United States Patent

Davis

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[54] **HELICAL PIPE MAKING METHOD**

[72] Inventor: **Paul K. Davis,** Alameda, Calif.

[73] Assignee: **Pacific Roller Die Co., Inc.,** Hayward, Calif.

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[52] **U.S. Cl.** 29/477.7, 29/477, 29/477.3, 228/17

[51] **Int. Cl.** **B23k 31/02**

[58] **Field of Search** 29/477, 477.3, 477.7; 228/17, 228/44, 47, 49

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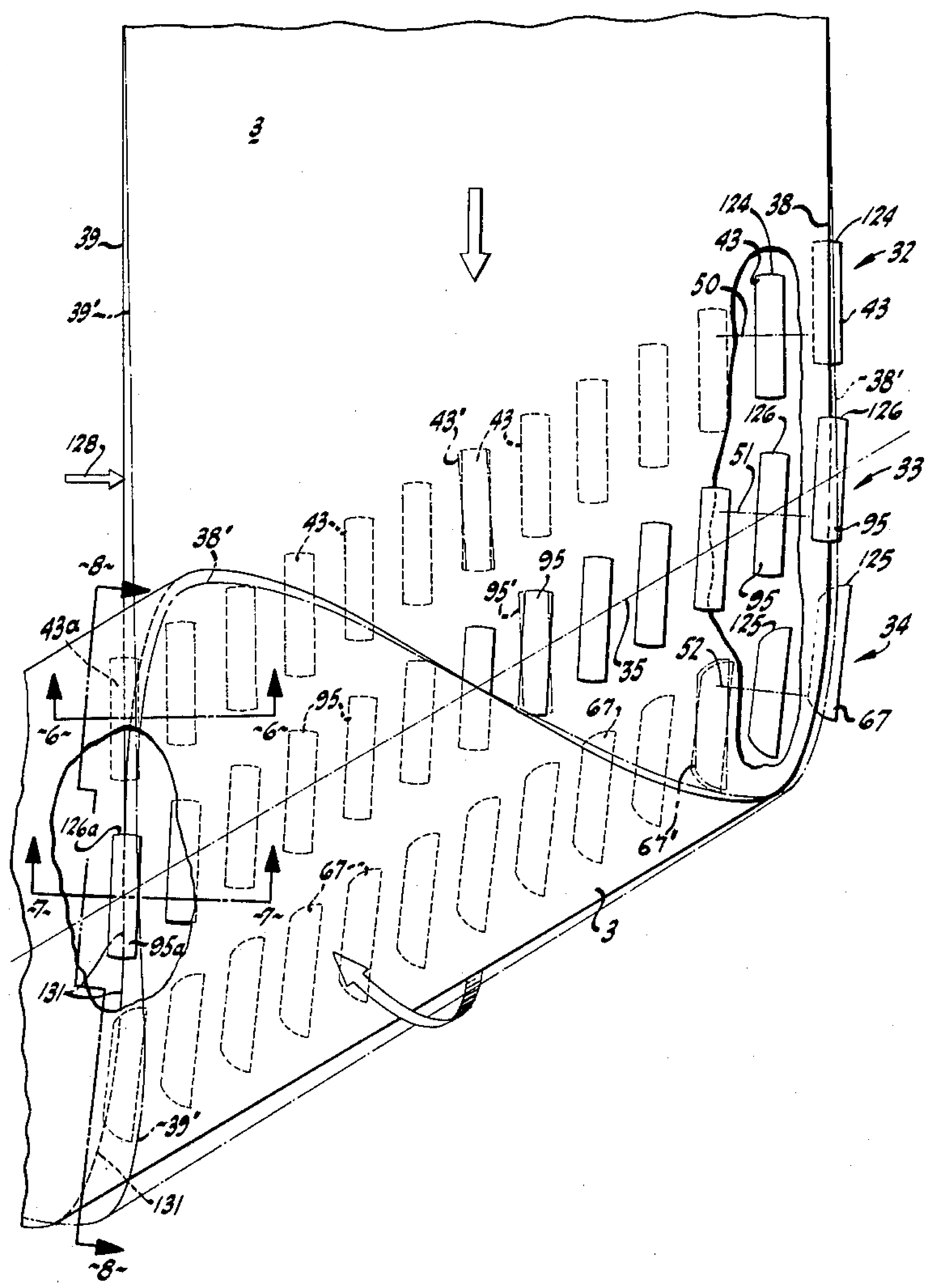
Primary Examiner—John F. Campbell
Assistant Examiner—Richard Bernard Lazarus
Attorney—Boyken, Mohler, Foster and Schwab

[57] **ABSTRACT**

Apparatus for and method of helically forming pipe from an elongated strip of metal. The elongated strip is curled between the rolls of a three-roll strip curling apparatus into a curved path, with the rolls exerting lateral forces on the strip during curling for guiding the strip so that such curved path is in the form of a helical convolution in which the trailing edge of a preceding portion of the strip converges into contact with the leading edge of a following portion thereof.

