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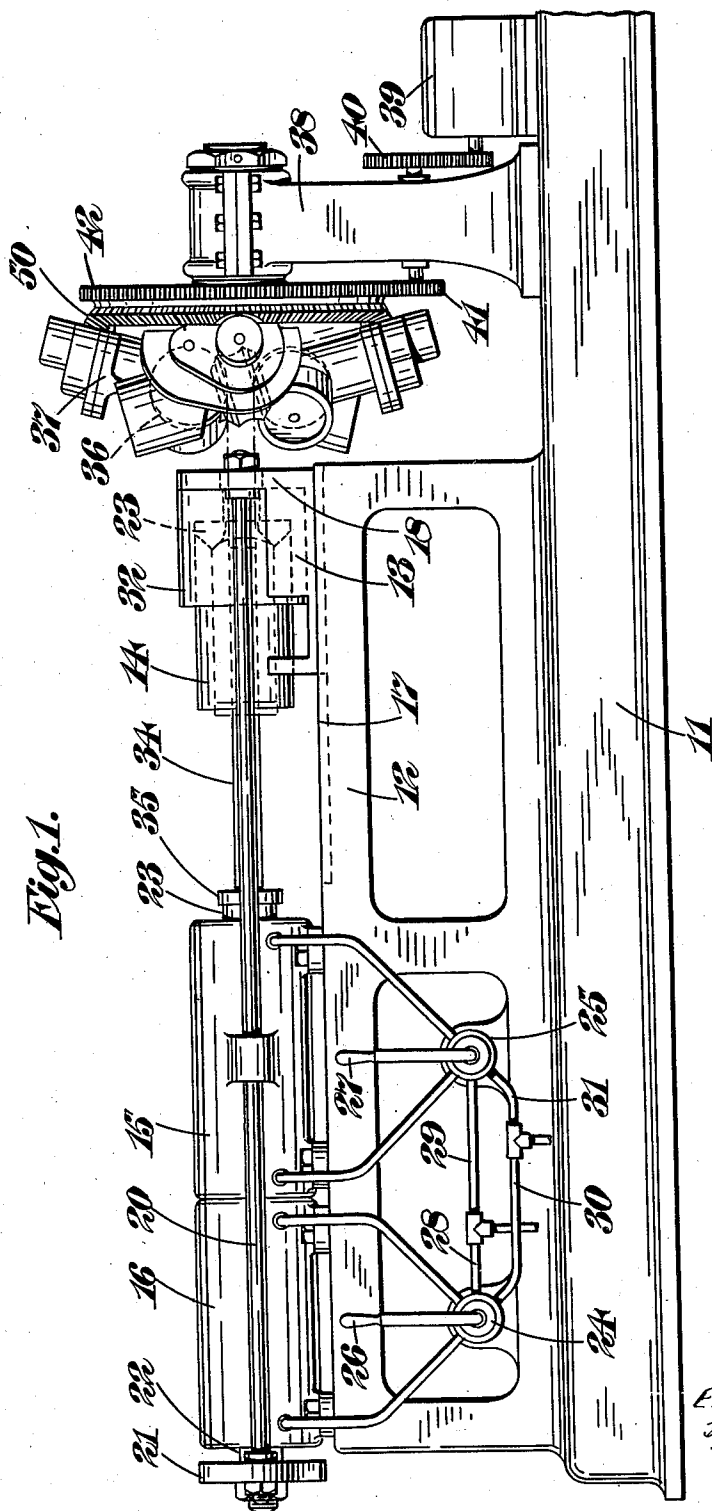
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2,026,979

APPARATUS FOR PRODUCTION OF STEEL TUBES AND OTHER SECTIONS

Filed Dec. 13, 1934

4 Sheets-Sheet 1



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Jan. 7, 1936.

