

June 28, 1966

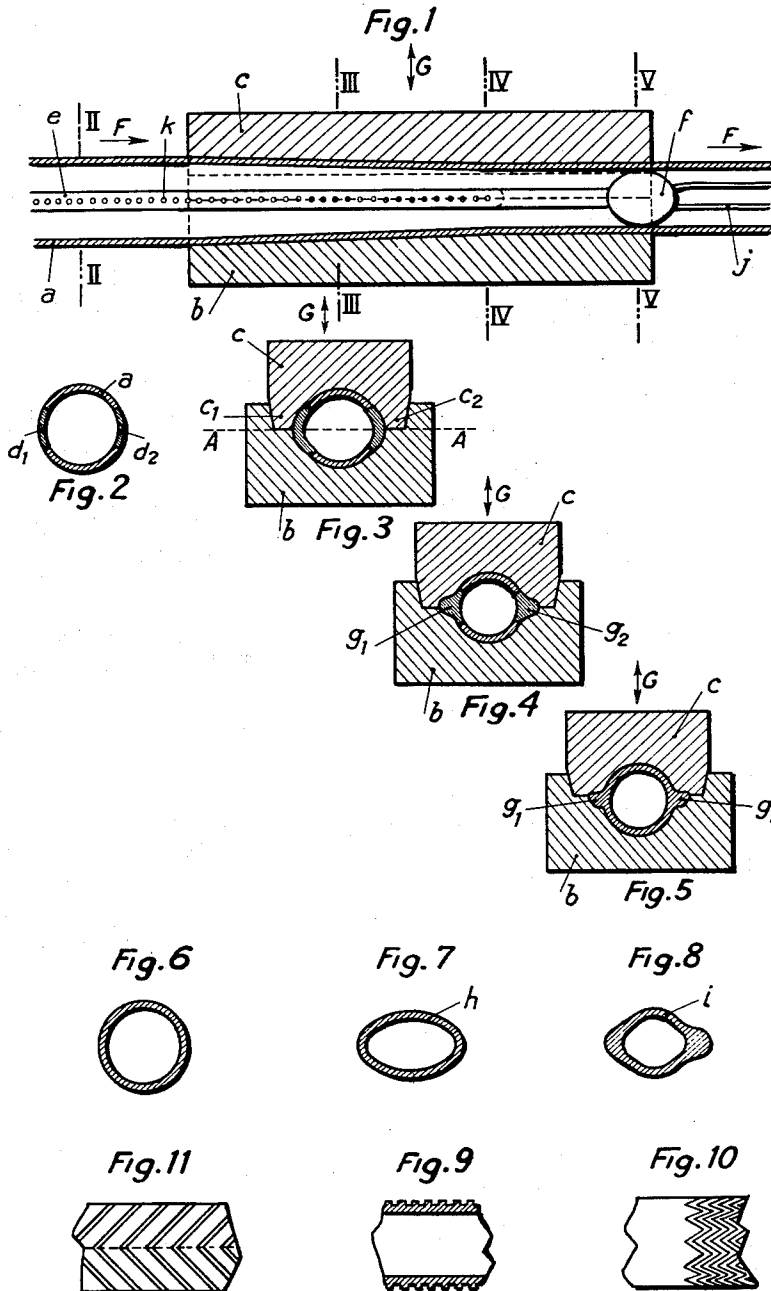
A. HUET

3,257,836

MACHINE FOR FORGING TUBES

Filed Oct. 9, 1962

4 Sheets-Sheet 1



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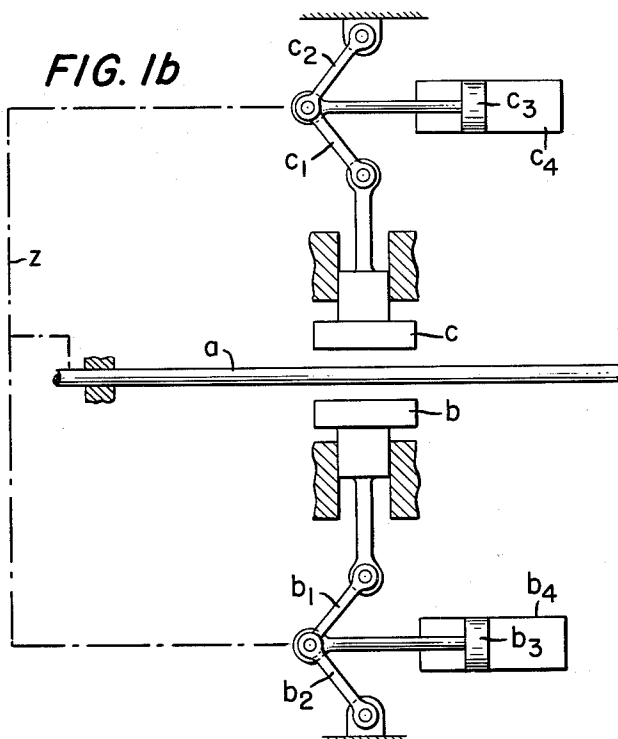
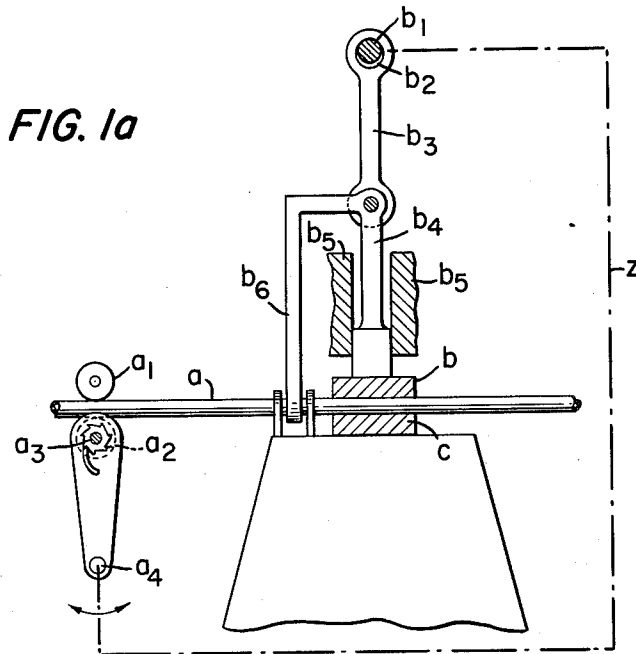
