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(54) STRUCTURAL MEMBER AND PROCESS FOR FORMING SAME.

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(73) Proprietor : **TUBE TECHNOLOGY PTY LTD**
134 Ingram Road
Acacia Ridge, QLD 4110 (AU)

(72) Inventor : **GOLEBY, Leslie, David**
134 Ingram Road
Acacia Ridge, QLD 4110 (AU)

(74) Representative : **Füchsle, Klaus, Dipl.-Ing. et al**
Hoffmann . Eitle & Partner Patentanwälte
Arabellastrasse 4
W-8000 München 81 (DE)

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Description

This invention relates to a structural member and a process for forming same according to the preambles of claims 1 and 6, respectively.

Non hollow or solid structural members such as I-beams, rolled steel joists (RSJ's) purlins and girts which are all used for structural purposes in buildings such as factories, houses and office buildings have been found to be normally satisfactory in use and have a basic cross sectional shape or profile which is very efficient in resisting bending movement. These conventional structural members or beams are normally formed from hot rolling processes.

However, such conventional solid structural members or universal beams which are generally formed from hot rolling processes generally comprise two parallel flanges and a single flat or planar web wherein the flanges are substantially thicker than the web. Such conventional solid structural members have certain disadvantages and these include the following:-

(i) exposed surface area to mass and strength ratios are high which lead to increased costs for both corrosion protection and fire proofing;

(ii) flange widths to thickness ratios are generally limited to avoid reductions in load bearing section capacity due to local buckling considerations;

(iii) web widths to thickness ratios are generally limited to avoid reductions in section load bearing capacity due to local buckling considerations;

(iv) the hot rolling method of manufacture leads to production of substantial mill scale and rust as well as providing a limited minimum thickness; and

(v) prime painting during manufacture is not a practical proposition.

There also have been used cold rolled structural members which include purlins and rectangular hollow sections and these are subject to certain disadvantages as described below.

In particular purlin sections which are generally of C or Z shape have flange widths to thickness ratios and web width to thickness ratios which are severely limited by local buckling considerations.

Rectangular hollow sections (RHS) have also been proposed as structural members wherein each wall of the rectangle was of substantially the same thickness. However, these conventional structural members were inefficient in regard to bending movement considerations and wall widths to thickness ratios were generally limited to avoid reductions in load bearing capacity due to local buckling considerations.

Structural members have also been proposed including a pair of hollow end sections which are separated by an intermediate web. Thus, for example, in U.S. Patent 3,342,007 to Merson, a structural member was proposed which was manufactured from a single piece of steel sheet by cold roll forming wherein there was provided triangular hollow end sections separated by a planar web. Each triangular hollow end section included a horizontal side or flange and a pair of sloping sides or flanges and the free ends of the single piece of steel sheet were comprised of ends of each of the sloping flanges which abutted the other adjacent sloping flange.

In addition the structural members described in both the abovedescribed Merson and Lanternier specifications had markedly reduced load bearing capacities for concentrated loads.

U.S. Patent 3,517,474 to Lanternier also described a flanged structural assembly including a pair of hollow end sections which were rectangular or trapezoidal and an intermediate planar web. The hollow end section and the web were all separate components and the web was welded to the hollow end sections. Each end section included a pair of free ends or edges which were bent or folded and which converged to the middle part of a top flange or wall of the hollow end sections.

U.S. Patent 426,558 to Ditheridge also described a structural member having a pair of hollow end sections and an intermediate planar web which was of an integral construction. Although no method of manufacture is described it would seem that Ditheridge refers to wrought steel or iron beams or sills which are formed in a mould.

However, in regard to the structural members described in the abovementioned U.S. Patents it was considered that these structural members would have markedly reduced load capacities due to local buckling considerations. This would seem to be the case especially of U.S. Patent 3,342,007 to Merson wherein the free ends of the single piece of steel sheet comprising one end of each sloping flange abutted the other sloping flange. This would also have applied to Lanternier.

The flanges structural assembly of Lanternier in not being formed from a single piece of metal strip would also have been relatively expensive to produce because it was formed from three components. Also the manufacturing step of folding the free edges of each rectangular or hollow end section as described above would seem to complicate manufacture and increase the cost thereof.

From EP-A-0 267 843, a structural member and a process for forming the same respectively according to the preambles of claims 1 and 6 are known. This document discloses a profiled beam comprising a solid web with hollow side flanges, these being formed from a single strip of metal. In formation of the profile member, ribs are formed in the web to form a depression corresponding to half the thickness of the metal strip, the lip of the respective hollow side flanges formed by the outer portions of the metal strip being located in the depression to form a structure symmet-

rical about the axis of the web plane. The lip is welded to the web, but the form of the weld is not disclosed.

It is an object of the present invention to provide a structural member and a process of manufacture of same that alleviates the abovementioned disadvantages associated with the prior art.

This object is solved according to the present invention by a structural member and a process of manufacture of the same respectively according to claims 1 and 6.

The structural member of the invention comprises a pair of hollow end sections and an intermediate web, each hollow end section being welded to the intermediate web so as to form two weld lines or joins extending along the structural member.

Preferably the intermediate web is predominantly planar and it is also preferred that the structural member be formed from a unitary sheet of metal having opposed edges whereby a respective edge is located adjacent said intermediate web and is welded perpendicular thereto to form the weld lines or joins.

The hollow end sections may be of any suitable shape and thus may be circular, rectangular, triangular or polygonal. It is also not necessary that each hollow end section have a similar shape so that it is within the scope of the invention to have differently shaped hollow end sections such as one being rectangular and the other being circular.

While it is preferred that each hollow end section be substantially of the same size this is not strictly essential and thus it is possible, having regard to the scope of the invention, that the hollow end sections be different in size as well as shape.

Reference may also be made to a process for forming the abovementioned structural member which may include the following steps:-

(i) passing substantially planar metal strip through a plurality of forming stations to successively deform opposed free edges of the metal strip so as to provide a pair of substantially hollow end sections wherein a respective free edge is located adjacent to an intermediate web interposed between each substantially hollow end section; and

(ii) welding the respective free edge perpendicularly to the intermediate web to form the weld lines or joins extending along the structural member.

In the process of the invention it is possible to initially subject the substantially planar metal strip to preforming operations wherein ancillary or additional structural features or embellishments may be imparted to the metal strip. These ancillary features include perforations, grooves, dimples, corrugations, protrusions and the like which may be considered appropriate having regard to the end use of the structural member or to increase load bearing capacity of the structural member.

The ancillary structural features made at the preforming stage may be either essentially unchanged or slightly or substantially modified by any subsequent forming operations. Thus if desired further ancillary structural features or embellishments may be imparted to the structural member of the invention after or during the forming operations.

In step (i) of the process of the invention the substantially planar metal strip may be successively deformed through a number of roll forming stations. Preferably each free edge portion may be successively or sequentially deformed so that the cross sectional profile of the metal strip is substantially W shaped after it passes through the forming stations. This is shown in detail in the drawings hereinafter. However, it will also be appreciated that other roll forming cross sectional profiles may be utilized such as for example the free edge portions of the metal strip being bent inwardly through a number of different passes so as to form a substantially triangular hollow end section. This is also shown in the drawings hereinafter.

It is also possible in regard to the forming step that the desired end profile of the structural member be formed directly after passage of the metal strip through the final forming station. However, it is also within the ambit of the invention that a basic shape e.g. two separate circles separated by a single web be formed after passage through the final forming station which is then subsequently subjected to further shaping procedures to produce a number of different cross sectional profiles. Another possible alternative is to produce the basic shape of two separate circles separated by a single web using different roll passes and then subjecting the basic shape to further shaping operations to produce a variety of cross sectional profiles.

In regard to the forming step (i) it is preferred to pass the metal strip through a plurality of cold roll forming stations. However, it is also possible to produce the structural member of the invention by other forming methods such as press braking or extrusion processes.

After the forming step the strip or workpiece is passed to a welding station in which the welding method of high frequency induction and/or electrical resistance welding is used.

Of the above it is preferred, having regard to the process of the invention to use high frequency induction welding.

In this type of welding a high frequency alternative current is used to induce currents in the areas requiring welding so that opposing weld join areas (e.g. a free edge of the strip abutting the intermediate web or being located closely adjacent thereto) at two separate locations are heated to a point where the weld rolls are able to forge weld the strip to form the desired cross sectional profile.

At the welding station it is also within the scope

of the process of the invention to apply one or more scarfing operations to the workpiece whereby weld projections or excess weld bead may be removed. As an alternative to scarfing to remove excess weld bead there also may be used weld bead flattening.

Finally and if desired the workpiece or metal strip may be passed to a straightening and/or shaping station wherein shaping rolls mounted in a number of cold forming roll stands are used to produce the desired cross sectional profile. The shaping rolls may successively deform the welded section. However, it is possible to avoid the use of shaping rolls by direct forming the workpiece so that after passing through the welding station it is already in the desired final shape. In this case however straightening may be an integral part of the direct forming process.

