the temperature of the mandrel should be between 300° C. and 350° C. when extrusion begins, as otherwise it would be subjected to undesirable thermal stresses upon coming into contact with the hot extruded material which may be at temperatures between 650° C. and 800° C. The usual practice is therefore to pre-heat the mandrel. During extrusion the temperature of the mandrel tends to increase very appreciably, for instance to 600° C., and if the mandrel remains in contact with the extruded material for some length of time its temperature may possibly rise even higher. Since the mandrel is withdrawn from the press as soon as each billet has been extruded it is usually subject to cooling for the purpose of prolonging its useful life. To this end the mandrel and its holder are hollow. The cooling water is carried for instance down a central tube into the cavity inside the mandrel, whence it returns outside the tube, cooling both mandrel and holder. However, if the mandrel is exposed to the cooling effect of the water for too long a period its temperature may drop to less than the required 300 to 350° C. and unless it is then reheated before the next extrusion begins it could suffer damage by the abrupt rise in temperature experienced when again brought into contact with the extrusion charge.

It is the object of the present invention to avoid this risk by confining the temperature fluctuations of the mandrel in the course of its working cycle to within narrow limits. According to the invention this is achieved by cooling the hollow mandrel with a liquid coolant, in the manner that is already known, whilst it is in contact with the hot extruded material or its temperature exceeds a definite predetermined minimum limit and at the end of a predetermined period of liquid cooling or as soon as the temperature of the mandrel falls below a predetermined minimum limit by replacing the liquid coolant by air or other gas, more particularly a gas that has no corrosive effect on the mandrel. The predetermined period of cooling that is necessary and sufficient to reduce the temperature of the mandrel say from 600° C. to 300° C. can be ascertained by empirical test. On the other hand, the temperature drop of the mandrel say to 300° C. may be continuously measured to permit the instant of replacement of the liquid coolant by air or the like to be properly timed. As soon as air or the like replaces the liquid coolant the further reduction in the temperature of the mandrel proceeds very slowly since an evaporating liquid withdraws heat at a much higher rate than a gas. Consequently, the cooling effect on the mandrel will not be excessive even if the intervals between consecutive extrusions are somewhat prolonged.

It may be mentioned that cooling the mandrel of steel or metal extrusion presses is, as such, not unknown. However, the principal feature of the invention is the alternate application of liquid and gas for achieving a

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controlled cooling effect. If a gas is used that will not corrode the steel, the life of the mandrel will be longer than when cooling is effected with air.

The method proposed by the present invention may be performed in a particularly favourable way in that a current of liquid cooling medium sent through the hollow mandrel in the conventional manner is cut off when the mandrel is withdrawn from operative position or when the temperature of the mandrel drops below a predetermined minimum limit, and that the liquid coolant is then ejected from the mandrel by means of the air or other gas. The liquid coolant is readmitted in place of the air or other gas as soon as the temperature of the mandrel again exceeds the predetermined upper limit or when the mandrel is advanced into operative position.

The apparatus required for performing the present invention may be of simple construction and consist for instance in that a compressed air line with closure means is arranged to deliver air into an admission pipe for a liquid on the down-stream side of closure means incorporated therein. The method may be performed automatically for instance by providing a time relay which automatically causes the closure means in the pipe line for the liquid to be closed and the closure means in the air line to be opened at a predetermined instant when the mandrel is withdrawn from operative position. The readmission of the liquid coolant may be controlled to take place during the subsequent advance of the mandrel into operative position. Alternatively, the supply of liquid and gaseous coolant may be timed by equipment which actually measures the temperature of the mandrel.

The invention will now be illustratively described with reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view in elevation and with parts in section for greater clarity and showing a press constructed in accordance with this invention;

Fig. 2 a view similar to Fig. 1 and showing the electrical control circuit for automatically controlling the admission of cooling water and cooling air in accordance with movements of the press ram; and

Fig. 3 a view similar to Fig. 1 and showing the electrical control circuit for automatically controlling the admission of cooling water and cooling air in accordance with the temperature of the mandrel.

