Dec. 29, 1925. 1,567,363

B. S. ELROD ET AL

FORMING CONTINUOUS SOFT METAL BARS FROM MOLTEN METAL

Filed Oct. 14, 1920 2 Sheets-Sheet 1

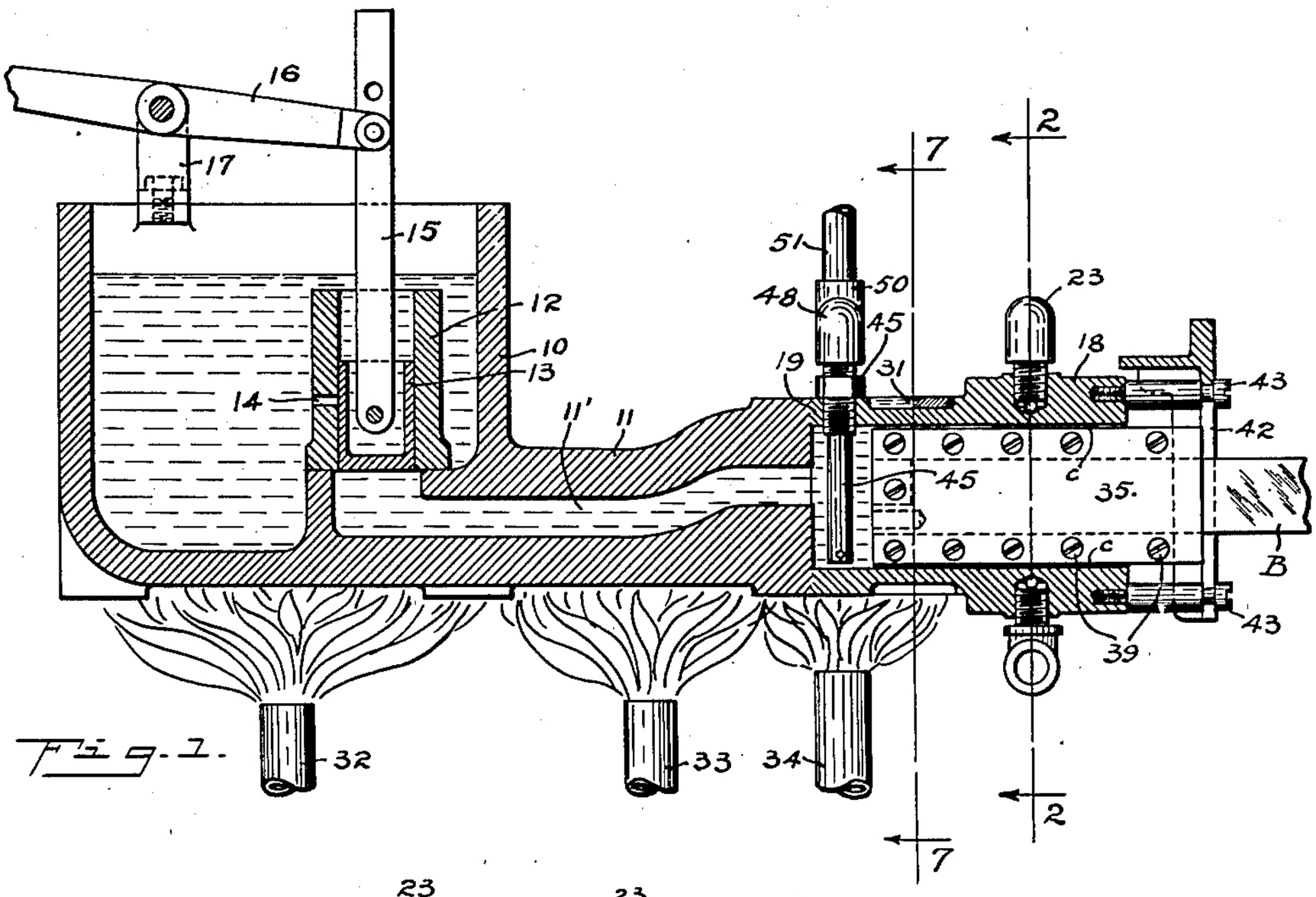

Fig. 1.