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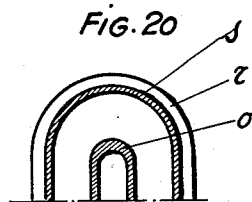
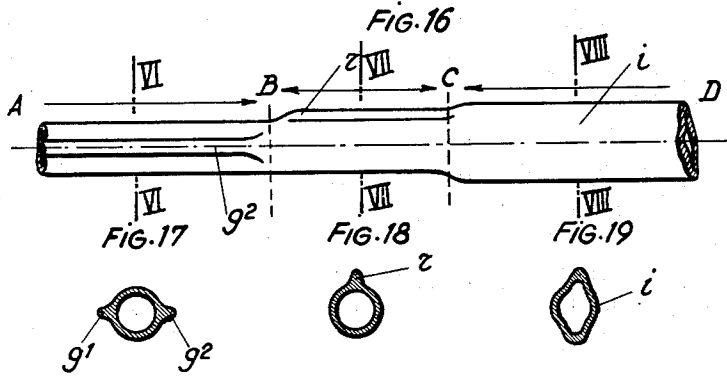
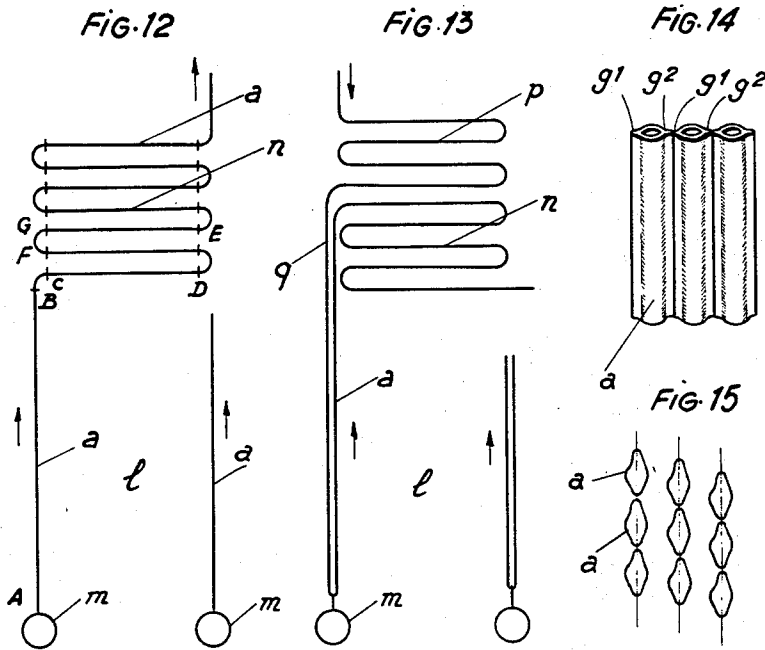
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4 Sheets-Sheet 3



