

Sept. 4, 1934.

C. C. JACOBSON

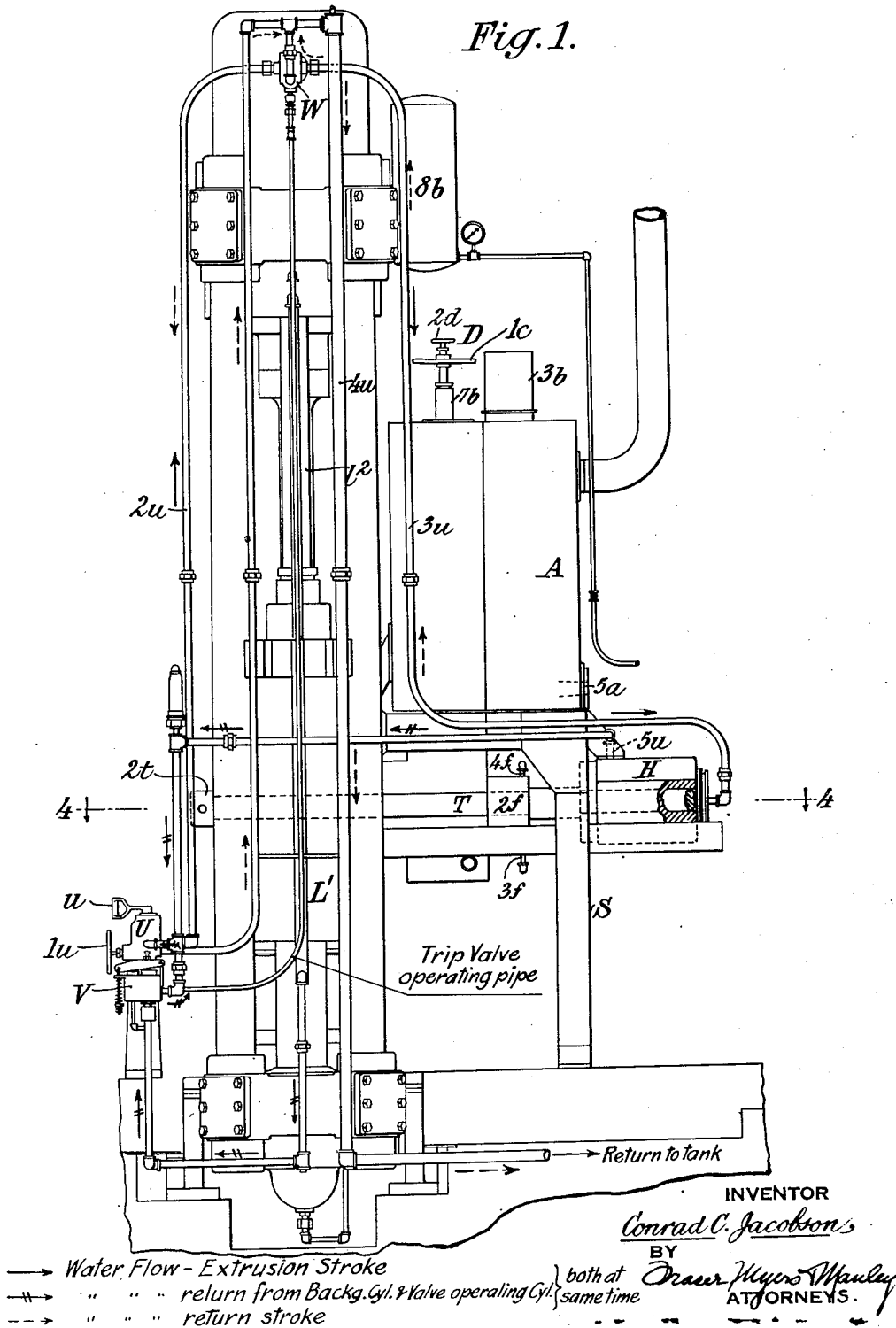
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APPARATUS FOR EXTRUDING METALS

Filed March 17, 1933

4 Sheets-Sheet 1

Fig. 1.



