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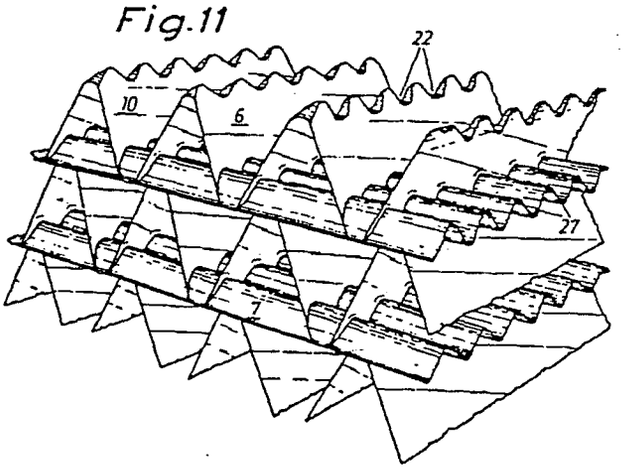
(54) **Heat transmission roll and a method and an apparatus for manufacturing such a roll.**

(57) The invention concerns a roll (12) comprising two superposed webs (6, 7) of material one (6) of which is formed with transverse ridges (10). At the ridge bases and tops are formed indentations (22). The other web (7) is provided with ribs (27) which are positioned in nesting relationship in the indentations, whereby the webs are secured to one another.

The invention likewise concerns a method and a machine for manufacturing rolls of this kind.

Fig.11



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Heat Transmission Roll and a Method and an Apparatus for Manufacturing such a Roll

The invention concerns a roll that is manufactured from two superposed webs, one of which is corrugated. The roll is primarily intended for use in so called regenerative heat exchangers.

It is already known to manufacture rolls for rotating heat-recovery devices by winding in superposed relationship one smooth web and one corrugated web of a metal foil, usually an aluminium foil, and joining together the two webs by means of an adhesive or bonding agent of composite type. To wind together the two webs the inner ends thereof are secured on a rotatably driven core sleeve. The smooth web is unreeled from a supply roll onto a spindle provided with a braking mechanism. The webs thus are wound into roll form while under some tension from the smooth web supply roll. Since the torque exercised by the core sleeve increases as the diameter of the winding-on roll increases, the adhesive bond between the smooth web and the ridges of the corrugated web will brake at a certain degree of tension in the smooth web on account of the braking force exerted by the un-winding spindle, and as a result one or several of the winding turns of the webs will separate from one another. As a consequence, the entire roll might collapse when it is transferred to a hardening oven for setting of the adhesive. Although sufficient amounts of the binding

agent may remain on the ridges of the corrugated web after breakage of the bond to allow the ridges to adhere to the smooth web, the adhesive on the smooth web at the original points of adherence will, however, in this case be positioned on the gap between the ridges with the consequential disadvantage that the cross-sectional area for air passage through the rotatably driven roll of the heat-recovery devices diminishes.

The purpose of the subject invention is to eliminate the glueing operation completely while at the same time provide considerably more efficient exchange of heat than in heat exchangers fitted with rolls of prior-art types.

In accordance with the invention are used two superposed webs of which the first web is provided with transverse equidistantly spaced ridges whereas the second web is provided with longitudinal ribs. The characteristic feature of the invention resides therein that the ridges of the first web are provided at the ridge tops as well as at the ridge bases with indentations having a pitch matching that of the ribs formed in the second web, in which indentations engage said ribs formed in the second web.

The invention also concerns a method of manufacturing the roll, which method is characterised by the steps of forming indentations on the ridges in the first web at the ridge tops as well as the ridge bases, said indentations having a pitch matching that of the ribs formed in the second web, and guiding at least one of the webs so as to ensure that the ribs are positioned in said indentations.

The invention likewise comprise a machine for manufacturing the roll in accordance with the invention, the machine being characterised in that it comprises first means arranged during the advancement of the second

web to form longitudinal ribs in said web, second means arranged during the advancement of the first web to form indentations at the ridge tops as well as at ridge bases of the first webs, said indentations having a pitch matching that of the ribs, and third means arranged to control one and/or both webs to ensure that the ribs of the second web will engage on the indentations of the first web.

The invention will be described in closer detail in the following with reference to the accompanying drawings, wherein

Fig. 1 is a schematic view of a machine in accordance with the invention, designed to manufacture rolls consisting of two superposed and interconnected webs of material,

Figs. 2-4 show in cross-sectional views and on an enlarged scale three different stations of producing one of the webs of material,

Fig. 5 is a lateral view of the station illustrated in Fig. 4,

Figs. 6 and 7 are plan views of the roll winding--on station, showing one of the end sections of the latter in different positions,

Fig. 8 illustrates on an enlarged scale a vertical longitudinal section of the winding-on station at the initial stage of the winding-on,

Fig. 9 is a similar view showing a later stage of the winding-on,

Fig. 10 shows on a still larger scale a section through the outer edge of the rotatably driven end section of the winding-on station,

Fig. 11 is a perspective view of a portion of the roll,

Fig. 12 shows on an enlarged scale a cross--sectional view through a part of the roll,

Fig. 13 is a section along line XIII-XIII in Fig. 12 in the longitudinal direction of the roll, and Fig. 14 is a partly cut end view of the roll.