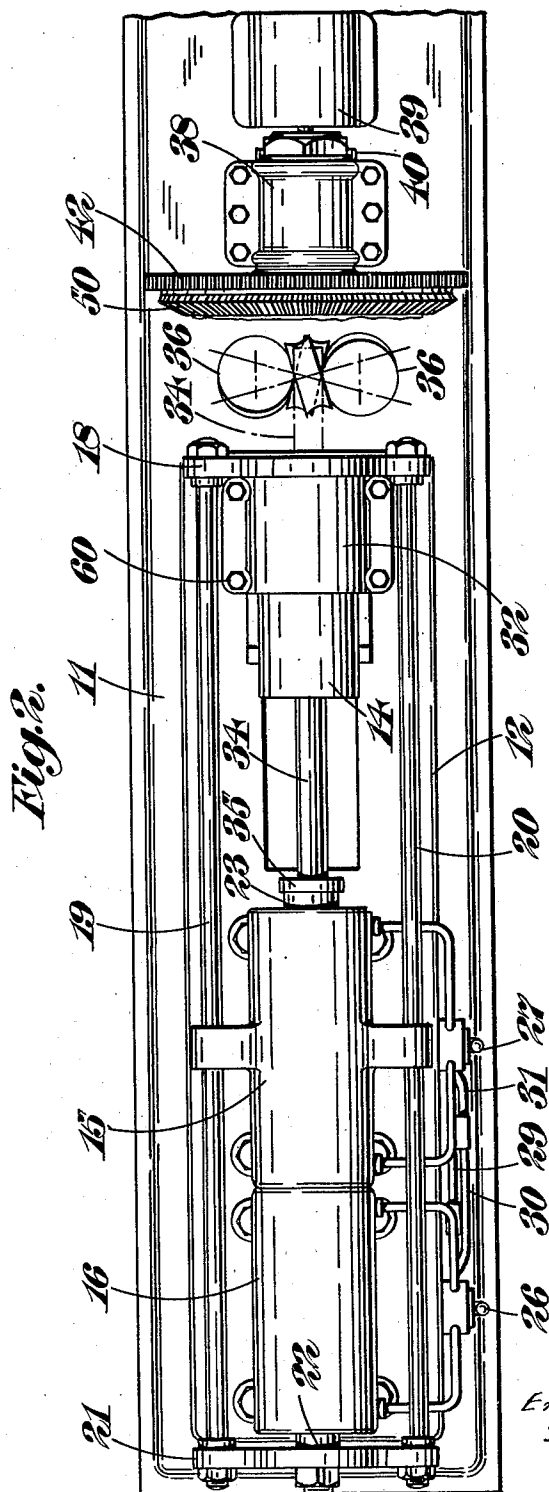
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APPARATUS FOR PRODUCTION OF STEEL TUBES AND OTHER SECTIONS

