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(54) APPARATUS FOR AND METHOD OF SOLDERING THIN-WALLED TUBES

(71) We, RHEINISCHES ZINKWALZWERK G.m.b.H. & Co., KOMMANDITGESELLSCHAFT, a Kommanditgesellschaft organised under the laws of the German Federal Republic, of 90 Bahnhofstrasse, 4354 Datteln, German Federal Republic, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an apparatus for and a method of soldering thin-walled tubes of non-ferrous metals, particularly downcomers, which tubes have been pre-shaped from strip metal elements and have longitudinal edges which are arranged to overlap and define in the region in which a solder seam is desired a clearance into which a solder strip can be inserted.

Downcomers may be manufactured from commercially available non-ferrous sheet metal, particularly sheet zinc, by soft-soldering pre-shaped tubes having a longitudinal joint at said joint. The joint may be a close-fitted joint, in which the clearance between the longitudinal edges of the pre-shaped tube does not exceed 0.5 mm. It is desired in this case that capillary action and the supply of sufficient heat cause the joint to be automatically filled with solder. In practice, this result often is not completely attained so that a soldered joint is obtained only in a comparatively very small area along the longitudinal edges. Alternatively, the joint may be a clearance joint, in which the surfaces to be soldered are spaced more than 0.5 mm apart so that there is no capillary action. In this case also, a soldered joint often is obtained only in a narrow area along the longitudinal edges. Such soldered seams constitute by no means a perfect joint. The main disadvantage of the practices described hereinbefore is that the soldered seams must be made by hand thus involving a considerable expenditure of labour.

It is an object of the invention to provide an apparatus and a method which enable an improved and more reliable soldering operation to join tubes of the kind defined hereinbefore by a longitudinal seam.

According to one aspect of the present invention there is provided apparatus for soldering a thin-walled tube of non-ferrous metal, which tube has been pre-shaped from a strip metal element and has longitudinal edges which are arranged to overlap and define in the region in which a solder seam is desired a clearance into which a solder strip can be inserted, the apparatus comprising

(a) a horizontally extending beam adapted to carry the pre-shaped tube which can be slidably fitted on said beam,
(b) an arm which is disposed above the beam and is as long as the latter,
(c) a comb-like arm which is liftable and lowerable and is disposed on that side of said first-mentioned arm which faces the beam,
(d) a first stop bar which is disposed on one side of the comb-like arm and is movable in height and resiliently supported, the stop bar being intended to be engaged by the outer longitudinal edge of the pre-shaped tube,
(e) a second stop bar which is movable in height and resiliently supported and which is intended to be engaged by the inner longitudinal edge of the pre-shaped tube, the second stop bar being provided in the beam and horizontally spaced from the first stop bar by a distance which is the same as the width by which the longitudinal edges of the pre-shaped tube overlap, and
(f) at least one torch which is disposed

on and spaced from that side of the comb-like arm which is remote from the first stop bar, the or each said torch either being stationary and by itself, if only one, or together, if more than one, extending throughout the length of the comb-like arm or being movable parallel to the comb-like arm.

In the case where the or each torch is movable parallel to the comb-like arm, the or each torch is arranged to produce only a narrow flame.

The comb-like arm which is liftable and lowerable is preferably connected to pressure-fluid operable actuators which are mounted on the soldering beam.

In order to ensure that the longitudinal edges of the pre-shaped tube are in forced engagement with the stop bars in the area in which a soldered longitudinal seam is to be formed, clamping means may be mounted below the soldering seam and adapted to be forced radially against the underside of the pre-shaped tube that has been slidably fitted on the soldering beam.

In order to influence the conduction of heat, a recess is provided beside the stop bar of the beam and extends throughout the length of the latter and throughout the width by which the longitudinal edges of the pre-shaped tube overlap.

Where one or more movable torches are provided, such torches are preferably mounted by means of a slide on two guide columns and are continuously movable along the comb-like arm by means of a drive screw.