At each end of an elongate stand 1 are rotatably mounted spindles 2, 3 each one holding a supply roll 4 and 5 of smooth aluminium foil webs 6 and 7. The stand also supports a station 8 for imparting corrugations to the web 6 of material, a station 9 for forming indentations at the tops and bases of the ridges 10 of the corrugated web, and a station 11 to wind the two webs 6 and 7 into a roll 12.

The corrugation station 8 comprises two rotatably driven cooperating rollers 13, 14 of cog-wheel appearance between which rollers the web 6 of material is guided so that transverse ridges 10 are formed therein,

Station 9 which is the station in which the indentations are formed at the tops and bases of the ridges is positioned after the corrugation station 8. Station 9 consists of two cog-wheel rollers 15, 16 and two back-up rollers 17, 18. The latter are provided with peripheral beads 19 (see Fig. 6) having a shape matching the configoration of notches 20 formed at the tops of the cogs 21 of the cog-wheel rollers 15, 16. Because of the flow of material in the press nips formed by the rollers 15, 17 and 16, 18, respectively, indentations 22 are formed at the ridge tops as well as at the ridge bases.

The indentations 22 at the tops and bases of the ridges 10 are displaced relative to one another by a distance corresonding to half a pitch (see Fig. 13), thus ensuring that the internal through-flow area remains constant over the entire length of the channel A thus formed.

A support plate 23 is arranged after station 9, on which plate the corrugated web 6 slides freely while being advanced. The web further travels through a pair

of guide or master rollers 24, 25 positioned ahead of the winding-on station 11. These rollers control the rotational speed of the rollers 13, 14 in relation to the winding-on speed of the roll 12.

The smooth web 7 is advanced from its supply roller 5. It travels through a pair of cooperating rollers 26 (similar to rollers 17, 18) which are provided with peripheral beads to shape ribs 27 in the web 7. The pitch of the ribs is identical with the pitch of the indentations 22 formed at the tops and bases of the ridges 10. Further, the web 7 passes a heating device 28, preferably consisting of two nozzles communicating with a source of hot air (not shown). Before reaching the winding-on station 11 the web 7 is guided for lateral alignment by means of an aligner mechanism 29, whereby is ensured that the ribs 27 of the web 7 are received in nesting relationship in the indentations 22 of the web 6. Since the web 7 is heated, it will retract when cooled, thus providing safe and secure attachment of the two webs 6, 7 forming the roll 12 to one another.

The winding-on station 11 comprises two coaxial and rotatably mounted end sections 30, 31. The distance separating the end sections in the operative position is approximately equal to the width of the webs 6, 7 of material, of which the ribbed web 7 should have a width which is fractionally (preferably by 2 millimeters) narrower than the width of the corrugated web 6. The shaft 32 of one of the end sections 30 is rotatably mounted in a bearing 33 in the stand 1 and is driven via a sprocket 34 at the outer end of the shaft 32. At the end opposite the sprocket 34 the shaft 32 is shaped as a trunnion 35 on which may be positioned one end of a core sleeve 36 on which the webs 6, 7 of material are to be wound. An expandable clamping sleeve 37 secures the sleeve 36 to the trunnion 35, and a bolt 39 with a head 38 thereon passes axially through said clamping sleeve 37,

the opposite bolt end being formed with external threads cooperating with internal threads formed on tensioning sleeve 40 which is able to turn in shaft 32 but which is prevented from performing axial movements.

The opposite end section 31 is by means of its shaft 41 rotatably mounted in a bearing 42 at the outer end of an arm 43, which is arranged to be pivoted outwards by means of a lever 45 about a vertical shaft 44 provided on the stand 1. In the inner position (Figs. 7, 8 and 9) a pin 46 on the shaft 41 engages the free end of the core sleeve 36 (the left-hand end as seen in Figs. 8 and 9).

On the face facing the opposite end section 31, the end section 30 is provided with a round disc 47 of rubber or similar elastic material which by means of screws 48 or equivalent members is attached along its inner and outer edges to the end section 30 proper. In the latter are displaceably mounted a large number of pistons 49 each one of which is provided with a head 50 positioned in a depression 51 formed in the end section internally of the round disc 47. The free ends 52 of the pistons 49 project beyond the rear face 53 of the end section 30.