Filed Dec. 13, 1934

4 Sheets-Sheet 2



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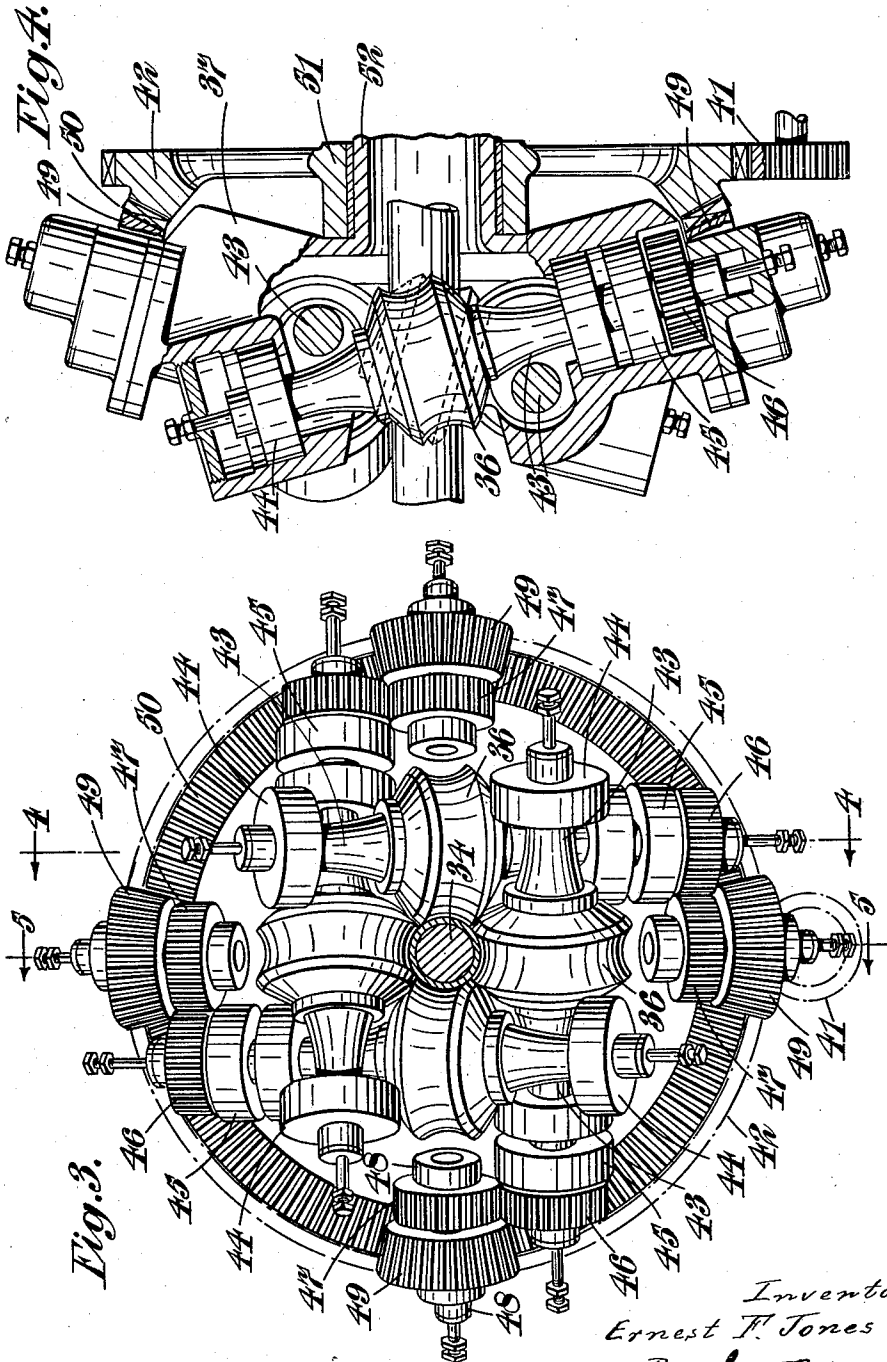
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APPARATUS FOR PRODUCTION OF STEEL TUBES AND OTHER SECTIONS

