

[54] SWAGING MACHINE FOR TUBULAR WORKPIECES, WITH REGULATION OF THE THICKNESS

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[22] Filed: May 25, 1973

[21] Appl. No.: 364,176

[30] Foreign Application Priority Data

May 26, 1972 France 72.18906

[52] U.S. Cl. 72/189, 72/208, 72/224

[51] Int. Cl. B21j 9/06

[58] Field of Search 72/189, 208, 209, 224, 72/225, 252, 402

[56] References Cited

UNITED STATES PATENTS

499,677 6/1893 Daelen 72/252

1,810,698 6/1931 Diescher 72/189
1,889,324 11/1932 Tryon 72/224

FOREIGN PATENTS OR APPLICATIONS

2,113,121 9/1971 Germany 72/224

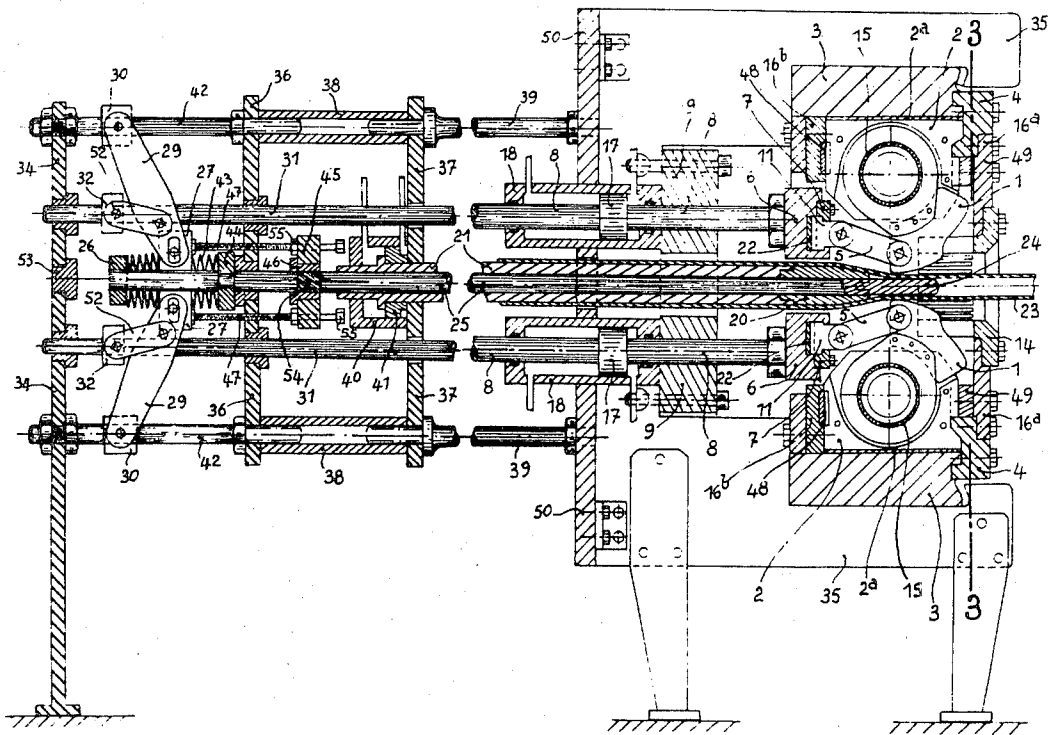
Primary Examiner—Lowell A. Larson

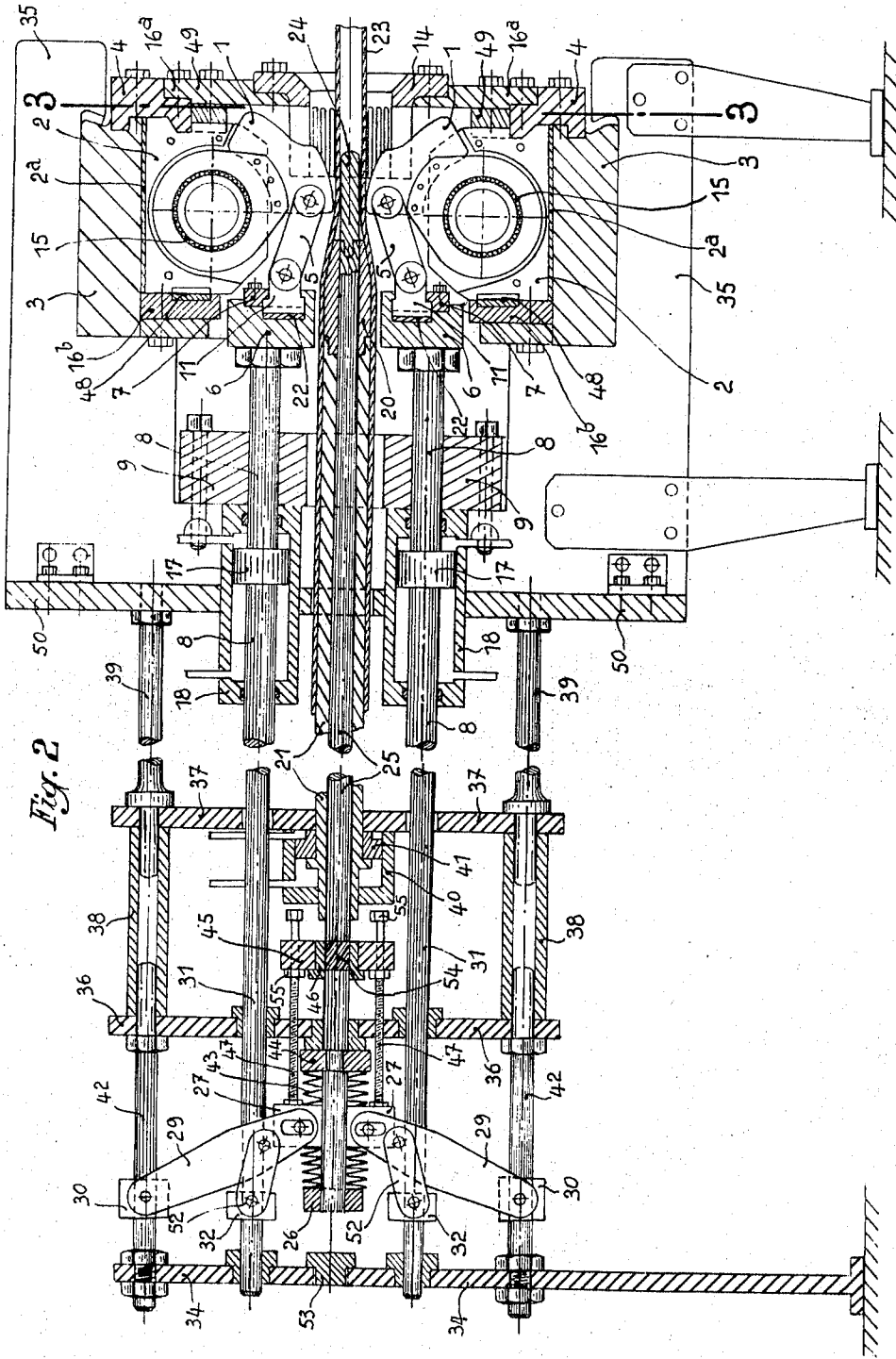
Attorney, Agent, or Firm—Waters, Roditi, Schwartz & Nissen

[57] ABSTRACT

A swaging machine having pivoted sectors disposed radially with respect to a mandrel and with curvilinear inwardly directed edges, the sectors being slightly inclined with respect to vertical planes passing through the axis of the mandrel, there being guide means for the curvilinear sectors in the immediate vicinity of their working zone consisting of a slotted ring to receive and guide the sectors during the working stroke.

6 Claims, 4 Drawing Figures





SWAGING MACHINE FOR TUBULAR WORKPIECES, WITH REGULATION OF THE THICKNESS

This invention relates to a swaging machine of the type comprising pivoted sectors disposed radially with respect to a pilot mandrel and with curvilinear inwardly directed edges, the sectors being slightly inclined with respect to vertical planes passing through the axis of the pilot mandrel and being supported by a plate movable parallel to the pilot mandrel to rock the sectors about their pivots, so as to bring their curvilinear edges into contact with the exterior of an article whose mouth is placed on the pilot mandrel, the support plate being guided by inclined splines so that it performs a slight rotary movement as it moves to rock the sectors, and a finishing mandrel adapted to project beyond the pilot mandrel as the mouth of the article is swaged by being drawn from the pilot mandrel by the sectors and upon which finishing mandrel the swaged mouth is rolled by the sectors, and in which the mandrel is adapted to be positively driven. Such machine is hereinafter referred to as "the type defined."

