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(54) **ROLL-FORMING UTILIZING SPLITTING TECHNOLOGY**

FORMWALZEN MIT VERWENDUNG VON TRENNUNGSTECHNOLOGIE

PROFILAGE PAR TECHNIQUE DE FENDAGE

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to roll-forming structural members, and, in particular, to a method of roll-forming I-beams using splitting technology.

Background Information

[0002] Roll-forming techniques have been employed to form structural members such as I-beams. One example of such a method is described in JP-A-60-22362 and GB-A-2 200 060 and includes providing a sheet blank having a thickness twice the thickness of the flanges of the I-beam which is to be ultimately formed. In a first roll stand, ends of the blank are split along the longitudinal axis thereof forming opposing flange portions at each end. The flange portions are then bent or straightened at each end of the blank in another roll stand so as to define the opposing flanges which are disposed generally transverse to the web or central portion of the I-beam. To achieve web and flange thicknesses which are generally equal, a further rolling operation must be performed on the web or central portion, between the flanges, reducing the thickness thereof to be equal to that of the flanges.

[0003] There is a continuing need to improve the method of roll-forming an I-beam structure such that the method is easy to perform and inexpensive to accomplish.

SUMMARY OF THE INVENTION

[0004] An object of the present invention is to fulfill a need referred to above. In accordance with the principles of the present invention, this objective is obtained by providing a method of roll-forming an I-beam structure having a web and a pair of opposing flanges at each end of the web. The method includes the steps of providing a flat blank having a thickness generally equal to a thickness of the web of the I-beam to be formed. The blank has a thickness thereof defined by opposite surfaces and terminating in opposite longitudinal ends. The blank has a longitudinal axis extending through the thickness of the blank. Each end of the blank is split along its thickness to form first and second flange portions at each of the blank ends. The first and second flange portions have respective edges on opposite sides of the longitudinal axis. The flange portions are then moved while in their split thickness into arcuate configurations so that the opposite surfaces at the first and second flange portions have concave configuration. The flange portions of split thickness are compacted at each of the blank ends to define flanges of generally equal thickness to that of the web. Each flange is disposed generally transverse with respect to the longitudinal axis.

[0005] Another object of the present invention is the provision of a method of the type described which is simple and economical to perform.

[0006] These and other objects of the invention will become apparent during the course of the following detailed description and the appended claims.

[0007] The invention may best be understood with reference to the accompanying drawings wherein an illustrative embodiment is shown.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

FIG. 1 is a schematic illustration of a roll stand, partially in section, for initially forming a flat blank of material,

FIG. 2 is a view similar to FIG. 1 showing a roll stand having vertical rollers for performing an initial splitting operation at the ends of the blank,

FIG. 3 is a view similar to FIG. 2 showing a stand having vertical rollers for further splitting the ends of the blank,

FIG. 4, is a view similar to FIG. 2 showing a roll stand having a pair of vertical rollers for initially bending flange portions at the ends of the blank,

FIG. 5, is a view similar to FIG. 4, showing a roll stand wherein vertical rollers further bend the flange portions at the ends of the blank defining a mass of material at each end,

FIG. 6, is a schematic illustration, partially in section, showing a roll stand wherein vertical rollers initially compact the mass of material at each end of the blank,

FIG. 7, is a view similar to FIG. 6, showing a roll stand wherein vertical rollers further compact the mass of material at each end of the blank, and

FIG. 8 is a view similar to FIG. 6 showing a roll stand having vertical rollers for further compacting the mass of material at each end of the blank to form flanges of an I-beam structure.

[0009] Referring now more particularly to the drawings, there is shown therein a series of successive roll stands employed in a method of the present invention. As shown in FIG. 1, the first roll stand, generally indicated at 10, includes a pair of identical, symmetrical horizontal rollers 12 and a pair of identical, symmetrical vertical rollers 14. Rollers 12 are mounted for rotation about

axles 16, while rollers 14 are mounted for rotation about axles 18. The horizontal rollers 12 have working faces comprising a cylindrical surface 20. Similarly, the vertical rollers 14 have working faces comprising a cylindrical surface 22. The horizontal rollers 12 and vertical rollers 18 cooperate to form a blank 24 of material. The blank 24 has a longitudinal axis A, a central portion 26 and opposing ends 28. In the roll stand 10, the blank 24 is formed as a flat sheet having a thickness B equal to a thickness of the web of an I-beam to be ultimately formed. It can be appreciated that the blank 24 can be formed by process other than roll-forming in stand 10. A blank 24 need only be provided which has a thickness B generally equal to a thickness of the web of an I-beam to be ultimately formed. Thus, it can be appreciated that stand 10 may be only an alignment stand for a preformed blank for guiding the blank to downstream roll stands.

[0010] Once the blank 24 is provided, the blank 24 is fed continuously through a series of successive roll stands to form the I-beam structure. In the illustrated embodiment, the blank 24 is conveyed to a roll stand 30 as shown in FIG. 2. Stand 30 is identical to the first stand 10 except that each vertical roller 32 has frusto-conical surfaces 34. Each roller 32 splits an associated end 28 along the longitudinal axis A of the blank 24, thereby forming a first flange portion 36 and a second flange portion 38 at each of the ends 28. The first and second flange portions 36 and 38, respectively, are inclined with respect to each other at an acute angle.