Filed Dec. 13, 1934

4 Sheets-Sheet 3



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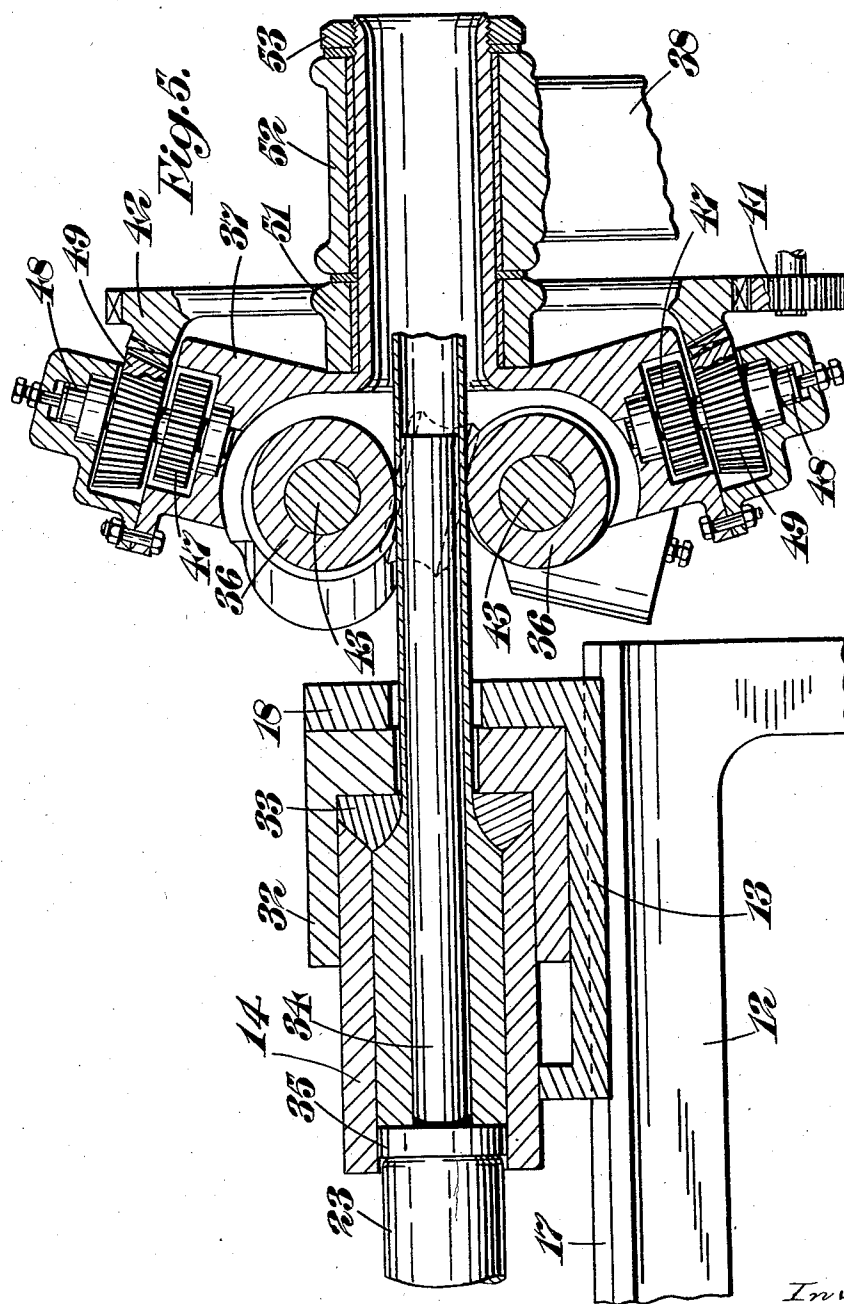
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2,026,979

APPARATUS FOR PRODUCTION OF STEEL TUBES AND OTHER SECTIONS

Filed Dec. 13, 1934

4 Sheets-Sheet 4



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2,026,979

APPARATUS FOR PRODUCTION OF STEEL
TUBES AND OTHER SECTIONS

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Application December 13, 1934, Serial No. 757,395
In Great Britain October 12, 1933

4 Claims. (Cl. 29—33)

This invention comprises improvements in or relating to the production of steel tubes and other sections and has for its object to provide apparatus for the manufacture of steel tubes by extrusion. Non-ferrous metals are commonly extruded in steel dies but hitherto extrusion of steel has offered difficulty on account of the high temperatures required. Extrusion demands that the metal should be forced through a die at a temperature approximating to its melting point and at this temperature, in a metal die the steel loses its heat so rapidly that the maintenance of the metal in the required plastic state up to the end of the extrusion operation is difficult or impossible. Attempts have been made to overcome this by heating the container by various means, but the difficulties are thereby not fully overcome.

It will be appreciated that in extruding a solid billet which has been brought to extrusion temperature by preheating in a furnace, the outer surface of the billet almost reaches the melting point at a time when the interior of the billet is still considerably below melting point. Since the billet must not be actually melted the time taken to bring it to a uniform temperature slightly below melting point is considerable and ordinarily, therefore, the hottest part of the billet is outside while the interior is at a temperature lower than that desirable for extrusion.

According to the present invention, however, apparatus for the production of extruded steel sections comprises in combination means for casting a billet of steel from molten steel, means for taking this billet while the steel is still solidified only superficially and extruding the steel out of a container provided with a die at one end through the die by means of suitably applied pressure upon the semi-molten metal in the container.