In a preferred embodiment of the invention, a plurality of torches, preferably two torches, are mounted on the slide, and the mean distance between the torches corresponds to the length of the seam which is to be soldered by the respective torch, this arrangement substantially reducing the soldering time.

In order to ensure that the tube to be which is offset from the first-mentioned soldered is heated on two sides, each torch may have associated with it another torch, torch by 180° and serves to cause a temperature equalization of the tube to be soldered.

The slide which carries the or each movable torch is preferably driven by a continuously adjustable gearmotor, which permits the soldering speed to be adjusted in adaptation to different wall thicknesses of the tube to be soldered, suitable means being provided for moving the torch to its soldering position.

In the operation of the soldering apparatus, the pre-shaped tube is slidably fitted onto the beam, the longitudinal edges are engaged with the stop bars in the region in which the longitudinal seam is desired, a solder strip is inserted into the clearance between the overlapping longitudinal edges, the comb-like arm is then lowered to compress the solder strip in the region in which the longitudinal edges of the tube overlap, and the overlapping longitudinal edges are then heated by the torch or torches to form the soldered longitudinal seam.

The tube which has been soldered is suitably supplied with an enforced air flow so that the tube is rapidly cooled.

An advantage of the present apparatus and the method of operating the apparatus is that a good soldered seam can be produced throughout the region in which the longitudinal edges overlap, at least 50% solder is saved and the time required is reduced by about 60%.

According to another aspect of the present invention there is provided soldering plant, wherein each of a plurality of the soldering apparatus in accordance with the invention, preferably eight thereof, is supported by means of a respective sleeve in a drum, which is rotatable about a horizontal axis, the sleeves protruding from a rear end of the drum, and wherein adjacent sleeves are connected to each other by drive means, and one sleeve is connected by additional drive means to a shaft for rotating the drum. This arrangement ensures that the orientation of each soldering apparatus will be maintained throughout one rotation of the drum so that the longitudinal seam is always formed in the same portion of the tube, preferably at the apex.

The shaft for driving the drum is preferably connected to a stepping mechanism, for moving the several apparatus in successive steps to respective stations.

The drive means preferably comprises chains, which are trained around chain sprockets, which are mounted on the sleeves and on the shaft for driving the drum.

Each torch of a soldering apparatus is conveniently connected by a hose to a gas pipe coupled by a universal-joint fitting to a conduit for delivering a gas-air mixture to the torch, and this conduit extends from a distributor, which is mounted on the shaft for driving the drum and communicates with a conduit for supplying the gas-air mixture.

In the method of operation of the soldering plant just indicated, each tube is moved through a plurality of stations as it is joined by a soldered longitudinal seam.

In a first station, the pre-shaped tube is slidably fitted on the soldering beam so that the longitudinal edges of the tube engage the stop bars. The drum is then advanced one step to move the tube to a second station, at which the clamping means is operated to force the longitudinal edges of the preshaped

tube against the stop bars, the solder strip is inserted into the clearance between the overlapping longitudinal edges, and the comb-like arm is lowered to force the overlapping longitudinal edges against one another. By the next step of the drum, the tube is moved to a third station, at which a gas-air mixture supplied through the torch is ignited to melt the solder strip. At a fourth station, the soldered tube is cooled, the comb-like arm is lifted, and the tube is then removed from the soldering beam. By the next step of the drum, the soldering apparatus is moved to the last station, at which the apparatus is cleaned.

In order to ensure that the drum moves the same distance at each step and each step takes the same time, it is desirable to join the tube by a longitudinal seam formed by soldering operations performed at three stations and to cool the soldered tube as it is moved through two stations.

This method enables quantity production of non-ferrous metal tubes having a soldered longitudinal seam to be achieved at relatively low cost.

In order to enable the invention to be more readily understood, reference will now be made to the accompanying drawings, which illustrate diagrammatically and by way of example some embodiment thereof and in which:—

Fig. 1 is a cross-sectional view of a soldering apparatus,

Fig. 2 is a longitudinal view of plant comprising eight of the soldering apparatus shown in Fig. 1,

Fig. 3 is an end elevation of the plant shown in Fig. 2,

Fig. 4 is a top plan view of another soldering apparatus, and

Fig. 5 is a section on the line I—I of Fig. 4 of the apparatus shown in Fig. 4.