3 Claims, 9 Drawing Figures



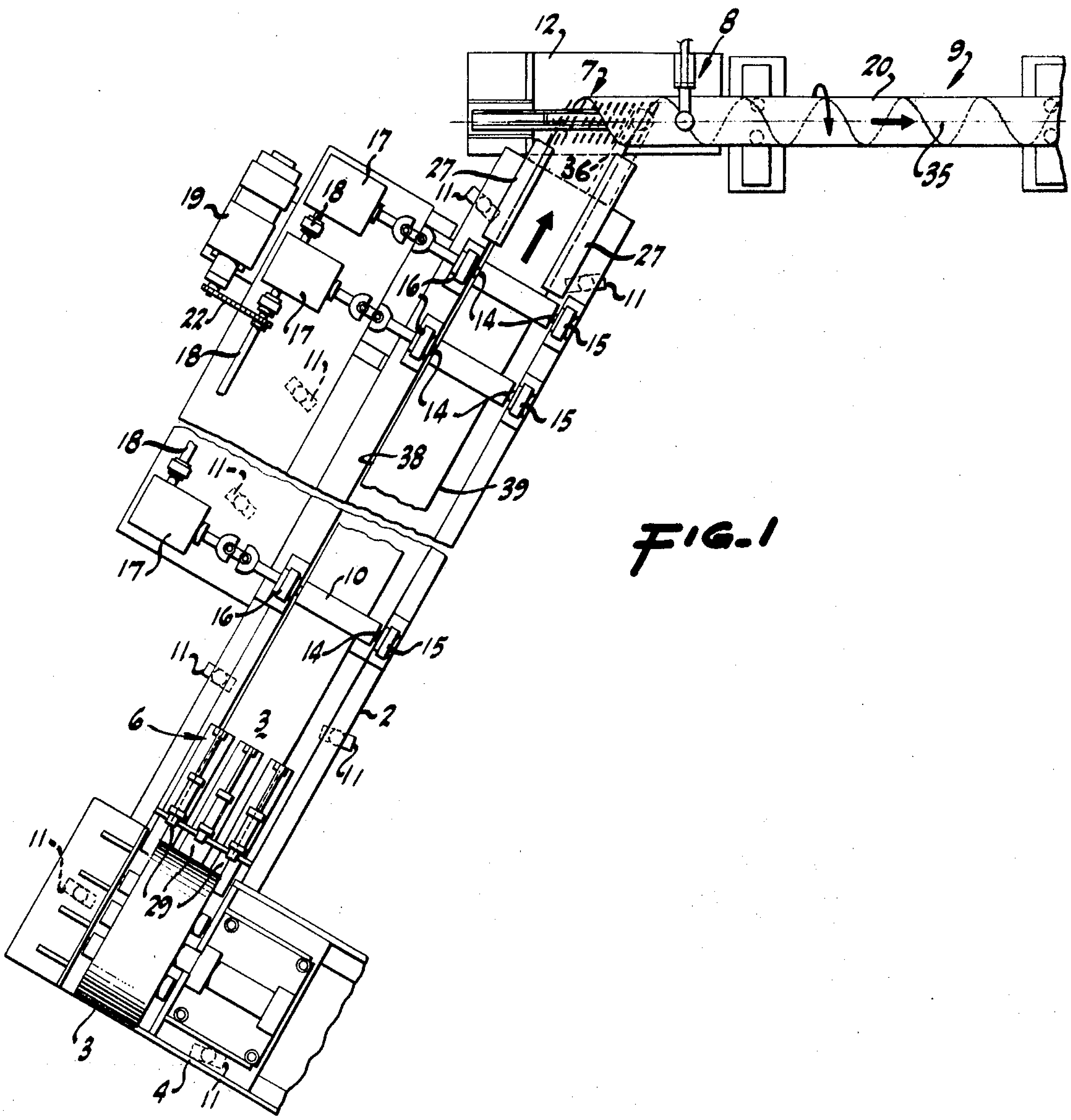


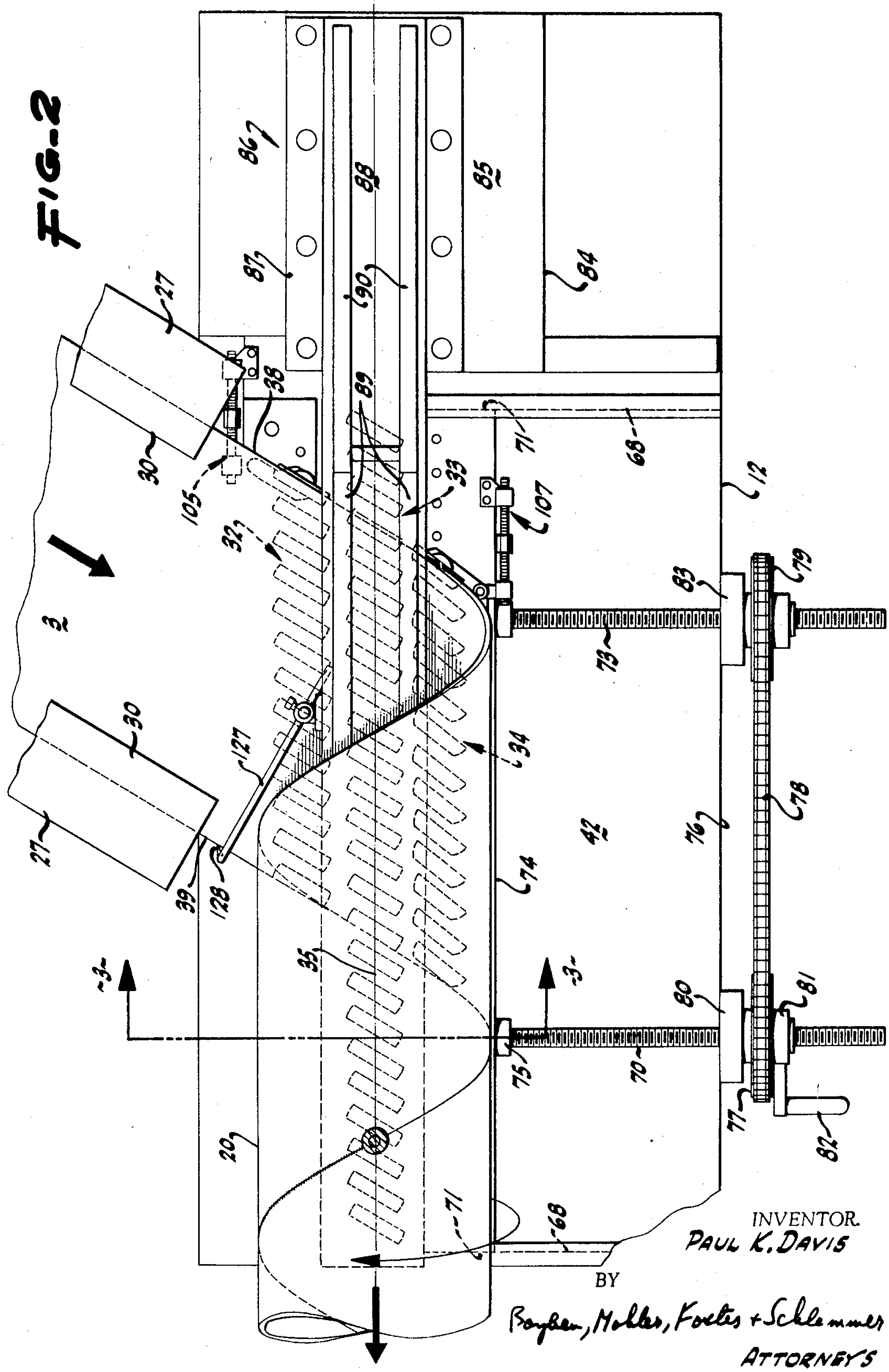
FIG-1

INVENTOR.
PAUL K. DAVIS

BY

Boyken, Mohler, Foster & Schlemmer