[0011] In the illustrated embodiment, the blank 24 is then conveyed to a roll stand 40, as shown in FIG. 3, which is similar to stand 30 and disposed downstream thereof. However, the vertical rollers 42 of stand 40 are shaped to split the ends 28 deeper than that shown in FIG. 2. The ends 28 are split so as to provide enough material to ensure that each of the I-beam flanges to be ultimately formed by the flange portions 36 and 38 has a thickness generally equal to the thickness B. As shown in FIG. 3, each of the flange portions 36 and 38 has a respective edge 44.

[0012] The blank 24 then proceeds to another roll stand 45, as shown in FIG. 4, disposed downstream of stand 40. In the illustrated embodiment, the stand 45 is identical to the stand 40, except that each of the vertical rollers 46 has a pair of working surfaces 48 of concave configuration. As shown, the rollers 46 bend the flange portions 36 and 38 about the longitudinal axis A such that the edges 44 of the flange portions are moved in a direction towards the central portion 26 of the blank 24.

[0013] In the illustrated embodiment, the blank 24 is then conveyed to roll stand 50 disposed downstream of stand 45. Stand 50 is generally identical to stand 45, except that each of the vertical rollers 52 has a pair working surfaces 54 of concave configuration, the concavity thereof being greater than that of the rollers 46. Thus, as shown, the flange portions 36 and 38 are bent further with respect to the longitudinal axis A thereby forming a mass of material 55 at each end of the blank 24. This is a thickening process that thickens the flange portions 36 and 38, which will ultimately become the I-beam flanges, as will become apparent below.

[0014] The blank 24 is then conveyed to the next stand 56, as shown in FIG. 6. Stand 56 is disposed downstream of stand 50 and includes a first pair of vertical rollers 58 and a second pair of back-up vertical rollers 60. Each roller 58 has a generally cylindrical working edge 62. Each roller 60 also has a generally cylindrical back-up edge 64. Rollers 58 and 60 cooperated to initially compact the mass of material 55 at each end of the blank 24.

[0015] The blank 24 is then moved through roll stand 66 which further compacts the mass of material 55. Finally, the blank 24 is directed through a stand 68 whereby the flange portions are compacted to a point to define solid, opposing flanges 70 of the I-beam structure at each end of the web 72. As shown, each of the flanges 70 of the I-beam is disposed generally transverse to the longitudinal axis A and has a thickness C which is generally equal to the thickness B of the web 72. Further, ends 74 of each of the flanges 70 are formed in the roll stand 68 so as to be generally parallel to axis A. This completes forming the I-beam and the I-beam can be cut to the desired length.

[0016] It can be appreciated that the roll stands shown are exemplary only. The roll stands may be of any construction and arrangement suitable to split, bend and compact the ends of the blank to form the flanges 70. Further, the number of stages used to form the I-beam is exemplary. For example, a plurality of intermediate stages may be employed or certain stages may be combined.

[0017] It can be seen that the invention provides an effective method of roll-forming an I-beam by continuously conveying a blank of material through a series of roll stands. The I-beam structure formed includes flanges having a thickness generally equal to a thickness of the web. The ability to form the flanges having the same thickness as the web without additional forming of the web advantageously reduces manufacturing costs.

[0018] It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing preferred embodiment of the present invention has been shown and described for the purposes of illustrating the structural and functional principles of the present invention. Therefore, this invention includes all modifications encompassed within the scope of the following claims.

Claims

1. A method of roll-forming an I-beam structure having a web and a pair of opposing
flanges at each end of the web, the method including the sequential steps of:

providing a flat blank (24) having a thickness generally equal to a thickness of the web of the I-beam to be formed, said blank having said thickness thereof defined by opposite surfaces and terminating in opposite longitudinal ends, said blank having a longitudinal axis (A) extending longitudinally through said thickness (B) of said blank,
splitting the thickness (B) of said blank at each of said opposite longitudinal ends (28) of said blank to form first and second flange portions (36, 38) at each of said longitudinal blank ends, such that the flange portions comprise sufficient material to produce flanges having a thickness generally equal to the thickness of the blank end of the web upon compacting, said first and second flange portions (36, 38) having respective edges (44) disposed on opposite sides of said longitudinal axis (A), **characterized by**
first moving said flange portions (36, 38) while in their split thicknesses into respective arcuate configurations so that said opposite surfaces at said first and second flange portions have concave configurations, then moving said first and second flange portions so that they are doubled over themselves and bent back so as to extend back towards said web, and
compacting each of said bent back flange portions of said split thickness to form respective flanges (70) on opposite sides of said longitudinal axis having a generally constant thickness, which thickness is generally equal to the thickness of the blank end of the web (72), said flanges (70) disposed generally transverse with respect to said longitudinal axis.

2. The method according to claim 1, wherein the splitting step includes splitting the longitudinal ends of the blank an amount so as to provide enough material to ensure that the thickness of the flanges (70) is generally equal to the thickness of the web (72) upon the completion of said compacting step.

3. The method according to claim 1, wherein the splitting step includes initially splitting the ends of the blank, and thereafter splitting the ends of the blank a further amount to provide enough material so as to ensure that the thickness of the flanges (70) is generally equal to the thickness of the web (72) upon the completion of said compacting step.