It will be seen that by extruding only a partially solidified billet the effect is obtained that the material in the billet is hotter in the centre of the mass than upon its surfaces, an effect which cannot be obtained by heating a solid billet in a furnace. The liquid or semi-liquid metal in the interior of the mass of the billet extrudes easily and also maintains the wall portions of the billet which are in contact with the mould at such a high temperature as to permit them to be extruded.

The billet may be cast in a mould containing a die, which mould is subsequently employed as the container to hold the billet during the ex-

trusion operation, the extrusion being carried out through the die in the mould.

Preferably the billet is a hollow billet and the pressure is produced by a plunger provided with an extension to pass centrally through the die aperture in the end of the container with the result that the extruded section is a steel tube. By this means it is possible to produce extruded steel tubes at a very much higher rate than steel tubing can be produced by the ordinary production on a draw bench.

The steel as it emerges from the die, although exceedingly hot, is free of scale and it is therefore practicable at this point without further preparation to coat the surface of the extruded section with another metal which may protect it from the influences of oxidation or corrosion. To this end, immediately outside the die there may be disposed means for applying to the extruded section a coating of zinc, cadmium, chromium or the like. For example a metal spraying plant may be provided which directs a spray of the selected metal in molten condition on to the surface of the steel.

Beyond the die or the spraying apparatus, if such is provided, there may be disposed driven rollers through which the extruded section as it comes from the die is passed while still hot, for improving its surface finish or for consolidating it or for imparting pressure to the protective coating which has just been sprayed upon the steel.

In the case where the extruded section is circular the driven rollers may be mounted to rotate about axes skewed relatively to the axis of the tube and mounted in a housing rotatable about the axis of the tube. The skewed rollers will trace a spiral path upon the surface of the circular extruded section and therefore their line of action is oblique to the lines of extrusion produced by the die. This is beneficial, both from the point of view of improving the finish and consolidating the metal and giving it a satisfactory structure.

The following is a description by way of example of one form of apparatus in accordance with the invention. The apparatus is illustrated in the accompanying drawings in which—

Figure 1 is a side elevation of an extrusion apparatus;

Figure 2 is a plan of the same;

Figure 3 is a detail looking in the direction of the axis of the extruded section of the consolidating rollers and associated parts;

Figure 4 is a section upon the line 4—4 of Figure 3, and

Figure 5 is a section upon the line 5—5 of Figure 3 looking in the direction of the arrows.

Referring to Figures 1 and 2, upon a base 11 there is supported a bed 12 which carries at one end a support 13 for an extrusion mould 14 and at the other end two hydraulic cylinders 15, 16 placed back to back. The support for the mould 13 is mounted so that it can slide in guideways 17 along the bed 12 and it comprises an upright crosshead 18 which is connected by side rods 19, 20 to a second crosshead 21 beyond the hydraulic cylinder 16. The cylinder 16 contains a ram 22 to act upon the crosshead 21 and draw the sliding support 13 along the bed. In so doing it will be drawn nearer to the hydraulic cylinder 15 which is provided with a ram 23 capable of being projected towards the mould 14 carried upon the sliding support 13.

The hydraulic cylinders 15, 16 are each associated with a control valve 24, the control valve 24 being allocated to the cylinder 16 and the control valve 25 to the cylinder 15. Each of the control valves is a two-way valve having a control handle 26 or 27, as the case may be, and capable of directing the hydraulic pressure into one end or the other of its associated cylinder, while at the same time connecting the end of the cylinder which is not under pressure with an exhaust pipe. The pressure supply pipes are shown at 28, 29 and the exhaust pipes at 30, 31. Valves for the purpose described are well known and need no further specification.