Referring now to Fig. 1, there is shown a soldering apparatus in which a tube 2, which has been pre-shaped from a zinc strip element of suitable size, has been slidably fitted on a longitudinally extending beam 1 so that the inner one of the overlapping longitudinal edges of the tube engages a stop bar 4, which is movable in height and resiliently supported and which is disposed in a recess 3 in the longitudinal beam 1. The upward and downward movement of the stop bar 4 is limited by pins 6, each of which extends through the soldering beam 1 transversely to its longitudinal direction and through a bore 5 in the stop bar 4. An arm 7 is disposed over the beam 1, a bar 9 for receiving a comb-like arm 10 being arranged in a guide 8 on that side of the arm 7 which faces the beam 1. The comb-like arm 10 is adapted to be lifted and lowered by means of a pressure fluid-operable actuator 11 which also controls the movement of the stop bar 4. A stop bar 12, which is movable in height and resiliently supported, is disposed beside the comb-like arm 10 and is spaced from stop bar 4 by a distance which is equal to the width by which the longitudinal edges of the pre-shaped tube 2 overlap, the outer one of the overlapping longitudinal edges engaging the stop bar 12. Actuator 11 also controls movement of the stop bar 12. A profiled solder strip 14 has been slidably inserted into a clearance 13 between the overlapping longitudinal edges of the pre-shaped tube 2. The conduction of heat during the soldering operation is influenced in a favourable sense by the provision of a recess 15 below the overlapping longitudinal edges of the pre-shaped tube 2. In order to produce the heat required for the provision of the soldered longitudinal seam, a gas-air mixture is supplied through an inclined torch 16, which is disposed laterally throughout the length of the comb-like arm 10.

In order to perform a soldering operation, the pre-shaped tube 2 is slidably fitted onto the beam 1 so that the overlapping longitudinal edges of the tube engage the stop bars 4 and 12 and the solder strip 14 is then positioned in the clearance 13 between the overlapping longitudinal edges of the tube. Then the comb-like arm 10 is lowered and, at the same time, the stop bar 4 is lowered and the stop bar 12 is lifted so that the overlapping longitudinal edges of the pre-shaped tube 2 are forced against each other. The gas-air mixture flowing out of the torch 16 is then ignited by a pilot flame to initiate the soldering operation. The flames extinguish when the soldering operation has been completed. When the soldered seam has been sufficiently cooled, the comb-like arm 10 is lifted and the tube 2 is pulled from the beam 1.

Referring now to Figs. 2 and 3, there is shown a soldering plant comprising a horizontal drum 19, which is rotatably mounted and driven by a stepping mechanism 30 and which contains eight of the soldering apparatus shown in Fig. 1, each soldering apparatus being carried at one end only by means of a sleeve 20 in the drum 19. The sleeves 20 of the soldering apparatus protrude from the rear end 31 of the drum 19 and carry chain sprockets 21, adjacent ones of which are interconnected by chains 22. The chain sprocket mounted on one of the sleeves is additionally connected by a chain 25 to a chain sprocket 24, which is mounted on a shaft 23 for driving the drum 19. This chain mechanism ensures that the orientation of each soldering apparatus is maintained throughout the rotation of the drum 19. Each torch 16 is connected by a universal-joint fitting 26 to a conduit 27 for delivering a gas-air mixture to the torch.

The delivery conduits 27 are connected to a distributor 28, which is mounted on the drum shaft 23 and communicates with a main conduit 29 for supplying the gas-air mixture.