June 28, 1966

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Filed Oct. 9, 1962

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Fig. 21

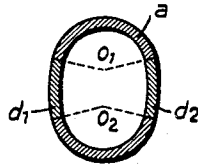


Fig. 22

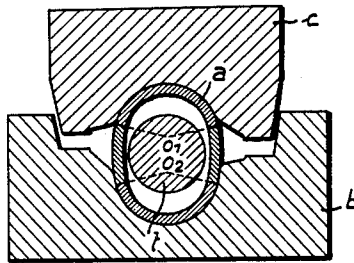
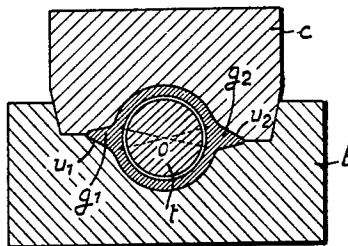


Fig. 23



1

3,257,836

MACHINE FOR FORGING TUBES

André Huet, 48 Ave. du President Wilson, Paris, France
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Claims priority, application France, Nov. 15, 1961,

879,016

11 Claims. (Cl. 72-412)

This invention relates to a machine for forming tubes. Various forms of tubes are known or have been proposed for use in boilers and heat exchangers having other than plain circular cross-sections. Such tubes include, for example, lenticular tubes which may be of asymmetrical cross-section, tubes with longitudinal fins and tubes with grooves on their external surfaces. However, the use of such tubes is governed by the shapes which can be formed or by the economy of forming the available shapes by conventional technique.

The invention includes a method of forming from a tube of cylindrical or substantially cylindrical shape a tube at least a part of which has a modified profile according to which the tube or tube part is subjected to a forming process in which, or in a step of which, the tube is forged by moving it longitudinally through at least one set of opposed dies to which is imparted relative reciprocating motion transverse to the tube and which has such varying cross-sections in the direction of movement of the tube through the die set or sets, that the profile of an element of the tube in passing through the set or sets of dies and being subject to successive blows, is progressively changed from its initial form to the modified form.

The invention also includes a forging machine suitable for carrying out the method, having a set of half dies or aligned sets of half dies, with working grooves varying continuously or step wise from the entry to the exit end of the, or each, set, actuating means for imparting relative reciprocating motion of the dies of the, or each, set transverse to the longitudinal axis of the grooves and means for moving a tube longitudinally through the set or sets of dies. Advantageously the actuating means are arranged to effect reciprocation at a high frequency of or in the neighborhood of ten cycles per second.

The invention further includes a tube in which an unjointed run includes a series of successive lengths spaced short distances from one another, adapted to form limbs in a sinuous heat exchange element and having a profile of lenticular form, the lengths being connected by sections of circular or substantially circular bore adapted to form return bends. The unjointed tube may also include a length having diametrically opposite external longitudinal fins extending in directions normal to the plane containing the major axes of the lenticular profiles of the lengths, and the invention also includes a heat exchanger with heat exchange surfaces comprising such tubes, the lengths with longitudinally extending diametrically opposite fins serving as wall tubes of a furnace chamber, the adjacent fins of neighboring tubes being welded together and the successive lengths extending in a tube bank, or tube banks, across a gas passage leading from the furnace chamber.

The invention furthermore includes a tube suitable for use in a sinuous heat exchange element in which an unjointed run includes a series of successive and equal lengths spaced short distances from one another and connected by sections having alternatively at one side and at the opposite side of the tube respective longitudinally extending wall thickenings or longitudinal external ribs.

The invention will now be described, by way of example, with reference to the accompanying partly diagrammatic drawings, in which:

FIGURE 1 is a sectional side elevation of the dies of

2

a split die, reciprocating forging machine and part of a tube being shaped by the machine.

FIGURES 1a and 1b show diagrammatically some elements of a forging machine fitted with the split die of FIGURE 1.

FIGURE 2 is a cross-section on the line II-II of the tube of FIGURE 1 before entry between the dies.

FIGURES 3 to 5 are cross-sections taken on respective lines III-III, IV-IV, V-V, of the tube of FIGURE 1 at different positions in its path of movement through the die.

FIGURE 6 is a section of a tube of circular section which may be treated in the machine so as to obtain the tube profiles shown in FIGURES 7 and 8.

FIGURE 9 shows in longitudinal section a tube whose external surface has cross fins formed on it.

FIGURE 10 shows in longitudinal section a tube whose external surface bears chevrons.