According to the present invention a swaging machine of the type defined comprises guide means for the curvilinear sectors in the immediate vicinity of their working zone, said guide means consisting of a ring having slots to receive and guide the sectors during the working stroke.

Because of the positive retention of the sectors in their radial positions, the guide prevents the formation of any lateral component of force which results when a radial force is offset from its axis and which cannot fail to cause the rapid deterioration of the tool.

Secondly, the actuating rod for each sector is hinged on a bearing positioned by a plate which has the same divisions as the slots in the ring.

Moreover, with the aim of simplifying the assembling, the bearing for each sector is mounted in a casing fastened inside an outer supporting ring, and each of the aforesaid casings has on its periphery a place to take a packing piece which withstands the strain imposed on it by the bearing, the thickness of this packing piece being predetermined in accordance with the yielding of the outer supporting ring caused by the work being done.

In the form of construction of swaging machine of the type defined, the limited stroke of the sectors only enabled workpieces to be produced whose length did not exceed the developed surface of the said sectors, and it is only possible to produce hollow workpieces whose periphery was circular.

It is a further feature of the invention to extend the field of use of such machine by enabling, firstly, long workpieces or tubes to be produced, and, secondly, thick workpieces which have on their outside periphery grooves or gear teeth to be produced by cold rolling, that is to say without any chip removal, and this with any desired degree of accuracy.

For this purpose, the central mandrel, which is driven in synchronism with the sectors, is successively given an alternate forwards and backwards movement and, in order to adapt the machine for producing long workpieces or tubes with a smooth outside surface, the aforesaid forwards and backwards movement of the mandrel is associated with a partial rotating movement of the mandrel at each end of its travel, this partial ro-

tating movement having a value which substantially corresponds to half the thickness of the operating sectors, while the pilot mandrel for its part is given, during the return stroke of the sectors, a backwards movement so that it eventually resumes its initial position at the moment when the next working cycle begins.

Finally, when making thick workpieces with a notched outside surface, such as in the form of gear teeth, without any chip removal and by an action which is similar to cold forging but without blows being struck, the alternate displacement of the mandrel holder is carried out by the interplay of two plates carrying radial jaws which, hydraulically actuated, alternately hold and release the said mandrel holder.

Two embodiments of the invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of a horizontally disposed machine, for forming long tubular workpieces,

FIG. 2 is a longitudinal section of the machine of FIG. 1;

FIG. 3, on a larger scale, is a section on the line 3—3 of FIG. 2; and,

FIG. 4 shows, sectionally in elevation, an example of a machine intended for making thick workpieces with a notched periphery in the form of gear teeth, the left half of the machine being represented in the top position, and the right half in the bottom position.

In the machine shown in FIGS. 1 and 2, the horizontal disposition makes it easier to insert the workpiece and remove it after it is finished, and the machine includes:

- sectors 1 actuated by connecting rods 5,
- pilot mandrel 20,
- mandrel 24,
- and outer supporting ring 3,
- elements 35 made from thick plate are joined to a base plate 50 and form a framework holding the outer supporting ring 3.

Each sector 1 is rigidly fixed to a needle bearing 15 housed in a casing 2 which withstands the load by bearing against the inside wall of the outer supporting ring 3, with a packing piece 2A being interposed. These casings 2 are positioned very exactly by means of recesses milled in plates 48—49 which are held in position by the circular plates 16a—16b. In addition, the casings 2 are held and radially positioned by recesses in a plate 4 which is divided into sectors for greater ease of assembly.

The sectors 1 lie in slots in a skirt on a guide ring 14 and are very accurately guided by them, during the working stroke in the immediate vicinity of their working zone. Each division in this guiding ring 14 is lined up with the plate 49, into which the guiding ring is sunk.

The connecting rods 5 actuating the sectors 1 are fastened by an articulating joint to bearings 11. These bearings are themselves very exactly positioned by a dividing plate 22 and are held in position by the sectors 7 in the plate 6, which latter plate is fastened to rods 8 and thus is given an alternate linear movement, imparted to it by pistons 17 of actuating cylinders 18 fixed behind a table 9 which ensures the guiding of the rods 8, the pilot mandrel 20 and the extension piece 21 which forms the mandrel holder passing through the table 9.