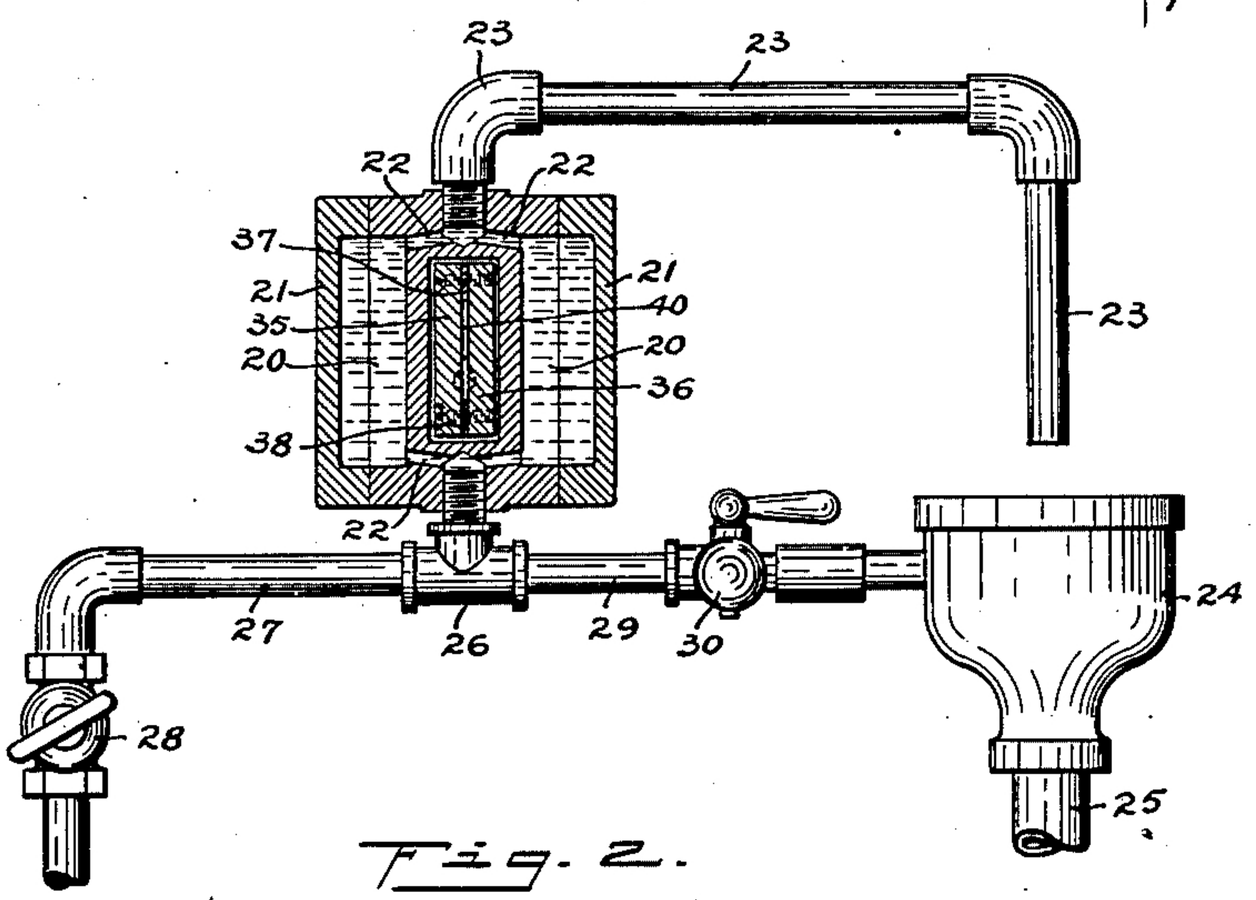

Fig. 2.

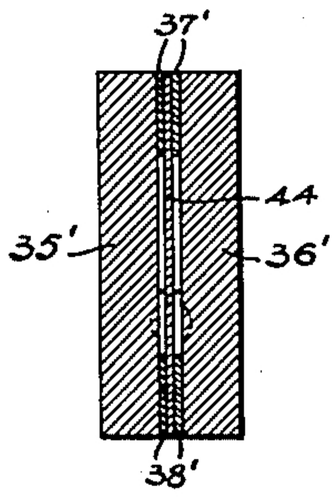

Fig. 3.

Witness:
R. J. Honomichl.