FIGURE 11 shows the side elevation of a tube coming from the machine with oblique grooves in opposite directions on upper and on lower part.

FIGURE 12 diagrammatically shows a tube, in accordance with the invention, equipping a boiler furnace.

FIGURE 13 is a variant of FIGURE 12.

FIGURE 14 shows a fragment of the water wall surrounding the boiler furnace.

FIGURE 15 diagrammatically shows in section the superheater placed above the boiler furnace.

FIGURE 16 shows one of the boiler tubes, shaped first as a water wall tube, and then as a superheater tube.

FIGURES 17, 18, 19 are respectively sections on VI-VI, VII-VII and VII-VII of FIGURE 16.

FIGURE 20 shows in section a tube bend with a single fin in the extrados.

FIGURE 21 shows in section an ovalized tube which is to be treated in order to obtain a tube with thickenings.

FIGURES 22 and 23 show, in section, the tube of FIGURE 21 during its passage between the dies of the machine with high speed reciprocation. In FIGURE 23 the tube is completed.

In the example which will now be described with reference to FIGURES 1 to 5, an ordinary round tube is to be converted into a round tube of smaller radius, with two longitudinal fins on opposite sides, the fins being short and thick. As the tube passes through suitable dies the tube is operated upon as follows in one operation: the tube is first heated on the sides at a level corresponding to the side openings of the dies and is slightly reduced in radius thus thickening the metal at the hot parts, then the forging action still further reduces the diameter and forms small fins on each side; finally in the last part of the die the tube is given a circular form, smaller in diameter than the original, and the fins are completed and chamfered.

FIGURE 1a shows schematically a forging machine, with a tube *a*, fed between fixed die *c* and movable die *b*. Die *b* is actuated by a reciprocating mechanism of a known type having a driving shaft *b1*, an eccentric *b2*, a connecting rod *b3* and a piston rod *b4* sliding within guides *b5*, with an element *b6* being used to clamp tube *a* before it comes in contact with die *b*. The feeding mechanism of tube *a* may consist of two rollers *a1-a2*, one of which is geared to a ratchet wheel *a3* actuated by an oscillating arm linked at its end *a4* to a reciprocating mechanism, not shown.

FIGURE 1b shows an alternative arrangement, wherein both dies *b* and *c* perform a reciprocating motion under the action of respective toggle-links *b1-b2*, *c1-c2*, and piston and cylinder assemblies *b3-b4*, *c3-c4*.

In the forging machine shown on FIG. 1a, the movements of eccentric *b2* are correlated to those of the

3

oscillating arm terminating at $a4$, to ensure that tube a is fed into dies b and c only when the dies are open. The required correlation of movements is performed by a synchronizing arrangement z diagrammatically represented by a chain-dotted line, which may be of any known type, e.g. a mechanical linkage or an electric device.

A similar synchronizing arrangement is provided in the machine shown on FIG. 1*b*, for correlating the movements of tube a to those of toggle linkages $b1$, $b2$ and $c1$, $c2$.

The circular section tube a to be treated is engaged in the direction of the arrow F between the half-dies b and c of the forging machine with high speed reciprocation. In the example chosen, the lower half-die b is an idle die and the upper half-die c has a rapid alternating movement in the direction of the double arrow G . This movement is for example at the rate of ten to-and-fro movements per second, and may be obtained by any suitable known type of mechanism such as the mechanism used on the Ryder Hammer machines.

FIGURES 3, 4, 5 show in greater detail how the grooves of the half-dies b and c are cut to give a progressively varying cross section from the feed to the delivery end, giving the tube a successive forms shown in FIGURES 3 to 5. Note that the upper die c is preferably tapered at c^1 , c^2 to engage the idle die b to ensure accurate positioning on each stroke.

As appears from FIGURES 3, 4 and 5, when the half dies b and c are closed, they come in close contact with each other on either side of the grooves, and they come in close contact with the peripheral face of the shaped tube, on the longitudinal extent of the die.

Before its entry between the dies the tube a is heated along two opposite generating lines d^1 , d^2 , in accordance with the regions in hatched lines on FIGURE 2, which will be subjected to the transformations indicated below.

Heating may be external from both sides of the tubes or internal by means of a stem e bearing an internal mandrel terminated by an olive f , which calibrates the inside of the tube as it leaves the machine. The heating fluid may escape for example by the orifices k provided in the stem e before the tube a enters the dies. These orifices k may be provided in the stem e in regions situated inside the tube a engaged in the dies, in order to heat from the inside, if necessary, certain regions of the tube a which are subjected to a more intense transformation during the passage of the tube inside the dies.