In a first station I of the drum, the pre-shaped tube 2 is slidably fitted onto the beam 1 by a feeder 36 so that the longitudinal edges of the tube engage the stop bars 4 and 12, respectively. At the next step of the stepping mechanism 30 of the drum 19, the soldering apparatus is moved through 45° to the second station II, in which clamping means embrace the underside of the tube 2 to force the longitudinal edges of the tube against the stop bars 4, 12. The profiled solder strip 14 is then positioned in the clearance 13 between the overlapping longitudinal edges and the comb-like arm 10 is lowered to force the overlapping longitudinal edges against each other so that the solder strip is flattened; downward movement of arm 10 is limited by the stop bar 4 to prevent deformation of the overlapping tube edges. Because the tube has now been fixed in position, the pipe clamp can be removed and the drum 19 performs the next 45° step to move the tube to the third station III. In the third station, the gas-air mixture supplied to the torch 16 is ignited by a continuously burning pilot flame disposed outside the drum 19 so that the soldering operation is initiated, which is continued in the fourth station IV and completed in the fifth station V, to which stations the apparatus is moved by respective 45° steps of the drum 19. In the sixth station VI, the flames are extinguished and cooling is effected by an enforced air flow. The cooling is continued in the seventh station in which the comb-like arm 10 is raised and the soldered tube 2 is pushed from the beam 1 by a pressure fluid-operated ejector means 37 before the apparatus is moved by the next 45° step of the drum 19 to the eighth station in which the soldering apparatus is cleaned. The cycle of operations thus described is performed by each soldering apparatus.

A station 32 for introducing the solder strip faces that end of the soldering apparatus at which the solder strip 14 is introduced into the clearance 13 between the overlapping longitudinal edges of the tube. The solder strip 14 is withdrawn from a reel 33 and deformed to a V-shaped configuration between rollers 34, 35 one of which is a driven roller.

Figs. 4 and 5, show a torch 38 which is movable throughout the length of a comb-like arm and may be used in the soldering apparatus of Fig. 1 instead of the stationary torch 16.

The torch 38 is mounted by means of a slide 39 on two guide columns 40 and 41 and can be moved along the arm 7 by means of a continuously adjustable gear-motor 43, a toothed belt 44, and a drive screw 42. The torch 38 is mounted on a piston rod 46 of a hydraulic actuator 45, which is operable to extend the torch to and retract it from a soldering position. The tube to be soldered can be supplied with additional heat from an additional torch 47 which in the illustrated embodiment is offset about 120° from the torch 38. The torches 38 and 47 are mounted in stationary positions and preferably associated only with station V.

WHAT WE CLAIM IS:—

1. Apparatus for soldering a thin-walled tube of non-ferrous metal which tube has been pre-shaped from a strip metal element and has longitudinal edges which are arranged to overlap and define in the region in which a solder seam is desired a clearance into which a solder strip can be inserted, the apparatus comprising

(a) a horizontally extending beam adapted to carry the pre-shaped tube which can be slidably fitted on said beam,

(b) an arm which is disposed above the beam and is as long as the latter,

(c) a comb-like arm which is liftable and lowerable and is disposed on that side of said first-mentioned arm which faces the beam,

(d) a first stop bar which is disposed on one side of the comb-like arm and is movable in height and resiliently supported, the stop bar being intended to be engaged by the outer longitudinal edge of the pre-shaped tube,

(e) a second stop bar which is movable in height and resiliently supported and which is intended to be engaged by the inner longitudinal edge of the pre-shaped tube, the second stop bar being provided in the beam and horizontally spaced from the first stop bar by a distance which is the same as the width by which the longitudinal edges of the pre-shaped tube overlap, and

(f) at least one torch which is disposed on and spaced from that side of the comb-like arm which is remote from the first stop bar, the or each said torch either being stationary and by itself, if only one, or together, if more than one, extending throughout the length of the comb-like arm or being movable parallel to the comb-like arm.

2. Apparatus as claimed in Claim 1, wherein the comb-like arm is connected to pressure fluid-operable actuators mounted on the first-mentioned arm.

3. Apparatus as claimed in Claim 1 and 2, wherein clamping means is disposed below

the beam and is adapted to be forced radially against the pre-shaped tube.

4. Apparatus as claimed in any one of Claims 1 to 3, wherein a recess is disposed beside the second stop bar and extends in length throughout the length of the soldering beam and in width for the distance by which the longitudinal edges of the tube overlap.