Reference may now be made to a preferred embodiment of the invention as shown in the attached drawings wherein:-

FIG 1 is a schematic view of apparatus used in the process of the invention including a forming section, edge preparation and welding section and a shaping and straightening section;
FIG 2 is a side elevation of the forming section;
FIG 3 is an end view of rolls S1-S2 shown in FIG 2;
FIG 4 is an end view of rolls F3-F4 shown in FIG 2;
FIG 5 is an end view of rolls F1-F2 shown in FIG 2;
FIG 6 illustrates a typical set of rolls F1;
FIG 7 illustrates a typical set of rolls S1;
FIG 8 illustrates a typical set of rolls F4;
FIG 8A illustrates another typical set of rolls F1 or F2;
FIG 8B illustrates another typical set of rolls F3 or F4;
FIG 8C illustrates another typical set of rolls S1 or S2;
FIG 9 illustrates a side view of the edge preparation and welding section;
FIG 10 illustrates an end view of rolls WP1;
FIG 11 illustrates an end view of rolls WP2;
FIG 12 illustrates an end view of rolls EP1;
FIG 13 illustrates a typical set of rolls WP1;
FIG 14 illustrates a typical set of rolls EP2;
FIG 15 illustrates a typical set of rolls EP1;
FIGS 16, 17 and 18 illustrate alternative views of the welding section showing welding apparatus (FIG 16), welding rolls (FIG 17), and scarfing apparatus (FIG 18);
FIG 19 illustrates a side view of the shaping and straightening section;
FIG 20 illustrates a typical set of rolls designated as SH3;
FIG 21 illustrates a typical set of rolls designated as SH1;
FIG 22 illustrates an end view of rolls SH1;
FIG 23 illustrates an end view of rolls SH2;
FIG 24 illustrates an end view of rolls SH3;
FIG 25 illustrates an end view of rolls SH4;
FIG 26 illustrates an end view of rolls SH5;
FIGS 27, 28 & 28A illustrate alternative flower sections that may be obtained in the forming step; and
FIGS 29-35 illustrate alternative cross sectional profiles that may be obtained in accordance with the invention.

In FIG 1 there is shown flat metal strip 10 being passed through a forming section 11 having forming rolls F1, F2, F3 and F4 as well as side rolls S1 and S2. There is also shown edge preparation and welding section 12 having rolls EP1, EP2 and WP1. Also shown is welder 13. Finally there is shown shaping and straightening section 14 having shaping rolls SH1, SH2, SH3 and SH4 and straightening rolls ST1. Also shown is structural member 15 having the desired cross sectional profile in accordance with the invention.

In FIGS 2-5 the shaping rolls F1-F2 as best shown in FIG 5 include adjusting screws or screw jacks 16, drive shafts 17 and drive unit 18. Also shown are upper rolls 19 and lower roll 20. Upper rolls 19 are each vertically adjustable by movement along adjusting screws 16. Also shown are bearing housings 21. Support stands 23 and 24 are also shown. Movement of rolls 19 along screw jacks 16 are caused by manual actuation of adjustment mechanisms 17A.

The forming rolls F3-F4 as best shown in FIG 4 include adjusting screws or screw jacks 25 for top rolls 26. Shafts 27-28 are connected to a drive unit such as drive unit 18 shown in FIG 5. There is also shown side rolls 26A and lower roll 26B. Horizontal adjustment of side rolls 26A relative to workpiece 10 are caused by adjusters 29. There is also indicated direct coupling 30 and connection shafts 31 which engage with gearboxes 32 to move the top roll 26 along screw jacks 25 in unison.

Actuation of vertical movement of rolls 26 is caused by manual adjustment wherein actuating spindle 32A is rotated by appropriate means.

The side rolls S1-S2 as best shown in FIG 3 include roll stands 33, bearing housings 34, vertical oriented rolls 35, lower roll 36 and roll shafts 37.

FIG 6-8 show sequentially the formation of strip 10 and the development of the desired W cross sectional profile. The side edges of strip 10 are gradually bent inwardly as shown by the action of rolls 19 and 20 in FIG 6, rolls 35 and 36 in FIG 7 and rolls 26A, 26B and 26 in FIG 8.

In FIGS 8A, 8B and 8C there is shown a modified sequence of shapes that are applicable to rolls F1 and F2, F3 and F4 and S1 and S2 respectively. Similar reference numerals are used as in FIGS 3, 4 and 5 with the exception that rolls 19A and 20 in FIG 8A, rolls 26V and 26W in FIG 8B and rolls 35A and 36A have

a different profile to the corresponding rolls 19 and 20 in FIG 5, 26 and 26B in FIG 4 and 35 and 36 in FIG 3.

FIGS 9-12 show the edge preparation and welding section wherein strip 10 passes sequentially through rolls EP1, EP2 and WP1.

FIGS 10-12 show rolls WP1, EP2 and EP1 which are all very similar in structure to rolls F3-F4 described in FIG 4 and hence similar reference numerals are shown. However the top rolls of FIGS 10, 11 and 12 are designated 26K, 26H and 26E respectively, the side rolls 26L, 26I and 26F and the bottom rolls are designated 26M, 26J and 26G. Each of rolls WP1, EP2 and EP1 are supported on roll stands 22.

FIGS 13-15 also show sequentially the development of the cross sectional profile of strip 10 after passing through rolls EP1, EP2 and WP1. The formation of the desired circular hollow end sections are shown from the W profile shown in FIG 13.

In FIGS 16-18 are shown welding apparatus used in the invention and this includes a high frequency welder 13 having welding contacts Aa, Ab, Ba and Bb which contact each free edge 38 of strip 10 and web part 39 as shown.

In relation to use of high frequency welder 13 the parts 38 and 39 of strip 10 are forced into abutment. However, it is emphasized that in the case of use of other welding means such as TIG or MIG parts 38 and 39 do not have to necessarily abut but be located closely adjacent thereto.

FIG 17 shows the operation of the rolls of roll assembly WP1 in producing the desired abutment of parts 38 and 39.

FIG 18 shows the operation of scarfing means 40 to remove excess weld bead as discussed above.

FIGS 19-21 show the operation of shaping rolls SH1, SH2, SH3, SH4 and SH5 and straightening rolls ST1.

The operation of a typical shaping roll is best shown in FIG 20 and this is very similar to the operation of forming rolls F3, F4 as described above, hence similar reference numerals have been utilized. The top roll has bene designated however 41, side rolls 42 and bottom rolls 43. All the rolls are supported on roll stands 44.

The operation of the straightening roll assembly ST1 is best shown in FIG 21 and this includes roll housing 45. There are provided a pair of top and bottom rolls 46-47 and a pair of side rolls 48. The entire assembly 49 of rolls 46, 47 and 48 may be pivoted about a centre axis designated by X in the plane of the drawing by actuation of handle 50 which engages in gearbox 51. There are also provided adjusters 52 and 53 for vertical adjustment movement of rolls 46 and 47 in supporting slides 54 relative to workpiece 10. There is also provided adjusters 55 and 56 for horizontal adjustment movement of side rolls 48 relative to workpiece 10 in supporting slides 57.

The sequential series of events which now take place in regard to the workpiece 10 are now shown in FIGS 22-26 which demonstrate that a workpiece 10 having a cross sectional profile as best shown in FIG 22 may be converted into a number of other shapes as shown in FIGS 23, 24, 25 or 26 to finally produce triangular hollow end sections. These were converted from circular end sections shown in FIG 22.

Typical flower sections that may be obtained in accordance with the process of the invention which are different to the preferred W profile as described previously are shown in FIGS 27, 28 and 28A after passage of strip 10 through a series of rolls as described above. FIG 27 illustrates a profile obtained wherein the web remains primarily planar during the forming process. On the other hand FIGS 28 and 28A show that this is not essential and that other shapes may be obtained such as sequential bending of the free edges of the strip inwardly or back upon themselves to produce triangular hollow end sections.

FIGS 29-35 show various possible cross sectional profiles of structural members that may be obtained in accordance with the invention. FIG 29 shows a preferred structural member having hollow triangular end sections 58 and web 59. Two weld joins 60 between end sections 58 and web 59 are also shown. For the sake of convenience similar reference numerals have been utilized in regard to the remainder of the structural members shown in FIGS 30-35. Differently sized hollow end sections 58A and 58B may be obtained in accordance with the invention as shown in FIG 32. There also may be provided grooves 61 as shown in FIG 35 is desired.

From the foregoing it therefore can be appreciated that structural members produced in accordance with the invention have a number of advantages when compared to the prior art. In this regard the structural member of the present invention combines the traditional advantages of cold formed hollow sections with a basic shape which is relatively efficient in resisting bending moment.

Therefore advantages attributable to the present invention when compared to conventional non hollow or solid structural members include the following:-

(i) minimum thickness of sections not limited by a hot rolling process in being preferably formed by cold rolling;

(ii) cold-rolling of strip during forming enhances yield;

(iii) removal of mill scale and rust during forming may be carried out; and

(iv) prime-painting during manufacture may also be carried out.

The basic shape of the structural members of the invention also will be relatively efficient for the following reasons:-

(a) the section consists of two hollow flanges or end sections connected by a single web;

(b) the structural members of the invention are thus similar to traditional universal beams which have two parallel flanges and single flat web with flanges substantially thicker than the web;

(c) a single web is much more efficient that two webs as in traditional cold-formed hollow sections;

(d) because the flanges are hollow the flanges are effectively much thicker than the web. This is much more efficient than having equal flange and web thicknesses;

(e) flange widths to thickness ratios are also less limited by local buckling and web buckling considerations than is the case with traditional universal beams;

(f) web widths to thickness ratios are effectively reduced by the width of the hollow section flanges which in turn reduces the effect of web buckling considerations on load beam capacity;

(g) because of these benefits in local buckling and web buckling considerations, higher yield strength steels can be used to provide significant economic advantages; and

(h) low exposed surface area to mass and strength ratios are obtained which assists in reducing costs for both corrosion protection and fire-proofing.

It should be noted that these advantages are inherently related to the ability to produce a welded hollow section with two weld joins. An open section of similar shape, i.e. a section where the ends of the strip were not welded to the web to form two closed hollow sections, would have markedly reduced load capacities due to local buckling considerations. This is clearly applicable to the prior art referred to previously, i.e. U.S. Patent 3,342,007 and U.S. Patent 3,517,474.

The main advantage of the structural members of the invention from a manufacturing viewpoint is that the structural members can be produced in an electric resistance welding tube mill. That brings all the advantages that cold-forming offers over hot-rolling, including a much lower investment in plant and greatly reduced energy requirements.

Structural members of the invention also have other advantages which are not offered by either universal beam sections or traditional cold-formed hollow sections. It is possible to utilize the space inside the hollow flanges for location of building services. In the case of water reticulation, the use of non-destructive procedures to test weld quality can be relatively easily extended to test water-tightness of the hollow sections.

It is also possible to provide pre-tensioning cables inside the hollow end sections to provide greater load capacity and control of in situ beam deflection.

