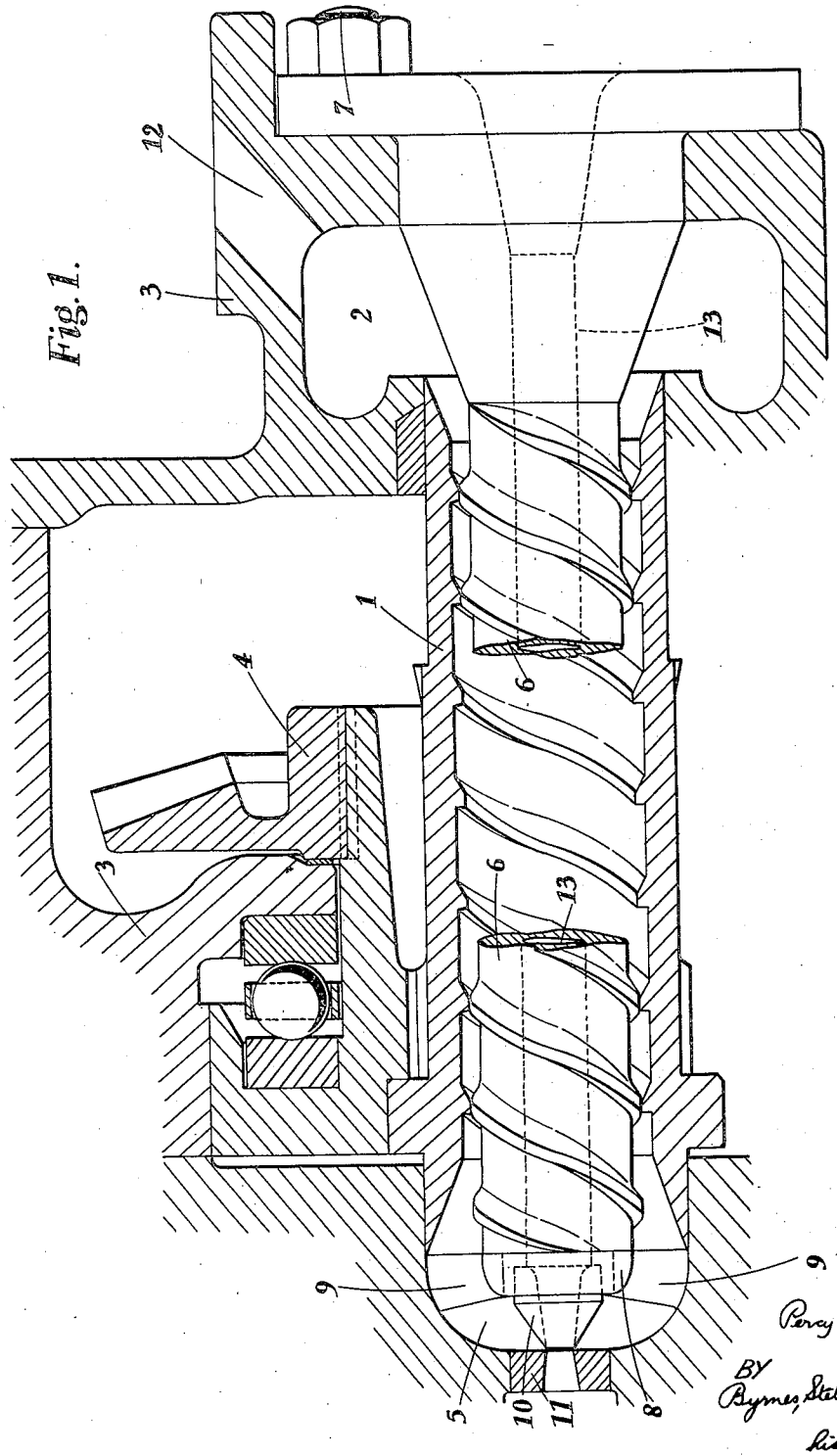
Aug. 18, 1936. P. DUNSHEATH 2,051,688

APPARATUS FOR THE EXTRUSION OF METAL

Filed Feb. 13, 1933 2 Sheets-Sheet 1

Fig. 1.