4. The method according to claim 1, wherein said moving step includes initially bending the flange portions (36, 38) a first amount and then bending the flange portions a second, greater amount to provide said flange portions (36, 38) with said arcuate configuration.

5. The method according to claim 1, wherein said compacting step includes forming edges of each of said flanges (70) so as to be generally parallel to said longitudinal axis.

6. The method according to claim 1, wherein said splitting step includes initially splitting each of said ends of the blank (24) using at least a first pair of vertical rollers (32) with one roller of said pair being associated with a respective end of said blank, each said roller of said pair having frusto-conical surfaces (34) to facilitate the splitting step.

7. The method according to claim 6, wherein said splitting step includes further splitting each of said ends of the blank after said initial splitting, using a second pair of vertical rollers (42), each roller of said second pair' of rollers having frusto-conical surfaces.

8. The method according to claim 1, wherein said moving step includes initially bending each of said ends of the blank using at least a first pair of vertical rollers (46), each roller of said pair having a pair of concave surfaces (48) to facilitate the bending step.

9. The method according to claim 8, wherein said moving step includes further bending each of said ends of the blank after said initial bending using a second pair of vertical rollers (52), each roller of said second pair of rollers having a pair of concave surfaces (54) of concavity greater than a concavity of the concave surfaces of each of said first pair of rollers (46).

10. The method according to claim 1, further comprising the step of cutting the formed I-beam structure to a particular size.

11. A method according to any preceding claim wherein said method utilizes a series of successive roll stands.

12. The method according to claim 11, wherein cooperating rollers flatten and increase the thickness of said flange portions until said flange portions form flanges of generally equal thickness to said web.

Patentansprüche

1. Verfahren zum Profilwalzen bzw. Formwalzen einer I-Trägerstruktur mit einem Steg und einem Paar gegenüberliegender Flansche an jedem Ende des Stegs, wobei das Verfahren die aufeinanderfolgenden Schritte umfaßt:

Bereitstellen eines flachen Werkstücks (24) mit einer Dikke, die im wesentlichen einer Dicke des Stegs des zu bildenden I-Trägers ent-

spricht, wobei das Werkstück, das dessen Dikke hat, durch gegenüberliegende Oberflächen bestimmt ist und in gegenüberliegenden longitudinalen Enden endet, und wobei das Werkstück eine longitudinale Achse (A) aufweist, die sich longitudinal durch die Dicke (B) des Werkstücks erstreckt,

Trennen der Dicke (B) des Werkstücks an jedem der gegenüberliegenden longitudinalen Enden (28) des Werkstücks, um erste und zweite Flanschabschnitte (36, 38) an jedem der longitudinalen Werkstückenden zu bilden, so daß die Flanschabschnitte ausreichend Material umfassen, um Flansche mit einer Dicke zu erzeugen, die im wesentlichen der Dicke des Werkstücksendes des Stegs beim Verdichten entspricht, wobei erste und zweite Flanschabschnitte (36, 38) jeweilige Kanten (44) aufweisen, die auf gegenüberliegenden Seiten der longitudinalen Achse (A) angeordnet sind, **dadurch gekennzeichnet, daß**

zuerst die Flanschabschnitte (36, 38), während diese gespaltene Dicken haben, in jeweilige gebogene Konfigurationen bewegt werden, so daß die entgegengesetzten Oberflächen an den ersten und zweiten Flanschabschnitten konkave Konfigurationen aufweisen, daß dann die ersten und zweiten Flanschabschnitte bewegt werden, so daß diese über sich selbst verdoppelt sind und zurückgebogen werden, so daß diese zurück hin zum Steg ragen, und

daß jeder der zurückgebogenen Flanschabschnitte mit getrennter Dicke verdichtet wird, um jeweilige Flansche (70) an gegenüberliegenden Seiten der longitudinalen Achse zu bilden, mit einer im wesentlichen konstanten Dikke, die im wesentlichen gleich derjenigen des Werkstückendes des Stegs (72) ist, wobei die Flansche (70) im wesentlichen quer bzgl. der longitudinalen Achse angeordnet sind.

2. Verfahren nach Anspruch 1, bei dem der Trennschritt den Schritt des Trennens der longitudinalen Enden des Werkstücks um einen Betrag enthält, so daß genügend Material bereitgestellt wird, um sicherzustellen, daß die Dicke der Flansche (70) im wesentlichen gleich der Dicke des Stegs (72) bei der Vollendung des Verdichtungsschritts ist.

3. Verfahren nach Anspruch 1, bei dem der Trennschritt anfänglich den Schritt des Trennens der Enden des Werkstücks enthält und danach den Schritt des Trennens der Enden des Werkstücks um einen weiteren Betrag, um genügend Material bereitzustellen, um sicherzustellen, daß die Dicke der Flansche (70) im wesentlichen gleich der Dicke des Stegs (72) bei der Vollendung des Verdichtungsschrittes ist.

4. Verfahren nach Anspruch 1, bei dem der Bewegungsschritt anfänglich den Schritt des Biegens der Flanschabschnitte (36, 38) um einen ersten Betrag enthält und dann den Schritt des Biegens der Flanschabschnitte um einen zweiten größeren Betrag, um die Flanschabschnitte (36, 38) mit der gebogenen Konfiguration bereitzustellen.