As discussed previously it is clear that the advantage that the structural member of the invention has over the prior art is that the structural member of the invention has two closed hollow flange sections connected by a single web.

An open section of similar shape, i.e. a section where the ends of the strip were not welded to the web to form two closed hollow sections, would have markedly reduced load capacities due to local buckling considerations.

It is important to note in U.S Patent 3,342,007 that this relates to an open section, in that the free edges of the strip merely abut the web section of the member. Because this product is an open section it would have markedly lower load capacities than achieved by the present invention.

In the Merson specification that portion of the flange which is bent to abut the web of the member would form substantial local buckles at relatively low loads. This is illustrated hereinafter in FIG 36. This is due to this segment of the section acting primarily as an unstiffened compression element, when the member is subject to either bending or compressive loading. Due to the local buckling of this portion of the section, the member as a whole would suffer dramatically reduced load carrying capacity.

This can be demonstrated relatively easily by modern theoretical analysis techniques for cold-formed steel sections. Alternatively it could be demonstrated by experimental testing of the product described in the Merson specification.

The local buckling problems associated with the Merson product are overcome in the structural members of the invention by the welding of the free edge of the flange section to the web at two separate locations, thereby creating two closed hollow sections connected by a single web.

The closed hollow end sections of the invention have a much greater resistance to local buckling than that afforded by the open section proposed by Merson. These web sections also have improved local buckling performance due to both reduced depth of web and the restraint offered to the web by the hollow flange sections.

It should also be noted that the assertions made in the Merson specification relating to resistance to concentrated loads would seem to be extremely dubious. It is claimed that load applied to the top flanges of the member will be transmitted equally by the sloping segments of the member to the web of the member. One sloping segment of the member is said to abut to the other sloping segment so that load "will be equally borne by the sloped extents and transmitted through these sloped extents to the web, without setting up members which might tend to cause the structural member to sway to either side".

These claims however would seem to be unjustified. The concentrated load will tend to follow the stiffest load path. That sloping section which is continu-

ous with the web will carry a far greater proportion of the concentrated loads. The degree of support offered by the abutting join is very doubtful. In fact at ultimate loads it is unlikely that the sloping member with abutting join will provide any support to concentrated loads. Further the comment on setting up moments and sway seems largely irrelevant. This would be clearly evident from appropriate experimental testing.

It should be noted that the above problems associated with the Merson specification could have been overcome by continuous welding of the free edge of the strip to the web of the section, instead of simply abutting the free edges. However such a welding operation would be difficult for the Merson section, because the two abutting joins are located on one side of the member. Welding of the section would induce substantial distortion into the finished section, which would have to be removed by some further straightening process.

It is important to emphasize that the preferred section is formed from a single unitary piece which is welded at two separate locations to form a basic shape of two separate circles connected by a single web. This basic shape consisting of two separate circles connected by a single web can then be shaped into a myriad of final section shapes.

The preferred section thus consists of two hollow section flanges of any shape connected by a single web. The triangular shape which is similar to Merson (though as previously noted, Merson is an open section and not a closed hollow section) is only one shape amongst a wide range of shapes which are included within the scope of the current invention.

Two preferred shapes of the present invention are the symmetrical triangular shape which equates to the current range of universal beams and a further symmetrical triangular shape which equates to the current range of hot-rolled channels.

As previously discussed it would also be possible to utilize the space inside the hollow end sections to provide for pre-stressing of the structural members by the installation of pre-tensioning members within the hollow end sections.

Claims

1. A structural member formed from a single strip of metal by a continuous cold rolling process, the structural member comprising:-

an intermediate web member (59) and hollow flanges (58) extending longitudinally of the intermediate web member (59);

characterized in that the

hollow flanges (58) are formed by a continuous seam welding of the respective free edges of the previously shaped hollow flange portions to the surface of the intermediate web member (59) adjacent respective junctions with the web member (59); and that

the free edges of the hollow flange portions are welded perpendicular to the surface of the intermediate web member (59) by high frequency electrical induction or resistance welding.

2. Structural member as claimed in claim 1, **characterized** in that the hollow flanges are of the same or different cross-sectional shapes.

3. Structural member as claimed in claim 1, **characterized** in that the hollow flanges are of the same or different cross-sectional areas.

4. Structural member as claimed in claim 1, **characterized** by at least one hollow flange having a symmetrical triangular cross-sectional shape.

5. Structural member as claimed in claim 1, **characterized** by at least one hollow flange having a circular cross-sectional shape.

6. A process for forming, in a substantially continuous roll forming operation, elongate, structural members comprising spaced hollow flange members (58) separated by an intermediate web member (59), the process including the steps of:

passing a planar continuous strip of metal through a roll forming mill to successively deform opposed free edge portions of the metal strip to form spaced parallel hollow flange portions (58) of predetermined cross-sectional shape, the hollow flange positions extending longitudinally of the intermediate web member (59);

characterized in that

a continuous seam weld is formed between each of the free edges of respective hollow flange portions (58) and the surface of the intermediate web member (59) adjacent the junction of the web member and respective hollow flange portions (58), and that the free edges of the hollow flange portions (58) are welded perpendicular to the surface of the intermediate web member (59) by high frequency electrical induction or resistance welding.

7. Process as claimed in claim 6, **characterized** in that one or both of the respective hollow flanges is subjected to further deformation in the roll forming mill after the welding step to change the cross-sectional profile of the one or both hollow flanges.

8. Process as claimed in claim 6, **characterized** in that the central region of the

planar metal strip which forms the intermediate web is subject to deformation in the roll forming mill to form a transversely contoured intermediate web.

9. Process as claimed in claim 8, **characterized** in that deformation of the central region of the metal strip occurs before the free ends of respective hollow flange members are welded to the surface of the intermediate web member.

10. Process as claimed in claim 9, **characterized** in that the transversely contoured web member is subject to a further deformation step in the roll forming mill to form a planar intermediate web member.

11. Process as claimed in claim 8, **characterized** in that the intermediate web member is transversely contoured in the roll forming mill after the step of welding the free edge of respective hollow flange members to the surface of the intermediate web member.

12. Process as claimed in claim 6, **characterized** in that the hollow flanges are formed with a circular cross-section.

13. Proces as claimed in claim 7, **characterized** in that one or both of the hollow flanges is formed with a triangular cross-section.

14. Process as claimed in claim 6, **characterized** in that both hollow flanges are formed with identical cross-sectional areas.

15. Process as claimed in claim 6, **characterized** in that the hollow flanges are formed with differing cross-sectional areas.

Patentansprüche

1. Strukturelement, aus einem einzigen Metallstreifen durch ein kontinuierliches Kaltwalzverfahren gebildet, wobei das Strukturelement folgendes umfaßt:
   - ein Zwischenstegelement (59) und sich längs des Zwischenstegelements (59) erstreckende hohle Flansche (58),
     dadurch **gekennzeichnet**, daß
   - die hohlen Flansche (58) durch ein kontinuierliches Nahtschweißen der jeweils freien Ränder der zuvor geformten hohlen Flanschabschnitte an die Oberfläche des Zwischenstegelements (59) benachbart zu den jeweiligen Verbindungsstellen mit dem Stegelement (59) gebildet werden, und daß
   - die freien Ränder der hohlen Flanschabschnitte senkrecht zur Oberfläche des Zwischenstegelements (59) durch elektrisches Hochfrequenz-Induktionsschweißen oder Widerstandsschweißen angeschweißt werden.

2. Strukturelement nach Anspruch 1, dadurch **gekennzeichnet**, daß die hohlen Flansche von gleicher oder unterschiedlicher Querschnittsform sind.

3. Strukturelement nach Anspruch 1, dadurch **gekennzeichnet**, daß die hohlen Flansche von gleicher oder unterschiedlicher Querschnittsfläche sind.

4. Strukturelement nach Anspruch 1, dadurch **gekennzeichnet**, daß wenigstens ein hohler Flansch eine symmetrische dreieckige Querschnittsform hat.

5. Strukturelement nach Anspruch 1, dadurch **gekennzeichnet**, daß wenigstens ein hohler Flansch eine kreisförmige Querschnittsform hat.

6. Verfahren zur Bildung von länglichen Strukturelementen mit beabstandeten hohlen Flanschelementen (58), die durch ein Zwischenstegelement (59) getrennt sind, in einem im wesentlichen kontinuierlichen Profilwalzvorgang, wobei das Verfahren folgende Schritte umfaßt:
   - Hindurchführen eines ebenen kontinuierlichen Metallstreifens durch eine Profilwalzmühle, um nacheinander die entgegengesetzten freien Randabschnitte des Metallstreifens zu verformen, um beabstandete parallele hohle Flanschabschnitte (58) einer vorbestimmten Querschnittsform zu bilden, wobei sich die Positionen der hohlen Flansche längs des Zwischenstegelements (59) erstrecken,
     dadurch **gekennzeichnet**, daß
   - eine kontinuierliche Schweißnaht zwischen jedem der freien Ränder der jeweiligen hohlen Flanschabschnitte (58) und der Oberfläche des Zwischenstegelements (59) benachbart der Verbindungsstelle des Stegelements und des jeweiligen hohlen Flanschabschnitts (58) gebildet wird, und daß
   - die freien Ränder der hohlen Flanschabschnitte (58) senkrecht zur Oberfläche des Zwischenstegelements (59) durch elektrisches Hochfrequenz-Induktionsschweißen oder Widerstandsschweißen angeschweißt werden.

7. Verfahren nach Anspruch 6, dadurch **gekennzeichnet,** daß einer oder beide jeweiligen hohlen Flansche nach dem Schweißschritt einer weiteren Verformung in der Profilwalzmühle unterzogen werden, um das Querschnittsprofil des einen oder der beiden hohlen Flansche zu verändern.

8. Verfahren nach Anspruch 6, dadurch **gekennzeichnet,** daß der zentrale Bereich des ebenen Metallstreifens, der den Zwischensteg bildet, einer Verformung in der Profilwalzmühle unterzogen wird, um einen in Querrichtung profilierten Zwischensteg zu bilden.