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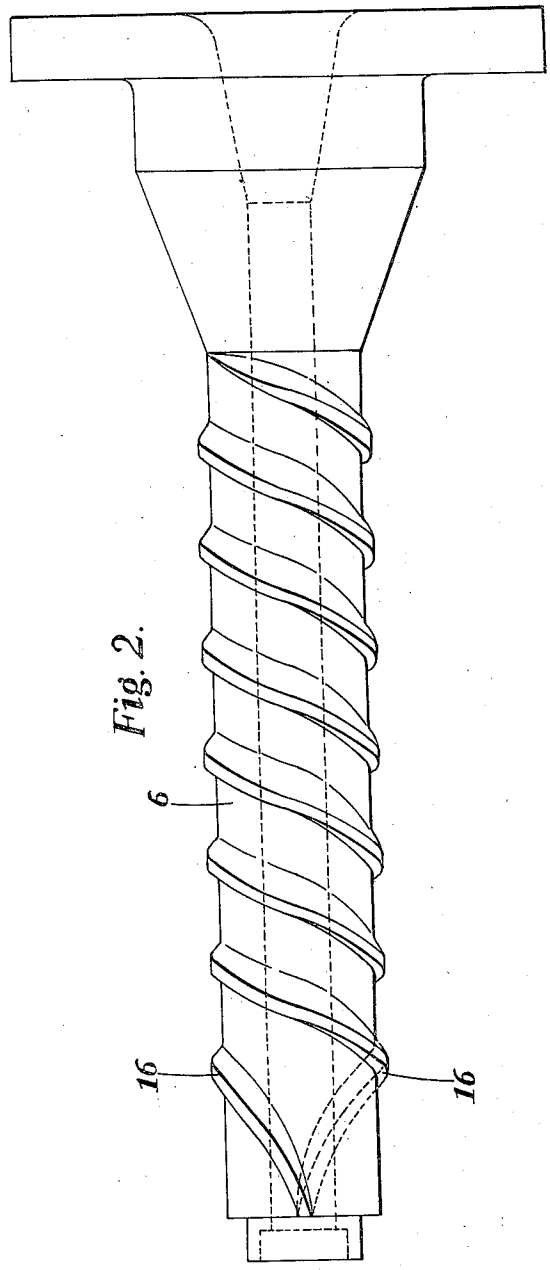

Fig. 2.

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APPARATUS FOR THE EXTRUSION OF METAL

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19 Claims. (Cl. 207—2)

This invention relates to the extrusion of metal by a method employing a rotating screw-threaded impelling device by which the metal is driven forward in the extrusion chamber to and through the die, or between an inner die and an outer die. The impelling device comprises two longitudinally extending concentric members of forms which are in general circular in cross section. These members have on their adjacent faces projections and/or recesses which are adapted to engage metal placed in the space between the members. The metal in the molten state is fed into one end of this space and is then subjected to cooling so that it acquires sufficient rigidity to co-operate mechanically with the projections and/or recesses on the faces. In effect there is continuously cast in the space between the two members of the impelling device a tube of metal shaped to fit the effective surfaces on these members. These surfaces are so formed that relative rotation of the two members causes the tube between them to be fed forward by a screwing action. Continuous rotary movement of the impelling device combined with continuous feeding of molten metal results in continuous delivery of metal in the solid state to the extrusion chamber and in extrusion of it by the pressure exerted on it by the following metal.

It will be seen that the method of working imposes certain limitations on the metals to which it is applicable. It is particularly useful in connection with lead and lead alloys and in extrusion in the form of pipes or as sheaths on electric cables.

The apparatus may conveniently be formed as a long annular chamber into one end of which the molten metal is fed by gravity, and from the other end of which the metal is extruded. The two ends of this chamber may be fixed and the central portion may be formed by the outer part of the screw threaded impelling device. The inner member of the impelling device may extend through the whole length of the chamber and carry an inner die (when this is required) at the extrusion end. This will co-operate with the outer die carried by the end of the chamber in providing an annular space of appropriate form and dimensions for the passage of the extruded metal. This inner member may be hollow to serve for the passage of an electric cable when the machine is being used for sheathing cables.