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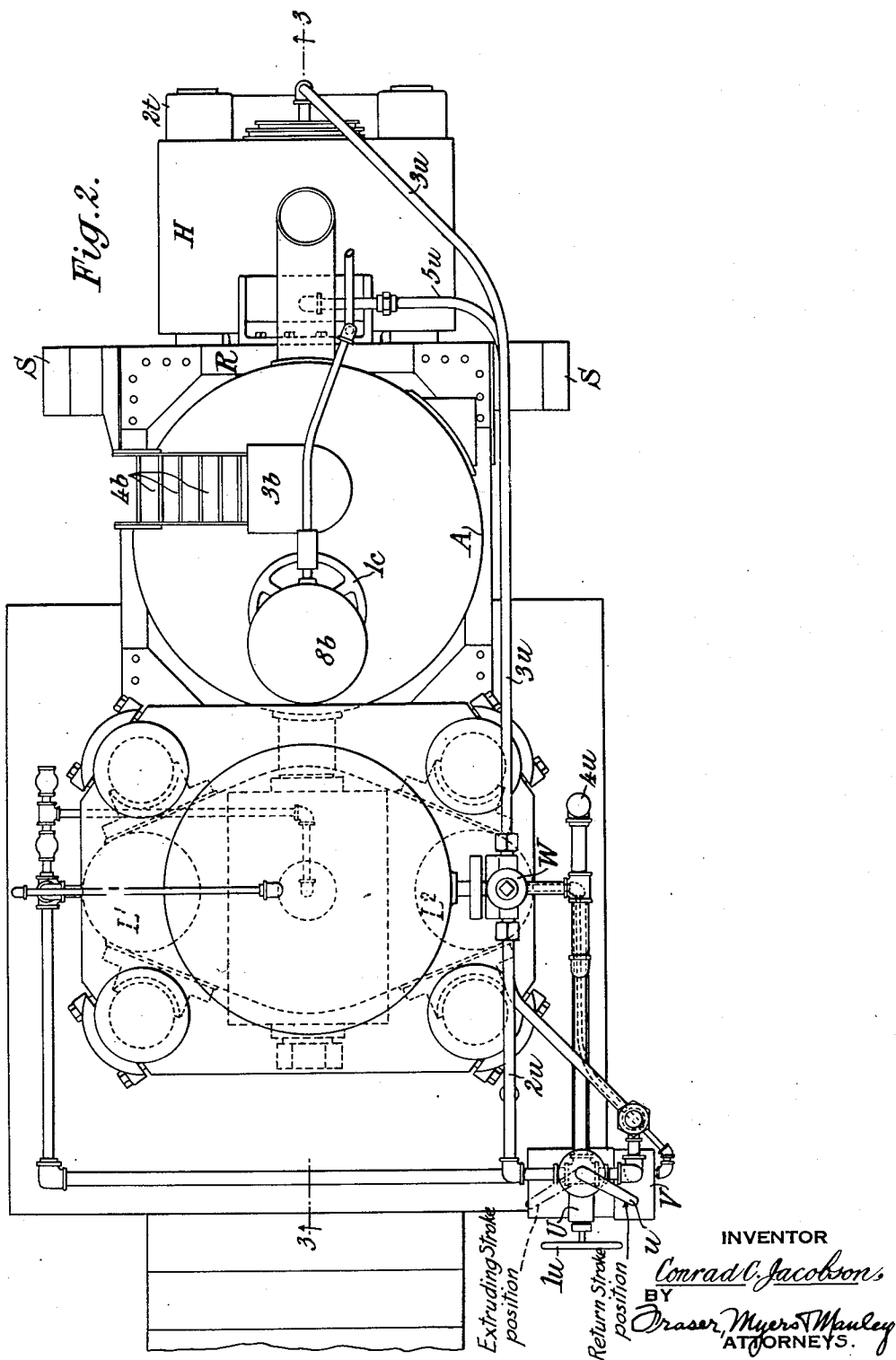
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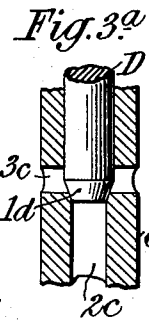