Upon rotation of the end sections 30, 31 a roller 54 rolls in contact with the rear face 53 of the end section 30, said roller 54 being rotatably mounted on a shaft 55 at the lower end of a guide bar 56. The guide bar 56 is vertically displaceable by means of a guide 57 in a guide track 58 formed in column 59 mounted above the bearing 33. The guide bar 56 is connected with an arm 60 projecting down in the gap 61 between the end sections 30, 31 and at the lower arm end is rotatably mounted a load-exerting roller 62 positioned approximately level with the pressure roller 54.

When the arm 43 has been pivoted outwards (Fig. 6) and a core sleeve 36 has been mounted in position with one end placed on the pin 35 and the expander sleeve 37 clamped thereto, the ends of the webs 6 and 7 of material are secured to the core sleeve with the aid of an adhesive. The drive mechanism of the machine is started and the winding-on of the webs onto the core sleeve 36 begins as a result of the rotation of the latter and of the end sections 30, 31. The two webs 6, 7 are positioned one on top of the other with the ribs 27 engaging in the indentations 22. As one winding turn after the other is wound onto the core sleeve 36, the roller 62 is gradually lifted, bringing along the arm 60 and the bar 56 including the clamping roller 54. During the rotation of the end section 30 the pistons 49 move past the roller 54 and in doing so they are urged inwards by the latter into contact with the round disc 47 which then projects like a bow somewhat inwards into the gap 61 between the end sections 30, 31. This exerts a lateral pressure on the most recently formed winding turns of the webs 6, 7, whereby these winding turns are clamped in position between the end sections. This means that the pulling force exerted by the shaft 32 is transferred directly to these most recent winding turns and the tensile stress exerted by the web 7 which is provided with the ribs 27 and which is retained in a taut condition by the braking mechanism provided on the unwinding spindle 3, thus is taken by the friction of the webs 6, 7 against the end sections 30, 31. The innermost winding turns of the webs on the core sleeve 36 thus are relieved. Consequently, there is no risk of compression of the winding turns already wound onto the core sleeve.

When the winding of the roller 12 is completed and the outer winding turn has been fastened with the

aid of an adhesive to the underlying winding turn, the arm 43 is again provided outwards and the pressure on the expander sleeve 37 is relieved. The roll 12 together with the core sleeve 37 may now be removed from the machine. In the subsequent cooling of the roll 12 at room temperature the above referred to fixation of the webs takes place owing to the contraction occurring through cooling of the ribbed web. The fixation of the webs to one another means that the finished roll cannot collapse.

The ribs 27 and the indentations 22 form through-flow channels A for the medium flowing through the heat exchanger of the appearance shown in Fig. 13. This configuration results in an enlargement of the heat-transmission area and also means that the flow through the channels A will be turbulent and not laminar. In laminar flows (which would have been the case had the limiting faces of the channels been completely straight) the layer of the medium flowing closest to the limiting faces acts as insulation, preventing the rest of the medium from contacting these faces. The turbulent flow generated in the channels of the roll in accordance with the invention means that a larger portion of the flowing medium will come into close contact with the limiting faces. The effect of this phenomenon and of the enlargement of the heat-transmission area of the channels A as a result of the provision of the ribs 27 make for considerably improved exchange of heat.

The embodiment as described and illustrated is to be regarded as an example only and the various parts of the machine may be constructively altered in a variety of ways within the scope of the appended claims. For instance, the roller 54 externally of the end section 30 may be replaced by a slip shoe supported by the bar 56. Also the opposite end section 31 may be fitted with a

round disc 47 of an elastic material. The slip shoe may have a length and/or width to ensure that it depresses two or several pistons 49 at the same time. There are also other ways of relieving the innermost winding turns. An arrangement including the use of pneumatically operated pistons which transfer the pulling force to the outermost winding turn is likewise possible.

Claims

1. A roll intended for transmission of heat and comprising two superposed webs (6, 7) of material wound about a core sleeve (36), the first one (6) of said webs provided with transverse equidistantly spaced ridges (10) and the second web (7) provided with lengthwise ribs (27), characterised in that the ridges (10) of the first web (6) are provided at the ridge tops as well as at the ridge bases with indentations (22), said indentations (22) having a pitch matching that of the ribs (27), in which indentations engage said ribs formed in the second web.

2. A roll as claimed in claim 1, characterised in that the indentations (22) formed at the tops of the ridges (10) are displaced by half a pitch relative to the indentations formed at the ridge bases.

3. A method of manufacturing rolls according to claim 1 by winding onto a rotatably driven core sleeve (36) two superposed webs (6, 7) of material, of which webs the first one (6) is formed with transverse ridges (10) and the second one (7) with lengthwise ribs (27), characterised by

forming indentations (22) on the ridges (10) in the first web (6) at the ridge tops as well as the ridge bases, said indentations (22) having a pitch matching that of the ribs (27) formed in the second web, and

guiding at least one of said webs so as to ensure that the ribs are positioned in the said indentations.