9. Verfahren nach Anspruch 8, dadurch **gekennzeichnet,** daß die Verformung des Zentralbereichs des Metallstreifens vorgenommen wird, bevor die freien Enden der jeweiligen hohlen Flanschelemente an die Oberfläche des Zwischenstegelements geschweißt werden.

10. Verfahren nach Anspruch 9, dadurch **gekennzeichnet,** daß das in Querrichtung profilierte Stegelement einem weiteren Verformungsschritt in der Profilwalzmühle unterzogen wird, um ein ebenes Zwischenstegelement zu bilden.

11. Verfahren nach Anspruch 8, dadurch **gekennzeichnet,** daß das Zwischenstegelement nach dem Schritt des Anschweißens des freien Rands der jeweiligen hohlen Flanschelemente an die Oberfläche des Zwischenstegelements in Querrichtung in der Profilwalzmühle profiliert wird.

12. Verfahren nach Anspruch 6, dadurch **gekennzeichnet,** daß die hohlen Flansche mit einem kreisförmigen Querschnitt gebildet werden.

13. Verfahren nach Anspruch 7, dadurch **gekennzeichnet,** daß einer oder beide der hohlen Flansche mit einem dreieckigen Querschnitt gebildet werden.

14. Verfahren nach Anspruch 6, dadurch **gekennzeichnet,** daß beide hohlen Flansche mit identischen Querschnittsflächen gebildet werden.

15. Verfahren nach Anspruch 6, dadurch **gekennzeichnet,** daß die hohlen Flansche mit unterschiedlichen Querschnittsflächen gebildet werden.

Revendications

1. Elément de construction fabriqué à partir d'une seule bande de métal par un procédé continu de laminage à froid, ledit élément de construction comportant :

- un élément intermédiaire en forme de bande (59) et des brides vides (58) s'étendant de façon longitudinale par rapport à l'élément intermédiaire en forme de bande (59);

caractérisé en ce que

les brides vides (58) sont formées par soudage à joint continu aux extrémités libres respectives des parties de brides vides, qui ont été formées auparavant, contre la surface de l'élément intermédiaire en forme de bande (59) au voisinage des jonctions respectives avec l'élément de bande (59); et en ce que

les bords libres des parties de brides vides sont soudés dans une position perpendiculaire par rapport à la surface de l'élément intermédiaire en forme de bande (59) par soudage à induction électrique de haute fréquence ou par soudage par résistance.

2. Elément de construction selon la revendication 1, caractérisé en ce que les brides vides représentent des formes de section identiques ou différentes.

3. Elément de construction selon la revendication 1, caractérisé en ce que les brides identiques représentent des surfaces de section identiques ou différentes.

4. Elément de construction selon la revendication 1, caractérisé en ce qu'au moins une bride vide représente une forme de section de triangle symétrique.

5. Elément de construction selon la revendication 1, caractérisé en ce qu'au moins une bride vide représente une forme de section circulaire.

6. Procédé pour former des éléments de construction allongés par une opération de formage de laminage continu, l'élément de construction comportant des éléments de brides vides (58) espacés, qui sont séparés par un élément de bande intermédiaire (59), ledit procédé comportant les étapes suivantes :

- faire passer une bande de métal plat continu par une machine de laminage afin de déformer, de façon successive, des parties de bords libres opposés de la bande métallique afin de former des parties de brides vides parallèles (58) en une forme de section prédéterminée, les parties de brides vides s'étendant de façon longitudinale par rapport à l'élément de bande intermédiaire (59) ;

caractérisé en ce,

qu'un joint de soudure continu est formé entre chacun des bords libres des parties de bri-

des vides respectives (58) et entre la surface de l'élément intermédiaire en forme de bande (59) au voisinage de la jonction entre l'élément de bande et entre la partie de brides vides respectives (58), et en ce, que les bords libres des parties de brides vides (58) sont soudées contre la surface de l'élément intermédiaire en forme de bande (59) en position perpendiculaire par soudage à induction électrique à haute fréquence ou par soudage par résistance.

7. Procédé selon la revendication 6, caractérisé en ce que l'une ou les deux brides vides respectives sont sujettes à une déformation supplémentaire dans une machine de laminage après l'étape de soudure afin de changer le profil de section de l'une ou des deux brides.

8. Procédé selon la revendication 6, caractérisé en ce que la région centrale de la bande de métal plate qui représente la bande intermédiaire, est sujette à une déformation dans la machine de laminage afin de former une bande intermédiaire représentant des contours transversaux.

9. Procédé selon la revendication 8, caractérisé en ce que la déformation de la région centrale de la bande métallique est effectuée avant que les extrémités libres des éléments de brides vides respectives soient soudées contre la surface de l'élément de bande intermédiaire.

10. Procédé selon la revendication 9, caractérisé en ce que l'élément de bande à contours transversaux est sujet à une étape de déformation supplémentaire dans la machine de laminage afin de former un élément de bande intermédiaire plat.

11. Procédé selon la revendication 8, caractérisé en ce que l'élément de bande intermédiaire reçoit les contours transversaux dans la machine de laminage après l'exécution de l'étape du soudage des bords libres des éléments de brides vides respectives contre la surface de l'élément de bande intermédiaire.

12. Procédé selon la revendication 6, caractérisé en ce que les brides vides sont formées avec une section circulaire.

13. Procédé selon la revendication 7, caractérisé en ce que l'une ou les deux brides vides sont formées en une section triangulaire.

14. Procédé selon la revendication 6, caractérisé en ce que les deux brides vides sont formées avec des surfaces de section identiques.

15. Procédé selon la revendication 6, caractérisé en ce que les brides vides sont formées avec des surfaces de section différentes.

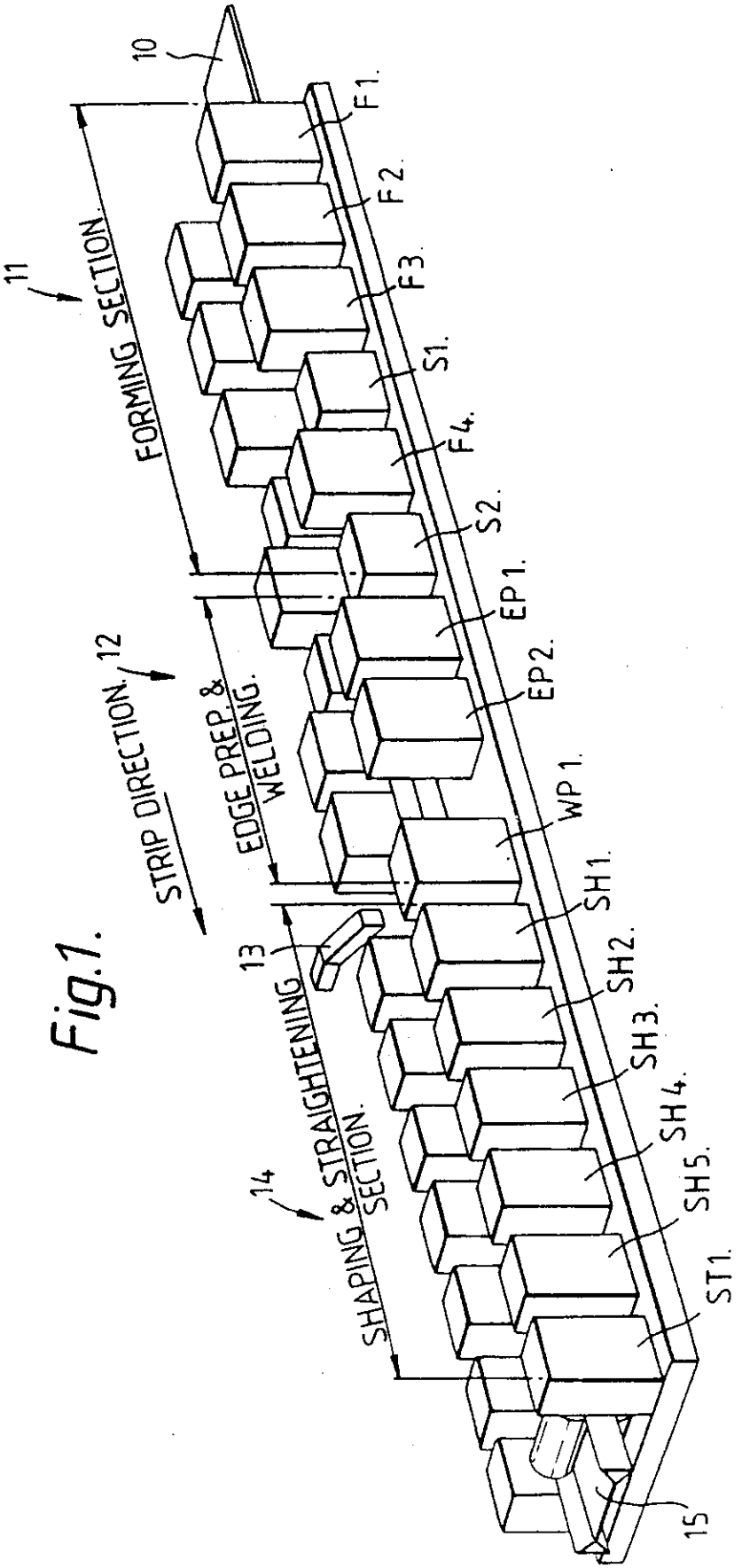

10
11
FORMING SECTION
F1.
F2.
F3.
S1.
F4.
S2.
EP1.
EP2.
WP1.
SH1.
SH2.
SH3.
SH4.
SH5.
ST1.
12
STRIP DIRECTION
EDGE PREP. & WELDING.
13
14
SHAPING & STRAIGHTENING SECTION.
15

Fig.1.