In Fig. 1, 1 represents a ram with a hollow longitudinal bore 2. The forward end of the ram carries the mandrel 3 which is held in position by the cap member 1a of the ram and which has an internal bore or cavity 4 of approximately similar size to the bore 2 of the ram 1. The ram 1 is secured to the piston 21 by means of a nut 20. The piston is likewise centrally bored as shown at 2a. The bore 2a connects with a pipe 5 with a lateral branch 6 for the discharge of cooling water. Centrally disposed inside the bore 2, 2a, pipe 5, and bore 4, and held in position by means not specially shown, is an admission pipe 7 for cooling water, the water entering at the rear end of said pipe 7 through a pipe 8. The cooling water is supplied through a pipe 9 and a flexible conduit 8a, the pipe 9 incorporating a control valve 10, followed by a non-return valve 51. A compressed air line 11 having a control valve 12 therein communicates with the cooling water pipe 9 by way of the non-return valve 51.

Otherwise the press is constructed in the conventional manner. The piston 21 is movably disposed in main cylinder 22 into which the liquid pressure medium is admitted and withdrawn in the normal way through a channel 22a. The piston 21 has a rearward extension 21a which projects from the cylinder and carries a cross-head 23 secured to the said rearward extension 21a by means of a nut 23a. Drawback plungers 24 which slidably work in cylinders 25 act on the cross head 23, water being admitted under pressure into cylinders 25

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through openings 25a in the conventional manner. The pressure water leaves the cylinders through the same openings. Both cylinders 22 and 25 are mounted in a frame 26 on a pedestal base 27 by means of which the press stands on a foundation bed. The pedestal base supports the receiver 28 and a die 29. A billet 31 with an internal diameter equal to the diameter of the mandrel 4 may be inserted into the receiver 28. The ram 1, 1a presses the material of the billet 31 through the annular gap between mandrel 3 and die 29 and out of the bore 30 in the pedestal base 27.

If it is desired to perform the method according to the invention by hand, the parts of equipment shown in the drawing but not hereinbefore described will not be in operation. They may even be entirely omitted if it is desired to confine operation to manual control. The procedure is as follows:

When the mandrel has been retracted into the position shown in the drawing, ram and mandrel are cooled. To this end the stop valve 10 is opened and cooling water or other liquid enters the cavity 4 inside the mandrel 3 through pipes 9, 8, and 7. The cooling water flows through the cavity 4, the bore 2, 2a, and leaves through pipes 5 and 6. At the end of a definite period of time, or as soon as the temperature of the mandrel 3 has dropped to a predetermined minimum temperature, say 300° C. valve 10 is manually closed and valve 12 opened. Air or other gaseous cooling medium will therefore be blown into the mandrel 3 and expel the water through pipe 6. When all the water has been thus ejected the compressed air line may again be closed at 12.

Preferably equipment is provided which will automatically re-admit the water as soon as the mandrel is again lowered into operative position. The change-over from water to air can likewise be automatically controlled, for instance by means of a time relay which receives an impulse when the mandrel 3 is withdrawn, and which causes the stop valves for water and air to be operated at the end of a definite period so determined that it will allow the mandrel 3 to cool off during its inoperative period, for example, from 600° C. to 300° C. Moreover, the time relay may be arranged to re-close the air admission valve automatically at the end of a further empirically determined period that is sufficient to ensure that all the liquid will have been expelled.

For the purpose of automatically controlling the admission of cooling water and cooling air in dependence upon the movements of the ram 1 the following additional equipment is provided on the press. The cross-head 23 carries a trip 40 which alternately engages electric switches 41 and 42. Switch 41 is electrically connected through 43 with an electric control box 44 containing a relay and a contactor. Switch 42 is similarly connected through a line 45 with a relay and an associated contactor housed in control box 44. Furthermore, valve 12 is fitted with a solenoid 46 which keeps the valve open for as long as the coil carries a current. The solenoid is electrically connected through a line 47 with control box 44. Another valve 48 is incorporated in the water admission pipe 9, said valve being held open by a solenoid 49 for as long as the latter is energized from the control box 44 through circuit 50. Finally, the non-return valve 51 in the pipe 9 is adapted to permit the flow of water in the upward but not in the downward direction.