Inventors:
B. S. Elrod.
Wm. Hector.
By David O. Barnell.
Attorney

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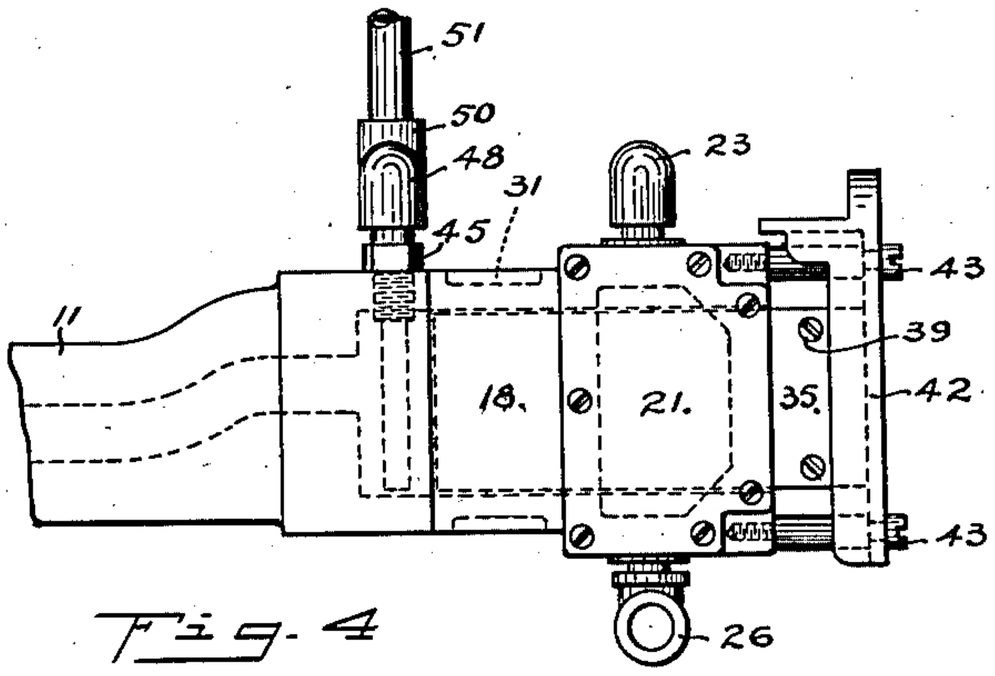

Fig. 4

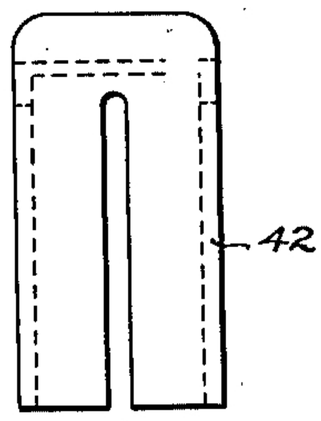

Fig. 5.

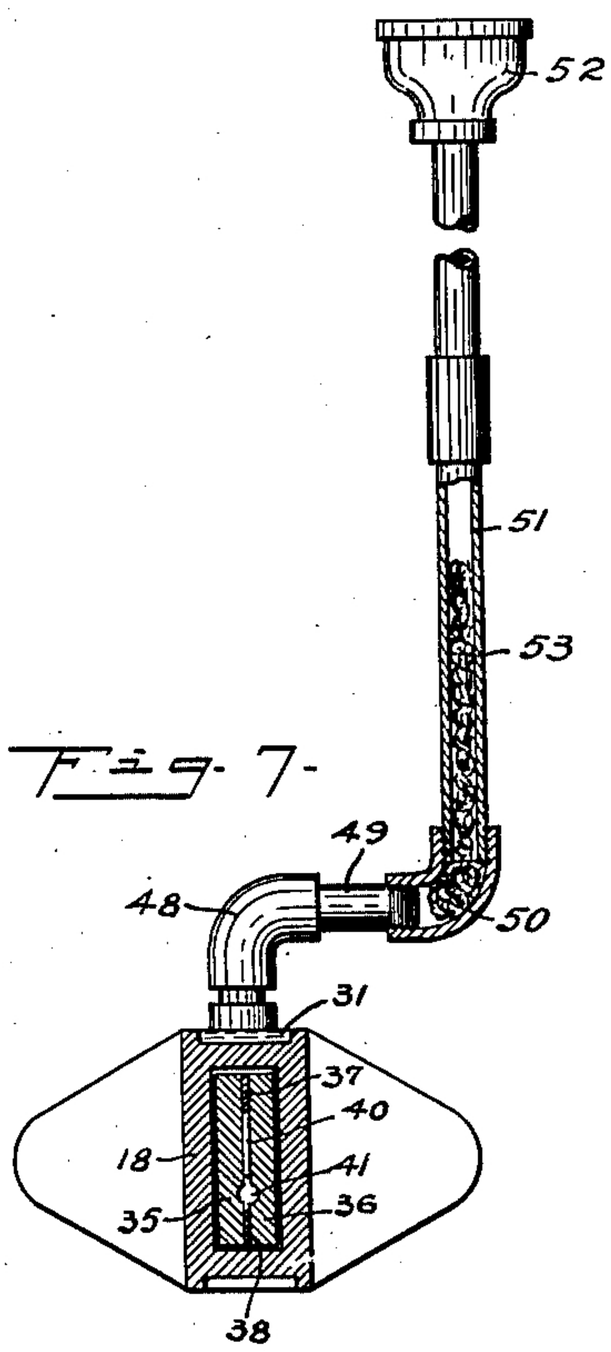

Fig. 7.