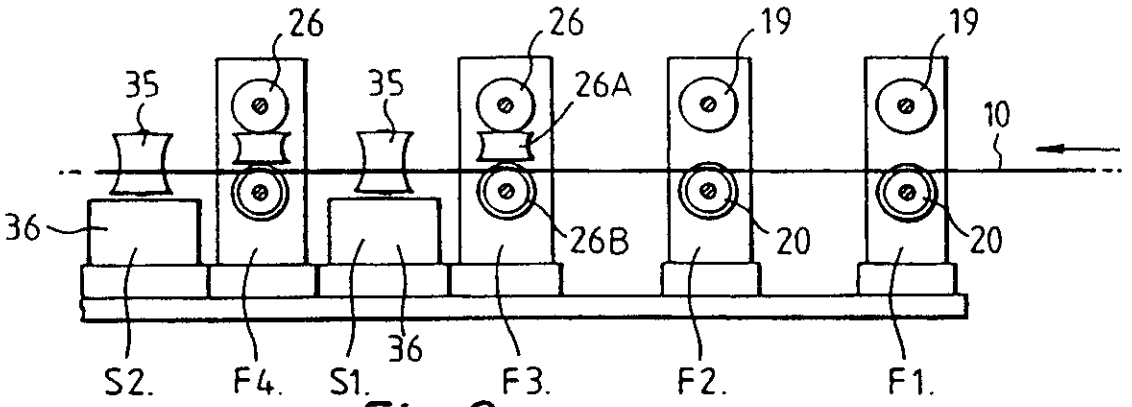


Fig.2.

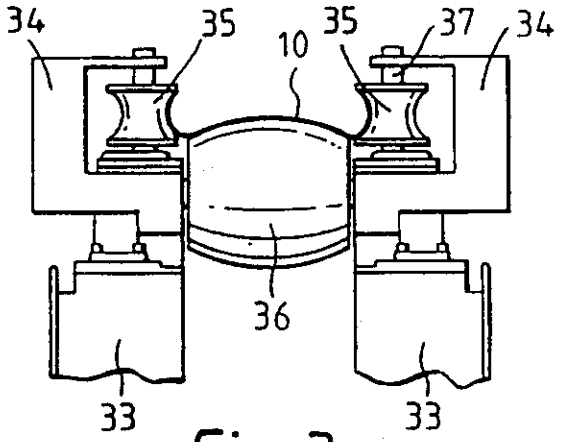


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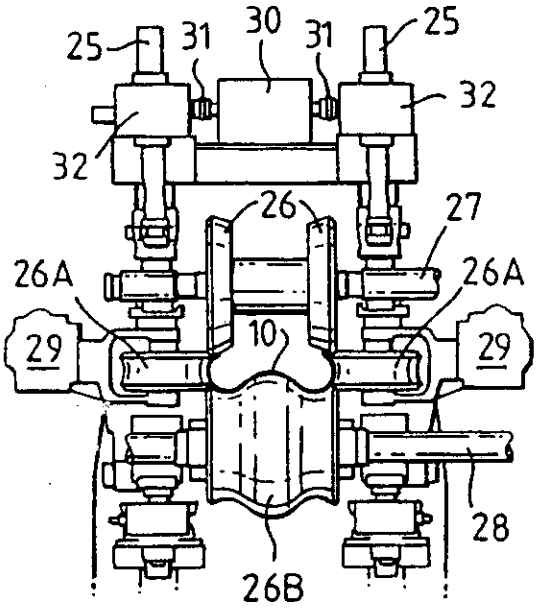
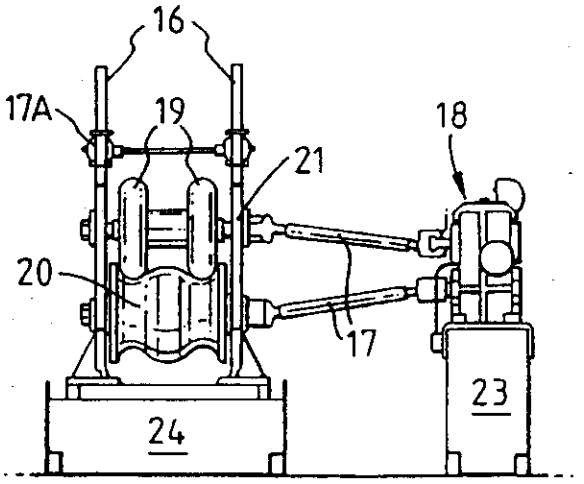


Fig.4.

Fig.5.



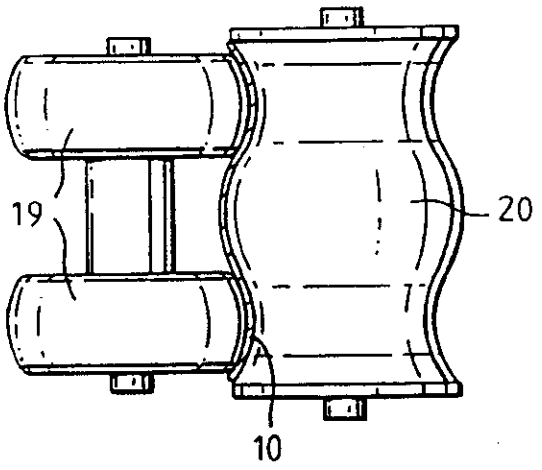


Fig.6.

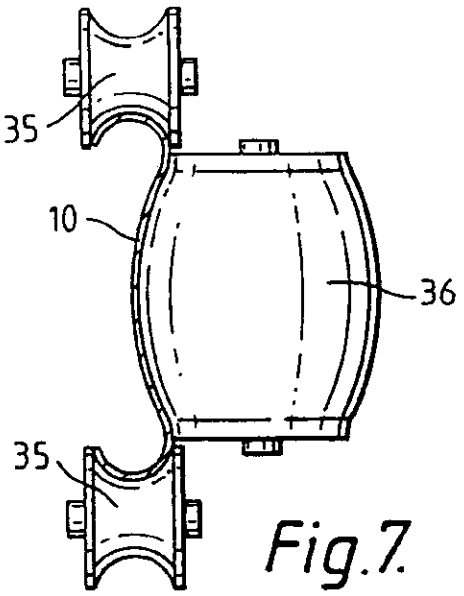


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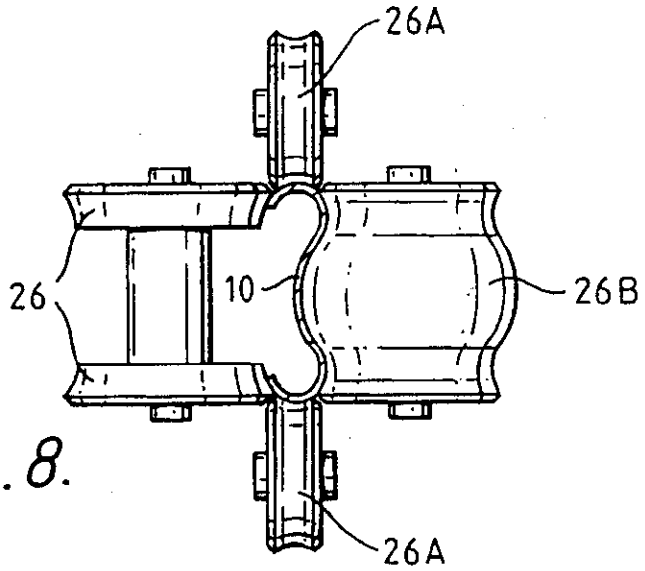


Fig.8.

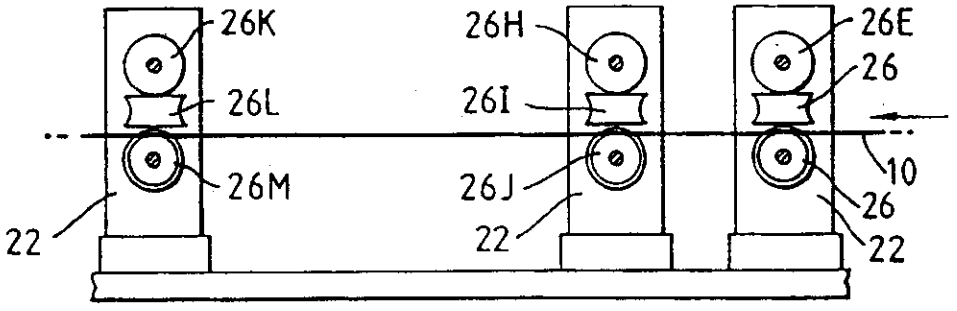


Fig.9.

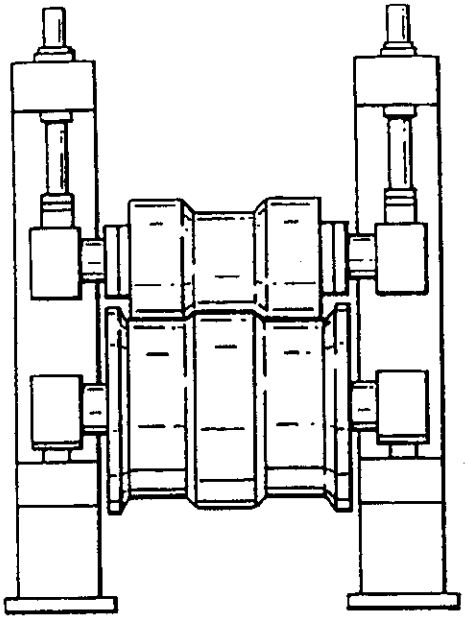


Fig.8A.

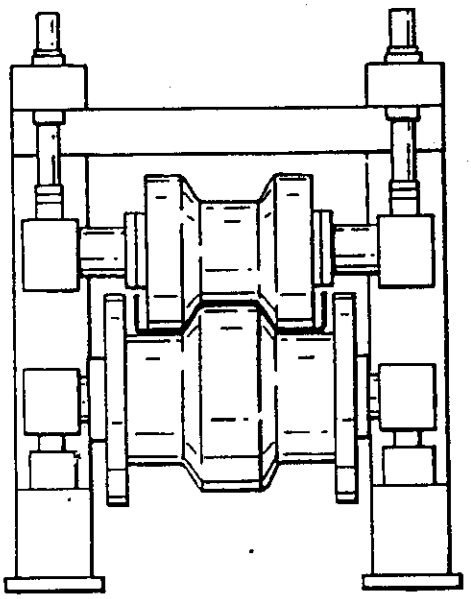


Fig.8B.