5. Verfahren nach Anspruch 1, bei dem der Verdichtungsschritt den Schritt des Formens von Kanten jedes der Flansche (70) umfaßt, so daß diese im wesentlichen parallel zu der longitudinalen Achse sind.

6. Verfahren nach Anspruch 1, bei dem der Trennschritt anfänglich den Schritt des Trennens jedes der Enden des Werkstücks (24) unter Verwendung zumindest eines ersten Paares von vertikalen Walzen (32) umfaßt, wobei eine Walze des Paares mit einem entsprechenden Ende des Werkstücks in Verbindung ist, und wobei jede Walze des Paares kegelstumpfförmige Oberflächen (34) aufweist, um den Trennschritt zu erleichtern.

7. Verfahren nach Anspruch 6, bei dem der Trennschritt weiterhin den Schritt des Trennens jedes der Enden des Werkstücks nach dem anfänglichen Trennen umfaßt, wobei ein zweites Paar von vertikalen Walzen (42) verwendet wird, und wobei jede Walze des zweiten Walzenpaares kegelstumpfförmige Oberflächen hat.

8. Verfahren nach Anspruch 1, bei dem der Bewegungsschritt anfänglich den Schritt des Biegens jedes der Enden des Werkstücks umfaßt, wobei zumindest ein Paar vertikaler Walzen (46) verwendet wird, und wobei jede Walze des Paares ein Paar konkaver Oberflächen (48) aufweist, um den Biegeschritt zu erleichtern.

9. Verfahren nach Anspruch 8, bei dem der Bewegungsschritt den Schritt des weiteren Biegens jedes der Enden des Werkstücks nach dem anfänglichen Biegen umfaßt, wobei ein zweites Paar vertikaler Walzen (52) verwendet wird, und wobei jede Walze des zweiten Walzenpaares ein Paar konkaver Oberflächen (54) mit einer Konkavität aufweist, die größer ist als die Konkavität der konkaven Oberflächen jeder der Walzen des ersten Walzenpaares (46).

10. Verfahren nach Anspruch 1, das weiterhin den Schritt des Schneidens der gebildeten I-Trägerstruktur zu einer bestimmten Größe umfaßt.

11. Verfahren nach einem der vorstehenden Ansprüche, bei dem eine Reihe von aufeinanderfolgenden Walzständen bzw. Walzwerken verwendet wird.

12. Verfahren nach Anspruch 11, bei dem zusammenwirkende Walzen die Dicke der Flanschabschnitte verringern und vergrößern, bis die Flanschabschnitte Flansche bilden, deren Dicke im wesentlichen der Dicke des Stegs entspricht.

Revendications

1. Procédé de laminage de profilés d'une structure de poutrelle I ayant une âme et une paire de brides opposées à chaque extrémité de l'âme, le procédé comprenant les étapes successives:

mettre à la disposition une pièce plate (24) ayant une épaisseur qui correspond pour l'essentiel à une épaisseur de l'âme de la poutrelle I à former, la pièce présentant l'épaisseur de celle-ci étant définie par des surfaces opposées et se terminant dans des extrémités longitudinales opposées, et la pièce présentant un axe longitudinal (A) qui s'étend de façon longitudinale à travers l'épaisseur (B) de la pièce,

diviser l'épaisseur (B) de la pièce à chacune des extrémités longitudinales opposées (28) de la pièce pour former des première et seconde sections de bride (36, 38) à chacune des extrémités longitudinales de la pièce, de sorte que les sections de bride comprennent suffisamment de matière pour produire des brides ayant une épaisseur qui correspond pour l'essentiel à l'épaisseur de l'extrémité de pièce de l'âme lors du compactage, des première et seconde sections de bride (36, 38) présentant des arêtes respectives (44) qui sont disposées de côtés opposés de l'axe longitudinal (A), **caractérisé par le fait que**

d'abord les sections de bride (36, 38) - alors que celles-ci présentent des épaisseurs divisées - sont déplacées dans des configurations courbées respectives de sorte que les surfaces opposées sur les première et seconde sections de bride présentent des configurations concaves, que, ensuite, les première et seconde sections de bride sont déplacées de sorte que celles-ci sont doublées sur elles même et recourbées de sorte qu'elles s'étendent en arrière vers ladite âme, et

que chacune des sections de bride recourbées avec l'épaisseur divisée est compactée afin de former des brides respectives (70) de côtés opposés de l'axe longitudinal avec une épaisseur pour l'essentiel constante qui est pour l'essentiel égale à celle de l'extrémité de pièce de l'âme (72), les brides (70) étant disposées pour l'essentiel transversalement par rapport à l'axe longitudinal.

2. Procédé selon la revendication 1, dans lequel l'étape de division comprend l'étape de la division des extrémités longitudinales de la pièce d'une telle mesure que suffisamment de matière est mise à la disposition pour assurer que l'épaisseur des brides (70) est pour l'essentiel égale à l'épaisseur de l'âme (72) lors de l'achèvement de l'étape de compactage.

3. Procédé selon la revendication 1, dans lequel l'étape de division comprend initialement l'étape de la division des extrémités de la pièce et ci-après l'étape de la division des extrémités de la pièce d'une autre mesure afin de mettre à la disposition assez de matière pour assurer que l'épaisseur des brides (70) est pour l'essentiel égale à l'épaisseur de l'âme (72) lors de l'achèvement de l'étape de compactage.