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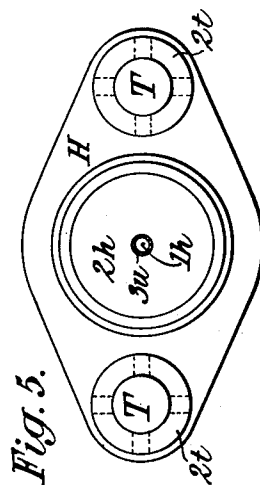
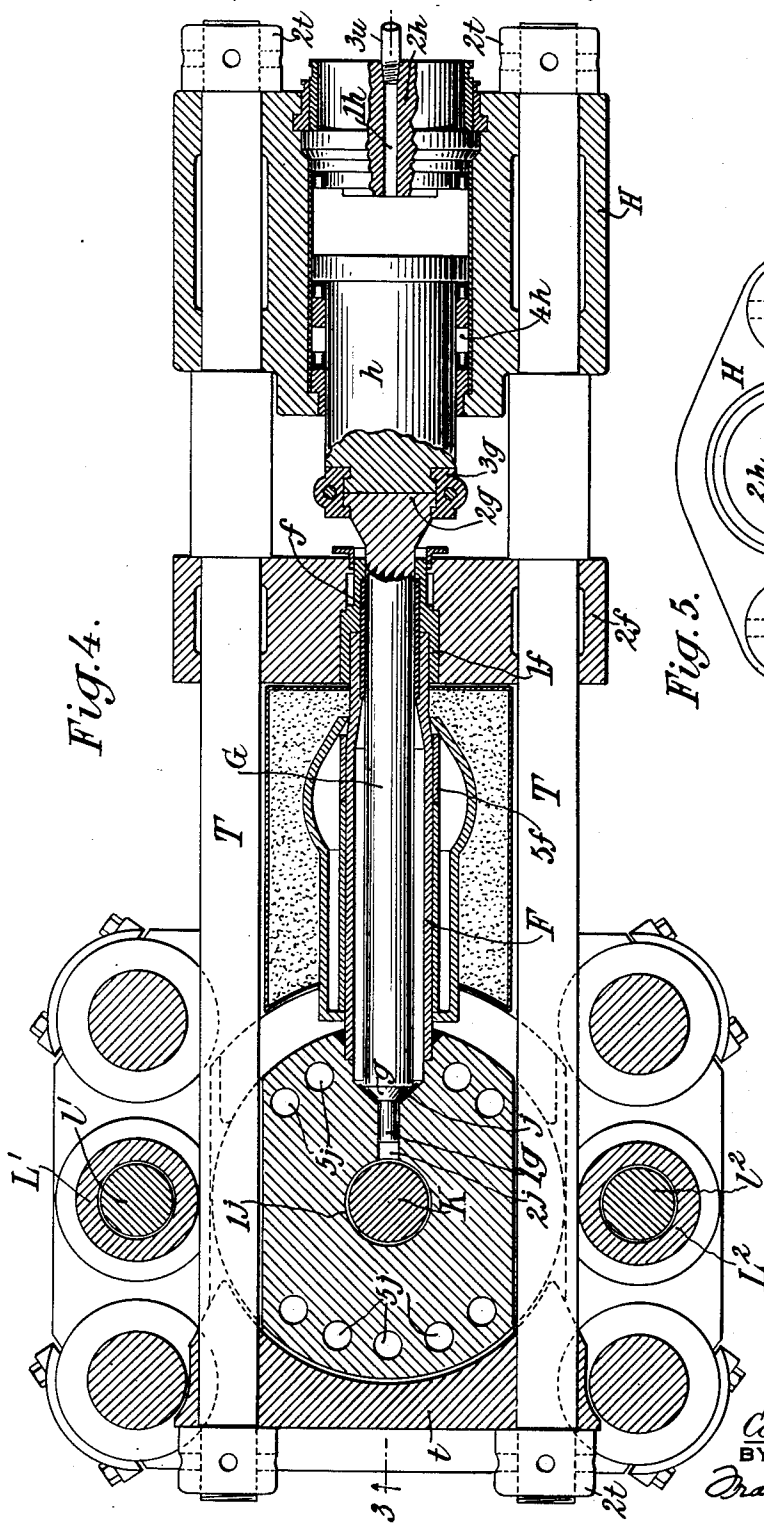
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APPARATUS FOR EXTRUDING METALS