ATTORNEYS

FIG-2



INVENTOR.
PAUL K. DAVIS

BY
Boyken, Mohler, Foster + Schlemmer
ATTORNEYS

FIG-3

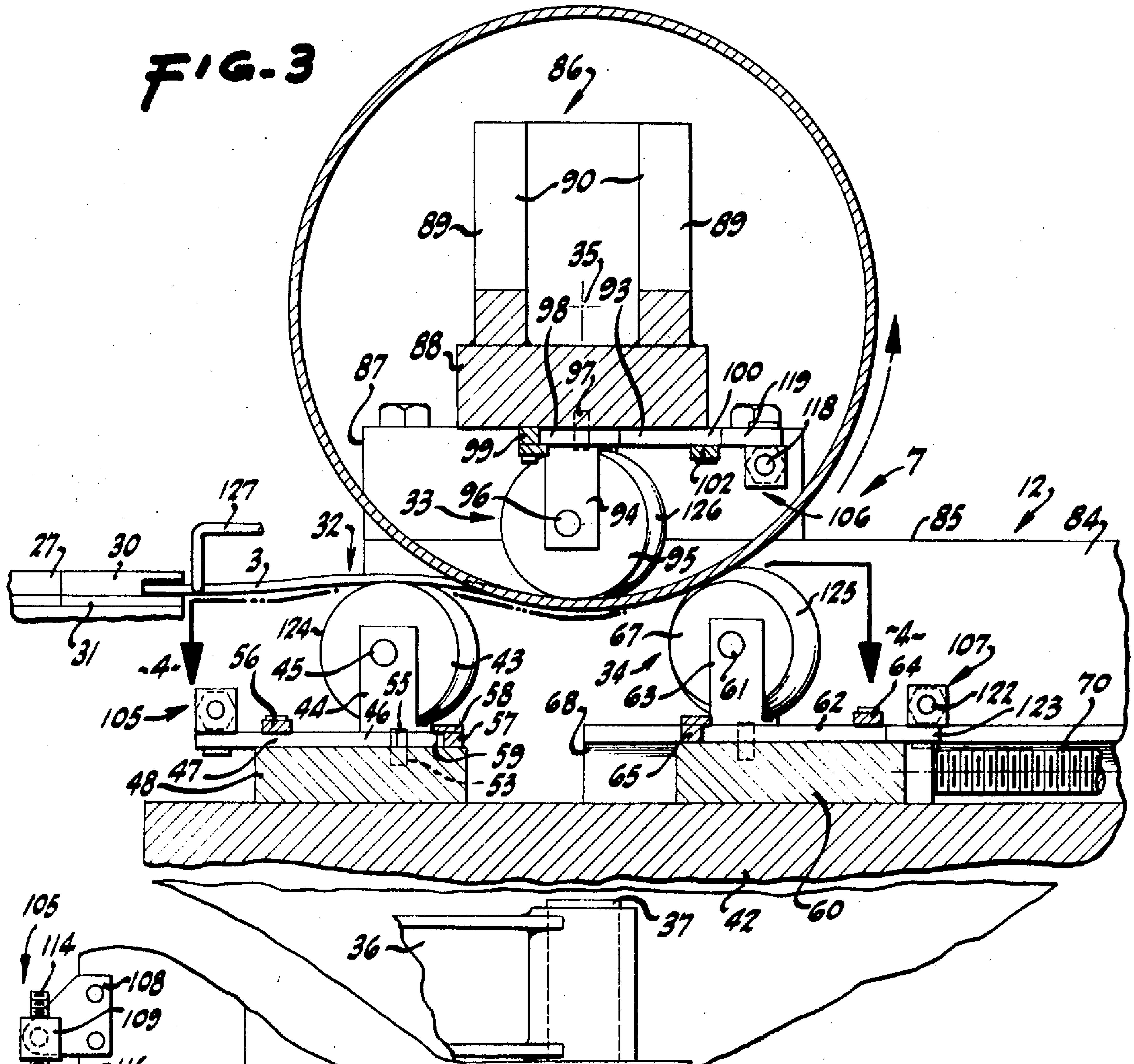
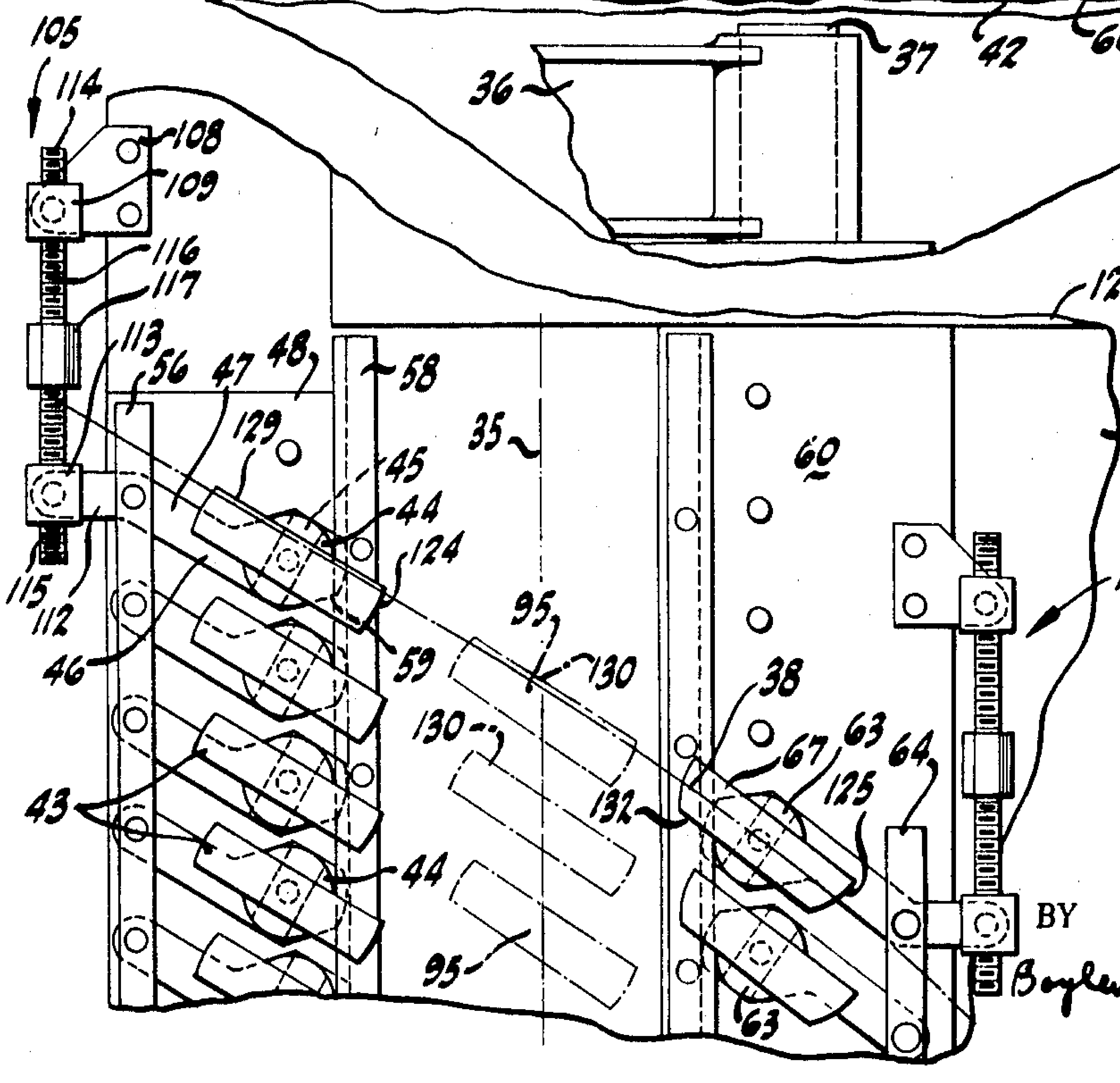