4. Procédé selon la revendication 1, dans lequel l'étape de déplacement comprend initialement l'étape de pliage des sections de bride (36, 38) d'une première mesure et ensuite l'étape de pliage des sections de bride d'une deuxième mesure plus importante afin de mettre à la disposition lesdites sections de bride (36, 38) avec la configuration courbée.

5. Procédé selon la revendication 1, dans lequel l'étape de compactage comprend l'étape de la formation d'arêtes de chacune des brides (70), de sorte que celles-ci sont pour l'essentiel parallèles à l'axe longitudinal.

6. Procédé selon la revendication 1, dans lequel l'étape de division comprend initialement l'étape de la division de chacune des extrémités de la pièce (24) en utilisant au moins une première paire de cylindres verticaux (32), un cylindre de la paire communiquant avec une extrémité correspondante de la pièce, et chaque cylindre de la paire présentant des surfaces tronconiques (34) afin de faciliter l'étape de division.

7. Procédé selon la revendication 6, dans lequel l'étape de division comprend en outre l'étape de la division de chacune des extrémités de la pièce après la division initiale en utilisant une deuxième paire de cylindres verticaux (42), chaque cylindre de la deuxième paire de cylindres présentant des surfaces tronconiques.

8. Procédé selon la revendication 1, dans lequel l'étape de déplacement comprend initialement l'étape de pliage de chacune des extrémités de la pièce en utilisant au moins une paire de cylindres verticaux (46), chaque cylindre de la paire présentant une paire de surfaces concaves (48) afin de faciliter l'étape de pliage.

9. Procédé selon la revendication 8, dans lequel l'étape de déplacement comprend l'étape de l'autre pliage de chacune des extrémités de la pièce après le pliage initial en utilisant une deuxième paire de cylindres verticaux (52), chaque cylindre de la deuxième paire de cylindres présentant une paire de surfaces concaves (54) avec une concavité qui est plus grande que la concavité des surfaces concaves de chacun des cylindres de la première paire de cylindres (46).

10. Procédé selon la revendication 1, qui comprend en sus l'étape de couper la structure formée de poutrelle I à une dimension déterminée.

11. Procédé selon l'une des revendications précédentes, dans lequel on utilise une série de laminoirs successifs.

12. Procédé selon la revendication 11, dans lequel des cylindres coopérants diminuent et augmentent l'épaisseur des sections de bride jusqu'à ce que les sections de bride forment des brides dont l'épaisseur correspond pour l'essentiel à l'épaisseur de l'âme.