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Application March 17, 1933, Serial No. 661,230

5 Claims. (Cl. 207—4)

My present invention relates to a method of and an apparatus for extruding metals, and more particularly to a cable sheath extrusion apparatus.

5 In cable sheathing as heretofore produced by the extrusion process, inherent defects have been recognized which have been traced to the presence of oxides in the lead, which give rise to the formation of seams or flow-lines in the lead sheath at the regions where the successive charges of metal fuse together. Somewhat similar flow-lines are shown to be present at the welds in the lead sheath at the regions where the streams of lead, after dividing in passing through the die-block, are reunited. The elimination of these so-called flow-lines or welds in cable sheathing has been for many years the goal of engineers whose duty it is to design such extrusion apparatus.

10 In several of my earlier filed applications I have disclosed means and methods for overcoming the aforementioned defects. In one of these applications I have shown and described a method and apparatus for extruding oxide-free cable sheath; in another, I have shown and described a die-block for extrusion presses for producing cable sheathing which is free from the so-called joint defects; in another I disclose an apparatus and method for producing both oxide-free and joint-free cable sheathing; and in still another application I disclose a self-charging cable sheath extrusion apparatus embodying certain features of my earlier applications for eliminating the hereinbefore described objectionable defects in cable sheathing.

15 My present invention constitutes an improvement upon the disclosures of my earlier applications and aims to provide a device of the character described through the medium of which the so-called flow-lines or fields of definite separation between consecutive charges of metal are entirely eliminated, and wherein the extrusion rate, as well as the general efficiency of the process, is substantially increased. The invention also embodies various novel combinations and sub-combinations of elements whereby the desired results are obtainable, all of which will be better understood from the detailed description thereof which follows, when considered in conjunction with the accompanying drawings which disclose a preferred embodiment of my invention, and wherein:

Figure 1 is a side elevation of the extrusion apparatus embodying my invention.

20 Fig. 2 is a top plan view on an enlarged scale of the apparatus shown in Fig. 1.

Fig. 3 is a vertical section through the apparatus taken substantially along the plane of the line 3—3 of Fig. 2, with certain parts of the apparatus being shown in elevation.

Fig. 3a is an enlarged section of a detail of the invention shown in Fig. 3.

Fig. 4 is a section partly in elevation, taken substantially along the plane of the line 4—4 of Fig. 1.

Fig. 5 is an end elevation of the lead valve operating cylinder.

Referring to the drawings, let A indicate a furnace which comprises an enclosing furnace shell a, supported in spaced relation to a second shell 1a, which, in turn, supports a fire box 2a constructed of suitable fire brick. The furnace is lined as is customary, with fire brick 3a, and the space between the shells a and 1a is provided with insulating material 4a. Opposite the fire box the furnace wall is formed with a suitable firing hole 5a, and near its top said wall is formed with a vent opening 6a.

Resting upon the top of the shell 1a which is reinforced by brackets 7a, is a top or cover plate B which dependingly carries a melting kettle b which sets within the furnace housing above the fire box. Eccentrically disposed within the melting kettle b and dependingly supported by the cover plate B is a melting chamber 1b, the bottom of which is disposed in spaced relation to the bottom of the melting kettle and has openings 2b therein for providing communication between the melting chamber and melting kettle. Above the melting chamber is a charging hood 3b having a roller table 4b (Fig. 2) upon which the lead pigs are charged into the melting chamber. The cover plate B in spaced relation to the charging chamber extending therethrough, is formed with a dome-shaped portion 5b, through the side of which extends a pipe 6b leading from a source of non-oxidizing gas 8b through a valve 9b to the interior of the kettle and through the top of which extends a valve rod c, to the outer end of which is secured a hand wheel 1c and to the inner end of which is secured a plug valve C. The valve rod c is preferably in the form of a tubular member having a channel or bore 2c extending longitudinally therethrough, which channel is continued through the valve plug C. Above the normal surface of the molten metal within the melting kettle the valve rod c is provided with lateral openings 3c for establishing communication between the channel in the valve rod and the space above the surface of the metal in the kettle. The channel or bore in the valve rod c from a point just below the lateral openings 3c to the outer end of the rod is somewhat enlarged, and extending into said enlarged bore is a second rod or pin D, the inner end of which 1d constitutes a valve adapted to seat against the shoulder formed by the bores of different diameter in the valve rod c (Fig. 3a). The outer end of the rod D extends through the top of the rod c above the hand wheel 1c and is provided with a hand wheel 2d. Through a suit-

able connection, preferably screw-threaded (not shown) between the rod D and the outer end of the valve rod c, the inner end 1d of the rod D is adapted to be brought into or out of engagement with the shoulder valve seat formed between the bores of different diameters within the rod c and thereby function to establish or cut off communication between the lower portion of the bore through the rod c and the space above the metal in the kettle. Suitable glands and packings are provided for the rods c and D to prevent the escape of gas therethrough or therearound.