Pipe 9 is also fitted with a flow meter 52 which enables the machine operator to keep the rate of flow of the water under observation. To this end the flow meter substantially comprises a cone-shaped transparent housing into which the water enters through pipe 9 from below. The water inlet is sealed by a plug 53 when no water flows through pipe 9. However, as soon as water begins to flow its pressure will raise the said plug 53 from its seating and the water will enter the housing of the flow meter 52, leaving this housing at the top.

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For as long as the water continues to flow the plug 53 will bob up and down in the rising current, for instance roughly at the level indicated at 53a. The higher the position of the plug 53 in the housing 52 the greater the rate of flow of the water. When the direction of flow is stopped or tends to reverse the plug will fall and close the inlet.

When a billet 31 has been inserted in the receiver 28 ram 1 and mandrel 3 are lowered in a manner that is well understood for extruding the billet 31. This causes the temperature of the mandrel 3 to rise. Overheating is now avoided because the trip 40 actuates switch 42 during the downward movement of the ram, and causes a relay in the control box 44 to be energized, as a result of which current is supplied through line 50 to solenoid 49 which therefore opens valve 48. Since during automatic operation of the system the manually operable valve 10 remains permanently open, water will flow through pipe 9, enter mandrel 3 and cool it. Valve 10 can be utilised to serve as a throttling means for manual adjustment according to the rate of flow observable in flow meter 52. When the billet has been extruded ram 1 and mandrel 3 are withdrawn. The mandrel 3 is now very hot and must be cooled to about 350° C. In the course of the withdrawal of mandrel 3 trip 40 actuates the electric switch 41 which closes circuit 43 and causes a time relay in the control box 44 to be energized. The latter breaks the energising circuit of solenoid 49 at the end of a set period of time, say 3 seconds, and energises solenoid 46 in its stead. It is assumed that the mandrel 3 will now cool down to a temperature of 350° C. in the course of the said three seconds. At this instant the supply of water through pipe 9 is therefore interrupted and the water remaining inside the mandrel 3 is ejected by the air admitted into mandrel 3 through pipe 9 as a result of valve 12 being opened. The time relay which controls this cycle of events may be so devised that it will again interrupt the energising circuit of solenoid 46, say at the end of a further 5 seconds, experience showing that 5 seconds are sufficient for all the water to have been ejected from the interior of mandrel 3. The press is then ready for a fresh working cycle in the course of which trip 40 will again actuate switch 42 and thereby restart the water cooling system.

All of the relays that are contained in box 44 of Figure 1 are particularly illustrated in Figures 2 and 3. Thus, Figure 2 illustrates the switch 42 of Figure 1 as including two pairs of contacts 42a and 42b. When the mandrel is moved down, the trip or cam 40 closes contacts 42a, while contacts 42b are open. By way of the normally closed contactor 71b of time relay 71, which limits the time during which the mandrel 3 is cooled with water, the relay 72 for the magnet 49 that actuates the water control valve 48 is excited and this relay becomes self-holding through its closed-circuit contactor 72a. This circuit can be traced as follows: from one side A of the power source through conductor or line 100, thence through relay 72, line 103, line 101, to closed contacts 42a of switch 42, thence through line 102 to 104, through contactor 71b and line 140 to the other side B of the power source. If relay 72 is energized, its contactor 72a bridges the left-hand pair of contacts so as to maintain the solenoid of relay 72 energized even though contacts 42a are opened as the cam or trip 40 passes the same. The holding circuit for relay 72 can be traced from the side A of the power source through line 100, relay 72, line 103, thence through the two contacts closed by contactor 72a, line 104, through the normally closed contactor 71b, and line 140 of the other side B of the power source, at the same time the center pair of contacts of relay 72 are closed by contactor 72b. The water control valve 48 is opened when relay 72 is energized. The mandrel 3 is, therefore, cooled with water until, in its return or upward movement, it allows the contacts 42a to open and contacts 42a to close.