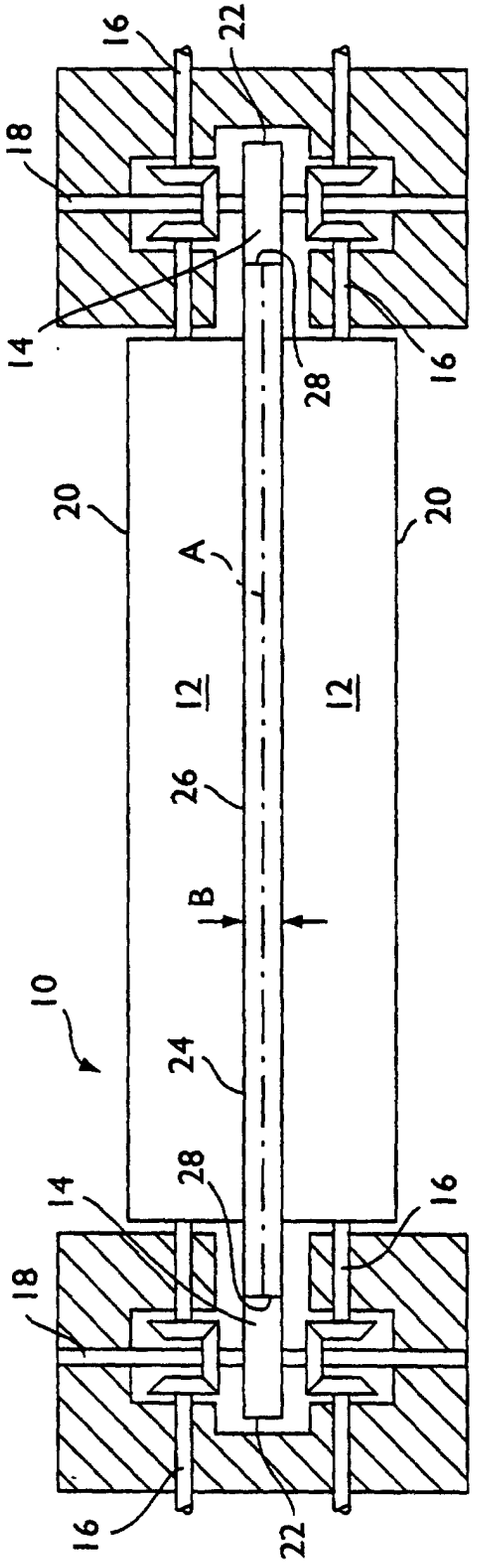

16
22
18
14
28
16
20
20
A
12
12
26
B
10
24
28
14
16
18
16
22

FIG. 1

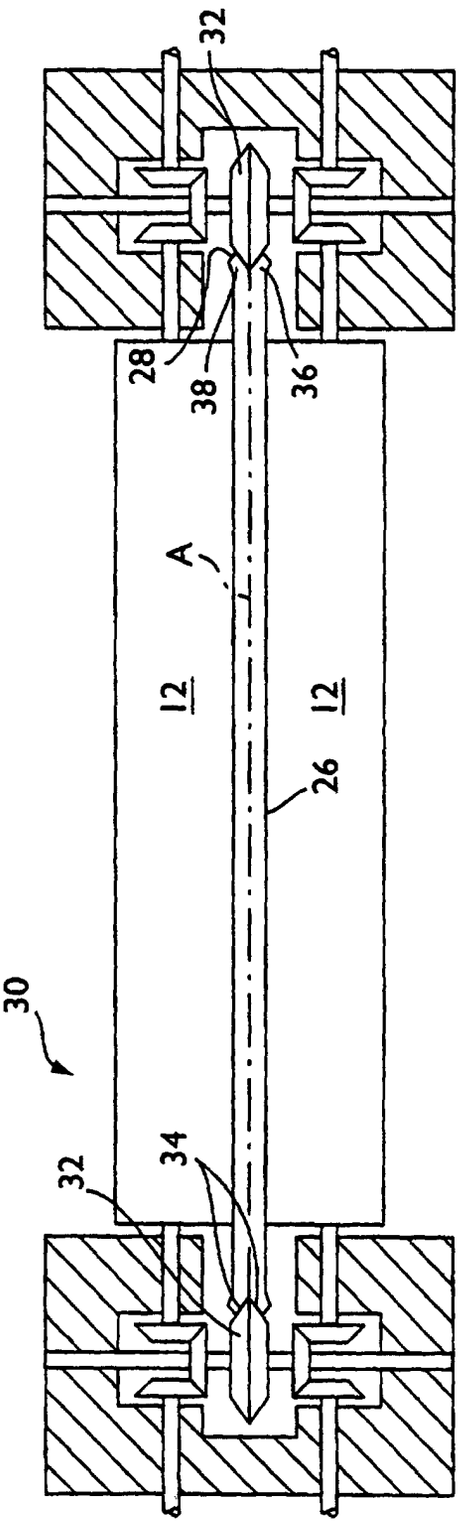

32
28
38
36
A
12
12
26
30
32
34

FIG. 2