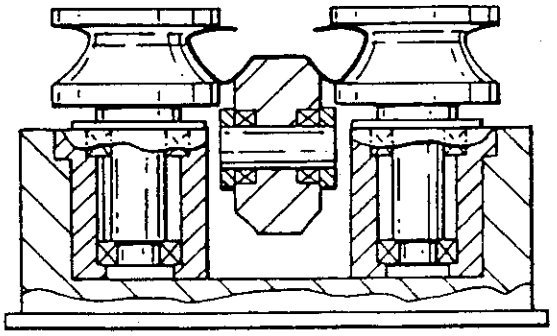


Fig.8C.

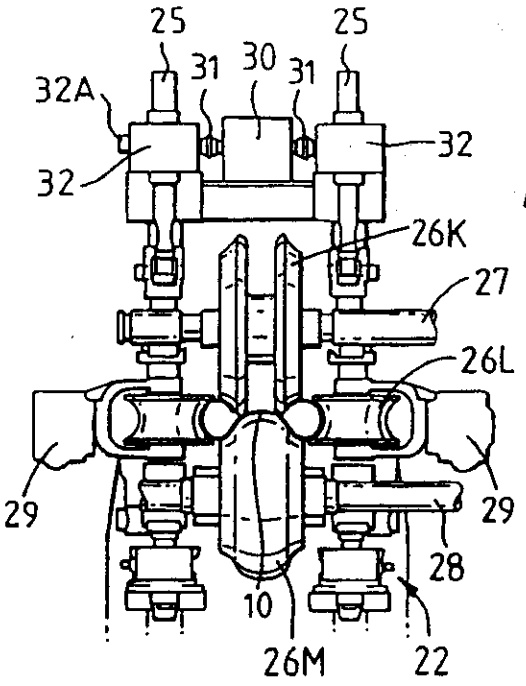


Fig.10.

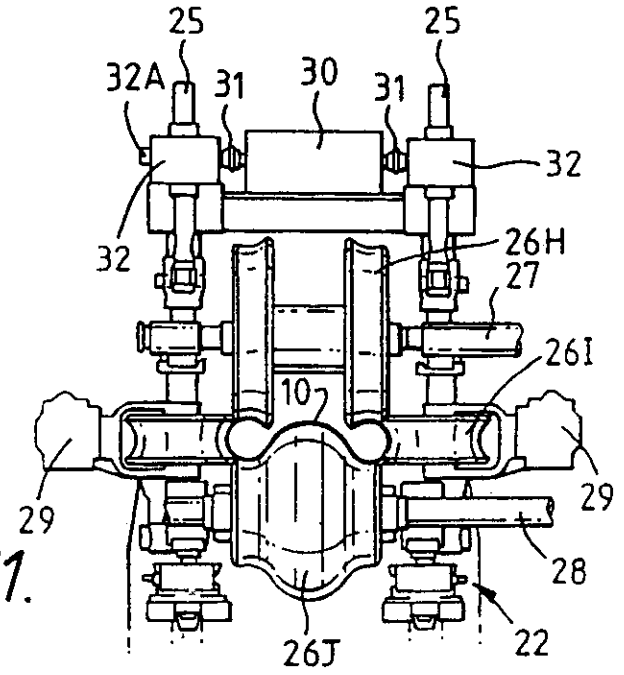


Fig.11.

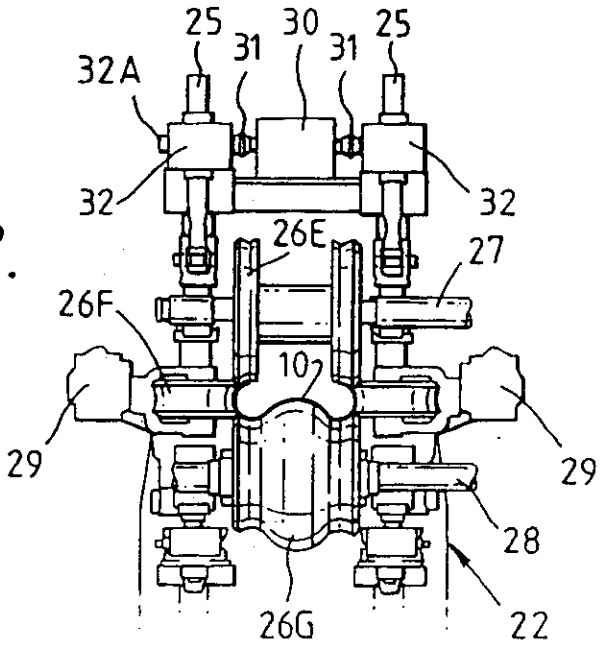


Fig.12.

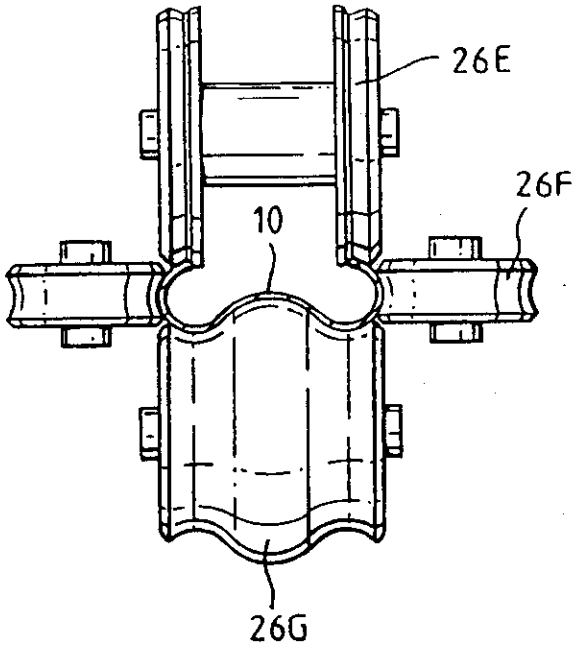


Fig.13.

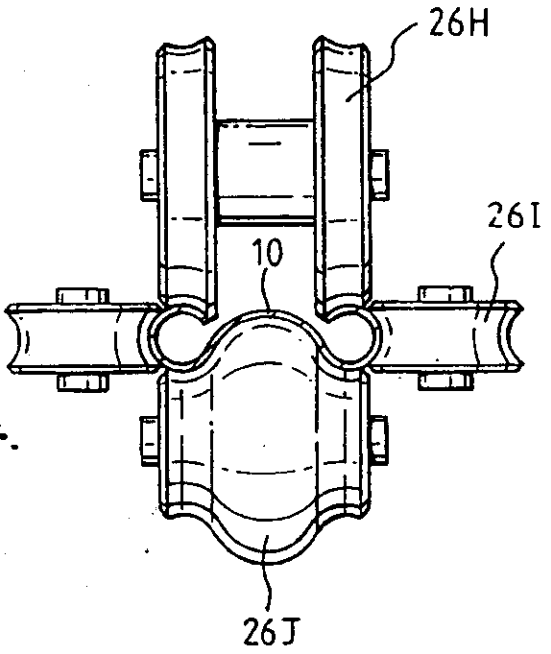


Fig.14.

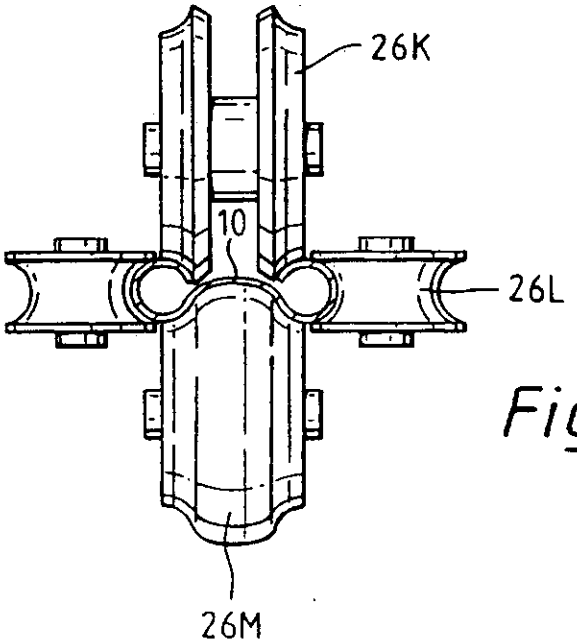


Fig.15.