Returning to the mould or container 14, it will be seen that this is held in the support 13 as in a cradle and that it is supported with the axis of the mould horizontal and precisely in line with the ram 23. Reference to Figure 5 will show that the mould consists of three parts, the mould proper 14 which is a tubular container, a base casting 32 into which the mould fits and a die 33. The die 33 is preferably in two diametrically severed halves. This assembly of mould, base casting and die is preferably used as the mould into which the molten steel which is used in the extrusion apparatus as the material to be extruded is originally cast. For this purpose it may be placed in a machine for producing hollow ingots as, for example, that described in British Patent specification No. 381,790. With the hollow billet thus produced in the mould and the walls of the steel cast therein just solidified, but the interior portions of the ingot still molten, the mould is laid in the cradle or support 13, a mandrel 34 having a head 35 being first introduced into the billet as far as it will go. The head 35 is of such a diameter as will fit the interior of the mould or container 14 and constitute a plunger therein, but in the initial position of the parts the mandrel 34 is held by the solid bottom of the billet from entering the mould sufficiently to permit the plunger 35 to be introduced into the container 14. Half of the mandrel and the plunger in this position of the parts project from the mould toward the cylinder 15, the ram 23 being retracted into the cylinder 15 by the operator before the mould is laid in place.

With the parts thus arranged the operator first causes the ram 23 to be advanced, pushing the plunger 35 and the mandrel 34 in front of it. The mandrel punches a disc of hot metal from the bottom of the billet through the die 33 and this disc of metal will drop out beyond the crosshead 18 of the support 13. When the ram 23

is fully advanced the parts reach the position illustrated in Figure 5 and molten steel from the billet begins to be extruded by the plunger 35 through the die 33 around the mandrel 34. It is not possible however for the ram 23, in the construction shown, to produce sufficient movement to effect the extrusion operation and the operator next actuates the cylinder 16 so that the crosshead 21 is moved, and through the side rods 19, 20, the crosshead 18, support 13 and container 14 are all moved together toward the left as viewed in the drawings, the mandrel 34 remaining at rest and the plunger 35 being held up to its work by the ram 23 which is left locked in its fully extended position. Consequently the die 33 is drawn to the left as viewed in the figure and the metal is caused to flow through it and to be extruded toward the right in the form of a tube.

In order to consolidate the tube thus produced a number of rollers 36 are grouped around the tube so as to constitute in effect a die. The position and shape of these rollers is such that they encircle the tube and bear upon it closely all around its periphery at a point where it is supported within by the end of the mandrel 34. One important reason for moving the mandrel to the right as viewed in the figure in the initial operation of the apparatus by the ram 23 is to ensure that the mandrel enters between the rollers and affords the necessary support to the tube. The rollers are mounted in bearings in a rotatable carrier 37 supported in a pedestal 38 on the base 11. They are positively driven from a motor 39 through a reduction gear 40, a pinion 41 and a driving gear 42, which latter is concentric with the axis of the carrier 37, and the details of the action of which will now be described.

Referring to Figures 3 and 4, it will be seen that the rollers 36 are skewed in relation to the axis of the extruded tube and each of the rollers is mounted on a stout spindle 43 carried in ball bearings 44, 45. The housings in the casting 37 which support the bearings 44, 45 have been omitted in Figure 3 in order to show the mechanism, but the shape of the casting 37 itself and its relation to the ball bearings 44, 45 can be seen in Figures 4 and 5. It will be observed that the rollers are hollowed on their peripheries so as to fit the tube and that they are bevelled on their edges so as to fit closely against one another without interfering with each other. Beyond the bearings 45 the spindles 43 carry spur wheels 46 which mesh with other spur wheels 47 carried on short stub shafts 48. The stub shafts 48 are each parallel with the sloping axes of the rollers 36, but as they are offset from these axes they can, if the spur wheels 46, 47 are made of suitable dimensions, be disposed as shown in the drawing so that their axes intersect the axis of the extruded section. They will, in fact, intersect it at the centre of the die aperture afforded by the four rollers 36. Each of the stub shafts 48 carries a bevel wheel 49 and the four bevel wheels 49 all mesh with a ring of bevel teeth 50 cut on the driving gear 42. The driving gear 42 has a hub 51 which runs freely on the hollow shank 52 of the casting 37 which supports the rollers. As will be seen from Figure 5 the shank 52 is extended through the top of the pedestal 38 in which it finds support and it is provided with a nut 53 to hold all these parts in place. Suitable locking means for the nut 53 are provided. The hollow shank 52 is made large enough for the extruded metal to pass through it and if desired or

found necessary these parts may be provided with passages for the circulation of cooling water so as to absorb any heat radiated by the extruded metal.