4. A method as claimed in claim 3, c h a r a c t e r i s e d b y heating the web (7) provided with the ribs (27) prior to winding so as to ensure that in a subsequent cooling of the roll (12) the webs will shrink and be secured relative to one another.

5. A method as claimed in claim 3 or 4, c h a r a c t e r i s e d i n t h a t the winding-on of the webs is carried out between two end sections (30, 31) which rotate together with a core sleeve (36), at least one (30) of said end sections being driven, and in that at least one of the webs (6, 7) of material, preferably the web (6) provided with the ridges (10), is clamped between the end sections during the winding-on operation in order to be rotated thereby.

6. A machine for performing the method according to claim 3, comprising a winding-on station (11) to which is supplied two webs (6, 7) of material one (6) of which is formed with transverse ridges (10), c h a r a c t e r i s e d i n t h a t the machine comprises

first means (26) arranged during the advancement of the second web (7) to form longitudinal ribs (27) in said web,

second means (15-18) arranged during the advancement of the first web (6) to form indentations (22) at the ridge tops as well as at the ridge bases, said indentations having a pitch matching that of the ribs, and

third means (29) arranged to control the first and/or the second web to ensure that the ribs of the second web will engage in the indentations in the first web.

7. A machine as claimed in claim 6, c h a r a c - t e r i s e d i n t h a t the means forming the lengthwise ribs (27) in the second web (7) are two cooperating rollers (26) having peripherally extending beads thereon, wherein the beads on one roller engage in the gap between the beads of the second roller, thus forming a press nip through which passes this web (7) of material.

8. A machine as claimed in claim 6, c h a r a c - t e r i s e d i n t h a t the means form the indentations (22) at the tops and bases of the ridges (10) in the first one (6) of said webs of material consist of notches (20) formed at the tops of the cogs (21) of a rotatably mounted cog-wheel roller (16), and of a roller (18) which is mounted in parallel with the cog-wheel roller and formed with peripheral beads (19), said second roller (18) mounted so as to ensure that the beads (19) of the second roller (18) engage in the notches (20) formed in the cog-wheel roller (16) upon rotation of the two rollers, thus forming a press nip through which passes the first web (6).

9. A machine as claimed in claim 6, c h a r a c - t e r i s e d by a rotatably driven end section (30) having a shaft (32) on which a core sleeve (36) may be mounted with its one end clamped to said shaft while the opposite core sleeve end is supported by a pin (46) formed on the opposite rotatably mounted end section (31), and by means arranged during the winding-on of the webs (6, 7) onto the core sleeve (36) to exert on at least one of the webs (6, 7)a lateral pressure while clamping said web between the end sections (30, 31) in order to bring along said web in the rotation of the end sections.

10. A machine as claimed in claim 9, c h a r a c - t e r i s e d i n t h a t a roller (12) sensing the momentarily outermost winding turn of the roll (12) being formed, is rotatably mounted on an arm (60) which is movable towards and away from the core sleeve (36) along a guide means (57, 58) together with a pressure--exerting member arranged to exert a lateral pressure on said winding turn in the direction towards the opposite end section (31), and that the end section (30) provided with the drive shaft (32) has a portion (47) thereof made from rubber or some similar elastic material, and in that the pressure member is a roller-shaped member (54) which is driven by the radial displacement movements of the sensing roller (62) and which is arranged to press said end section portion (47) resiliently inwards at a point opposite the sensing roller (62).

of guide or master rollers 24, 25 positioned ahead of the winding-on station 11. These rollers control the rotational speed of the rollers 13, 14 in relation to the winding-on speed of the roll 12.

The smooth web 7 is advanced from its supply roller 5. It travels through a pair of cooperating rollers 26 (similar to rollers 17, 18) which are provided with peripheral beads to shape ribs 27 in the web 7. The pitch of the ribs is identical with the pitch of the indentations 22 formed at the tops and bases of the ridges 10. Further, the web 7 passes a heating device 28, preferably consisting of two nozzles communicating with a source of hot air (not shown). Before reaching the winding-on station 11 the web 7 is guided for lateral alignment by means of an aligner mechanism 29, whereby is ensured that the ribs 27 of the web 7 are received in nesting relationship in the indentations 22 of the web 6. Since the web 7 is heated, it will contract when cooled, thus providing safe and secure attachment of the two webs 6, 7 forming the roll 12 to one another.