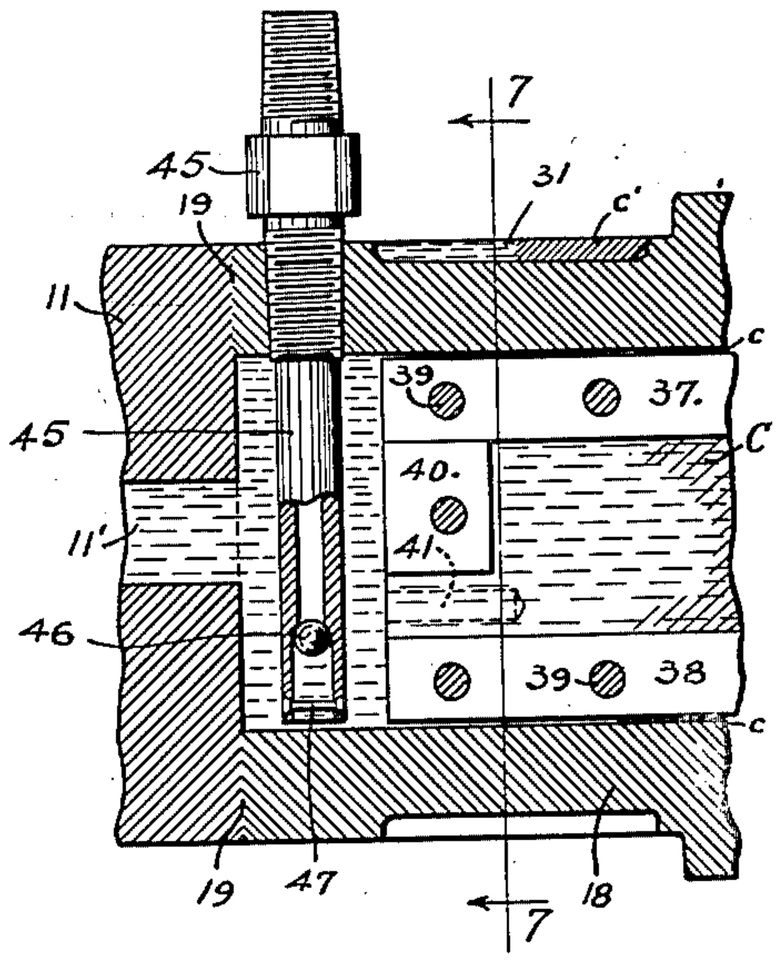

Fig. 6.

Witness:
R. J. Honomichl.

Inventors:
B. S. ELROD.
WM. HECTOR.
By David O. Barnell,
Attorney

Patented Dec. 29, 1925. 1,567,363

UNITED STATES PATENT OFFICE.

BENJAMIN S. ELROD AND WILLIAM HECTOR, OF OMAHA, NEBRASKA, ASSIGNORS, BY MESNE ASSIGNMENTS, TO OMAHA TRUST COMPANY, TRUSTEE, A CORPORATION OF NEBRASKA.

FORMING CONTINUOUS SOFT-METAL BARS FROM MOLTEN METAL.

Application filed October 14, 1920. Serial No. 416,904.

To all whom it may concern:

Be it known that we, BENJAMIN S. ELROD and WILLIAM HECTOR, citizens of the United States, and residents of Omaha, in the county of Douglas and State of Nebraska, have invented certain new and useful Improvements in Forming Continuous Soft-Metal Bars From Molten Metal, of which the following is a specification.

Our invention relates more particularly to forming continuous soft-metal bars by methods and means of the general class disclosed in the application of Elrod, filed May 14, 1917, Serial No. 168,546, (now Patent No. 1,438,951, dated December 19, 1922) wherein molten metal is delivered into a mold, or rather die, having a channel of approximately the cross-sectional form of the desired bar, the metal being cooled so as to solidify while passing through the channel, the bar formed by the cooling and solidification of the metal being pulled from the channel while the space in the channel from which the solid bar-portion is withdrawn is constantly refilled with a fresh supply of the molten metal, and a lubricant being introduced into the mold-channel along with the molten metal whereby to prevent any tendency for adhesion between the bar and the mold. It is the object of the present invention to provide, for the purposes indicated above, an improved form of die especially adapted for the production of thin bars; to provide an improved method of connecting the die with the receptacle from which the molten metal is delivered, whereby to prevent leakage of metal at the joints and to facilitate removal and replacement of dies; to provide improved means for supplying the lubricant, and for preventing escape of molten metal through the lubricant-supplying conduit; as also to provide a die wherein two bars may be formed and delivered simultaneously, whereby to double the output of the casting machine without addition of any moving parts or other elements except the specially formed die.