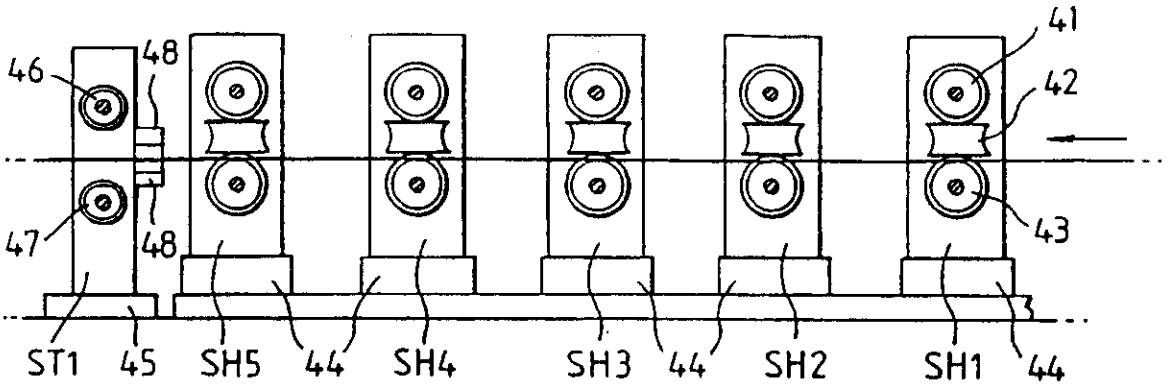


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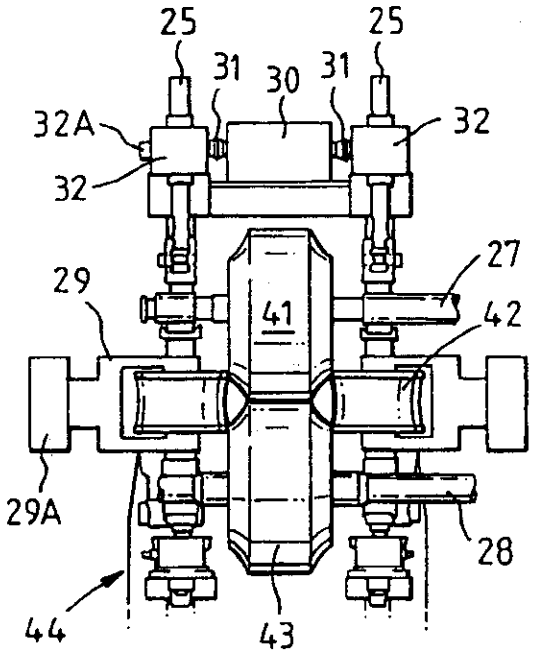


Fig.20.

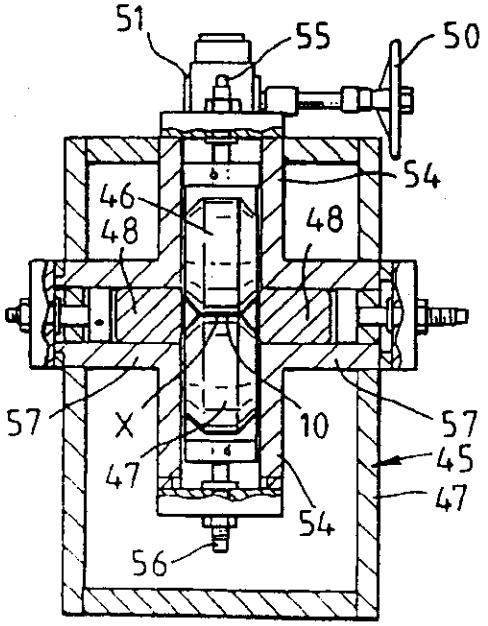


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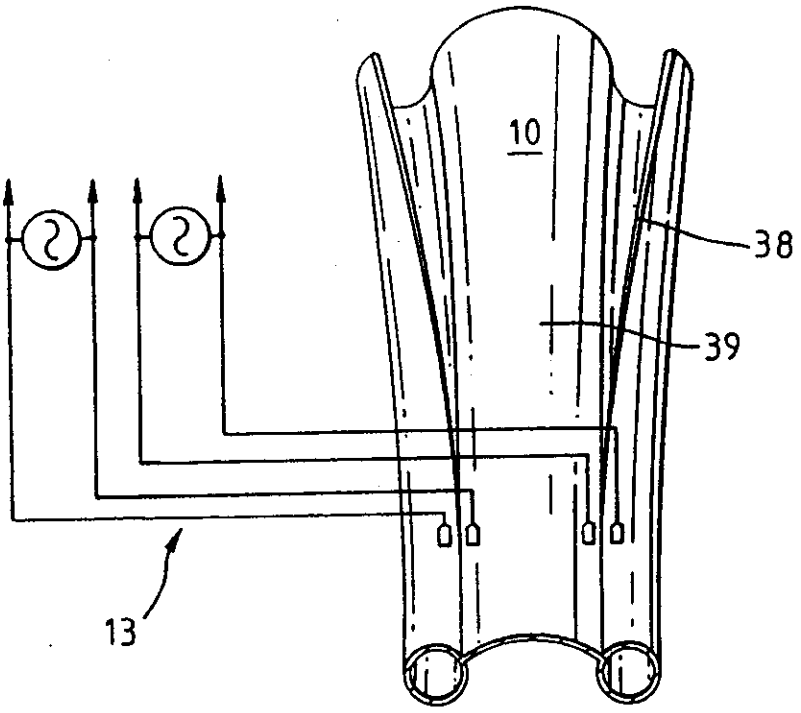


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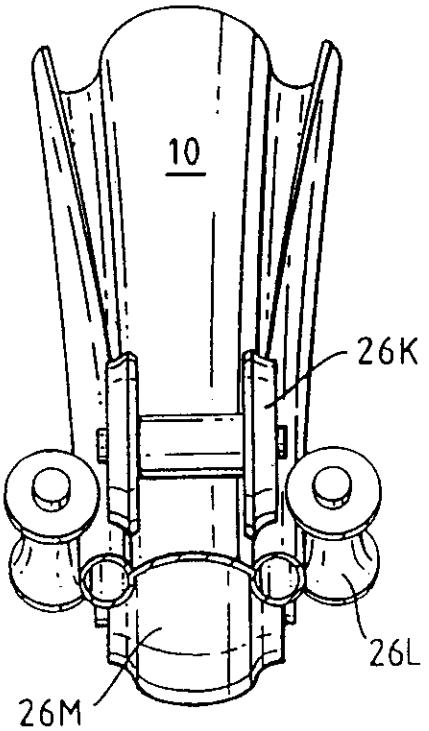


Fig.17.

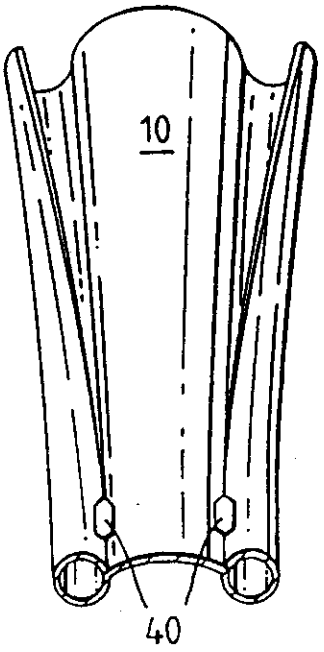


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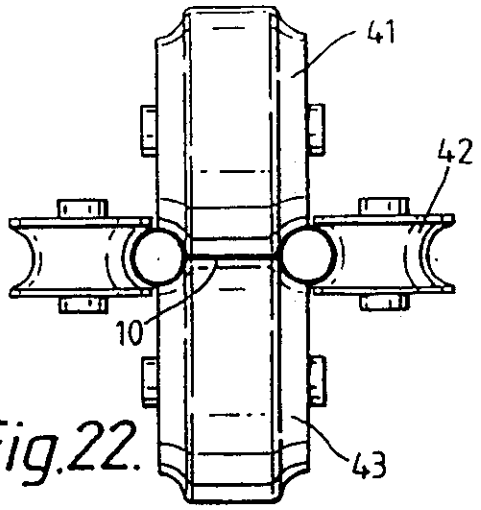


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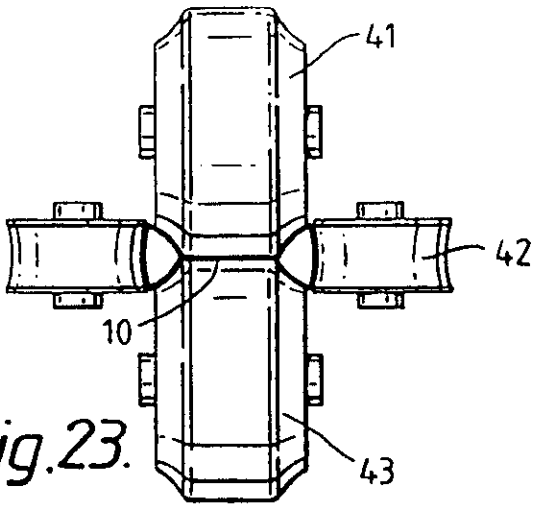


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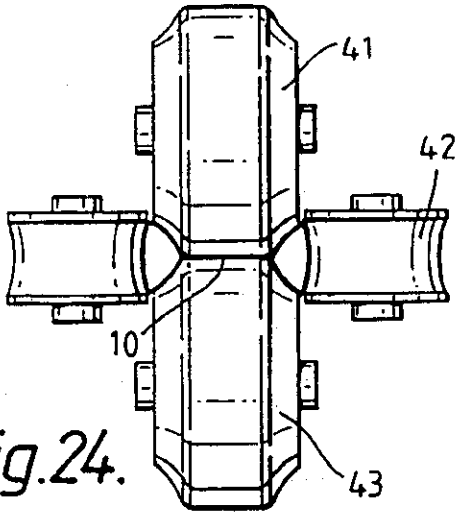


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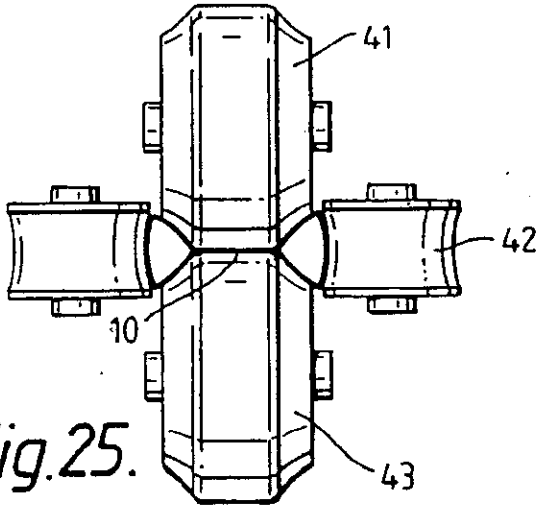