FIG-4



INVENTOR
PAUL K. DAVIS

BY
Boyken, Mohler, Foster & Schlemmer
ATTORNEYS

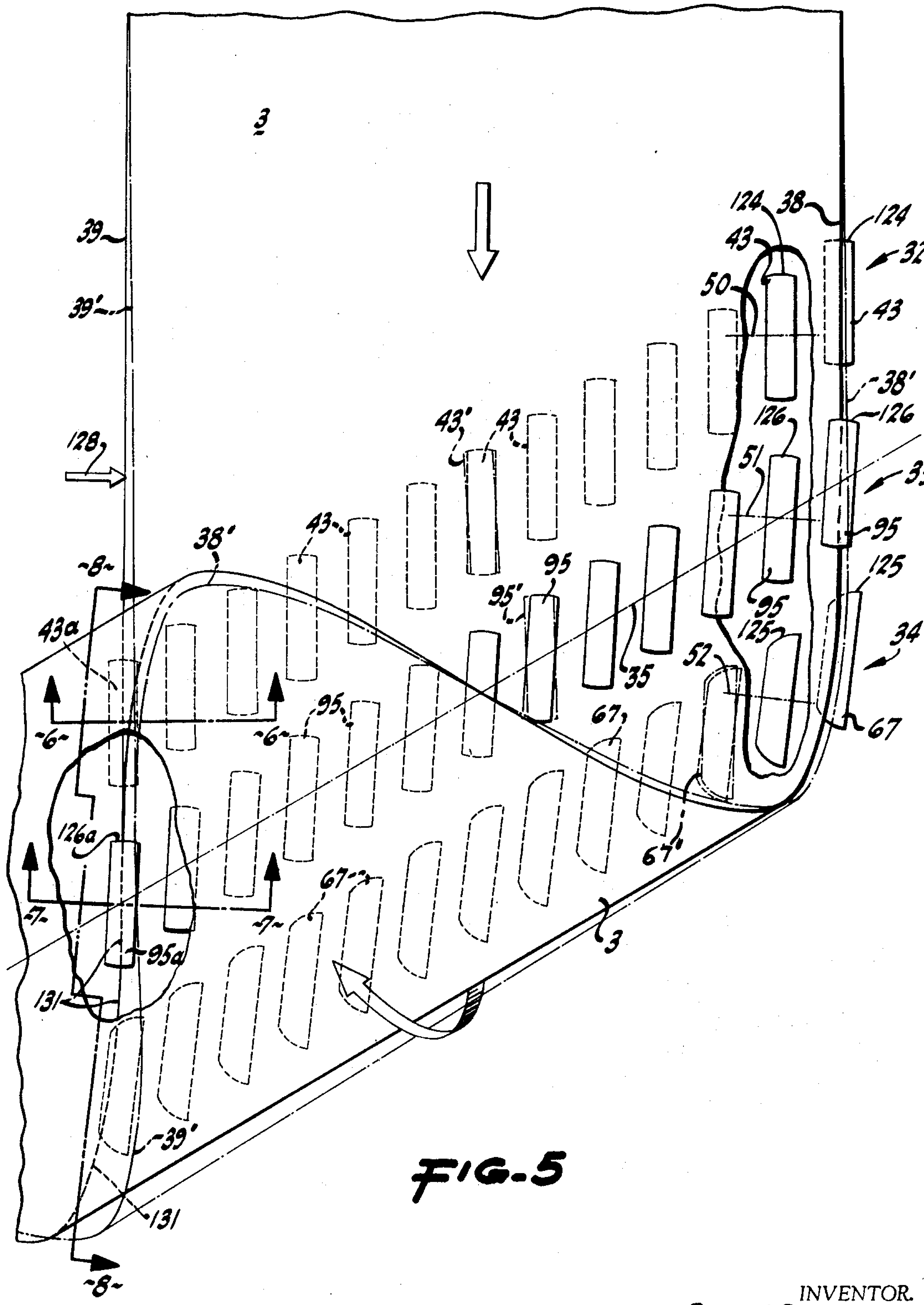


FIG-5

INVENTOR.
PAUL K. DAVIS

BY

Baylen, Mohler, Foster & Schlemmer
ATTORNEYS

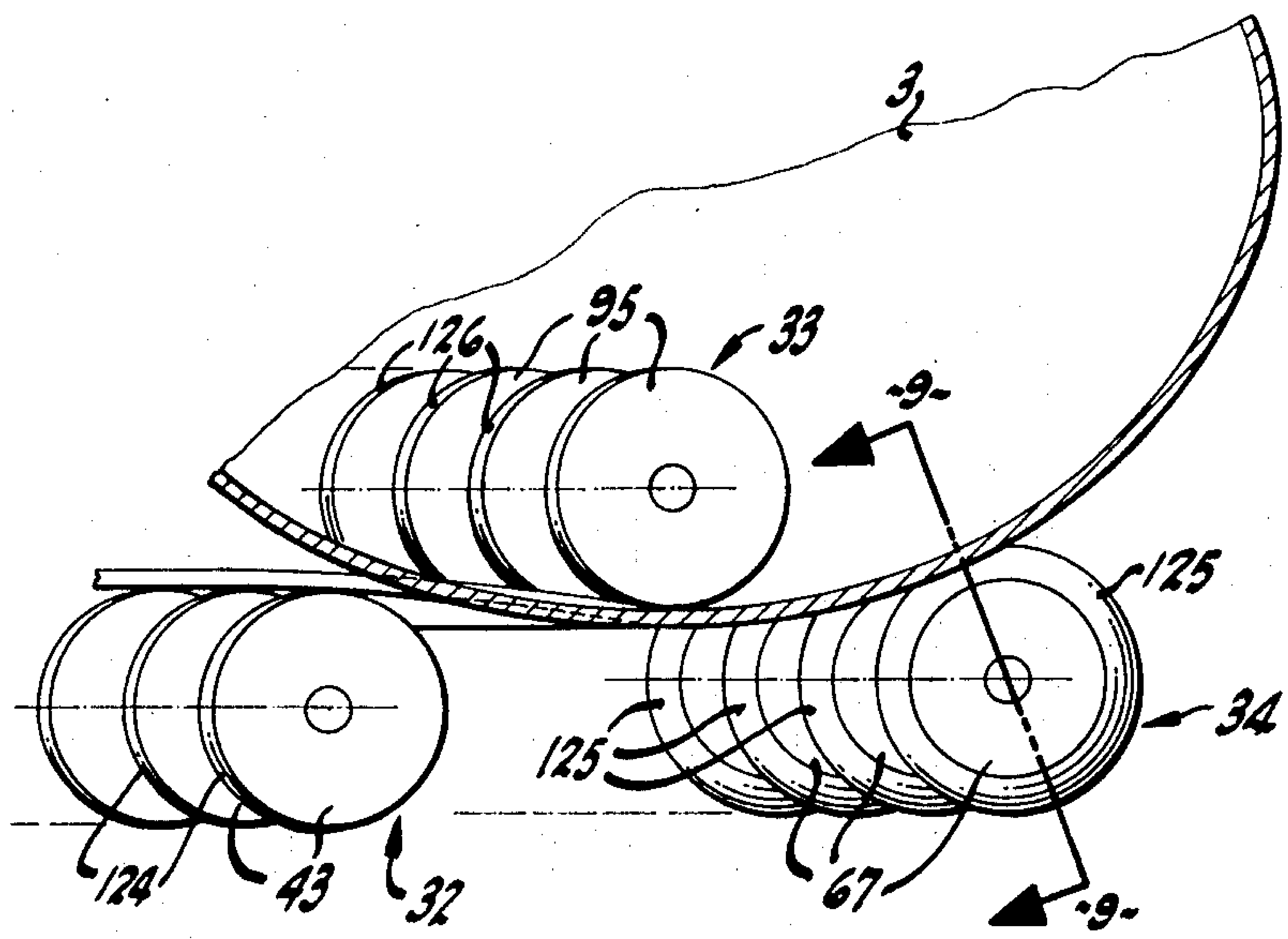


FIG-8

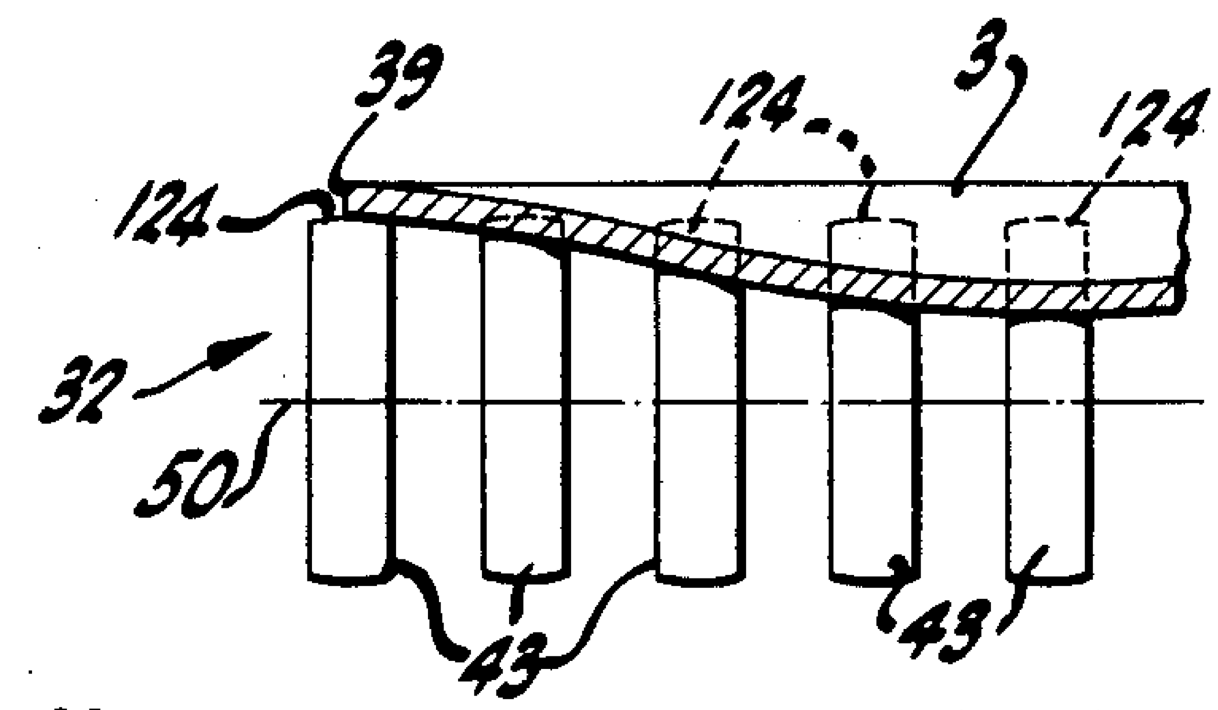


FIG-6

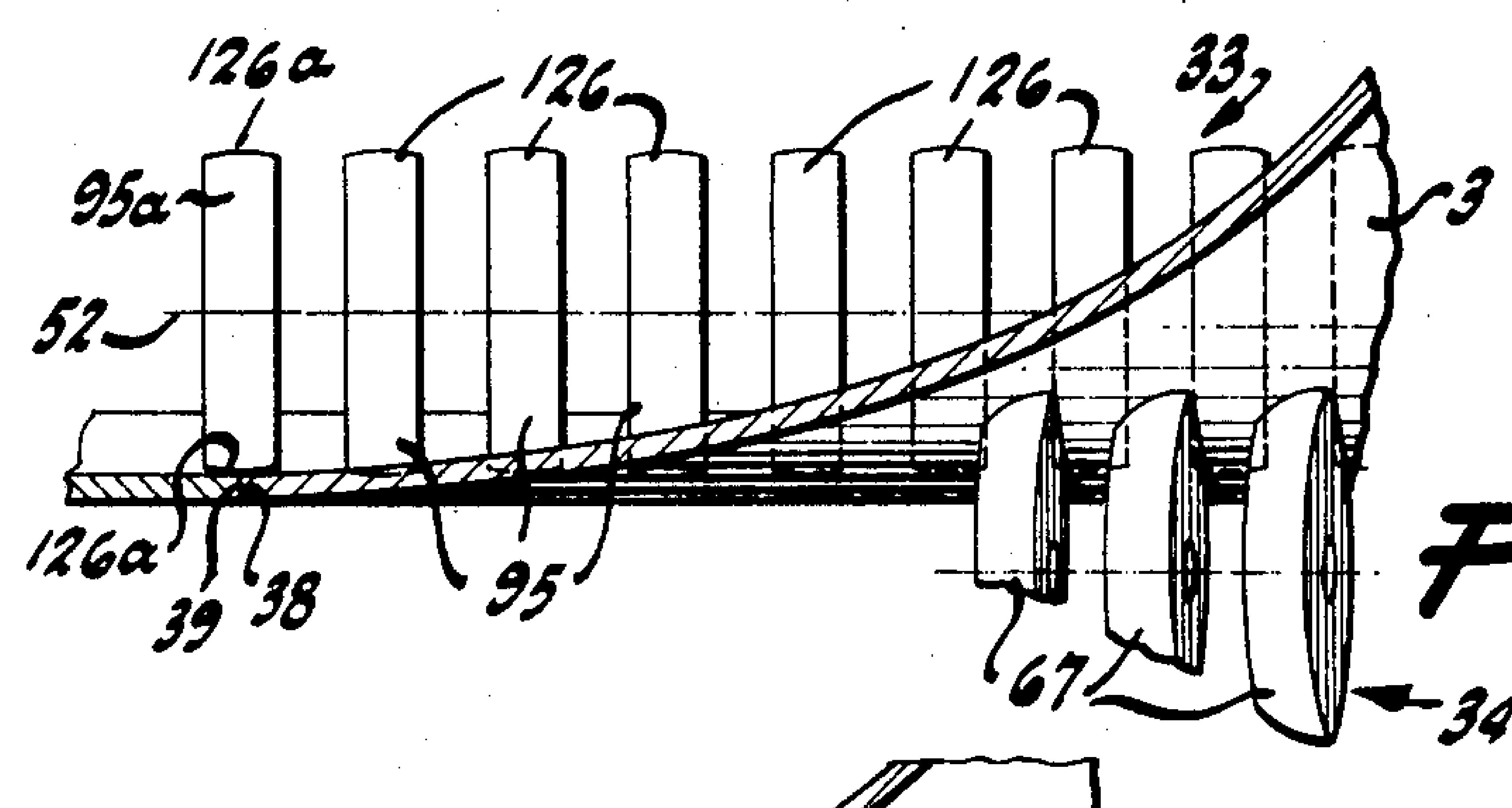


FIG-7

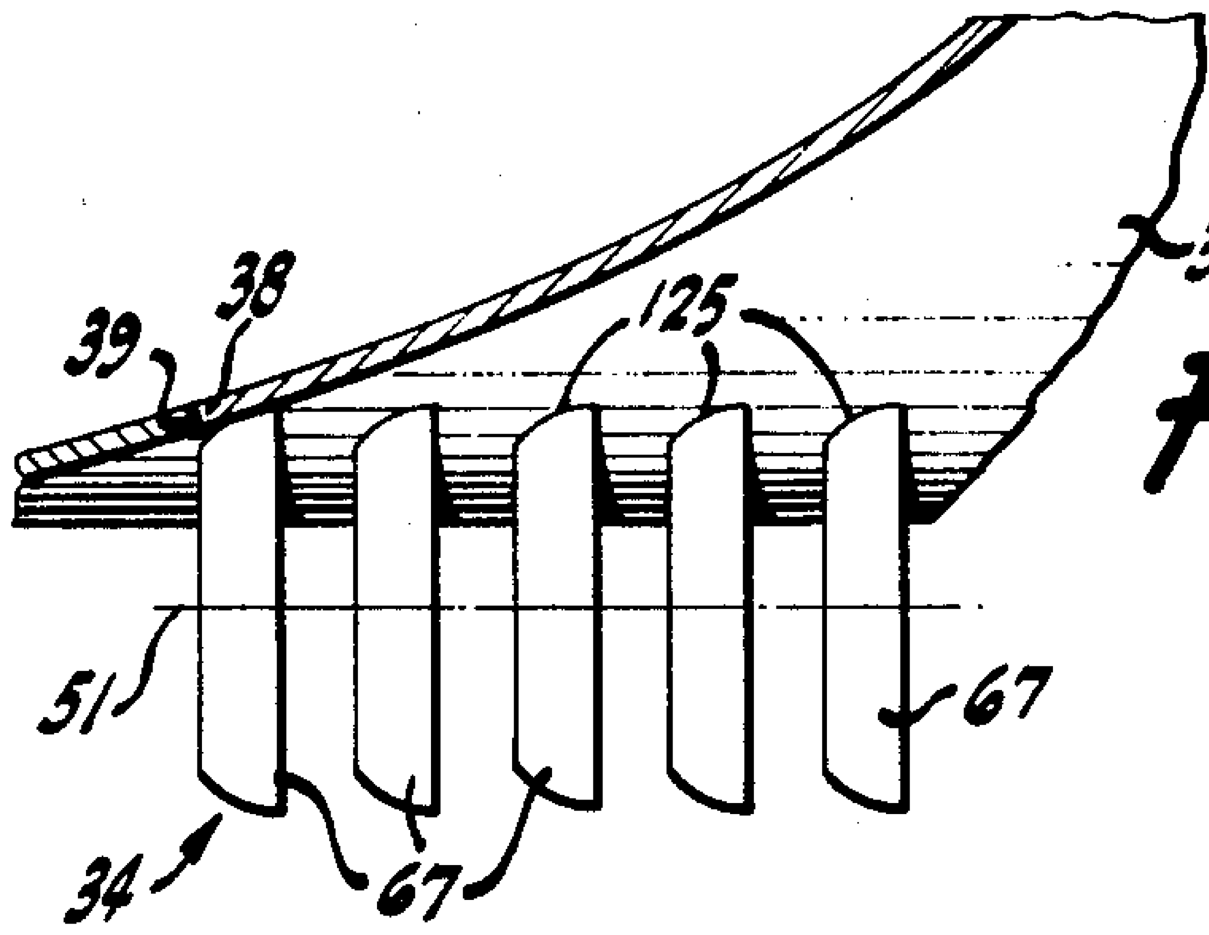


FIG-9

INVENTOR.
PAUL K. DAVIS

BY

Baylen, Mobley, Foelts & Schlemmer
ATTORNEYS

HELICAL PIPE MAKING METHOD

BACKGROUND OF THE INVENTION

This invention relates to apparatus for and a method of making pipe and, more particularly, to helically forming metal pipe from an elongated strip of metal.

Pipe formed as herein described may be of the smooth wall type, such as employed in conveying solid materials or petroleum products; or it may be corrugated pipe, of the type used for underground drains, culverts, and the like. Pipe diameters may range from 6 inches to in excess of 96 inches. Bending or curling of the strip material from which such pipe is formed normally requires the application of very large bending forces. The metal material thickness in smooth wall pipe may exceed one-eighth inch, and corrugated material, while normally is not as thick as that used in the smooth wall pipe, offers great resistance to bending. When bending the strip by application of great bending forces, the problem of adequate control of the strip for proper engagement and joinder of the strip edges is of critical importance.

Known methods and forms of machines employed in fabricating pipe by curling an elongated strip of metal into helical convoultions and joining adjacent edges of the strip at a welded seam, lock seam, or the like, have involved forcing the strip around a stationary mandrel. Inherent in such prior machines and methods are objectionably great friction and uneven stressing of the strip, with less than effective control of the strip. In other machines and methods heretofore used or proposed, the strip is forced against unrestrained or free-rolling caster rollers or ball type forming elements which cannot accomplish any control of the strip.

Further, so far as is known to applicant, prior machines for forming helical pipe have been restricted to formation of a single size, or require extensive adjustment or modification each time pipe diameter is changed, which interrupts pipe production.

SUMMARY OF THE INVENTION