5. Apparatus as claimed in any one of Claims 1 to 4, wherein the or each torch is mounted by means of a slide on two guide columns and is continuously movable along the comb-like arm by means of a drive screw.

6. Apparatus as claimed in Claim 5, wherein the drive screw is connected to a continuously adjustable gearmotor.

7. Apparatus as claimed in any one of Claims 1 to 6, wherein a plurality of torches is mounted on a slide and the mean distance between the torches corresponds to the length of the seam which is to be soldered by each torch.

8. Apparatus as claimed in any one of Claims 1 to 7, wherein the or each torch has associated therewith another torch, which is offset 180° from the first-mentioned torch.

9. Apparatus for soldering in accordance with Claim 1 substantially as hereinbefore described with reference to Fig. 1 alone or as modified by Figs. 4 and 5 of the accompanying drawings.

10. A method of operating the apparatus claimed in any one of Claims 1 to 9, wherein the pre-shaped tube is slidably fitted onto the beam, the longitudinal edges are engaged with the stop bars in the region in which the longitudinal seam is desired, a solder strip is inserted into a clearance between the overlapping longitudinal edges, the comb-like arm is then lowered to compress the solder strip in the region in which the longitudinal edges of the tube overlap, and the overlapping longitudinal edges are then heated by the or each torch to form the soldered longitudinal seam.

11. A method as claimed in Claim 10, wherein the soldered tube is cooled by an enforced air flow.

12. Soldering plant, wherein each of a plurality of the apparatus claimed in any one of Claims 1 to 9 is supported by means of a respective sleeve in a drum which is rotatable about a horizontal axis, the sleeves protruding from a rear end of the drum and wherein adjacent sleeves are connected to each other by drive means and one sleeve is connected by additional drive means to a shaft for driving the drum.

13. Soldering plant as claimed in Claim 12, wherein the drum supports eight of the soldering apparatus.

14. Plant as claimed in Claim 12 or 13, wherein the shaft for driving the drum is connected to a stepping mechanism.

15. Plant as claimed in any one of Claims 12 to 14, wherein the sleeves and the shaft for driving the drum are interconnected by chain drives.

16. Plant as claimed in any one of Claims 12 to 15, wherein each torch of a soldering apparatus is connected by a universal-joint fitting to a conduit for delivering a gas-air mixture to the torch and wherein this conduit extends from a distributor which is mounted on the shaft for driving the drum and communicates with a main conduit for supplying the gas-air mixture.

17. Soldering plant in accordance with Claim 12 substantially as hereinbefore described with reference to Figs. 2 and 3 in combination with Fig. 1, or as modified by Figs. 4 and 5 of the accompanying drawings.

18. A method of operating the plant claimed in any one of Claims 12 to 17, wherein each tube is moved through a plurality of stations as it is joined by a soldered longitudinal seam.

19. A method as claimed in Claim 18, comprising the steps of slidably fitting a pre-shaped tube at a first station on the beam of the apparatus present at the station, so that the longitudinal edges of the tube engage the stop bars, advancing the drum one step to move the tube to a second station, at which clamping means is operated to force the longitudinal edges of the pre-shaped tube against the stop bars, the solder strip is inserted into the clearance between the overlapping longitudinal edges, and the comb-like arm is lowered to force the overlapping longitudinal edges against one another, advancing the drum a further step to move the tube to a third station in which a gas-air mixture supplied through the torch is ignited to melt the solder strip, at the conclusion of the soldering operation advancing the drum a still further step to move the tube to a fourth station, in which the soldered tube is cooled, the comb-like arm is lifted and the tube is then removed from the soldering beam, and then advancing the drum to a last station, in which the soldering apparatus is cleaned.

20. A method as claimed in Claim 18 or 19 wherein the soldering operation is performed at three stations.

21. A method of soldering a tube of non-ferrous metal, which has been pre-shaped from a metal element and has longi-

tudinal edges which are arranged to overlap and define in the region in which a solder seam is desired a clearance into which a solder strip can be inserted, substantially as hereinbefore described with reference to Fig. 1, or Figs. 1 to 3, or Figs. 1 to 3 as modified by Figs. 4 and 5 of the accompanying drawings.