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Upon the further withdrawal of the mandrel, the switch 41 is closed, so that the time relay 71 is excited, for the purpose of limiting the time the mandrel is cooled with water, by blowing air through the mandrel. This circuit can be at least from the side A of the power source through relay 71, line 105, the center pair of contacts of relay 72 that are closed by contactor 72b, line 106, through the closed contacts of switch 41, the closed contacts 42b of switch 42, through normally closed contactor 74a, thence through line 140, to the other side B of the power source. The time relay 71 is a slow-to-close relay, so that approximately three seconds after exertation as described above, the contactor 71b is opened. This de-energizes relay 72 to allow valve 48 to close. The upper contacts of relay 71 are closed by contactor 71c and the lower contacts by contactor 71a. Closure of the upper contacts by contactor 71c energizes relay 73 through the following circuit: from the side A of the line through line 100, relay 73, thence through line 107, and the normally closed contacts of contactors 72c of relay 72, thence through line 170, through the closed contacts of contactors 71c, then through line 140 to the other side B of the power source. A holding circuit for the time relay 71 is established through the closed contacts of contactor 71a as follows: through the side A of the power source, then through relay 71, line 108, to the closed contacts of contactor 71a, thence through line 109 to the closed contacts 42b of switch 42, then through line 110 and the normally closed contacts of contactor 74a to the line 140, and then to the other side B of the power source.

Energization of relay 73 operates solenoid 46 to open valve 12 and closes a pair of contacts by contactor 73a. Closure of these contacts energizes relay 74 in the following manner: through side A of the power source, thence through relay 74, line 111, the closed contacts of contactor 73a, and line 112 to the other side B of the power source. Relay 74 is a slow-to-open relay such that the contactor 74a does not disengage its contacts until after approximately five seconds have elapsed. Upon disengagement of contacts by movement of contactor 74a, the holding circuit for relay 71 is interrupted to deenergize relay 71, which allows the contactors 71a and 71c to move such as to deenergize relay 73 to close valve 12 and open the contacts of contactor 73a so as to deenergize relay 74 in readiness for another cycle of operations during the succeeding stroke.

Alternatively, the two valves 48 and 12 may be operated in dependence upon the actual temperature of mandrel 3. To this end the frame 26 of the press may be fitted with a measuring device 60 which responds to thermal radiation, and which is electrically connected through a line 61 with a current amplifier 62. When energized, the current amplifier 62 actuates a pointer 63 on a compensator 64. Let it be assumed the adjustable contact 65 had been set to say 350° C. When the pointer 63 is deflected to the left of contact 65 the water admission valve 48 will be closed, i.e. solenoid 49 will not be energized. However, as soon as the mandrel 3 is withdrawn into its raised position, as shown in the drawing, and the high temperature of the mandrel of say 700° C. causes the measuring device 60 to respond, then the amplifier 62 will deliver a more powerful current and deflect pointer 63 in the clockwise direction to the other side of contact 65. As soon and so long as the pointer 63 is on the right of contact 65, and this will depend upon the magnitude of the temperature radiation from the mandrel 3 acting upon the measuring device 60, the water admission valve 48 will be open and the air admission valve 12 closed, so that the mandrel will be cooled by water. As soon as the temperature of the mandrel 3 drops, pointer 63 will move to the other side of contact 65 in the counterclockwise direction. The relays in the control box 44 will therefore cause the

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water admission valve 48 to be closed and the air admission valve 12 to be opened for a short period of time, say five seconds. The water in the mandrel will thus be ejected. The water admission valve 48 is subsequently reopened when after insertion of a fresh billet, the mandrel is lowered again. The means that have already been described, i.e. trip 40 and electric switch 42 can be employed for this purpose.