The winding-on station 11 comprises two coaxial and rotatably mounted end sections 30, 31. The distance separating the end sections in the operative position is approximately equal to the width of the webs 6, 7 of material, of which the ribbed web 7 should have a width which is fractionally (preferably by 2 millimeters) narrower than the width of the corrugated web 6. The shaft 32 of one of the end sections 30 is rotatably mounted in a bearing 33 in the stand 1 and is driven via a sprocket 34 at the outer end of the shaft 32. At the end opposite the sprocket 34 the shaft 32 is shaped as a trunnion 35 on which may be positioned one end of a core sleeve 36 on which the webs 6, 7 of material are to be wound. An expandable clamping sleeve 37 secures the sleeve 36 to the trunnion 35, and a bolt 39 with a head

aid of an adhesive to the underlying winding turn, the arm 43 is again pivoted outwards and the pressure on the expander sleeve 37 is relieved. The roll 12 together with the core sleeve 37 may now be removed from the machine. In the subsequent cooling of the roll 12 at room temperature the above referred to fixation of the webs takes place owing to the contraction occurring through cooling of the ribbed web. The fixation of the webs to one another means that the finished roll cannot collapse.

The ribs 27 and the indentations 22 form through-flow channels A for the medium flowing through the heat exchanger of the appearance shown in Fig. 13. This configuration results in an enlargement of the heat-transmission area and also means that the flow through the channels A will be turbulent and not laminar. In laminar flows (which would have been the case had the limiting faces of the channels been completely straight) the layer of the medium flowing closest to the limiting faces acts as insulation, preventing the rest of the medium from contacting these faces. The turbulent flow generated in the channels of the roll in accordance with the invention means that a larger portion of the flowing medium will come into close contact with the limiting faces. The effect of this phenomenon and of the enlargement of the heat-transmission area of the channels A as a result of the provision of the ribs 27 make for considerably improved exchange of heat.

The embodiment as described and illustrated is to be regarded as an example only and the various parts of the machine may be constructively altered in a variety of ways within the scope of the appended claims. For instance, the roller 54 externally of the end section 30 may be replaced by a slip shoe supported by the bar 56. Also the opposite end section 31 may be fitted with a

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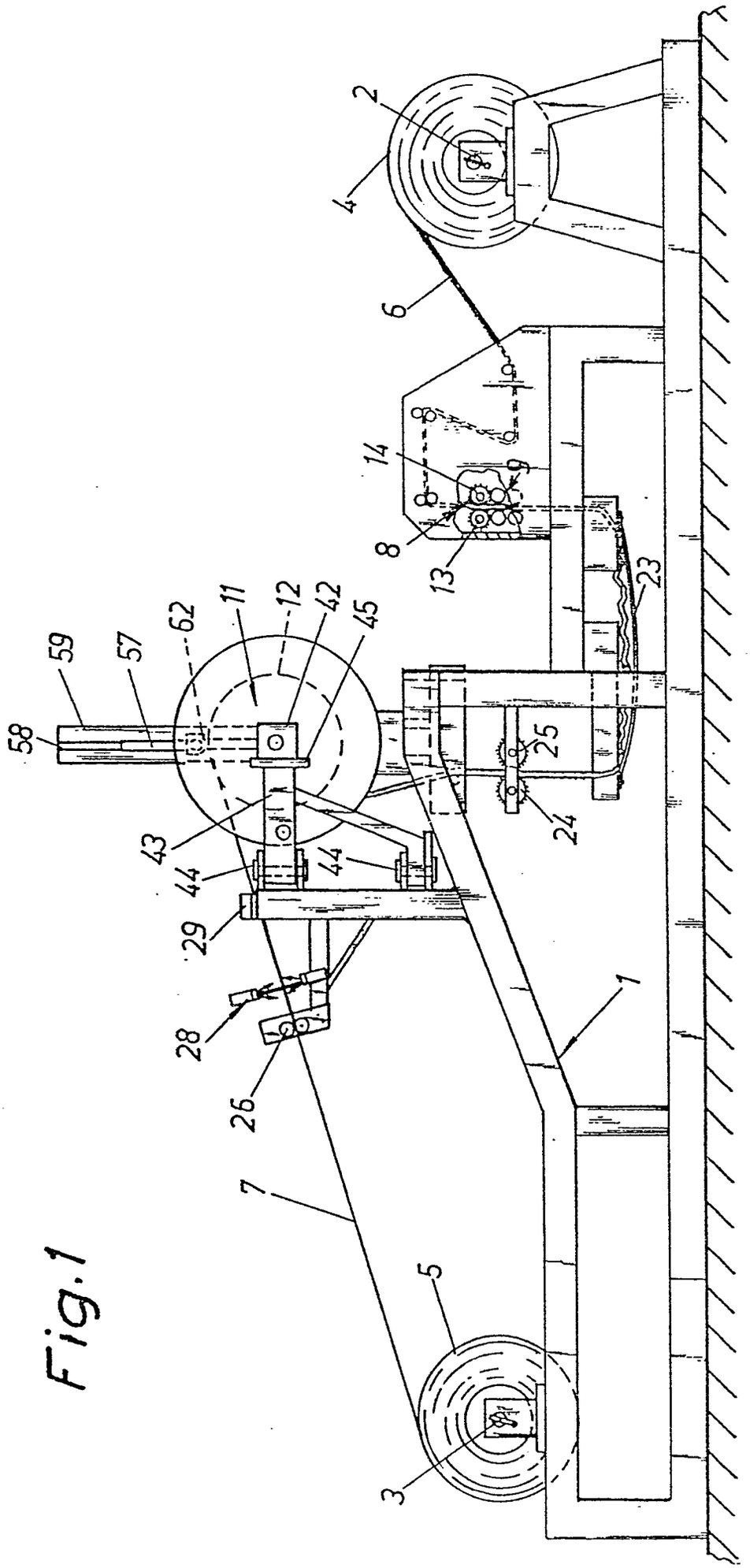