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1576482 COMPLETE SPECIFICATION

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Sheet 1

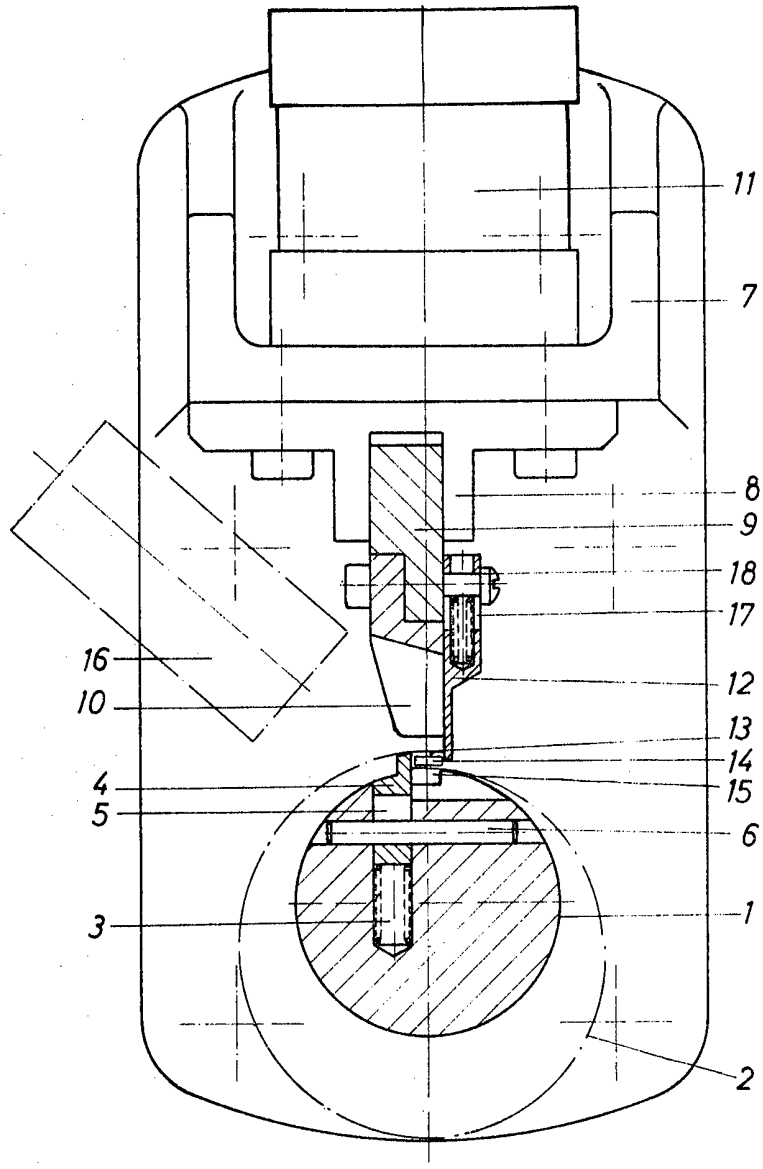

Fig.1