The tube is moved in the direction of the arrow F by pushing or pulling it or both. Movement may be continuous or interrupted. The mechanism which feeds the tube a forward is furnished with one or more elastic buffers, for example springs or rubber blocks, which allows some spring when the dies close, especially when feed is continuous.

This mechanism may be of any suitable known type, such as the feeding mechanism used on the Bliss presses.

The force and the speed with which the tube is pulled or pushed between the dies are related to the rates of variation of section of the grooves provided in the dies so that the tube passes continuously or discontinuously from one shape of section to another shape of section without creasing of the metal occurring in the wall of the tube.

The rate of variation of section of the grooves provided in the dies is rapid in the regions where it is wished to increase the thickness of the wall of the tube. On the other hand, if the walls are to be kept at the original thickness while the section is altered, this rate of variation is slow, i.e. the longitudinal slope of the die grooves is very gradual.

When, in its progress between the dies, the original round tube a has reached the line of section III—III of FIGURE 1, its upper and lower faces have a radius of curvature somewhat less than that of the original tube, while the side regions situated in the median plane A—A are thickened as in FIGURE 3. Between the lines of

4

section III—III and IV—IV of FIGURE 1, the progressive changes in the grooves of the dies cause two embryo fins g^1 , g^2 to form from the thickenings on the diametrically opposite generating lines of the tube, whilst the radius of curvature of the lower and upper parts of the tube is further slightly reduced. Between the lines of sections IV—IV and V—V of FIGURE 1 the shape of the fins g^1 , g^2 is completed and chamfers are formed, while the radius of the tube, which is smaller than its original radius, does not change after the line IV—IV of FIGURE 1.

It is also possible with a machine of this type, using a round tube as in FIGURE 6, to obtain a tube h of elliptical section with walls thickened at the ends of the major axis as shown in FIGURE 7. Suitable dies will also produce a tube of generally lenticular shape i , one side of which is more curved than the other, with simultaneous thickenings at the ends of the major axis.

Instead of the idle and moving dies, two moving dies operating at high speed may be used.

It is also provided for that, instead of having only two long half-dies, as shown in FIGURE 1, the machine may comprise a series of couples of half-dies, separated by free spaces, in which the periphery of the tube, wholly or in certain regions, may be heated, or cooled from the outside, as required.

At the delivery end of the couple of half-dies, or in the last couple of half-dies (if a machine is used which comprises several couples of dies), the die throats may be formed with grooves, ribs or projections so as to impress any required hollows or reliefs on the outside of the tube. Thus small transverse fins may be obtained as shown in FIGURE 9; or chevrons as shown in FIGURE 10; or diagonal fins inclined in opposite directions on the top and bottom faces, giving the surface shown in FIGURE 11.

When a mandrel such as e is used inside the tube, its head f may have any desired shape and may be cooled by water or air, the inlet of which is shown diagrammatically by the pipe j . The head f then calibrates the inside of the final tube, eliminating any internal irregularities or creases. The head f may also have projections to produce scores on the inside wall of the tube.

The special advantages of the process which is the subject of the invention are as follows:

(a) The process of hammering the tube between the dies, for example at a speed of ten blows per second, has the advantage of cooling the tube less than ordinary die-pressing, because the repeated blows heat the tube and forging is facilitated by the reduced contact cooling. Further, the heat has time to spread through the metal of the tube again between successive blows, and the moulding of the tube form takes place at a more uniform temperature in each section, which avoids the formation of creases. Finally, since during its passage between the dies, the tube passes progressively through several contours and possibly several different thicknesses of wall, the fact that the operation takes place as the tube advances, makes each section which has been newly shaped support the section which follows it while the latter is subjected to the operation of deformation, which prevents the wall from collapsing and hence from creasing.

(b) The length of passage of the tube through the dies b and c has the effect that, when longitudinal fins as at g^1 , g^2 are being forged, it is impossible for the tube to twist during the forging operation, so that the finished tube comes out of the dies quite straight.

The tube may be guided at feed and delivery in any desired way, by means of rollers, fixed guides, etc.

It is also provided for that, instead of treating only one tube, the half-dies may be designed to forge simultaneously a series of parallel tubes which go into the appliance side by side, and leave it in the same way, which ensures quicker and more economical manufacture.

It is proposed to equip a boiler furnace l , diagram-

5

matically shown in FIGURE 12, tubes such as *a* will be used which, starting from a lower header *m*, constitute a continuous sealed water wall all round the furnace *l*, and then are prolonged into a serpentine part, situated in the upper part of the furnace, and intended to serve for example as a superheater *n*.