Extending through the bottom of the kettle b in axial alignment with the valve rod c is a draw-off tube E which extends into the kettle a substantial distance above the bottom thereof and at said end is provided with a valve seat against which the plug valve C is adapted to seat. For movement of the plug valve onto and from its seat, a suitable screw-threaded connection (not shown) may be provided between the rod c and a bushing 7b carried by the top of the dome member 5b. The lower end of the draw-off tube E is suitably connected, preferably by welding, to a charging tube or cylinder F, one end of which is secured to and in open communication with the extrusion cylinder of the extrusion press.

Extending through said cylinder F and movable therein is a valve rod G, the left hand end of which, as viewed in Fig. 3, is provided with a conical portion g constituting a valve, which terminates in an axial cylindrical portion 1g, while the opposite end of said rod is somewhat enlarged and terminates in an annular flange 2g which is secured to one end of a movable hydraulic ram h through the medium of a split clamping ring 3g. The cylinder F at the right hand end thereof, as viewed in Fig. 3, is provided on its interior with a Monel metal bushing f which is held in position by a suitable shouldered gland 1f bearing against the end of the cylinder, which gland, in turn, is encircled by a yoke 2f having a shoulder bearing against a shoulder on the gland 1f and an in-turned flange bearing against the outer end of said gland and providing an annular space therebetween through which a cooling fluid lead thereinto and therefrom by pipes 3f and 4f may be caused to circulate. The Monel metal bushing f, which will be cooled by the fluid circulating in the cooling passage, will function to prevent cutting or scoring of the lead valve rod G in its movements within the cylinder.

For moving the valve rod G to cause seating or unseating of the valve g, I provide hydraulically-controlled means consisting of an hydraulic valve-operating cylinder H, within which the ram h is movable to the left under hydraulic pressure adapted to enter the cylinder through the passage 1h in its removable end wall or head 2h, and which ram is adapted to move to the right upon the operation of suitable valves, which will be presently explained, whereby the hydraulic fluid from the pressure side of the cylinder will pass to waste, and fluid under pressure will enter the backing side 4h of said cylinder through the conduit 3h. By having the cylinder head 2h removable, it will be appreciated that inspection or repair of the lead valve rod through the cylinder H may be readily accomplished. The valve g is designed to seat against a Monel metal valve seat j provided within a recess in the outer wall of the extrusion cylinder J, said valve seat communicating with the interior of the cylinder chamber 1j through the opening 2j.

Reciprocable within the cylinder J is an extru-

sion ram K, which, at its outer end, is somewhat enlarged and formed with a flange K, which, through the medium of a split clamping ring 1k of slightly larger internal diameter than the flange k, connects the extrusion ram to a bolster block 2k, which, in turn, is secured to a platen 3k through the medium of bolts 4k, and said platen, in turn, being secured to the hydraulic ram 5k through the medium of securing bolts 6k. The ram 5k is reciprocable within an hydraulic cylinder L in the conventional manner, that is to say, it is caused to move downwardly upon hydraulic pressure fluid being admitted into the cylinder L and to move upwardly upon hydraulic pressure fluid being admitted into the backing cylinders L', L² which cause the rams l' and l² to move the platen 3k upwardly. Screw-threadedly engaging within the outer end of the cylinder J is a Monel metal bushing 7k, the internal wall of which is provided with annular conical recesses 8k and at its top is provided with an annular recess 9k through which cooling fluid may circulate through the pipes 10k. Encircling the outer end of the cylinder J in encompassing relation to the bushing 7k is a second annular chamber 2j, through which cooling fluid may circulate, such fluid being adapted to enter and leave said chamber by the pipes 3j. The cooling chambers 2j and 9k are adapted to maintain the outer end of the cylinder at a temperature sufficiently low to congeal any lead which passes up around the ram K and finds its way into the grooves 8k, in which grooves said congealed lead will function as a self-sealing packing thereby preventing the entry of air into the extruding chamber and the outward flow of any molten metal from said chamber past said gland. The extrusion ram K is of somewhat smaller diameter than the chamber j and does not directly contact therewith, and thus cutting and scoring of said chamber is averted. Due to the slightly larger internal diameter of the channeled clamping ring 1k over the flange k, the ram has limited lateral play with respect to the clamping ring and will therefore be self-centering in the bushing 7k. The extrusion chamber at its lower end, which is in contact with a die-block M, is preferably of somewhat larger diameter, and is thus formed by outwardly tapering the chamber, as shown at 4j, from an upper portion thereof downwardly toward the die-block. The purpose of providing the lower end of the extrusion chamber with a larger diameter is to allow for use of larger capacity die-blocks in relatively small extrusion presses.