Constructions embodying our invention are illustrated in the accompanying drawings, in which Fig. 1 is a longitudinal section of the metal melting pot and die-housing, Fig. 2 is a transverse section of the die and housing on the vertical plane of the line 2—2 of Fig. 1, Fig. 3 is a transverse section of the double-bar die, Fig. 4 is a detail side view of the die-housing, Fig. 5 is a detail front view of the die-guard, Fig. 6 is a partial longitudinal section of the die, housing and lubricant-supply conduit, and Fig. 7 is a detail transverse section of the die and housing on the vertical plane of the lines 7—7 of Figs. 1 and 6, a portion of the lubricant-supply pipe also being shown in vertical section.

It will be understood that the illustrated structures are parts of an organized machine, such as that shown in the aforesaid application, said machine including, in addition to the parts herein shown, a suitable supporting frame, means for pulling the formed bar from the die, means for cutting pieces of the desired length from the continuous bar, and means for actuating the pump by which the molten metal is driven into the die simultaneously with the pulling of the formed bar therefrom.

Referring to Fig. 1 of the drawings, there is shown a melting-pot 10 having an integral spout 11 extending horizontally from the lower part thereof. The channel or passage 11′ through the spout communicates with the lower end of a pump-cylinder 12 which is secured in the lower portion of the pot, as shown, a piston 13 working slidably in said cylinder and moving reciprocatingly between the lowered position shown and a raised position at which the lower end of the piston is above a lateral port 14 in the side of the cylinder. The piston-rod 15 is a flat bar pivotally connected at its lower end with the piston, and pivotally connected near its upper end with the forked end of a lever 16, the latter being fulcrumed on a bracket 17 mounted on the upper edge of the melting-pot. The lever 16 is oscillated about its fulcrum by suitable actuating means working in unison with the means for pulling the formed bar from the die, and so that the pulling of the bar from the die occurs during the downward stroke of the piston. Near the end of the spout the passage 11′ is upwardly offset for a purpose which will appear hereinafter.

The die-housing 18 is formed with a uniform substantially rectangular longitudinal passage extending through it from

end to end. The rear end of the die-housing is welded to the end of the spout 11 so as to become substantially integral therewith, whereby any possibility of leakage at the joint 19 is prevented. The vertical dimension of the passage through the spout 11 is considerably less than that through the die-housing, and the adjacent ends of said passages are so arranged that the former enters the latter at a level somewhat above the center thereof. Near the front end of the die-housing the same is laterally enlarged and provided at each side with a water-chamber 20, the outer sides of said chambers being closed by removable cover-plates 21. Small passages 22 are extended in diagonally from the upper and lower parts of the water-chambers 20, as shown in Fig. 2, said passages connecting with threaded openings in the upper and lower sides of the housing. To the upper opening there is connected a discharge-pipe 23 which is extended laterally and then downwardly, terminating above a waste-basin 24 from which a drain pipe 25 is extended as desired. To the lower opening in the housing there is connected a T-pipe 26, and to one branch of the latter is connected the water-supply pipe 27, which is provided with a suitable control-cock 28. To the other branch of the T 26 is connected a pipe 29 which is extended to and connected with the waste-basin 24. In the latter pipe there is arranged a shut-off cock 30, which is normally closed, whereby the water from the supply-pipe 27 is caused to flow up through the chambers 20 and pass therefrom through the discharge-pipe 23. By opening the cock 30, after closing the supply-cock 28, the water-chambers 20 may be emptied.

In the upper side of the die-housing, between the rear end thereof and the laterally enlarged portion containing the water-chambers 20, there is a shallow recess 31 in which is placed a small specimen of the metal which is being cast. Said specimen of metal is employed as an indicator to show the correct operating temperature for the mechanism. The melting-pot, the spout, and the rear end-portion of the die-housing are heated by suitable burners 32, 33 and 34 disposed beneath them, as shown in Fig. 1.

Dies for casting bars of any desired form, within the capacity of the machine, may be disposed in the rectangular longitudinal channel of the housing 18, the external form of said dies being such that they will fit loosely within the channel through the housing, or so that a slight space is left between the outer surfaces of the die and the inner surfaces of the housing.