In FIGURE 12 only one of these tubes *a* is shown. In the part of this tube which extends from A to B, the tube is rectilinear, and is provided, for example, with small, diametrically opposite thickenings or longitudinal fins g^1, g^2 . The fins g^1, g^2 of two contiguous tubes are later welded so as to form a water wall, a fragment of which is shown in FIGURE 14. After the portion AB, the tube *a* in its portion BC is bent, then it defines the loops of the superheater *n* above the furnace *l*. The tube of these loops *n* will have, for example, a profile of lenticular section, with unequally curved faces, possibly thickened at the ends of the major axis, and arranged as shown in partial section in FIGURE 15.

In the modified version of FIGURE 12, shown in FIGURE 13, the tube *a* rises above the part of the same tube which acts as superheater *n*. Also another tube *q* which can also be forged with variable profiles, constitutes an economiser *p*, situated on the furnace gas circuit after the superheater *n* and descending by a rectilinear part *q* to the lower header *m* of the boiler. The two tubes *q* and *a* could be connected at their lower part by a stub manifold, before reaching the header *m*, and the latter in that case would only be a stabilizer-equalizer of the water between the different tubes, which would make it possible to give it very reduced dimensions.

It is thus possible to constitute the tube *a* shown in FIGURES 12 and 13 from end to end without welding. For this purpose, the straight round tube as seen in FIGURE 16 is treated in its portion AB by means of the process described above, so that it takes a tubes profile like that shown in FIGURE 17, provided with small, diametrically opposite longitudinal fins g^1, g^2 . In the portion BC which is to be bent, the tube may be left with its circular section, or treated so that it has only a single fin *r* (FIG. 18). Finally, in the portion CD which corresponds to one of the branches of the superheater situated above the furnace, the tube is treated, still by means of the process described above, so that it assumes a lenticular profile *i*, as seen in FIG. 19.

It may thus be seen that, without welding, the same tube *a* can go, over its whole length, from one end of the thermal installation to the other, fulfilling the various functions which it is desired to assign to it.

To execute the tube of FIGURE 16, the portion AB will for example be engaged in the machine with high speed reciprocation provided with dies as described above for giving to the tube the desired profile, then, either by a change of dies or by passing into another machine, the portion BC will be treated, then the portion CD and so on.

It is particularly provided for, in the execution of the process, that the portions of the tube which are to be bent, such as those between BC, DE, FG . . . (FIGURE 12) can be treated before the other portions of the original round tube, in such a way that the circular section of the tube in these portions is slightly reduced in diameter, and thickened, either equally over the whole perimeter, or only in certain zones. The later result is obtained by asymmetrical heating of the tube before or during its passage through the dies described above. In this way, when the tube which has been thus treated is passed into the forging machine with high speed reciprocation in order to execute the profiles of the other portions, the portions such as BC of the tube, whose diameter has been reduced, will pass through the dies without any change and without it being necessary to displace the tube from one machine to another.

To execute the profile of the part intended to be bent, it can be treated like the parts forming the water wall,

6

leaving it with two fins g^1, g^2 , diametrically opposite, then eliminating one of the fins by grinding, milling or cutting away, etc. . . ., so as finally to obtain a tube with a single longitudinal fin or thickening. This unilateral fin *r* can also be obtained directly with suitable dies, after which the tube is bent as seen in FIGURE 20, in the case of a bend to 180° , so that the longitudinal fin *r* is in the external region of the bend. During bending, the internal wall situated in the intrados of tube *a* and which can be heated, thickens at *o*, whilst the presence of the external fin *r* stiffens the region of the extrados of the bend and prevents a diminution of the thickness of the wall at *s* in this region, which can also be heated during bending in order to reduce internal tensions.

When use is made, in the parts intended to be bent, of a tube whose circular profile is of reduced external diameter, and which has an asymmetrical thickening of the wall as proposed above, the greatest wall thickness is placed in the region which will become the external region of the bend.

When the last couples of half-dies, between which the tube passes, have the object of forming fins, grooves or scores on the surface of the tube, the external surface of the tubes may be heated specially just before the operation, for example in the interval between the penultimate and the last couple of half-dies. Simultaneously, the internal surface of the tube may be cooled, for example by atomised water or by air from the olive *f* or from an appropriate special device, which has the object of rendering the internal surface of the tube more rigid and making it act as a sort of anvil situated under the external surface of the tube and finally makes it possible to make the fins project more, or to form them with more exactness.

The olive used in combination with this process may have a profile which recedes in the direction of progress of the tube, so that, during the thrust exerted on the advancing tube, disengagement between the metal and the surface of the olive may be easier.