During the alternate partial circular movement of the sectors 1, the distance between the active portion of these sectors and the incurved surface of the pilot mandrel 20 remains equal to the thickness of the wall of the workpiece 23, with the object of counteracting any puckering on the circumference. The thickening resulting from the reduction is then reduced by cold rolling to the extent desired, by the rolling of the sectors 1 against the mandrel 24.

The accuracy of the work done is due to the adjustment resulting from the choice of the packing pieces 2a, which are selected according to the amount of the reaction of the sectors and the yielding of the outer supporting ring which results from this.

At the moment when the pilot mandrel withdraws from the workpiece, whose rear shape does not correspond to that of the profile, the pilot mandrel, being in the forward position, must move back. This movement is imparted to it by its holder 21 being rigidly fixed to an actuating piston 41 the cylinder 40 of which is fixed to a table 37. This table 37 also serves as the rear support of the machine. It is attached to the machine by pillars 39, and carries by means of distance pieces 38 and pillars 42 tables 36 and 34 in succession.

As regards the movement imparted to the mandrel, it must be synchronized with that of the sectors. Thus the actuating rods 8 for the sectors 1 are rigidly connected at their back ends to rods 31 which actuate tie rods 52, hinged on supports 32, these tie rods transmitting their movement to a block 27 by means of levers 29. It should be noted that the positioning of the support 30 of the levers 29 permits very close correction of any difference in travel between the workpiece 23 and the sectors 1.

At the end of the return stroke, the mandrel holder 25 is arrested by a stop 53 and rotates, taking the workpiece with it, in the reverse direction to the movement produced during the forward stroke, and the next cycle commences.

For this purpose, the mandrel holder is provided with a long-pitch thread 54 engaging in a nut 46 which is rigidly fixed to a support 45 through which pass rods 47, each carrying two stops 55, situated on either side of the said support 45. The mandrel holder 25 also has two stop collars 44 and 26, and the supporting block 27 imparts its movement to the mandrel holder 25 through spring washers 43. Thus, when one of the collars 44 and 26 comes into contact with its stop plate 36 or 34, so that the collar is prevented from further movement, the movement of the supporting block 27 continues by the spring washers 43 being squeezed together; this causes the support 45 to move, and therefore the nut 46 to move, because of the stops on the rods 47. The movement of this nut then produces, via the thread 54, the rotation of the mandrel holder 25, first in one direction at the end of its forward stroke, and then in the other direction at the end of its backward stroke.

Because of the provision of the pilot mandrel, it is also possible to transform cylindrical tubes into tubes whose section is not produced by a rotary movement, such as, for example, rectangular, square or any other sections, in which case the mandrel which passes through the pilot mandrel has itself the section of the profile desired. The sectors should then be braced against a packing piece which bears on the outer supporting ring and has a face which is perpendicular to their direction. The tubes thus produced can also have

projecting or hollow grooves of various shapes on their surfaces. It is likewise possible to make truncated conical workpieces, provided that their length does not exceed that of the developed surfaces of the sectors.

In the type of construction shown in FIG. 4, which deals with making castellations or teeth on a solid workpiece 23 without any chip removal and simultaneously over all its periphery, the machine works as follows. In the head of the machine, which remains the same as in FIGS. 1 to 3, the mandrel 24 accepts the workpiece 23 which is firmly fixed to it by a threaded part with a nut 55. The pilot mandrel is dispensed with and the mandrel 24 is mounted on the mandrel holder 25 which slides, without turning, in a ball-bearing guide 56 housed in the table 9 and in the guide 57 housed in the plate 50. These two plates, which are rigidly fixed to each other and to the outer supporting ring 3 by the framework 35, are exactly centered.

The movement of the mandrel 24-25 is made, as previously stated, in synchronism with the sectors 1, by the tie rods 29 reproducing the movement of the said sectors. Moreover, the mandrel holder 25 should have a length which is sufficiently great as to allow all the length to be worked to pass under the sectors. It is, in fact, rigidly fastened to the workpiece 23 and should ensure, over and above its reciprocating stroke necessary for the work, that between each cycle the workpiece is fed forward by an amount which is slightly less than the pitch of the forwards movement. Therefore it cannot be joined in a permanent manner to the driving block 27.

The relative movement of the mandrel-sectors assembly is obtained by stopping the return movement of the mandrel holder 25 before the end of the return stroke of the sectors 1. For this purpose a plate 58, rigidly fixed to the plate 50, is equipped with radial actuating cylinders operated by means of an electrically driven valve controlled by a micro-switch; these cylinders stop the mandrel holder 25 as soon as the sectors have freed the workpiece 23, before the end of their return stroke.