Hitherto in apparatus of this kind one of the members of the impelling device has been stationary and its effective surfaces have been formed so as to guide the metal parallel with the axis, and restrain it from following the rotary movement of the other member, which has been provided with screw-threads. For this purpose the stationary part has been given ribs or flutes running parallel with the axis of the machine. It is the object of the present invention to increase the efficiency of operation of such apparatus by reducing the proportion of the supplied energy which is wasted by the friction between the metal which is being extruded and the two members of the impelling device and by the internal friction of the metal itself resulting from the application of excessive shearing forces to it by the two members of the impelling device as previously constructed. In accordance with the present invention both members of the impelling device are provided with surfaces such as threads, ribs or flutes which are inclined in helical form. These are disposed in opposite senses on the two members. On producing relative rotation between the two members the effective helical surfaces of both of them impart to the metal between them an endwise thrust.

In general, one of the members carrying the helical driving surfaces will be stationary, but it is within the scope of the invention to make both members to rotate, the rotations being in opposite senses. In this case if both members have threads of approximately equal pitch and are given approximately equal rates of rotation they may cause the metal to travel along the extrusion chamber without rotation about the axis. If one of the members is fixed and the other rotates the metal will receive a rotation as well as an endwise movement.

The invention will be further described by the aid of the accompanying drawings of which Figure 1 shows a longitudinal section of parts of an extrusion apparatus embodying the invention and Figure 2 shows an alternative form of inner member. It is to be understood that Figure 1, as regards the general construction of the machine, is to a large extent diagrammatic. It shows the relative disposition of the important parts of the machine, but is not intended to indicate the details of their construction.

In this example the rotary part of the impelling device is the outer tubular member 1. It is carried by bearings in the frame 3 and is driven by the wheel 4. It makes a running joint at the inlet end with the wall of the feeding chamber 2 and also makes a running joint at the delivery end with the wall of the extrusion chamber 5. The inner member 6 of the impelling device is fixed to the frame 3 at the rear end as by studs

7 and is supported at the front end in a ring 8 forming part of a spider 9. It carries at its front end the inner die 10 which cooperates with the outer die 11.

The lower part of the frame 3 and its contents have been omitted as their presence is unnecessary for an understanding of the present invention. On similar grounds the means for fixing the outer die and other details are not shown.

In the operation of the machine molten metal is continuously fed into the chamber 2 and flows into the space between the two members, 1 and 6, of the impelling device. It is there cooled to a sufficient extent to become plastic and to be engaged by the threads of these members. It would be noted that, as previously mentioned, the threads are of opposite hands, that on the member 1 being right-handed and that on the member 6 being left-handed. The rotation of the member 1 causes its threads to act upon the metal in the space between this member and the concentric member 6. The threads of the member 1 impart both a forward motion and a rotary motion to the metal. The rotary motion presses the metal against the threads of the member 6 and the reaction of these threads on the metal assists to force it forward. As a result of these actions the metal is delivered into the extrusion chamber 5 and forced out through the space between the dies 10 and 11. The member 6 is provided with a central passage 13 through which can be inserted an electric cable when the extrusion apparatus is to be employed for applying a lead sheath to a cable.

The advantageous results of giving a helical formation to the effective surfaces on the second of the two concentric members instead of making them parallel to the axis are at least of two kinds. The stress to which the metal is subjected by the combined actions of the effective surfaces of the two members is materially decreased and the frictional losses, in driving the metal through the chamber, are reduced. The stress produced in the metal is due to a tendency to shear that part of the metal, which is directly acted upon by the effective surfaces of one of the concentric members, over that part of the metal which is acted upon by the effective surfaces of the other member. The surfaces on which this shear tends to take place is a cylinder or cone lying between the two concentric members. In the example illustrated there is a tendency to cause the metal, which lies between the threads of the outer member 1, to slide over the metal which lies between the threads of the inner member 6. The surface of shear is accordingly a cylinder enveloping the threads of the member 6 and lying within the threads of the member 1. From the nature of the metal being dealt with and the fact that it is at a comparatively high temperature, it follows that the metal cannot possess high resistance to shear. It is therefore important for the efficient working of the machine that the tendency to shear should be kept low. It appears doubtful whether shearing can be entirely prevented since the material which is being impelled is rather of the nature of a highly viscous liquid than of the nature of a solid, but it is obvious that it is desirable to keep the shearing movement as small as possible. The inclination of the effective surfaces of the second member of the impelling device, so as to make them helical instead of parallel with the axis, greatly reduces the tendency to shear. In practice it has been found that it has the effect both of reducing the slip between the threads and the metal and of reducing the power absorbed by the machine for a given output. In the example illustrated the threads on the two members 1 and 6 are shown as having the same pitch. This will in general be a desirable condition since a large angle with a plane containing the axis is desirable in each case and the conditions controlling this angle will be approximately the same in both the inner and outer member. It appears that this angle can advantageously be made 70° and upwards.