In addition, the olive used preferably has a profile slightly smaller than the internal profile of the tube, particularly in the direction perpendicular to the approach movement of the half-dies. And it is provided for that, during the movement of separation of the half-dies which do the forging, another couple of half-dies alternating in movement in a direction of approximately 90° from the direction of movement of the first ones, is applied to the sides of the tube situated at approximately 90° from those which have just been forged, so as to cause a swelling of the said tube and consequently the separating from the olive of the wall portion which was bound on to the olive during the preceding forging operation.

The periodic reciprocal movement of the forging machine is made up of three periods: during the first, there is the blow of the forging half-dies to cause the impress of the fins on the tube; during the second period when the preceding dies rise, the dies situated at about 90° close in to cause the necessary swelling of the tube to detach it from the olive; and finally, during the third period, the tube moves forward a certain amount, and the operation starts again.

The arrangements which have just been indicated apply equally to the case in which the central olive has to make an impress inside the tube, since in this case also the swelling pressure separates the tube from the olive.

The olive, which is supported by a stem inside the tube, may, by an appropriate channel, receive an injection of graphite or of forging paste, which facilitates the work of forging and separating.

The movement of the forging half-dies, as well as the movement of the separating half-dies, and finally the movement of advance of the tube, are synchronized by any suitable and well-known mechanical means, such as eccentric synchronised pinions, for example.

It has been said above that in order to obtain a tube having lateral thickenings, or embryo fins g^1, g^2 , a start was

made with a tube of slightly greater diameter than the final diameter of the tube which it was wished to manufacture and that, when it was passed between two dies animated by a high speed reciprocal movement, thickenings of the metal were formed progressively in the regions of the tube situated in the plane of junction of the dies, which regions were suitably heated.

In a variant, also starting with a tube of diameter greater than the diameter of the final tube, during the first operation, preferably carried out cold, the tube is ovalised so as to give it a section such that, at the end of the major axis of the oval, the radius of the cylindrical portions of the tube may be equal or practically equal to the radius of the final tube. After which the tube, heated along the two regions situated at the ends of the small axis of the oval, passes between the dies of the machine with high speed reciprocation which, by hammering, create thickenings or embryo fins in the heated portions.

These arrangements are shown in FIGURES 21 to 23.

The first operation consists in ovalising an ordinary tube whose circular section is of a radius slightly greater than the radius of the final tube. This ovalisation is preferably carried out cold. It may be obtained outside the machine with high speed reciprocation, or in the machine, by passing an original tube, or circular section, through dies shaped to make it oval. This oval shape is shown in FIGURE 21. It is such that the two portions of the tube which are situated at the ends of the major axis of the oval are respectively cylindrical portions of axis O^1 and axis O^2 , whose radius is equal to the radius of the final tube. This being so, the tube is heated in the regions d^1 , d^2 , situated at the ends of the small axis of the oval tube, and is introduced between the dies b and c of the machine, as is seen in FIGURE 22, this FIGURE 22 reproducing FIGURE 3. As the two dies, animated with a high speed reciprocal movement, close in, the heated regions d^1 , d^2 are progressively transformed into thickenings, and finally the tube provided with embryo fins g^1 , g^2 is obtained, as shown in FIGURE 23, a tube whose axis O is achieved by progressively closing in the axes O^1 , O^2 of the original oval tube.

Inside the tube a , during the passage through the machine, there may be placed a cylindrical mandrel t , which calibrates the inside of the final tube and, in the heated regions d^1 , d^2 , prevents the metal of the wall from swelling towards the inside of the tube under the effect of the hammering of the dies.

The advantage of the process which has just been described lies in the fact that the piling up of the metal of the tube wall, to make thickenings or embryo fins, is effected much more methodically, and more regularly, when the bottoms of the dies b , c fit from the start of the forging operation on to the regions of the treated tube whose radius is that of the final tube.

If the initial ovalisation of the tube whose section was originally circular is undertaken in the machine with high speed reciprocation, it may be seen that the dies which produce the ovalisation are animated by a closing-in movement directed at right angles to that of the dies b , c which cause thickening in the heated regions.

It is provided for that the transformation of the tube of FIGURE 21 into the tube of FIGURE 23, instead of being effected by dies with high speed reciprocation, could be effected by passing the tube through a set of rollers which progressively compress the tube.

The initial tube may be ovalised in a separate machine by means of rollers for example. In that case, when the ovalised tube is about to enter the machine with high speed reciprocation, which will transform the ovalised tube into a tube with embryo fins, it may be made to pass through a calibre, or stay, which has the effect of preventing any rotation or torsion of the tube around its axis during the hammering movement of the dies. The same guiding effect may be produced by the ovalisation rollers themselves, if the machine with high speed reciprocation

is placed immediately after the rollers which in addition to the guiding effect can also ensure, or at least help, the propulsion of the tube.