A die of suitable form for producing a simple rectangular bar is shown in Figs. 1, 2, 6 and 7, and comprises a pair of rectangular side-plates 35 and 36, spaced apart by narrow plates 37 and 38 disposed between them near their upper and lower edges, said parts being secured together by screws 39 which pass transversely through the plates 35, 37 and 38, and enter threaded openings in the plate 36. Preferably, also, there is a short baffle-plate 40 disposed between the side-plates at the rear end of the die and secured in place by one of the screws 39, said baffle-plate fitting against the lower edge of the upper spacing-plate 37, but leaving an opening or feed-passage at its lower edge, between said edge and the lower spacing-plate 38. In the die shown, which is for producing a relatively thin bar, the feed-passage beneath the baffle-plate is enlarged laterally by forming recesses 41 in the adjacent sides of the plates 35 and 36, said recesses extending from the rear end of the die past the front edge of the baffle-plate. Said recesses 41 are conveniently produced by drilling in from the rear end of the die after its parts are assembled. Said lateral enlargement of the feed-passage is unnecessary except for relatively thin bars. The length of the dies is made such that a portion thereof will protrude from the front end of the housing, and accidental displacement of the die from the housing is prevented by means of a guard-plate 42 of the form shown in Figs. 1, 4 and 5. Said guard-plate has a central vertically extending slot therein, adapting the same to straddle a pair of neck-grooved studs 43 which extend horizontally from the front end of the housing, above and below the die.

Leakage of metal through the clearance-space between the die and housing is prevented by circulation of water through the chambers 20 in sufficient quantity to maintain the front end portion of the housing at a temperature below the melting-point of the metal being cast. Under such conditions, some of the molten metal which enters the rear end of said clearance-space freezes or solidifies upon reaching the cooled portion of the housing, and the metal itself is thus caused to seal the joint around the die and form a fluid-tight connection *c* between the mold and housing.

When it is desired to change dies, the operation of the bar-pulling device and of the pump is stopped, with the pump-piston at a lowered position such as shown in Fig. 1, or so that the feed-port 14 is closed by the piston. The water-supply cock 28 is then closed, and the drain-cock 30 opened, so as to drain the water from the chambers 20, thus permitting the heat from the burners to melt the metal *c* which seals the joint between the mold and housing. Thereafter the guard-plate 42 is lifted off the support-

ing studs 43, and the die then pulled out of the housing, in which it rests loosely after the melting of the sealing-metal. After the melting of the sealing-metal, and particularly after the removal of the die from the housing, substantially all of the metal within the housing-channel, as well as that in the front portion of the spout-channel 11′, will flow out of the open end of the housing. But, on account of the upward offset thereof of the metal in the rear portion of the spout-channel 11′ will not escape, and escape of metal from the pot will be prevented by the pump-piston. When replacing a die in the housing, the same is merely inserted in the channel, and the guard-plate dropped down in front of it to prevent its being pushed out of the housing by the first flow of molten metal into the rear portion of the housing. The water-cock 30 is then closed, and the supply-cock 28 opened to re-establish the flow of water through the chambers 20 and cool the housing. The pump-piston is then raised sufficiently to uncover the feed-port 14 and permit metal from the pot to flow out through the spout and into the housing. Any air trapped in the housing behind the die escapes through the clearance-space around the mold, being followed by the molten metal, which freezes and seals the joint upon reaching the cooled portion of the housing. It will be understood, of course, that in starting the operation of the machine the opening of the die-channel is closed by a previously-formed bar of the proper size, which is inserted in the die-channel prior to admitting the molten metal to the housing. The bar inserted in the die-channel forms a "bait" to which the metal congealing within the mold-channel becomes attached, and whereby the first-formed portion of the new bar may be pulled out of the die.

It has proven entirely practicable, when casting thin substantially rectangular bars, to double the capacity of the machine by using a die having two parallel channels therein, separated by a thin partition plate, whereby two bars are formed simultaneously, the same being pulled from the mold and cut into the desired lengths by the same mechanism employed for a single bar. A die of this kind is shown in Fig. 3, said mold comprising side-plates 35′ and 36′, two pairs of spacing-plates 37′ and 38′, and a central partition-plate 44. Except for the partition-plate and the extra pair of spacing-plates the structure of this double-bar die is the same as that of the single-bar die first described.