In the helical pipe making apparatus and method of this invention means are provided for advancing an elongated strip of metal in a generally planar path along its longitudinal axis for feeding to a forming device at which the strip is curled between three sets of rollers into helical convolutions. The sets of rollers extend in rows at an angle relative to the longitudinal axis of the incoming strip, such angle being so related to the radius of the convolutions and the width of the strip that the trailing edge of a preceding portion of the strip converges into contact with the leading edge of the following portion of the strip. The peripheries of the rollers of the three sets exert laterally directed forces against the strip surfaces for guiding the strip, and the positioning of the peripheries of the rollers of at least one set is precisely adjustable for so guiding the strip such that the desired contact between said trailing and leading edges is effected and maintained.

It is, therefore, a principal object of this invention to provide a novel and improved apparatus for and method of curling an elongated strip of flat metal into helical pipe, in which a desired relationship between the trailing edge of the preceding portion of the strip and a leading edge of the following portion of the strip is precisely effected and maintained.

Another object of the invention is provision of an apparatus for and method of curling an elongated strip of metal into helical pipe, effecting a high degree of control over the strip where the thickness or character of such strip requires the application of extremely large bending forces.

A further object of the invention is the provision of a helical pipe forming apparatus and method yielding greater strip control than heretofore with a minimum of friction between the apparatus and material of the pipe.

An additional object of the invention is the provision of an apparatus and method of the above character which is readily adaptable to formation of pipe of different diameters.

Other objects and advantages of the invention will become apparent from the following description of a preferred embodiment of the invention.

DESCRIPTION OF THE FIGURES

FIG. **1** is a top plan view of a pipe making apparatus embodying a preferred form of this invention;

FIG. **2** is a top plan view of the pipe curling or forming portion of the apparatus of FIG. **1**, on a scale enlarged relative thereto;

FIG. **3** is a vertical sectional view of the pipe curling portion of FIG. **2** as seen from line **3—3** of FIG. **2** on a scale enlarged relative thereto;

FIG. **4** is a fragmentary top plan view of sets of curling rollers and associated structure, as seen from line **4—4** of FIG. **3**;

FIG. **5** is a simplified top plan view illustrating the sets of curling rollers and the manner in which they guide the strip for effecting and maintaining desired contact between opposite edges of the strip.