As may be seen in FIGURE 23, the two embryo fins g^1 , g^2 are not chamfered in the same direction, that is to say that, for the embryo fin g^1 , the chamfer u^1 is directed towards the bottom of FIGURE 23, whilst for the embryo fin g^2 , the chamfer u^2 is directed upwards. Thus, the welding together of the embryo fins of two contiguous tubes arranged in parallel, to constitute a water wall for example, is facilitated, even if, during manufacture of the tube, the height or relief of the fins obtained is not strictly constant over the whole length of the tube. In fact, if the chamfer of a fin on one tube is welded to the chamfer directed in the opposite sense of the fin of the neighbouring tube, there may be a slight overlapping of the extremities of the fins, which remedies the variations in height or relief of the said fins.

Of course, it is also possible to execute tubes with embryo fins with chamfers directed in the same sense. In that case, if it is wished to obtain an overlapping of the fins, all that is necessary is to arrange two contiguous tubes heads-and-tails.

What I claim is:

1. A forging-machine for forming from a tube of substantially cylindrical shape a tube at least a part of which has a modified profile including fin portions thereon, said forging-machine comprising at least one set of opposed complementary dies with complementary working grooves varying in cross-section from the entry to the exit end of the set, said grooves including lateral recesses for the forming of fins on said tube, said dies having faces for coming in close contact with each other from said entry to said moving said tube longitudinally through the dies when in a closed position, actuating means for imparting relative reciprocating motion to the dies of the set transverse to the longitudinal axis of the grooves, so as to make and break contact between said contact faces, and means for moving said tube longitudinally through the dies when said faces are not in contact, whereby the profile of a heated element of the tube passing longitudinally from end to end of said dies and being subjected to successive blows from the dies, acquires at each blow, between said entry and exit ends, an external shape having the profile of said complementary grooves and fin portions, and is progressively changed from its initial form to said modified form.

2. A forging-machine as claimed in claim 1, comprising means for heating the tube.

3. A forging-machine as claimed in claim 1, comprising means for heating the tube internally during forging.

4. A forging-machine as claimed in claim 3, wherein said heating means consist of a pipe placed longitudinally within a portion of tube which is being forged, said pipe having at least one orifice for delivering a heating fluid within the tube.

5. A forging-machine as claimed in claim 4, wherein said pipe is obturated at one end by an olive shaped calibrating element placed within the tube in the vicinity of the exit end of said dies, and bears perforations on its side wall for delivering a heating fluid within a portion of the tube which is being forged, said forging-machine comprising means for delivering a cooling fluid to said calibrating element.

6. A forging-machine as claimed in claim 1, having a calibrating element within the tube portion which is being forged.

7. A forging-machine as claimed in claim 1, comprising means for cooling the tube in the vicinity of the exit end of said dies.

8. A forging-machine as claimed in claim 1, wherein said contact faces include faces which are tapered relatively to the direction of said reciprocating motion.

9. A forging-machine as claimed in claim 1, wherein said actuating means operate at a high frequency of about ten cycles per second.

10. A forging-machine for forming from a tube of initial substantially cylindrical shape a tube at least a part of which has a modified profile, of non-circular cross sectional shape, said forging-machine comprising at least one set of opposed complementary dies with complementary working grooves varying in cross sectional shape from the entry to the exit end of the set, said grooves including portions for forging said non-circular cross sectional shape, said dies having faces for coming in close contact with each other from said entry to said exit end on either side of their respective grooves when in a closed position, actuating means for imparting relative reciprocating motion to the dies of the set transverse to the longitudinal axis of the grooves, so as to make and break contact between said contact faces, said reciprocating motion occurring along one single direction relatively to said tube, and means for moving said tube longitudinally through the dies, when said faces are not in contact, whereby a heated portion of the tube passing longitudinally from end to end of said dies and being subjected to successive blows from the dies, acquires at each blow, on all its external face comprised between said entry and exit ends, a shape having the profile of said complementary grooves, and is progressively changed from its initial form to said profile of noncircular cross sectional shape.

11. A forging-machine as claimed in claim 10, wherein said actuating means operate at a high frequency of about ten cycles per second.

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CHARLES W. LANHAM, *Primary Examiner*.

CHARLES SUPALO, *Examiner*.

WILLIAM J. STEPHENSON, M. A. ANTONAKAS,
G. P. CROSBY, *Assistant Examiners*.