Minute quantities of a suitable lubricant, such as heavy oil, are introduced into the die along with the molten metal, by the following means: In the upper side of the die-housing near the rear end thereof is a threaded opening into which is screwed a tube 45 having a reduced lower portion which extends down into the housing-channel behind the rear end of the die, and terminates near the lower side of said channel, as shown in Figs. 1 and 6. Near the lower end the bore of the tube is enlarged, thereby forming at the upper end of the enlarged portion a seat for a valve-ball 46, which is disposed in the tube and retained therein by a pin 47 extending transversely across the tube at the end, as shown in Fig. 6. The upper end of the oil-tube 45 is connected by an elbow 48 with a short horizontally extending pipe 49, and the latter is connected by an elbow 50 with a vertically extending pipe 51 which may be provided at its upper end with a cup 52, as shown in Fig. 7. In the lower portion of the pipe 51, adjoining the elbow 50, there is disposed a plug or packing 53 of asbestos or like porous or fibrous material, adapted to limit flow of oil through the tube. Oil supplied to the cup 52 and descending the vertical pipe 51, seeps slowly through said packing. The rate of flow of the oil through the packing is dependent largely upon the length of the pipe portion which is filled with the packing material, and the density to which the packing is rammed therein. A further control of the oil feed is attained by variation of the temperature to which the packed portion of the feed-pipe is subjected, the feed being increased by higher temperature, which causes the oil to become thinner. Variation of the temperature of the feed-pipe, within the desired limits, may be attained by swinging the horizontal pipe 49 pivotally about the valve-tube 45, from a laterally extending position, such as shown in Fig. 7, to a position in which said horizontal pipe extends longitudinally of the spout 11 and mold-housing. In the latter position the packed portion of the feed-pipe is shielded from direct impingement thereon of the heated air from the burners 33 and 34, but in the position shown in Fig. 7 the pipe is directly exposed to the ascending current of heated air, and thus receives more heat than in the shielded position.

When the machine is in operation, the valve-ball 46, by floating upon the surface of the molten metal entering the lower end of the oil-tube 45, is caused to engage the valve-seat, and thereby prevents further entry of the metal into the tube. During each upward stroke of the pump-piston, prior to the uncovering of the feed-port 14 in the side of the pump-cylinder, there is a certain suction exerted in the passage between the pump and the die, and during this time the valve-ball is lowered from its seat and oil is drawn down through the tube 45, so as to emerge from the lower end thereof. The oil is thus fed into the lowermost part of the

housing, behind the die and below the feed-opening thereto. The oil, being lighter than the metal tends to rise to the top thereof, but owing to the movement of the metal through the passage, the oil is carried into the die therewith. The baffle-plate 40 at the rear end of the die insures the entry of the oil into the lower portion of the die-channel and thus causes a substantially uniform distribution of the lubricant over the inner surfaces of the die, the amount of the lubricant supplied being merely enough to prevent adhesion of the soft metal to the die surfaces.

For the best operation of the mechanism, the molten metal in the pot and spout should be maintained at a temperature only moderately above the melting-point thereof, so that the cooling and solidification of the metal in the die-channel may be easily and rapidly effected by the circulation of water through the chambers 20. A proper balance of temperatures, between the heating and cooling means, is indicated by the condition of the sample of metal contained in the recess 31 on top of the die-housing, a proper working condition being shown when the metal in the rear portion of said recess is melted while the metal *c'* in the front portion of said recess remains solid, as indicated in Fig. 6. The solid metal *c* forming the seal between the die and housing, and the solid metal C within the mold-channel begin at points slightly farther forward than the point at which solidification of the metal occurs in the external recess 31, since the latter is subjected to the cooling effect of the atmosphere, while the heat radiated to the water-jacket from the interior parts is constantly replenished by that from the fresh supply of molten metal entering the die. The point at which solidification of the metal occurs in the die-channel will also vary more or less according to the rate at which the cast bar is being pulled out of the die, but the freezing-point of the metal in the die-channel must always be beyond the front edge of the baffle-plate 40, as otherwise the upper portion of the cast bar will be defective, and consist merely of a series of pieces connected to each other by a continuous solid portion having the sectional form of the feed-channel below the edge of the baffle-plate.

Now, having described our invention, what we claim and desire to secure by Letters Patent is:

1. In the art of forming continuous soft-metal bars from molten metal, wherein is employed a die having a longitudinal channel in which such metal is congealed and from which it is withdrawn progressively, a conduit for feeding molten metal to one end of the mold-channel, and means for cooling a portion of the mold thus to congeal the metal within such channel; the method of forming a fluid-tight joint between the die and metal delivering conduit, consisting in inserting the die within said conduit so as to partly but not completely close the open end thereof, then cooling the die and conduit near the open end thereof, and finally delivering the molten metal into the conduit, whereby said metal by tending to escape through the joint between the conduit and die will be congealed therein and seal the same.

2. In a mechanism for forming continuous bars from molten metal, the combination with a conduit for delivering such metal, of a die-housing connected with said conduit and having a longitudinal passage open at one end and arranged to receive at the other end the metal from the conduit, a die insertible in the open end of the passage through the housing and fitting loosely therein, and means for cooling the housing adjacent to the open end thereof, whereby to congeal a portion of the metal which tends to escape through the space between the die and housing and to thereby seal the joint between said parts.