Fig.1

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Fig.2

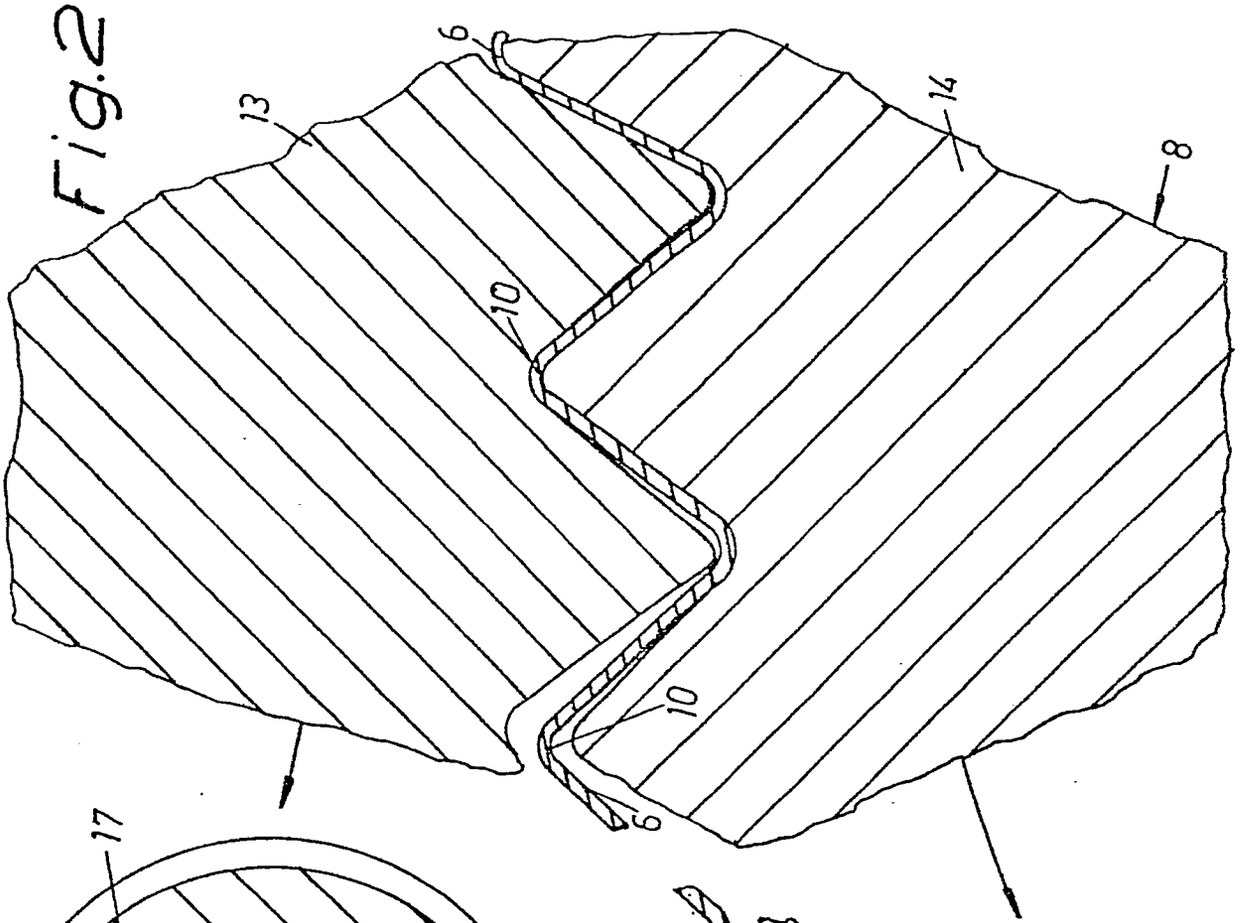