When the temperature responsive device 60, broadly indicated in Figure 1, detects a temperature of, for example, more than 350° C., the compensator 64 and with it the contact 65 are actuated by means of the amplifier 62, see Figure 3. Following this, an auxiliary relay 82 is excited through the following circuit: from the side A' of the power source, line 190, the closed contacts 65, thence through line 120 and through relays 82 to the other side B' of the power source. By closing the normally open contacts 82a, the relay 76 is excited from side A' of the power source, through line 200, thence through contacts 82a, thence through line 200 to and through the normally closed contacts 78a through line 210 to and through relay 76 and thence through line 220 to the other side B' of the power source for actuating the solenoid 49 of water control valve 48, to open this valve so that the mandrel is cooled with water. The normally open contact 76a when closed by energization of relay 76 excite the auxiliary relay 86. This circuit can be traced from the side A' of the power source through line 124, through closed contacts 76a, thence through line 121 to and through relay 86 to the other side B' of the power source. When relay 86 is excited, contacts 86a thereof are closed. This relay becomes self-holding as follows: through side B' of the power source, thence through relay 86, through the new closed contacts 86a, thence through normally closed contacts 79a of relay 79 through line 230 and back to the other side A' of the power source. When the temperature becomes less than 350° C., the contact 65 opens. The relay 82 is thus deenergized and the normally closed contact 82b, which was opened upon energization of relay 82, is simultaneously closed. The relay 76 is also deenergized and the water control valve 48 closes to shut off the water. The auxiliary relay 86 remains energized through closed contact 86a and the closed contact 86b remains closed, so that by way of the normally closed contact 82b, the relay 78 for the solenoid 46, which opens air valve 12 responds. The circuit for energizing relay 78 can be traced from side B' of the power source through line 240 to and through the relay 78, thence through line 122, to and through the closed contacts 86b and 82b, thence through line 20 to the other side A' of the power source. The normally open contact 78b is accordingly closed and the time relay 79 is energized. The energizing circuit for relay 79 can be traced from side B' of the power source through line 250, thence through the relay and through line 123 through closed contacts 78b, thence through line 124 to the other side A' of the power source. The normally closed contact 79a is thereby open, the auxiliary relay 86 is deenergized, the relay 78 is deenergized, and the slow-to-open time relay 79 opens after the time selected for the blowing through of the air. During the succeeding stroke, the same cycle of operations is repeated.

It will be readily understood that the invention is also applicable to presses in which the mandrel is a piercing ram adapted to be advanced and retracted relatively to the main ram, as well as to angle presses in which the receiver axis is at right angles to the axes of die and ram.

What is claimed is:

1. In combination, a ram member, a hollow mandrel member carried by said ram, means for moving said members into an extruding position and into an inoperative position, and apparatus for controlling the cool-

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ing of said hollow mandrel, said apparatus comprising a liquid supply conduit communicating with the interior of said mandrel for delivering a liquid cooling medium thereto, a drain conduit communicating with the interior of said mandrel for discharge of cooling medium therefrom, a liquid shut-off valve in said liquid supply conduit, a gas supply conduit connected to said liquid supply conduit on the downstream side of said liquid shut-off valve for delivering a gaseous cooling medium to the interior of said mandrel, a gas shut-off valve in said gas supply conduit, operating means for said liquid shut-off valve and said gas shut-off valve, control means connected to said operating means and actuating means for said control means, said actuating means being located along the path of travel of said members and actuated by said members to open said liquid shut-off valve and close said gas shut-off valve to deliver liquid cooling medium to said mandrel in one position of said members and to close said liquid shut-off valve and open said gas shut-off valve to eject said liquid cooling medium from said mandrel and deliver gaseous cooling medium thereto in the other position of said members.

2. An apparatus as defined in claim 1 in which said actuating means comprises spaced limit switches mounted in fixed relation with respect to said members and means on said members engageable with said switches in said two positions of said members to initiate operation of said control means.

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3. An apparatus as defined in claim 1 in which said actuating means comprises a heat responsive element disposed in spaced relation to said mandrel and operative in response to differences in temperature of said mandrel in said two positions to initiate operation of said control means.

4. An apparatus as defined in claim 1 and including a liquid flow control valve and a liquid flow indicator disposed in said liquid supply conduit between said liquid shut-off valve and the connection of said gas supply conduit with said liquid supply conduit.

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