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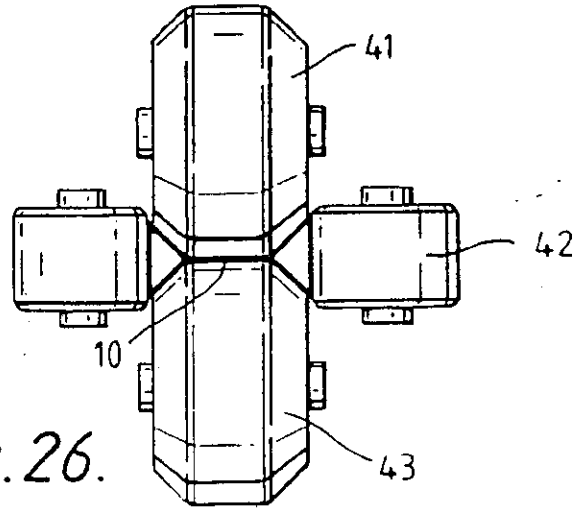


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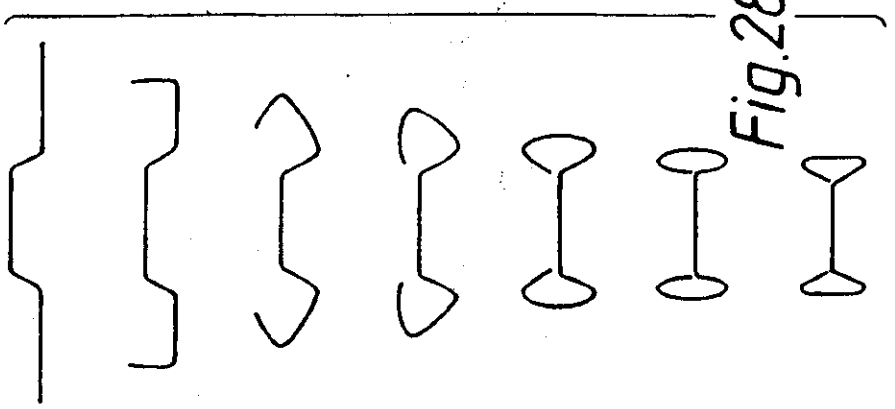


Fig.28A.

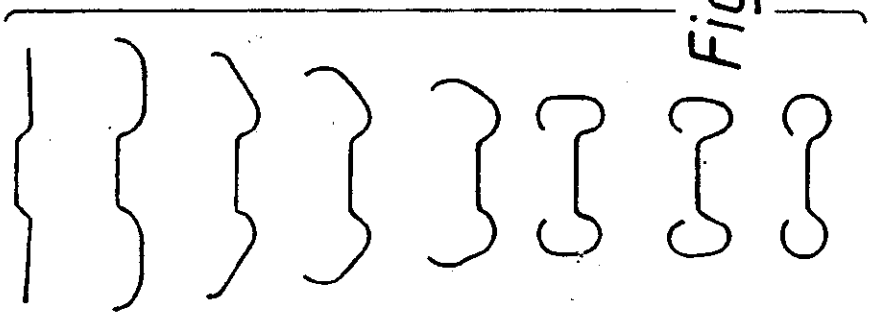


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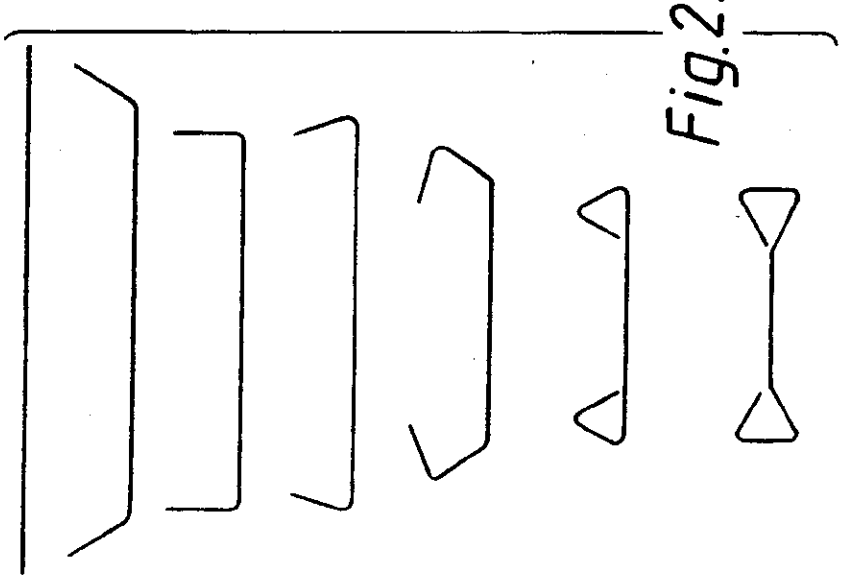


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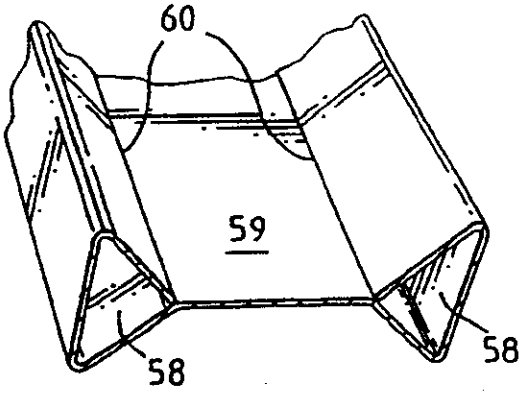


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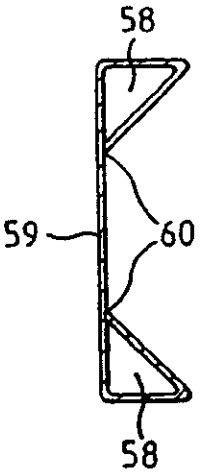


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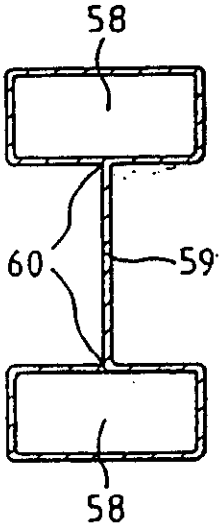


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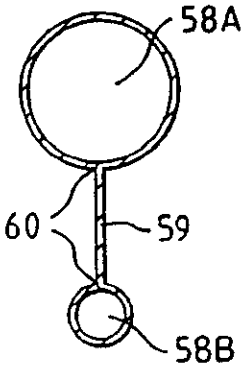


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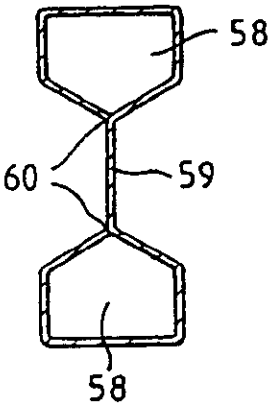


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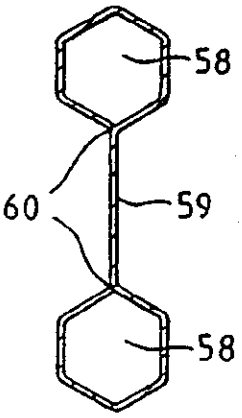


Fig.34.

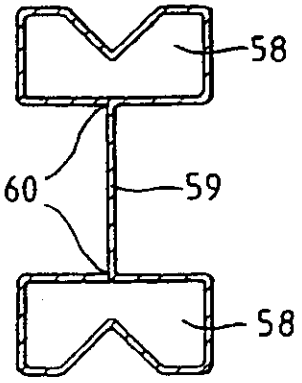


Fig.35.

REGISTER ENTRY FOR EP0381727

European Application No EP89908372.9 filing date 25.07.1989

Priorities claimed:
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18.11.1988 in Australia - doc: 153488

PCT EUROPEAN PHASE
PCT Application PCT/AU89/00313 Publication No WO90/01091 on 08.02.1990

Designated States BE CH DE FR GB IT LI LU NL SE AT

Title STRUCTURAL MEMBER AND PROCESS FOR FORMING SAME.

Applicant/Proprietor
TUBE TECHNOLOGY PTY LTD, 134 Ingram Road, Acacia Ridge, QLD 4110, Australia [ADP No. 57692733001]

Inventor
DAVID LESLIE GOLEBY, 134 Ingram Road, Acacia Ridge, QLD 4110, Australia [ADP No. 57692741001]

Classified to
E04C B21D

Address for Service
S J AVERY & CO, Sardinia House, 52 Lincoln's Inn Fields, LONDON, WC2A 3LZ, United Kingdom [ADP No. 00006304001]

EPO Representative
DIPL.-ING. KLAUS FÜCHSLE, Hoffmann . Eitle & Partner Patentanwälte Arabellastrasse 4, D-8000 München 81, Federal Republic of Germany [ADP No. 50574284001]

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DIPL.-ING. KLAUS FÜCHSLE, Hoffmann . Eitle & Partner Patentanwälte Arabellastrasse 4, D-8000 München 81, Federal Republic of Germany [ADP No. 50574284001]
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15.04.1993 S J AVERY & CO, Sardinia House, 52 Lincoln's Inn Fields, LONDON, WC2A 3LZ, United Kingdom [ADP No. 00006304001]
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S J AVERY & CO, Sardinia House, 52 Lincoln's Inn Fields, LONDON, WC2A 3LZ, United Kingdom [ADP No. 00006304001]
to
HOFFMANN EITLE & PARTNER, Sardinia House, Sardinia Street, 52 Lincolns Inn Fields, LONDON, WC2A 3LZ, United Kingdom [ADP No. 00009050001]
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TUBE TECHNOLOGY PTY LTD, 134 Ingram Road, Acacia Ridge, QLD 4110, Australia [ADP No. 57692733001]
to
TUBE TECHNOLOGY PTY LTD, Incorporated in Australia, 160 Ingram Road, Acacia Ridge, Queensland 4110, Australia [ADP No. 06725220001]
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Tube Technology Pty Ltd, Incorporated in Australia, 160 Ingram Road, Acacia Ridge, Queensland 4110, Australia

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