FIG. **6** is a vertical sectional view taken along line **6—6** of FIG. **5**, showing rollers of the set which first contacts the strip and the manner of contact between the rollers and the strip;

FIG. **7** is a vertical sectional view taken along line **7—7** of FIG. **5**, showing rollers of the second set to contact the strip and the manner of contact between roller and strip;

FIG. **8** is vertical sectional view taken along line **8—8** of FIG. **5**, showing rollers of the third set to contact the strip;

FIG. **9** is a vertical sectional view taken along line **9—9** of FIG. **8**, showing the rollers of FIG. **8** and the manner in which they contact the strip.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. **1**, the helical pipe making apparatus of this invention comprises an elongated carriage **2** supported on ground wheels **11**, and stationary frame **12** adjacent an end of carriage **2** and supporting a strip curling or forming device **7**. On the end of carriage **2**, remote from curling device **7**, is a coil handling means **4** for a strip **3** of metal material in coiled form. Adjacent coil handling means **4**, there is preferably provided a strip separating or peeling means **6**, and at successive stations along carriage **2** are a plurality of strip drive rolls **10**. On frame **12**, which supports strip curling device **7**, there is also a welding station **8** at which the opposite edges of strip **3** are joined for completion of the pipe **20** (FIG. **1**). The completed pipe discharges at a pipe discharge station **9**.

Coil handling means **4** may be any suitable means for supporting the coiled strip **3** for rotation about an axis to enable uncoiling, and preferably includes provision for rotating the coil for initiating such uncoiling and advancement of strip **3** in a path along its longitudinal axis. Straightening of strip **3** from the coiled to a generally planar form is facilitated by peeling means **6** having a series of blades **29** supported for interposition between the coiled portion of the strip and adjacent longitudinally advancing portion.

Strip drive rolls **10** are arranged in a plurality of stands or pairs, each having an upper roll and lower roll, and the stands of rolls **10** are generally horizontally aligned so that strip **3** will pass between the upper and lower rolls thereof. The shafts **14** of each stand are supported in bearings **15** at one end. The other end of shafts **14** extend through a bearing **16** to connection with gear box **17**, each of such gear box interconnecting the upper and lower rolls **10** of each stand for driving together, and all gear boxes **17** being connected by coupling shafts **18** and to drive motor **19** as by pulley drive **22**, so that all rolls **10** are driven together at the same speed. The upper rolls **10** of each stand are vertically adjustable by any suitable means for effecting proper spacing between the upper and lower rolls corresponding to the thickness of the strip **3** passed therebetween for being driven by the rolls toward the curling device **7**. Located beyond the leading stand of drive rolls **10** and projecting from the end of carriage 2 and to frame 12, are a pair of elongated edge guides 27 (FIGS. 1, 2 and 3) extending in the direction of advance of strip 3 for guiding the strip therebetween, and including an upper flange portion 30 (FIG. 3) and lower flange portion 31 between which the edge portion of strip 3 is confined for preventing the strip from being curved substantially from the generally planar form.

The curling device 7 supported on frame 12 (FIGS. 2 and 3) comprises an assembly of three parallel forming rolls including, in the order in which they contact the advancing strip, a lead roll 32, a mandrel roll 33, so denominated because it is disposed internally of the path of the curled strip 3, and a buttress roll 34. Rolls 32 and 33 are mounted so that opposite surfaces of incoming strip 3 are engaged thereby, and buttress roll 34 is supported on the opposite side of mandrel roll 33 from lead roll 32, remote from carriage 2, and is offset upwardly (FIG. 3) from the feed path represented by the plane of strip 3 and is adapted to engage the same surface of strip 3 as roll 32. Rolls 32, 33 and 34 function to curl strip 3 into an arc with mandrel roll 33 serving as a fulcrum as strip 3 is driven therethrough by drive rolls 10.

Although in the preferred form, rolls 32, 33 and 34 are constructed of a plurality of individual rollers, each said roll may be considered generally as a unitary roll having an axis parallel to a pipe axis 35 (FIGS. 1, 3) about which strip 3 is curled, said axis 35 extending at an oblique angle relative to the longitudinal axis of incoming strip 3. Supporting the rolls 32, 33 and 34 with their axes at an oblique angle to the feed path of strip 3 causes said strip to be curled by said rolls into helical convolutions, the pitch angle of which is the same as said oblique angle less 90°. In order to support said rolls at selected different oblique angles relative to the feed path of strip 3, and arm 36 (FIGS. 1, 3) rigid with carriage 2, extends outwardly from the output end thereof, and has its outer end swingably mounted about a generally vertical pivot pin 37 (FIG. 3) fixed with respect to the frame 12 of curling device 7. Carriage 2 is therefore supported on ground wheels 11 for swinging relative to frame 12 about pivot pin 37 which is located with its axis generally intersecting the pipe axis 35 and extending from a point substantially directly below the leading longitudinal side edge 39 (FIGS. 1, 2) of strip 3.

The oblique angle between the feed path of strip 3 on carriage 2 and rolls 32, 33 and 34 may be adjusted in relation to the width of strip 3 so that the trailing edge 38 (FIGS. 1, 2) of the preceding portion of strip 3, when curled through a convolution of 360° (FIG. 2), engages the leading edge 39 (FIGS. 1, 2) of a following portion of said strip. In this manner, strip 3 is curled into closed, continuous, helical convolutions the adjacent edges of which may be joined to complete a continuous pipe discharged from curling device 7 along pipe axis 35.

Because of imperfections of the strip 3, in uneven thickness, width, or hardness in different portions, or "camber" (i.e., the edges are not straight and parallel), or other differences between the actual and the theoretical, the strip may not always follow the path calculated from the width, diameter, and helix angle factors. For this reason, some trial and error in effecting fine adjustments to bring the adjacent edges of the convolutions into engagement is often required. In addition, when the seam is joined by welding, more or less pressure may be desirably exerted axially of the edges depending on the type of welding system employed.

It has been found that such adjustment readily can be effected by slightly changing the angle of the rollers of the forming rolls, most particularly rollers 95 of mandrel roll 33 and secondarily rollers 67 of buttress roll 34. Since movement of the edges of strip 3 toward and away from each other has been effected by such adjustment, it is believed that the strip 3 tends to follow a line in a plane perpendicular to the axis of rotation of the roller over which the strip is being curled. It is understood that the forming rolls must extend at an oblique angle to the longitudinal axis of the strip in order to form it into helical convolutions. If any 'f the rolls, particularly mandrel roll 33 were a solid, elongated cylinder, strip 3 would tend to follow a path perpendicular to the roll axis and the pipe axis rather than along the proper helix angle.

The effect of comprising the forming rolls of individual rollers, each mounted with its axis of rotation substantially perpendicular to the longitudinal axis of the strip is to orient the surface of the roller which engages the strip so that it moves in the same direction as a true helix for the strip width, pipe diameter and angle involved. It will also be noted that the axes of rotation of the rollers are absolutely perpendicular to the strip axis in the theoretical condition that the strip is in planar condition where it engages the rollers. Since the strip is substantially curved at engagement with buttress roll 34, the axes of rotation of rollers 67 are offset from the perpendicular to the extent necessary to meet the above-described condition of movement of the roller surface and strip at point of contact. By means to be described, the fine adjustment of the positions the rollers of rolls 32, 33, 34 may be accomplished whereby the strip is guided during curling with a high degree of precision for effecting and maintaining desired engagement between opposite edges 38, 39.

Rolls 32 and 34 are supported on the base 42 of frame 12 (FIGS. 2, 3, 4). Roll 32 comprises a plurality of disc-shaped rollers 43 (FIGS. 3, 4), each having a periphery 124 preferably of slightly rounded contour. The individual roller 43 is mounted for rotation in a generally vertical plane about a pin 45 and within an upstanding yoke 44 fixed on an end of an elongated mounting plate 46. Mounting plate 46 rests on an elongated mounting block 48 fixed on base 42 and extending in the direction parallel to the desired direction of extent of pipe axis 35, and a pin 55 (FIG. 3), integral with mounting plate 46 and having an axis intersecting the axis of pin 45 at its midpoint, projects downwardly into a bore 53 in the upper portion of mounting block 48 for pivoting of mounting plate 46 thereabout on the mounting block 48. Mounting plates 46 each include a tail portion 47 (FIGS. 3, 4) and are interconnected for pivoting together by a rod 56 extending longitudinally of mounting block 48 pivotally connected to the outer end of the tail portion 47 of each mounting plate 46. The end 59 of mounting plate 46 opposite therefrom is rounded and abuts against an elongated gib 57 (FIG. 3) fixed to and extending longitudinally of mounting block 48, and including a portion 58 which overlies end 59 of mounting plate 46. Gib 57 with portion 58 provides a way within which end 59 of mounting plate 46 slides during pivoting thereof.