One of the primary purposes of the present apparatus being to eliminate the welds or so-called flow-lines normally caused by the absence of homogeneous continuity of the lead mass in the cylinder between the metal of consecutive charges, and to cause homogeneous fusion between said metal of consecutive charges, it will be appreciated that the extrudable metal within the extrusion chamber which remains from one charge and merges with the metal of a succeeding charge into the chamber should be maintained in a molten state so that true fusion and homogeneity of the metal of successive charges will result. Accordingly the extrusion chamber in the region of contact between successive charges is maintained at a temperature high enough to insure complete fusion of the extrudable metal therein. This may be accomplished by suitably heating the extruding cylinder J in said region by gas firing, electric heating elements or by the high

frequency induction method. As shown in the drawings, the central portion of the extrusion cylinder J is enclosed within an insulated casing or housing N having a flue *n* communicating with the interior of the furnace and within which casing suitable gas fired heating means may be caused to function. In order, however, that the metal being extruded will be in a sufficiently congealed state to permit extrusion, the lower portion of this cylinder has encircling it an annular chamber O through which cooling fluid may be caused to circulate through the pipes o and lo. To permit thorough and uniform heating of the cylinder J around the region of ingress of the molten metal, said cylinder is formed with heat conduction passages 5j. Similarly, for maintaining the extrudable metal in the valve cylinder F and draw-off tube E in the molten state, said parts are enclosed within an insulated firing chamber or housing O', having gas firing openings o'. To prevent overheating of said last named parts E and F with the attendant possible burning of the extrudable metal, said parts are provided with cast iron protecting shields e and 5j, respectively.

To allow for non-uniform expansion of the furnace, the draw-off tube connected to the melting kettle and the lead valve cylinder, the furnace is floatingly supported at its bottom wall upon a roller P extending thereacross, whereby the furnace will be permitted to tilt or rock to compensate for temperature variation without introducing detrimental strains on the various parts. The roller P rests upon a steel plate Q which is supported through the medium of a channel reinforcing frame R upon a pair of supporting legs S, and by the extrusion cylinder J through the intermediary of the casing N, to which the channel frame R is secured. For eliminating all stress on the pipe connection parts E and F between the kettle and the extrusion cylinder, the valve operating cylinder H is connected by columns T to the extrusion cylinder J through the medium of a yoke t, the yoke 2f and the tightening nuts 2t.

For controlling the operation of the extruding ram K and lead valve *g*, there is provided a reversing valve U having an operating handle *u* and provided with a by-pass valve operable by a hand wheel 1u and a spring-mounted holding valve V, the conventional quick return valve W and the hydraulic piping connections between said various valves.

Operation.—In the operation of the apparatus hereinbefore described, let us assume that the lead kettle *b* is full of molten lead at a temperature of 700 to 750° F. and tank 8b contains CO₂ or H₂ gas at a pressure of approximately 2 lbs. per square inch above atmosphere. By opening the valve 9b, gas from the tank 8b will flow into the top of the kettle above the molten lead therein. Now let us assume further that the extrusion cylinder J has been brought up to required temperature of 650° F. at its central region and approxi-

by turning the hand wheel 1u to maintain hydraulic pressure in the backing cylinders L' and L² and at the backing side of the valve-operating cylinder 4h in order to keep the lead valve *g* away from its seat *j*. All the air in the draw-off tube E, the valve-operating cylinder F, the extrusion cylinder J and the die-block M is expelled or greatly diluted with a sufficient quantity of non-oxidizing gas by opening the valve 1d, which will allow the gas to flow from the kettle above the molten lead of said aforementioned parts through the central passage 2c in the valve rod *c*, thence through the plug valve C.