When the next cycle starts, the plate 58 frees the mandrel holder 25, while a plate 59, identical with plate 58, that is to say also having radial cylinders 60, but rigidly fixed to the driving block 27, is actuated to perform the carrying forward of the said mandrel holder 25, and therefore the workpiece 23.

This machine first of all enables a great saving of time in the making of a castellated workpiece such as gear teeth, as compared to conventional machining methods. Secondly, it allows the number of teeth to be changed by fixed dividers, easily interchangeable, and the guide which obviates all errors. Because the workpiece does not turn, the wear on the active parts is very low.

Furthermore, working without a hammering action makes possible a progressive deepening with the minimum of hammer-hardening, and an adjustment of the internal stresses. It is known, in fact, that crowns made by machining often become oval as soon as they are released but by the considerable contraction exerted on the workpiece which is braced against the mandrel, there is obtained by the machine specified above a calibrating action which greatly improves the circularity of the finished workpiece, both in its internal and external diameters.

When shaping gear teeth, with a view to obtaining the maximum accuracy, the table is rigidly fixed directly to the outer supporting ring.

It should be emphasized that the sectors positioned in the guide 14 act like a funnel and, guiding the workpiece by its outside diameter, facilitate its insertion; they also act as a check on the workpieces by prohibiting the insertion of a workpiece which is too large in diameter.

Finally, it is evident that several workpieces can be mounted on the same mandrel and dealt with simultaneously.

It should also be emphasized that the results obtained for circular workpieces, both as regards their circularity and finish, are due to the great number of sectors which, as regards their working action, profit from the very low variation in the height of the chamber which corresponds to the arc worked upon by the width of each sector. For example, the height of the camber of a sector of 6°, which for a diameter of 80 mm is 0.0572 and for a diameter of 60 mm: 0.0429, that is to say, a difference of 0.0143. This allows, therefore, for a reduction of 25 percent a departure from circularity of 14 microns — a departure which is reduced to 7 by the overlap on the return stroke. This special feature enables the rolling sectors to be made with a fixed profile, and therefore no alternation need be made to the working surface for diameters which are very different — which is not possible with swaging equipment which has a small number of tools requiring an attacking profile of truncated cone shape.

What I claim is:

1. A swaging machine comprising a pilot mandrel, pivoted sectors disposed radially with respect to the pilot mandrel, said sectors having curvilinear inwardly directed edges, said sectors being slightly inclined with respect to vertical planes passing through the axis of the pilot mandrel, means to pivot the sectors in a working stroke to bring their curvilinear edges into contact with the exterior of an article whose mouth is placed on the pilot mandrel, a finishing mandrel adapted to project beyond the pilot mandrel as the mouth of the

article is swaged by being drawn from the pilot mandrel by the sectors and upon which finishing mandrel the swaged mouth is rolled by said sectors, means for positively driving said pilot mandrel in alternate forwards and backwards movement in synchronism with the pivoting of said sectors, and guide means for said sectors disposed in the immediate vicinity of the curvilinear edges thereof, said guide means comprising a ring having slots to receive and guide said sectors during the working stroke.

2. A swaging machine as in claim 1, wherein said means to pivot the sectors comprises an actuating rod for each sector, a bearing hinged to each rod, and a plate receiving the bearings and having the same divisions as the slots in said ring.

3. A swaging machine as in claim 1, comprising a bearing to which each sector is secured, a casing in which said bearings are housed, an outer supporting ring in which said casing is secured, and a packing piece interposed between the casing and the supporting ring, the thickness of the packing piece being predetermined in accordance with the yielding of the supporting ring caused by the work being done.

4. A swaging machine as in claim 3 wherein the drive means drives said mandrel with a partial rotation movement of the said mandrel at each end of its stroke, said partial rotating movement having a value which substantially corresponds to half the thickness of the sectors.

5. A swaging machine as in claim 4, comprising means whereby during the return stroke of the sectors the pilot mandrel is given a backwards movement, and it resumes its initial position at the moment when said sectors start working again at the beginning of the next cycle.

6. A swaging machine as in claim 1, wherein when producing notched workpieces or gearing, the drive means for alternate movement of the mandrel comprises two plates carrying radial jaws which, actuated hydraulically, alternately hold and release said mandrel.

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