Fig.3

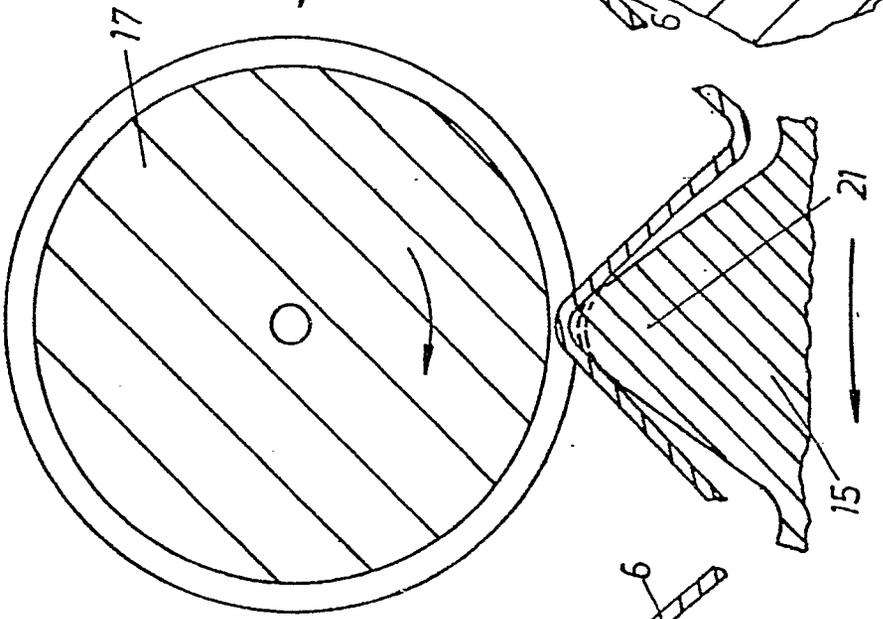

Fig.4

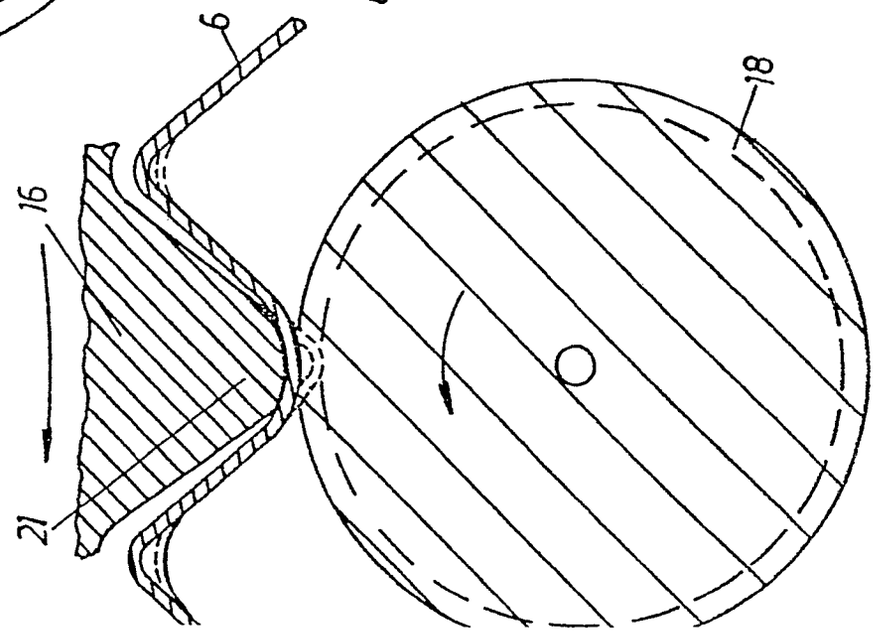