When all the internal passages and parts aforementioned have been thoroughly cleansed of oxygen by means of non-oxidizing gas, as explained in the preceding paragraph, the valve 2d is closed and the plug valve C is opened by raising the same from its seat through the medium of operating hand wheel 1c. The unseating of the plug valve C will allow the molten lead to flow through the draw-off tube and valve cylinder into the extrusion chamber and die-block, filling all of said parts and allowing gas to leak out at the gland 8k around the ram at the top of the extrusion cylinder.

From this point on, the plug valve C is left unseated and the extrusion operation is started by opening the hand wheel 1u of the by-pass valve and placing the handle *u* in extruding or dotted line position, then closing the by-pass valve until the required extrusion speed has been obtained. The specific constructions of the hydraulic reversing valve U and spring-loaded holding valve V need not here be described, but their operations with regard to the direction of hydraulic flow of fluid through the pipes are as follows:

For the extruding stroke, hydraulic water is conveyed from the reversing valve through pipe 2u to the top of the hydraulic cylinder L to force the extruding ram down into the extruding cylinder and also through pipe 3u to the lead valve operating hydraulic cylinder H for closing the lead valve *g*, thereby sealing the extrusion cylinder at said point. By means of the spring-loaded holding valve V which establishes a pressure in the backing cylinders L' and L² which must be overcome by the pressure in the extrusion ram cylinder L, the valve G is enabled to close upon its seat before the ram K begins to move downwardly and to move off from its seat before said ram begins its upward stroke. The spring-mounted holding valve V has a capacity of about 850 lbs., and where it is sought to maintain the back pressure in the backing cylinders by the loading spring of said valve at say 400 lbs. per square inch in a press in which the extruding ram cylinder has a diameter of 25 inches and each backing cylinder has a diameter of 7 inches, the pressure which must be created in the 25" diameter extrusion ram cylinder before the ram will move downwardly will be

$$\frac{\text{pressure acting on the backing cylinder}}{\text{area of the extrusion ram cylinder}} = \frac{400 \times 2 \times \pi \times \left(\frac{7}{2}\right)^2}{\pi \times \left(\frac{25}{2}\right)^2} = 62\frac{1}{2} \text{ lbs. per square inch.}$$

mately 350° F. in proximity to its top and bottom; and also that the die-block M and the extrusion ram K are at or above a temperature of approximately 350°.

The extrusion ram is brought to its uppermost position by moving the handle *u* of the reversing valve to its return stroke position (full line position, Fig. 2) and partly closing the slack-off valve

This pressure acting on a 15" diameter ram of the lead operating valve cylinder produces a pressure of

$$\left(\frac{15}{2}\right)^2 \times \pi \times 62\frac{1}{2} \text{ or } 176.7 \times 62\frac{1}{2} = 11,000 \text{ lbs.}$$

or 5½ tons upon the lead valve *g* closing the same before the extrusion ram starts. When the ex-

trusion pressure acting upon an 8" diameter extrusion ram reaches 60,000 lbs. per square inch, the pressure per square inch acting upon the 25" diameter ram piston will be

$$\frac{(4)^2 \times \pi \times 60,000}{\pi \times \left(\frac{25}{2}\right)^2} = 6,100,$$

and on a 4½" diameter lead valve will be

$$\frac{6100 \times 176.7}{\pi \times \left(\frac{9}{4}\right)^2} = 67,500 \text{ lbs. per square inch,}$$