The disc shaped rollers 67 (FIGS. 3, 4) of buttress roll 34 are mounted in similar but reversed fashion relative to the path of the incoming strip 3, and each has a rounded periphery 125 that is angled relative to the roller axis as hereinafter more fully described. There are provided yokes (FIG. 3) 63, mounting plates 62, mounting block 60, pivot pins 61, connecting rod 64 and gib 65, all corresponding to similar parts associated with lead roll 32. Mounting block 59 is of greater thickness than mounting block 48 for elevating the rollers 67 of roll 34 relative to rollers 43. Further, mounting block 59 is slidable on base 42 in directions toward and away from roll 32 between a pair of ways 68 (FIGS. 2, 3) in engagement with and overlying the opposite ends 71 thereof (FIG. 2). Ways 68 extend in a direction normal to the direction of extent of mounting block 60 so that it is maintained parallel to mounting block 48. Means for effecting sliding of mounting block 60 includes a spaced parallel pair of threaded rods 70, 73 (FIGS. 2) fixed to mounting block 59 at the side 74 thereof remote from carriage 2, through connecting collars 75. Rods 70, 73, respectively, are freely received through bearing blocks 80, 83 fixed on the edge 76 of base 42 remote from carriage 2. Rod 70 is also received through a sprocket wheel 77 connected to the outer side of bearing block 80 and for rotation relative to said block 80 and having an internally threaded hub 81 which carries a handle 82. Threaded rod 73 is received through an internally threaded sprocket wheel 79 connected to the outer side of bearing block 83 for rotation relative thereto. A continuous chain 78 is engaged around sprocket wheels 77, 79 for rotation together of the sprocket wheels upon turning of handle

82, whereby rods 70, 73 are screwed through sprocket wheels 77, 79 for drawing or pushing mounting block 60, depending on the direction of rotation of handle 82.

At the end of frame 12, remote from pipe discharge station 9, is a frame end portion 84 (FIGS. 2, 3) providing an upper generally horizontal surface 85 elevated with respect to the upper surface of base 42, and on which is supported an arm structure generally designated 86 (FIGS. 2, 3). Arm structure 86 extends from frame portion 84 in the direction of pipe axis 35 above and across the path of incoming strip 3, and comprises a lower bolting block 87 for bolting to frame end portion 84 on surface 85, and structural members including lower arm member 88 and side members 90 having upper surfaces 89 inclined downwardly from a point slightly inwardly of bolting block 87 toward the free end of arm member 88. The combination of bolting block 87 and structural members 88, 90 provides an overhanging arm structure 86 of great rigidity and strength. At the underside of arm member 88 is the mandrel roll 33 comprising a plurality of roller mounting plates 93 (only one of which is shown in FIG. 3), each being connected to arm member 88 by a pivot pin 97 for pivoting about a generally vertical axis. Depending from mounting plate 93 are the legs of a yoke 94 which receives disc shaped roller 95 with rounded periphery 126, for rotation in a generally vertical plane about a pin 96 directly below pivot pin 97. The plurality of mounting plates 93 with the rollers 95 extends parallel to rolls 32, 34, i.e., parallel to pipe axis 35. Mounting plates 93 slide at one end 98 within a way 99 extending parallel to pipe axis 35, and the opposite ends 100 of the mounting plates 93 are pivotally interconnected by a rod 102. Thus, roller 33 is constructed in similar fashion to rolls 32, 34, but with rollers 95 lowermost. A single size and form of arm structure 86 may be employed in forming most diameters of pipe. However, in forming pipe in the smallest diameters, e.g., 12 inches and smaller, an arm structure of a size most desirably used in forming larger diameter pipe with roll 33 may be too large to be accommodated within the curled strip, and a smaller arm structure will be utilized. Bolting block 87 facilitates removal of arm structure 86 for interchanging with the smaller arm structure.

In each of the rolls 32, 33 and 34 the associated rollers are parallel, i.e., the peripheries of the rollers of a particular roll lie in parallel planes, and parallel relationship is maintained during pivoting by the associated one of connecting rods 56, 64 or 102. Precise positioning of rollers 43 of lead roll 32 is effected through use of roller adjusting means 105 (FIGS. 2, 3, 4). Similar adjusting means 106 (FIG. 3) and 107 (FIGS. 2, 3, 4) are associated with mandrel roll 33 and buttress roll 34, respectively. Roller adjusting means 105 includes a horizontally disposed bracket 108 (FIG. 4) fixed to frame 12 at a point generally in line with connecting rod 56, and secured on bracket 108 for pivoting about a vertical axis is an internally threaded sleeve 109. An arm 112 formed integrally with the mounting plate 46 that is nearest frame portion 84, projects from the end of the tail portion 47 thereof, and pivotally carries an internally threaded sleeve 113, with the threads of sleeve 113 in alignment with and oppositely directed from those of sleeve 109. Sleeves 109, 113 respectively receive the oppositely threaded end portions 114, 115 of an adjusting rod 116 having a central nut portion 117 for gripping by a wrench or the like. Turning of adjusting rod 116 in one direction causes connecting rod 56 to be drawn toward the bracket 108 and mounting plates 46 with rollers 43 to be pivoted in the corresponding direction about pins 53. Opposite turning of adjusting rod 116 causes connecting rod 56 to be displaced from bracket 108 with resulting corresponding opposite pivoting of rollers 43. Roller adjusting means 106 of mandrel roll 33 similarly includes an adjusting rod 118 for causing pivoting of rollers 95 through an arm 119 integral with the roller mounting plate 93 nearest frame portion 84, and roller adjusting means 107 of buttress roll 34 has a corresponding adjusting rod 122 operatively connected to roller 67 through an arm 123.

In the preferred construction of the curling device 7, rollers 43 of lead roll 32 are positioned with the uppermost portion of the roller periphery 124 (FIG. 3) projecting into the planar feed path of strip 3, said strip being slightly curved out of and above such path at contact with rollers 43. The lowermost portion of the periphery 126 of rollers 95 in mandrel roll 33 engages strip 3 directly below pipe axis 35, and rollers 95 are vertically positioned such that they cause strip 3 to be curved from such position above the planar feed path downwardly to the level of the path. Strip 3 is thus slightly curved toward periphery 126 of roller 95, immediately ahead of as well as beyond the roller as the strip is curled therearound. The upper portion of the periphery 125 of roller 67 in the upwardly offset buttress roll 34 engages strip 3 for curling it into an arc, the diameter of which is determined by the horizontal spacing between roll 34 and mandrel roll 33, which spacing is readily adjustable by rotation of handle 82.

Surface contact between the peripheries of the sets of rollers 43, 67 and 95 and strip 3 yields a high degree of control over the lateral positioning of the strip during curling as a result of the application of substantial lateral forces on the strip. By adjustment of the positions of the rollers through adjusting means 105, 106 and 107, the strip can be effectively maintained in a desired lateral position or displaced laterally from an incorrect to a desired position, for proper convergence of opposite strip edges 38, 39.

Given a particular width of strip 3 and the diameter of pipe to be formed therefrom about a pipe axis 35 (FIG. 5), a particular predetermined angle must be maintained between the longitudinal axis of strip 3 as it arrives at lead roll 32 and the pipe axis 35 to yield pipe in which the trailing edge 38 of a preceding portion of strip 3 will converge into engagement with the leading edge 39 of a following portion. Specifically, the oblique angle between the longitudinal axis of strip 3 and pipe axis 35 is to be equal to the pitch angle of convolutions forming the pipe plus 90°. As seen in FIG. 2, an indicator rod 127 adjustably mounted on arm structure 86 and having a pointer 128 may be employed immediately ahead of lead roll 32 for locating the correct position of the incoming strip and providing indication of lateral shifting of the strip from the correct position by reference to strip edge 39.

In FIG. 5, pointer 128 is schematically illustrated at edge 39 of strip 3 that is correctly positioned as it arrives at lead roll 32, as described, so that opposite edges 38, 39 converge into engagement as at the seam line 131 (FIG. 5) as the strip is curled by rolls 32, 33 and 34, into helical convolutions. For maintenance of such positioning of strip 3, rollers 43, 67 and 95 are positioned for movement of their peripheries 124, 125 and 126, respectively, in the direction of movement of the correctly positioned strip, at contact with the rollers, i.e., each roller 43 (FIGS. 5, 6) 67 (FIGS. 5, 9) and 95 (FIGS. 5, 7) is disposed in a vertical plane that extends in the direction in which the correctly positioned strip is moving at contact with that roller. With specific reference to roll 33 (FIGS. 5, 7) where a roller contacts strip 3 at the strip edge, e.g., roller 95*a*, it is positioned so that the direction of movement of its periphery 126*a* is in a vertical plane that includes the tangent to the correctly positioned strip edge (38 or 39) at the point along the edge at which the roller contacts the strip. The remaining rollers 95 are parallel to roller 95*a*, so that at contact with strip 3 the peripheries 126 of all rollers 95 move in directions parallel to the direction of movement of roller periphery 126*a*. As seen in FIG. 5, the direction of movement of strip 3 changes as it undergoes different stages of curling at rolls 32, 33, 34, respectively. Correspondingly, the roller peripheries of a particular one of rolls 32, 33, 34 move in different directions than the roller peripheries of the other two rolls, i.e., the vertical planes of the rollers of a roll are angularly disposed relative to the planes of the rollers of the other two rolls.