3. In a mechanism of the class described, a melting-pot having an integral discharge conduit provided termir ally with a die-housing, a die fitting loosely in said housing, means for cooling the housing around the die whereby to congeal metal tending to escape through the joint between the die and housing and to seal said joint, and means for heating the housing when desired to melt the sealing-metal and enable free removal and replacement of the die.

4. In a mechanism of the class described, a die body having a continuous longitudinal channel through it, means connected with said die-body for delivering molten metal to one end of said channel, means for cooling the die to solidify the metal during its passage through the channel, and a central partition in the die-channel extending from the cooled portion thereof to a point at which the metal is constantly molten, whereby to divide the molten stream and cool the same into separate bars.

5. In a mechanism for forming continuous soft-metal bars from molten metal, a die having a longitudinal channel of the sectional form of the desired bar, a conduit for delivering molten metal to one end of the die-channel, a housing connected with said conduit and surrounding the die transversely, means for cooling the housing and die adjacent to the open end thereof, a guard-plate arranged to prevent displacement of the die from the housing by pressure of metal in the conduit, and means detachably connecting said guard-plate with the housing.

6. In a mechanism for forming continuous

soft-metal bars from molten metal, a die having a substantially uniform longitudinal channel of the sectional form of the desired bar, means connected with said die for delivering molten metal to one end of the longitudinal channel, and means partially blocking the entry to said channel whereby to direct the incoming metal primarily into the lower portion thereof.

7. Mechanism as set forth in claim 6, including means for feeding a lubricant into the molten metal at a point adjacent to and below the entry to the die-channel, whereby said lubricant will be carried into the die along with the molten metal.

8. In a mechanism of the class described, a die having a continuous channel through it in which molten metal is progressively congealed and from which it is thereupon delivered, means forming a feed-passage connecting with one end of the die-channel, means for supplying molten metal to said feed-passage, means for causing alternate pressure and suction upon the metal in said passage, a tube extending into said passage, means for supplying oil to said tube, and an inwardly-opening valve in said tube whereby to admit oil to the passage during the suction phase and to prevent egress of the molten metal through the tube during the pressure phase of the operation.

9. Mechanism as set forth in claim 8, in which the oil-tube extends to and terminates at a point near the bottom of the feed-passage, whereby the oil from said tube is delivered substantially at the bottom of the molten metal in said feed-passage.

10. Mechanism as set forth in claim 8, in which the oil-tube extends vertically, and the valve in said tube is arranged near the lower end of the tube, the valve being adapted to float upon the molten metal entering said end of the tube, and being thereby lifted to engage the valve-seat.

11. In a mechanism of the class described, a bar-forming die, a conduit for delivering molten metal to the die, an oil-tube for delivering oil into said conduit so as to be carried into the die with the molten metal, and means for varying the flow of oil through said tube, said means comprising a porous packing disposed in a portion of the tube, and means for controlling the temperature of the packed portion of the tube whereby to vary the fluidity of the oil passing through the porous packing.

12. A die for forming bars and like articles from molten metel received from a suitable supply, said die comprising a member provided with a longitudinal channel of approximately the cross-sectional form of such article, and means partially blocking the entry to such channel, whereby the incoming metal is primarily directed into one portion thereof.

13. A die for forming bars and like articles from molten metal received from a suitable supply, said die comprising a member provided with a longitudinal channel of approximately the cross-sectional form of such article, and means partially blocking the entry to such channel, whereby the incoming metal is primarily directed into the lower portion thereof.

14. A die for forming bars and like articles from molten metal received from a suitable supply, said die comprising a member provided with a longitudinal channel of approximately the cross-sectional form of such article, and a baffle plate partially blocking the entry to such channel, whereby the incoming metal is primarily directed into one portion thereof, the unobstructed portion of such entry being laterally widened.

15. A die for forming bars and like articles from molten metal received from a suitable supply, said die comprising complementary side plates and spacing plates secured therebetween, whereby a longitudinal channel is provided of approximately the cross-sectional form of such article.

16. A die for forming bars and like articles from molten metal received from a suitable supply, said die comprising complementary side plates, spacing plates secured therebetween, whereby a longitudinal channel is provided of approximately the cross-sectional form of such article, and a baffle plate of the same thickness as said spacing plates secured in such channel at the entry thereof, whereby the incoming metal is primarily directed into one portion of such channel.

17. A die for forming bars and like articles from molten metal received from a suitable supply, said die comprising complementary side plates, spacing plates secured therebetween, whereby a longitudinal channel is provided of approximately the cross-sectional form of such article, and a baffle plate of the same thickness as said spacing plates secured in such channel at the entry thereof, whereby the incoming metal is primarily directed into one portion of such channel, the inner walls of said side plates being cut away adjacent the restricted portion of such entry so as to laterally widen the same.

BENJAMIN S. ELROD.
WILLIAM HECTOR.