or 7500 lbs. per square inch in excess of the extruding pressure

At the end of the extrusion stroke the hand wheel 1u of the by-pass valve of the reversing valve U is opened and the operating handle u is moved to the full line position for the return stroke, whereupon, by closing the by-pass valve, water from the top of the hydraulic cylinder L and lead valve operating cylinder H will return through the reversing valve and the by-pass in the quick return valve W through pipe 4u and 3u to the pump tank, and hydraulic pressure will be applied to the backing side 4h of the cylinder H through pipes 5u (Fig. 2) and 2u. Also when the pressure is sufficient to compensate for the weight of the ram 5k, platen 3k, bolster block 2k, clamping ring k and extrusion ram K, as well as the weight of the backing rams 1' and 1" and the spring-actuating plungers in the holding valve V, a total of approximately 500 lbs. per square inch, the extrusion ram will start upwardly. However, the 500 lbs. per square inch hydraulic pressure will act on the backing side of the lead valve cylinder 4h, which has a diameter of 13", first opening the lead valve g with a pull equal to the differential area of the lead valve piston multiplied by said pressure or $(176.7 - 132.7)$ or $44 \times 500 = 22,000$ lbs., thereby insuring the opening of the lead valve before the extrusion ram starts on its upward stroke when lead under a 6'-0" head will flow into the extrusion cylinder, filling the void left by the ascending ram K.

At the end of the upstroke of the extrusion ram, the by-pass valve of the reversing valve U is opened and the operating handle B is placed in extrusion position, whereupon, by closing the by-pass valve in the reversing valve U, the extrusion operation will again proceed.

With my present apparatus extrusion can be made 90% continuous, since no time is required for the lead cooling, since said lead is cooled on its travel towards the die-block in the lower part of the extrusion chamber at a rate of 24 inches in 6½ minutes, or 3.7 inches per minute. This will prevent burning or carbonizing of the insulation surrounding cable.

From the foregoing detailed description and explanation of operation of the apparatus disclosed, it will be apparent that I have provided a novel method and means for accomplishing the objects of my invention in a simple, practicable and efficient manner, and while I have shown and described certain details of construction it is to be understood that the present disclosure is primarily an exemplification of my invention and is not to be construed as limiting, since various changes therein may be made within the range of engineering skill without departing from the spirit of my invention.

What I claim is:

1. In combination, an hydraulically operable extrusion press having an extrusion cylinder, a ram reciprocable within said cylinder, a source of molten metal, means for conducting said metal to said cylinder, an hydraulically operable charging valve controlling the supply of molten metal to the cylinder, valve means controlling the supply of fluid pressure for the press operation and for the operation of the charging valve, and a holding valve responsive to a predetermined pressure of the fluid supply for causing the opening of the charging valve to take place slightly in advance of the starting of the return stroke of the ram and the closing of the charging valve to take place slightly in advance of the extruding stroke of the ram.

2. In combination, an hydraulically operable extrusion press having an extrusion cylinder, a ram reciprocable within said cylinder, a source of molten metal, means for conducting said metal to said cylinder, an hydraulically operable charging valve controlling the supply of molten metal to the cylinder, valve means controlling the supply of fluid pressure for the press operation and for the operation of the charging valve, a holding valve responsive to a predetermined pressure of the fluid supply for causing the opening of the charging valve to take place slightly in advance of the starting of the return stroke of the ram and the closing of the charging valve to take place slightly in advance of the extruding stroke of the ram, and means for holding the molten metal charging valve upon its seat during the extrusion stroke of the ram by a unit pressure greatly in excess of that developed upon the surface of the metal in the extrusion cylinder.

3. In combination, an hydraulically operable extrusion press having an extrusion cylinder, a ram movable in said cylinder, a piston for operating said ram, a molten metal cylinder disposed transversely to and having a port in communication with the extrusion cylinder, which latter has a valve seat in its outer wall at the port of communication, an hydraulically operable valve carried by a ram movable in said molten metal cylinder and controlling said port, a piston for operating said valve-carrying ram, and valve means controlling the fluid pressure on said pistons for substantially simultaneously closing the valve carried by the ram and starting the extrusion ram on its extrusion stroke.

4. An extrusion press comprising an extrusion cylinder, a gland of somewhat smaller internal diameter than said cylinder in one end thereof, an extrusion ram movable in said cylinder through said gland and a bolster block by which the ram is carried, the connection between the bolster block and the ram being such as to allow for limited relative transverse movement therebetween so that the ram will be practically self-centering in the gland.

5. An extrusion press comprising an extrusion cylinder, a gland of somewhat smaller internal diameter than said cylinder in one end thereof, an extrusion ram movable in said cylinder through said gland and a bolster block, said ram being connected to the bolster block by a clamp ring within which the ram head has limited transverse play whereby the ram will be practically self-centering in the gland.

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