Curling of strip 3 occurs about a horizontal pipe axis 35 that extends at an oblique angle with respect to the longitudinal axis of the strip. The individual rollers 43, 67, 95 have axes of rotation 50, 51, 52, respectively (FIG. 5), which extend at an angle with respect to pipe axis 35, such axes being horizontal and normal to the direction of movement of the strip at contact with such roller. Consequently, with respect to the direction of extent of axes 50, 51, 52 strip 3 is laterally inclined (FIGS. 6, 7, 9). In FIG. 7 it is seen that at contact with periphery 126 of a mandrel roller 95 strip 3 is inclined upwardly from edge 39. Periphery 126 has a slightly rounded contour for approximating the contour of the portion of the strip which it contacts to prevent the strip from riding on a corner of the roller. Further, the area of contact between strip 3 and the periphery of roller 95 is maximized, which is of considerable importance, since increased contact contributes to increased control of the strip.

Strip 3, at contact with periphery 124 of a lead roller 43 (FIG. 6) is inclined downwardly from edge 39, to a slight degree, because of the slight curl imparted to the strip as it is curved around roll 32, and periphery 124 has a rounded contour, whereby the strip surface is prevented from engaging the corner of the rollers and contact between strip and roller maximized. At contact with the external buttress rollers 67, (FIGS. 5, 8, 9) strip 3 is curled upwardly away from said rollers into substantially its final curvature, and in the direction of extent of the roller axis of rotation 51, is inclined upwardly from edge 39 (FIG. 9) to a greater degree than at contact with mandrel rollers 95. Periphery 125 of roller 67 has a surface contour that is rounded and angled with respect to axis 51. Such surface contour enables the roller to provide a generally flat contact surface though the angle of inclination of the contacting portion of strip 3, with respect to axis 51, may differ within a wide range depending on the diameter of pipe to the formed, width of strip 3 and other geometric factors.

When the rollers of any or all of rolls 32, 33, 34 are oriented so that their peripheries do not move in the direction in which the properly positioned strip is moving at contact with such rollers, lateral forces between the rollers e.g., 43′, 95′ and 67′ of FIG. 5, and properly positioned strip create increased friction and stressing. Such forces tend to cause a lateral shifting of the strip, as indicated by edges 38′, 39′ (FIG. 5), yielding improperly formed convolutions such as with displaced edges 38′, 39′. Incorrect positioning of rollers at an angle offset to the other side of correct may cause overlapping or deformation of edges 38, 39. The area of contact between strip 3 and a roller 95 is greater than that between the strip and rollers 43, 67, and greater forces are exerted on the strip by roller 95 then by other rollers. Therefore, adjustment of rollers 95 through positioning means 106 will be most effective in maintaining proper positioning of strip 3.

In operation, carriage 2 and frame 12 are initially relatively positioned at an oblique angle determined by the width of strip 3 and desired diameter of completed pipe 20, roll 34 is positioned along ways 68 through handle 82, and the sets of rollers 43, 67 and 95 are positioned through adjusting means 105, 107 and 106, respectively. The stands of drive rolls 10 (FIG. 1) on carriage 2 advance strip 3 in the direction of its longitudinal axis along a planar feed path. In the case of a new coil of strip material, coil handling means 4 advances strip 3 until the leading edge thereof engages the first stand of drive rolls 10. At the leading or output end of carriage 2, immediately ahead of lead roll 32 of forming device 7, strip 3 is passed between edge guides 27 (FIGS. 1, 2), including upper and lower horizontally extending flange portions 30, 31, respectively, (FIG. 2), which vertically confine strip 3 for preventing objectionable buckling which might otherwise occur when the advancing strip encounters curling rolls 32, 33 and 34. Edge guides 27 permit strip 3 to be slightly upwardly curved from the planar path by lead roll 32, so that the strip upper surface is slightly above the bottom surface of the rollers of mandrel roll 33 until the strip is curved downwardly thereby, by which arrangement, the area of contact between strip 3 and each roller 95 is increased.

As strip 3 passes and is bent against mandrel roll 33 by lead roll 32 and buttress roll 34, it is curled about pipe axis 35 into helical convolutions, and it can be determined if the incoming strip 3 is correctly positioned by noting whether adjacent strip edges 38, 39 of convolutions converge into proper engagement at a point lying substantially within the plane of the strip feed path, directly below pipe axis 35. When the strip is incorrectly positioned, rollers 95 of roll 33 may be adjusted through adjusting means 106 to laterally shift the strip, rollers 43, 67 may be correctly positioned with their peripheries moving in the direction of movement of the strip at contact, and pointer 128 may then be located at the correctly positioned edge 39. During curling, a high degree of control is maintained over the strip 3 by rollers 43, 67 and 95, such that lateral shifting is held to a minimum. Should such shifting occur, however, the strip readily can be repositioned by adjusting the positions of rollers 95 through adjusting means 106.

Finally, the adjacent edges 38, 39 of the curled strip are welded by conventional means (not shown) at welding station 8 to complete pipe 20 which is discharged for further handling at discharge station 9.

From the foregoing, it can be appreciated that this invention provides a method of forming pipe from an elongated strip which is advanced in a planar path along its longitudinal axis. The advancing strip is contacted at one surface by contact surfaces disposed in a first row extending out an oblique angle to the longitudinal axis of the strip. The strip is next passed between a second parallel row of contact surfaces contacting the other surface of the strip, and a third parallel row of contact surfaces, contacting the one surface of the strip in a plane different from the plane of the advancing strip, for curling it into helical convolutions of a given radius about a pipe axis extending at the same oblique angle relative to the longitudinal axis of the strip. The oblique angle is related to the radius of the convolutions and the width of the strip such that adjacent edges of the strip as curled into such convolutions converge into engagement. The contact surfaces of at least the second row move in the direction in which the strip moves at contact therewith when the strip is positioned for curling into helical convolutions with engaged adjacent strip edges. The method yields a high degree of control over the strip with a minimum of objectionable friction between strip and contact surface.

It is to be understood that the claims appended hereto are intended to cover all changes and modifications of the example herein chosen for purposes of disclosure which do not depart from the spirit and scope of the invention. For example, the stands of rolls on carriage 2 may include strip corrugating rolls for production of corrugated pipe, and in place of a welded seam, the strip edges may be bent and interengaged to form a lock seam. Further, instead of manually operated adjusting means 105, 106 and 107, means for adjusting the positions of curling rollers may be automatically actuated responsive to sensing means which sense a shift in position of strip 3.

I claim:

1. A method of helically forming pipe from an elongated strip of metal having parallel side edges, comprising:

a. advancing said strip in a substantially planar feed path along the longitudinal axis of said strip;
b. rollingly engaging one surface of said strip with a plurality of rolling contact surfaces disposed for intercepting said feed path along a first row extending at an oblique angle relative to said longitudinal axis;
c. rollingly engaging the other surface of said strip with a plurality of rolling contact surfaces disposed for intercepting said feed path along a second row extending at said oblique angle relative to said longitudinal axis;
d. rollingly engaging said one surface of said strip with a plurality of rolling contact surfaces disposed for intercepting said feed path along a third row extending at said oblique angle at points offset to one side of said feed path for curling said strip toward said contact surfaces extending along said second row, into a curved path of a radius about a pipe axis extending at said oblique angle;
e. controlling movement of said strip along the rotational axes of said rolling contact surfaces of said first, second

and third rows by providing frictional forces between said strip and said rolling contact surfaces of at least said second row and constraining said surfaces of at least said second row to rolling movement in the same direction as a true helix line for said angle, for the width of said strip and for the radius of said path at the points of engagement of said surfaces and said strip; whereby the trailing edge of a preceding portion of said strip converges into engaging relation with the leading edge of a following portion of said strip to form a seam along said edges.

2. The method of claim 1, including:

f. joining said side edges of said strip so curled into said curved path for forming a pipe seam.

3. The method of claim 1, wherein:

f. said rolling contact surfaces of said first, second and third rows are positionable to move only in the direction in which said strip moves at contact therewith, when said strip is positioned for curling into said curved path.

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