As indicated in the preceding description the effect of the inclination of the operative surfaces of the second member is to facilitate the rotation of the metal about the axis of the machine as it travels forward. This rotation in general should not continue up to the point of extrusion. It can be restrained by the engagement of the metal in the extrusion chamber with the stationary end wall. Additional restraint can be provided by stationary surfaces projecting into that chamber. In the example illustrated such surfaces are provided by the legs of the spider 9. These legs may be provided with surfaces which, at the side at which the metal comes to them from the impelling device, are inclined so as to be substantially parallel with the direction of movement of the metal leaving that device and are then curved so as to divert the movement of the metal from a helical movement into a movement parallel with the axis. In many cases however this inclination and curvature will not be necessary.

As an alternative means of restraining the effect of the rotary component of the movement of the metal, near the extrusion end of the chamber, the operative surfaces on the stationary member of the impelling device may be made substantially parallel with the axis at that end. This involves a change of the angle of the inclination of these surfaces which may be continuous over a considerable length thereof or may take place mainly at the delivery end. The latter appears to be the preferable arrangement and is illustrated in Figure 2 where the threads 16 increase in pitch in the course of the last turn. This formation of the stationary thread may be combined with a change in the inclination of the thread on the rotary member of which the pitch decreases as the pitch on the stationary member increases. Alternatively the threads on the rotary member may terminate at a short distance away from the delivery end as shown in Figure 1.

What I claim as my invention and desire to secure by Letters Patent is:—

1. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members, means for producing relative rotary motion between said members, said members being provided on their adjacent faces with substantially continuous surfaces inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that of the inner member and positive means for preventing the rotation of the metal, the said means acting on the metal after it leaves the impelling device.

2. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members, means for fixing one of these members in position, and means for rotating the other of these members, the two members being provided on their adjacent faces with surfaces inclined in helical form about the axis of rotation, the inclination on the fixed member being of opposite sense to that on the rotary mem-

ber and the pitch of the helical surfaces of the stationary member being gradually increased at the delivery end so that the final part of it is approximately parallel with the axis.

3. A rotary impelling device for the extrusion of metal, comprising two cylindrical members located one within the other, means for fixing one of these members, means for rotating the other of these members, screw threads projecting from the adjacent faces of the two members, the thread on the outer member being of opposite hand to that on the inner member, means for feeding molten metal into the one end of the space between the two members, a chamber receiving the metal delivered in plastic form from the other end of the said space, stationary projections in said chamber engaging the metal as it passes through the chamber, and a die mounted in said chamber and providing an outlet for the extruded metal.

4. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members, means for producing relative rotary motion between said members, said members being provided on their adjacent faces with substantially co-extensive continuous surfaces inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that of the inner member and the two helices being of approximately equal pitch.

5. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members, means adjacent one end of said members for the introduction of molten metal, means for producing relative rotary motion between said members, said members being provided on their adjacent faces from the point of introduction of the molten metal to a point adjacent the opposite ends of said members with continuous surfaces inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that of the inner member whereby to minimize shearing and chopping of the metal between the point of introduction and the point of discharge at the opposite ends of said members.

6. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members, means adjacent one end of said members for the introduction of molten metal, means for producing relative rotary motion between said members, said members being provided on their adjacent faces from the point of introduction of the molten metal to a point adjacent the opposite ends of said members with continuous surfaces inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that of the inner member and the two helices being of approximately equal pitch, whereby to minimize shearing and chopping of the metal between the point of introduction and the point of discharge at the opposite ends of said members.

7. A rotary impelling device for the extrusion of metal tubes, comprising two longitudinally extending concentric members, an extrusion chamber adjoining the ends of said members, an extrusion die in the wall of said chamber on the delivery side thereof, a second die mounted on the end of the inner longitudinally extending member, and means for rotating the outer longitudinally extending member, said members for at least the major portion of their lengths being provided on their adjacent faces with substantially continuous surfaces inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that of the inner member.

8. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members, means for producing relative rotary motion between said members, said members for at least the major portion of their lengths being provided on their adjacent faces with substantially continuous surfaces inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that on the inner member, and the inclination of one of said members being at least seventy degrees to a line parallel with the axis.

9. A rotary impelling device for the extrusion of metal comprising two longitudinally extending concentric members, means for producing relative rotary motion between said members, said members being provided on their adjacent faces with substantially continuous projections inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that on the inner member, the inner edges of the said projections on the outer member and the outer edges of the said projections on the inner member each lying substantially in a cylindrical surface over the major part of the length of said projections.

10. A rotary impelling device for the extrusion of metal comprising two longitudinally extending concentric members, means for producing relative rotary motion between said members, said members being provided on their adjacent faces with substantially continuous projections inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that on the inner member, the inner edges of the said projections on the outer member and the outer edges of the said projections on the inner member each lying substantially in a cylindrical surface over the major part of the length of said projections and these cylindrical surfaces being nearly coincident.

11. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members, one being stationary and the other rotary, and means for producing rotary movement of the latter member, both said members being provided on their adjacent faces with substantially continuous projections inclined in helical form round the axis of rotation, the inclination on the stationary member being in opposite sense to that on the rotary member and the projections on the stationary member having their edges lying on a cylindrical surface, at least over the major part of the length of said member.

12. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members, means for producing relative rotary motion between said members, said members being provided on their adjacent faces with substantially continuous projections inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that on the inner member, the pitches of the helices being equal at least over a substantial portion of the length of the said members near the end at which metal is fed thereto, the inner edges of the said projections on the outer member and the outer edges of the said projections on the inner member each lying substantially in a cylindrical surface over the major part of the length of said projections.

13. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members, means for fixing one of these members in position, and means for rotating the other of these members, the two members being provided on their adjacent faces with substantially continuous surfaces inclined in helical form about the axis of rotation, the inclination on the fixed member being of opposite sense to that on the rotary member and the pitch of the helical surfaces of the stationary member being increased gradually in the final turn at the delivery end.

14. A rotary impelling device for the extrusion of metal, comprising two cylindrical members located one within the other, means for fixing one of these members, means for rotating the other of these members, screw threads projecting from the adjacent faces of the two members, the thread on the outer member being of opposite hand to that on the inner member, means for feeding molten metal into the one end of the space between the two members, a chamber receiving the metal delivered in plastic form from the other end of the said space, a spider in said chamber supporting the end of the inner cylindrical member and engaging the metal as it passes through the chamber and a die mounted in said chamber and providing an outlet for the extruded metal.

15. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members having on their adjacent surfaces helical projections running in opposite senses on the two members, means for feeding molten metal into the space between the said members to keep this space completely filled with metal which solidifies therein, and rotary driving means applied to said members and producing continuous feeding forward of solidified metal by the combined and cooperative actions of the inner and outer sets of helical projections engaging therewith.

16. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members having on their adjacent faces helical surfaces, the helix on the outer member being of opposite sense to that on the inner member, means for producing relative rotary motion between said members, means for feeding molten metal into the space between the helical surfaces where it solidifies, the said surfaces being effectively continuous over the major portion of the length of the said members from the feeding point to the delivery end thereof.

17. A rotary impelling device for the extrusion of metal, comprising two longitudinally extending concentric members, means for fixing one of these members in position and means for rotating the other of these members, the two members being provided on their adjacent faces with surfaces inclined in helical form about the axis of rotation, the inclination on the fixed member being of opposite sense to that on the rotary member and the fixed member having at the delivery end at least one projecting surface which is substantially parallel with the axis.

18. A rotary impelling device for the extrusion of metal comprising two longitudinally extending concentric members, an extrusion chamber located beyond the end of said members and receiving metal therefrom, a die in the delivery side of said chamber and means for producing relative rotary motion between said members, said members being provided on their adjacent faces for at least the major portion of their lengths with substantially continuous surfaces inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that of the inner member.

19. A rotary impelling device for the extrusion of metal comprising two longitudinally extending concentric members an extrusion chamber located beyond the end of said members and receiving metal therefrom, a die in the delivery side of said chamber, means for producing relative rotary motion between said members, said members being provided on their adjacent faces for at least the major portion of their length with substantially continuous surfaces inclined in helical form round the axis of rotation, the inclination on the outer member being in opposite sense to that of the inner member and the two helices being of approximately equal pitch.

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