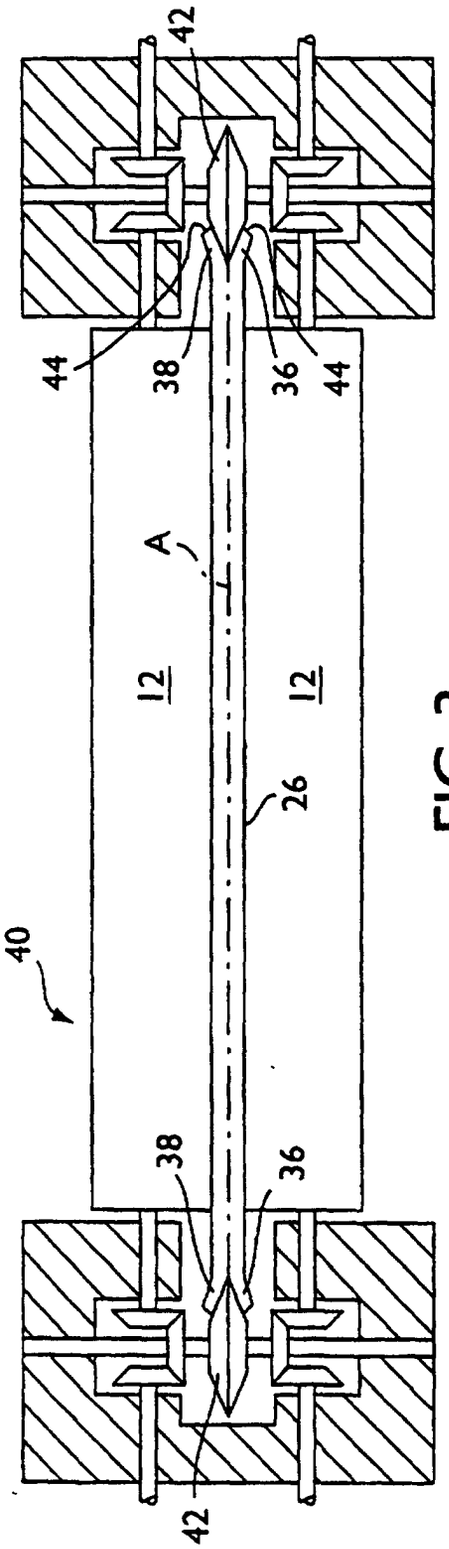

42
44
38
36
44
A
12
12
26
40
38
36
42

FIG. 3

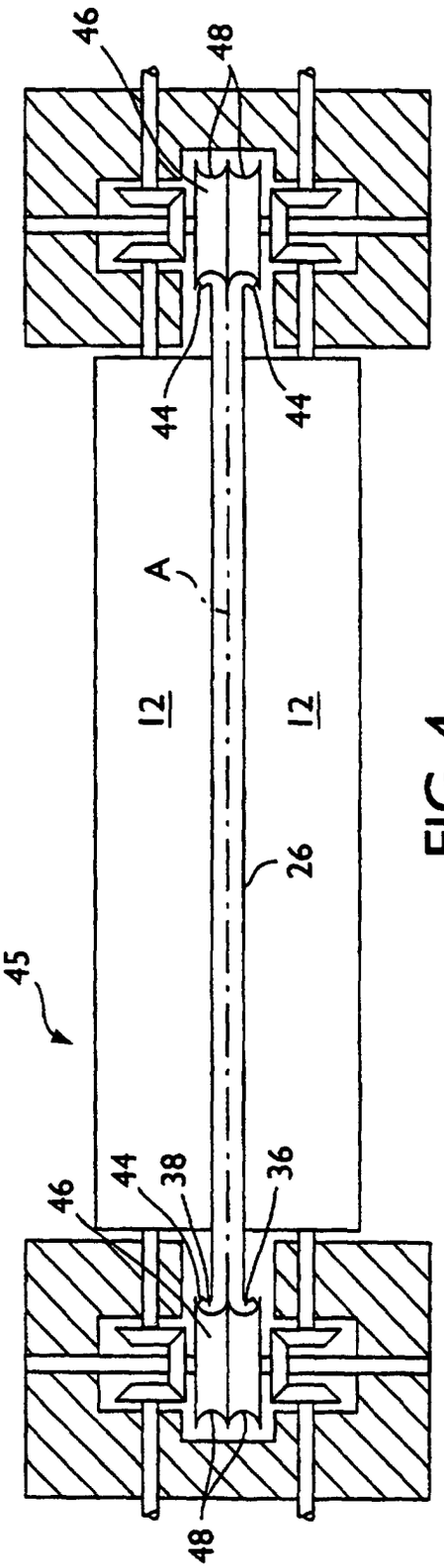

46
48
44
44
A
12
12
26
45
46
44
38
36
48

FIG. 4