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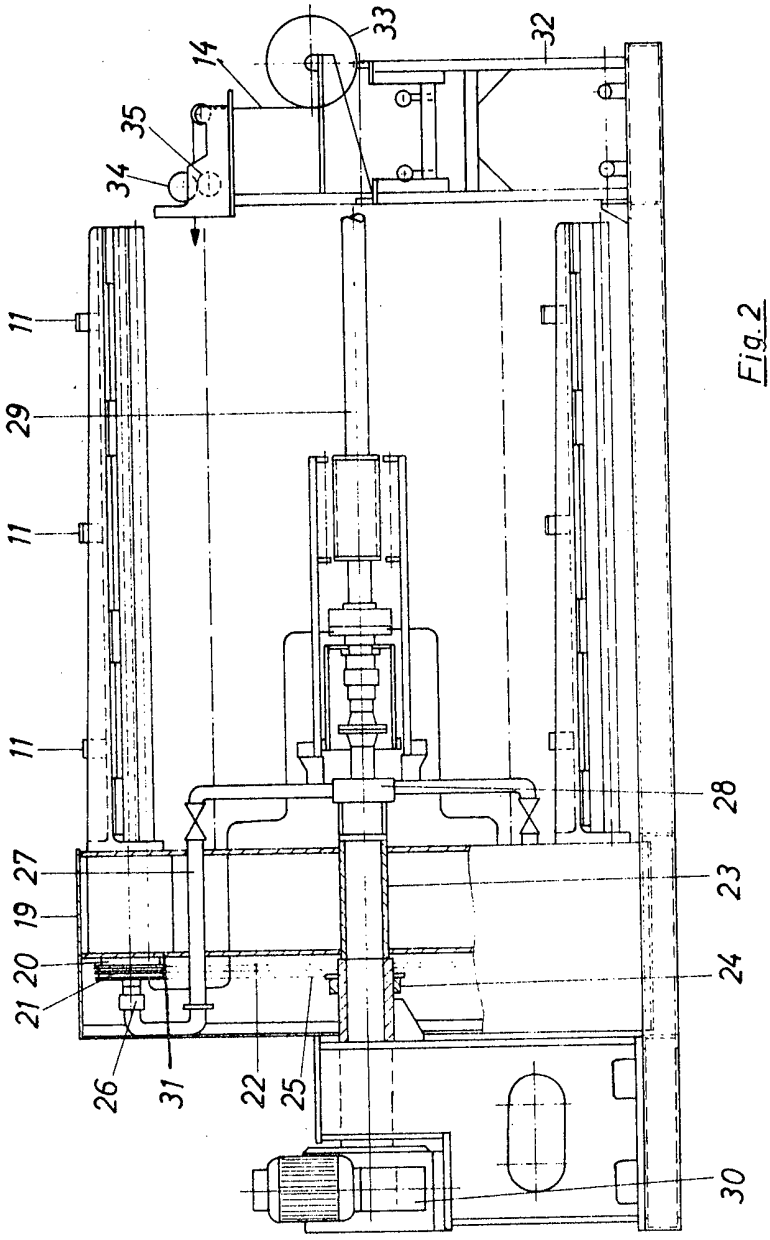

Fig.2

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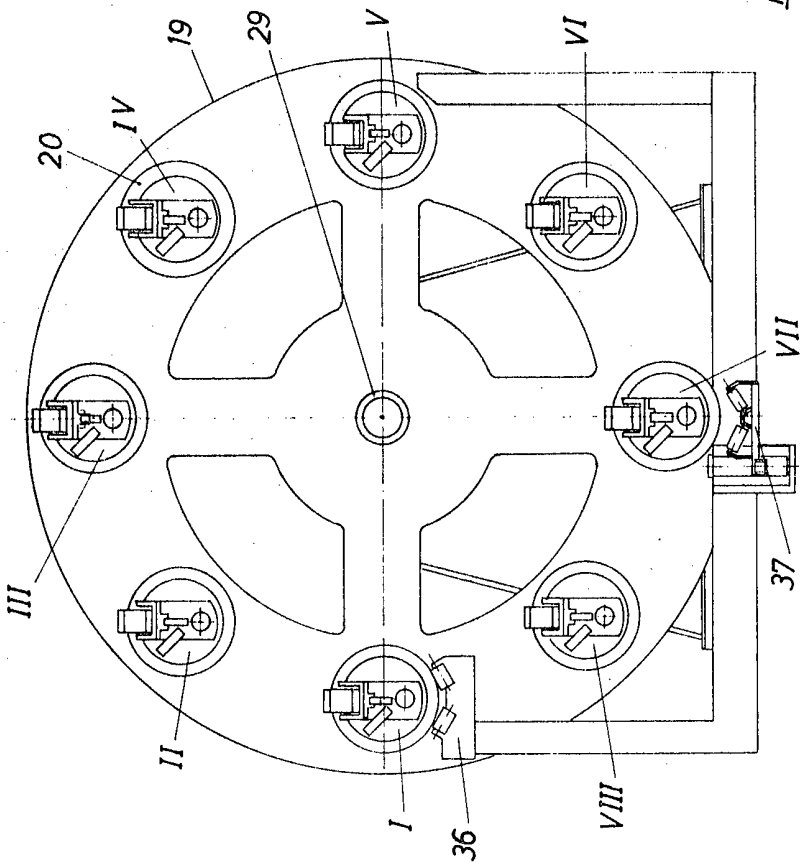
Sheet 3