It is to be observed that the rollers 36, being mounted upon a rotatable carrier 37, can not only rotate about their own axes with a rolling motion upon a tube or other circular section passing through them but can also be carried round about the axis of the section by rotation of the carrier. As the rollers are skewed, in order to get a true rolling motion on the extruded metal, it is necessary that the carrier should rotate and the rollers will describe in effect a spiral path around the extruded section. The direction of rotation of the carrier 37 is made so that it is the same as that of the gear wheel 42, and owing to this fact, and to the reaction afforded at the teeth 50 on the gear wheel, which is transmitted in the form of side thrust to the bearings of the stub shaft 48, there is a tendency to rotate the frame by the gear wheel as well as to drive the rollers about their own axes. If the rollers were held from rotation about their own axes the whole mechanism would revolve at the same speed as the gear wheel 42. If the casting 37 were held from rotation the rollers 36 would be driven but at a faster speed than that which they attain if the casting 37 is allowed to rotate slowly. Owing to the tendency of the rollers 36 to resist any sideways slipping motion around the tube the effect of this mechanism is to make the casting 37 rotate at such a rate that the combined movement, due to its rotation and the rotation of the rollers 36, makes a pure spiral rolling movement around the extruded section.

If it is desired to coat the extruded metal with any non-corrosive metal this is directed by spraying or otherwise on to the extruded section as it emerges from the die and before it reaches the rollers 36. The spraying means are not illustrated in the drawings and may take any form desired.

When the plunger 35 has been advanced right down the pot of the mould 14 until it reaches the die 33 extrusion ceases and it becomes necessary to remove the parts from the machine. To this end the casting 32 is made in two halves held together by bolts 60 (Figure 3) and on the bolt 60 being unscrewed the upper half of the casting can be removed. The die 33 being diametrically split can be likewise removed and the ring of steel adhering to the back end of the extruded tube can thus be reached and broken or cut off. In order to facilitate these operations, of course, the rams will be withdrawn into their respective hy-

draulic cylinders, thus permitting the mandrel 34 to be withdrawn, if necessary, along with the outer part of the mould 14.

As soon as the machine has been freed from these parts a fresh mould may be laid in place and another length of tube extruded.

I claim:—

1. Apparatus for the extrusion of circular steel sections comprising in combination a holder to receive the mould, a mould containing a circular die and constituting an extrusion pot, which mould is adapted to be readily placed in and removed from the holder, a plunger to fit the mould, a ram to operate the plunger, a plurality of rollers mounted about axes skewed relatively to the axis of the section and located in line with the die with their peripheries abutting upon one another to constitute in effect a rolling die through which the section passes and by which it is consolidated and a mandrel carried by said plunger and extending through the die for a distance such as to enable it to enter between the rollers to support the tube against the pressure thereof.

2. Apparatus for the extrusion of circular steel sections comprising in combination a holder to receive the mould, a mould containing a circular die and constituting an extrusion pot, which mould is adapted to be readily placed in and removed from the holder, a plunger to fit the mould, a ram to operate the plunger, a plurality of rollers mounted about axes extending transversely relatively to the axis of the section and located in line with the die with their peripheries abutting upon one another to constitute in effect a rolling die through which the section passes and by which it is consolidated and a mandrel carried by said plunger and extending through the die for a distance such as to enable it to enter between the rollers to support the tube against the pressure thereof.

3. Extrusion apparatus as claimed in claim 1 wherein each of the skewed rollers is geared to a driven member mounted to rotate about the axis of the extruded section independently of the roller support and the geared member is driven by a suitable source of power so that the rollers and the roller support are each free to rotate and to select a spiral rolling path around the extruded section.

4. Extrusion apparatus as claimed in claim 2 wherein the rollers are driven from a source of power so as to avoid placing undue longitudinal strain upon the extruded section coming from the die.

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