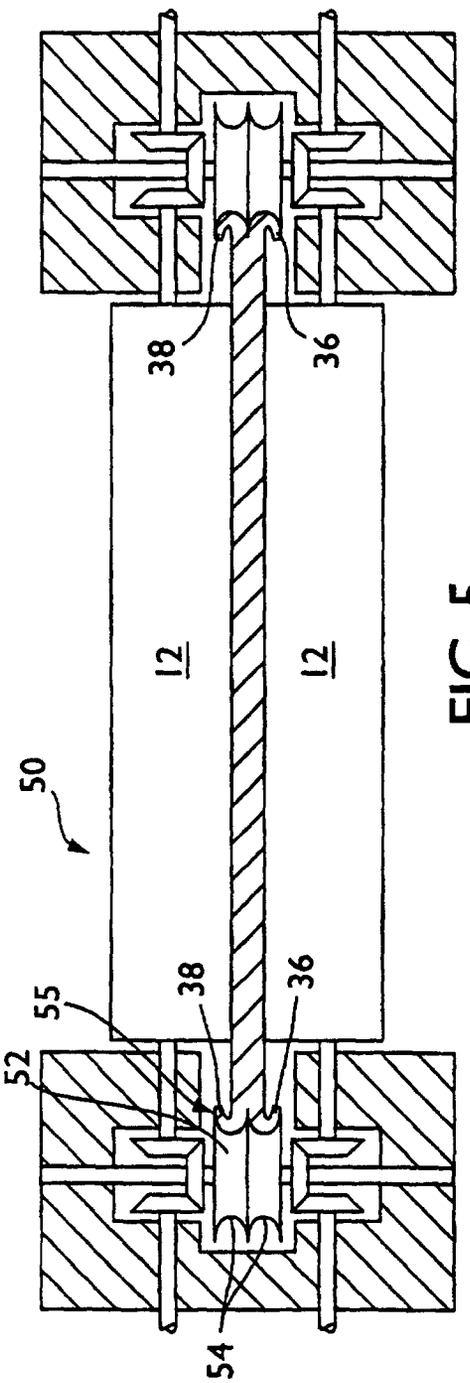


FIG. 5

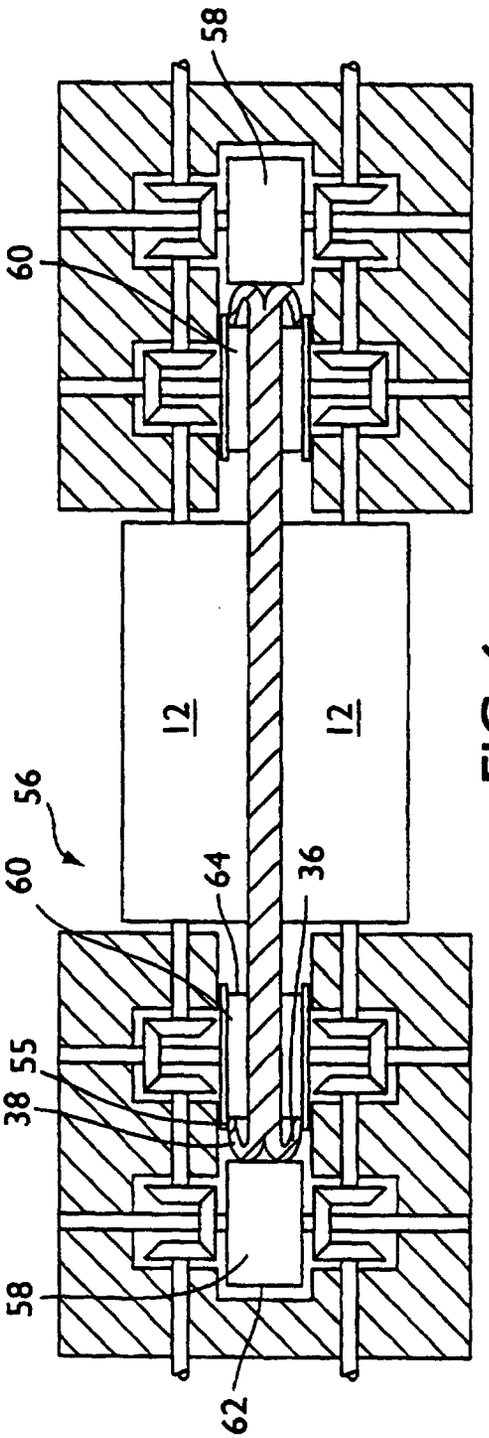


FIG. 6

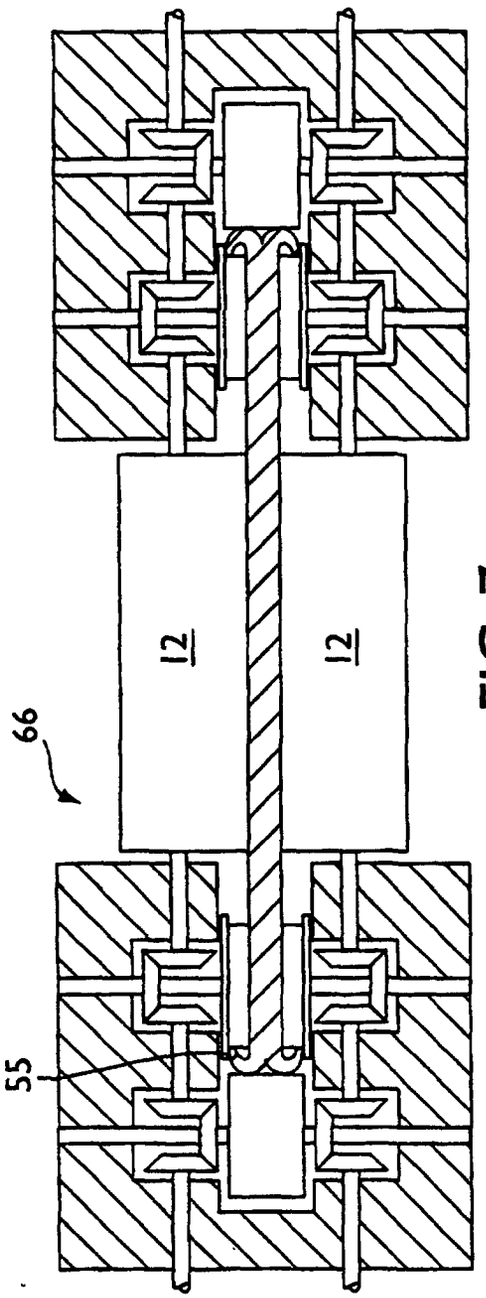


FIG. 7

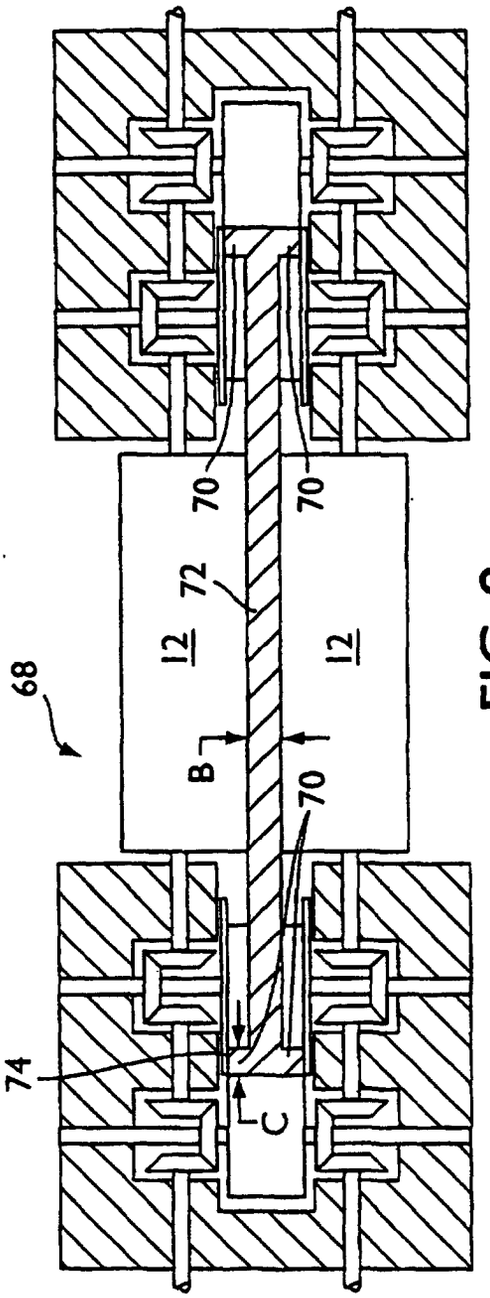


FIG. 8