Fig.3



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Sheet 4

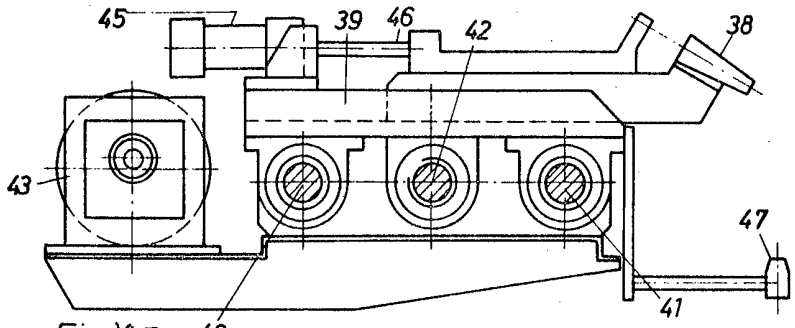

Fig.5

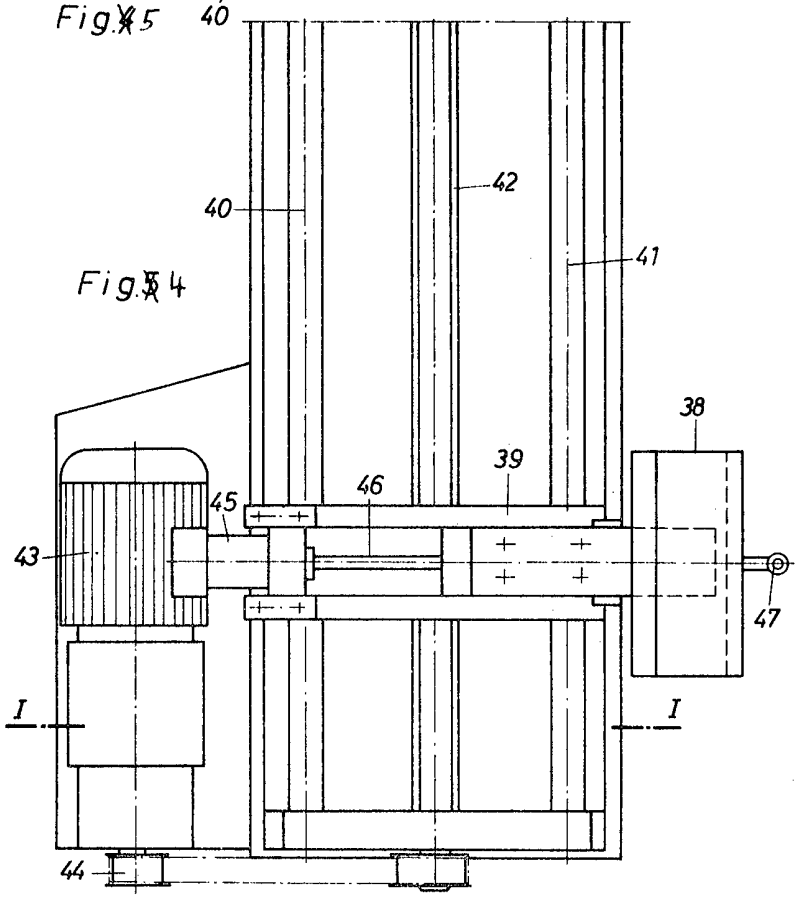

Fig.4