Fig.5

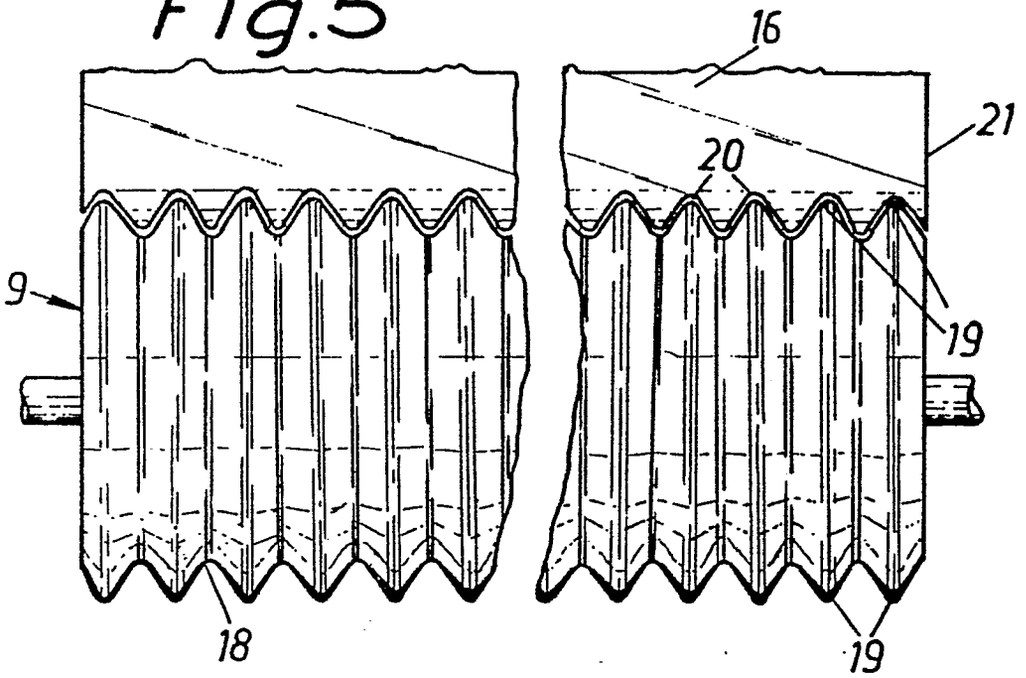

Fig.11

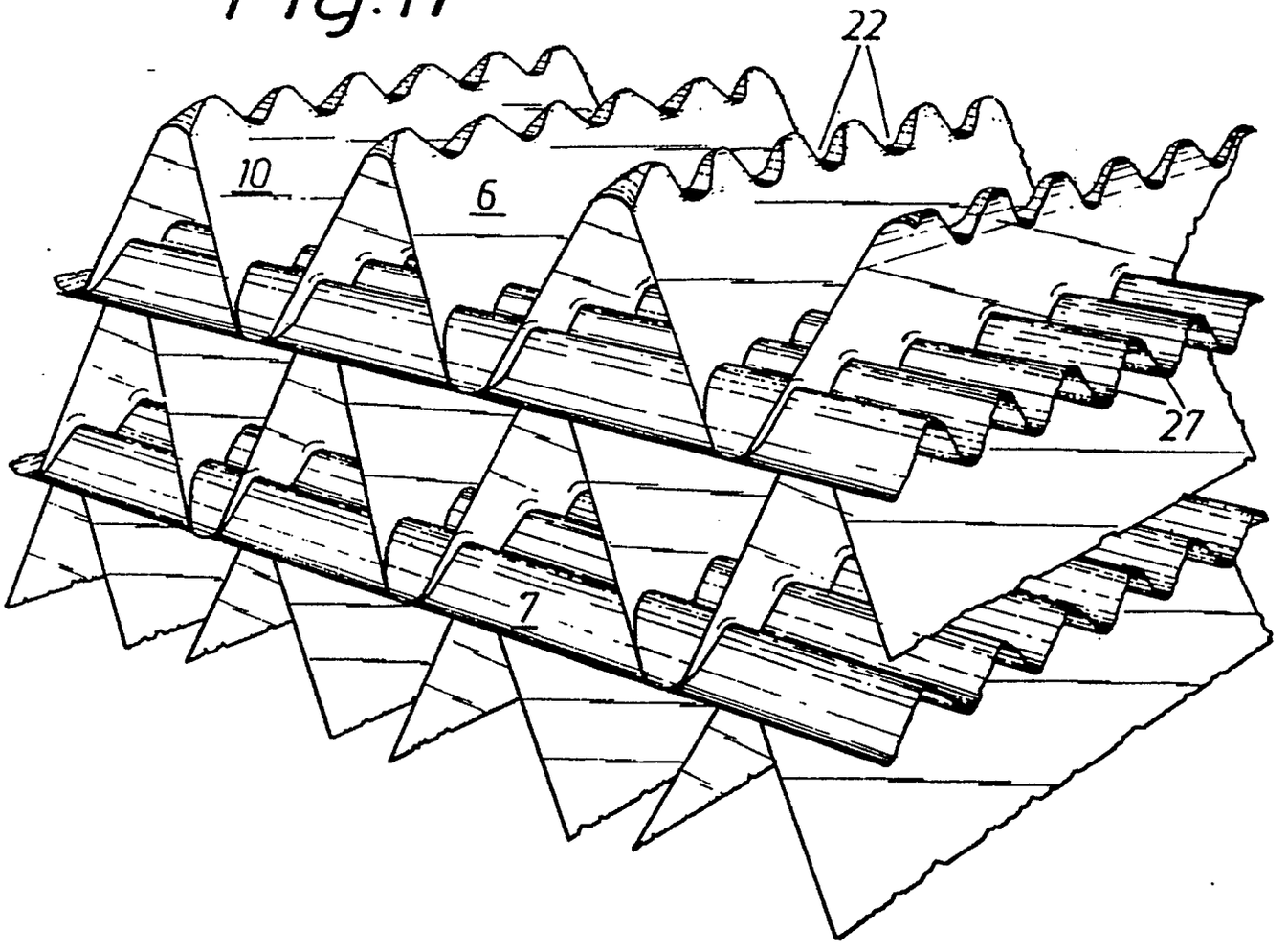

Fig.6

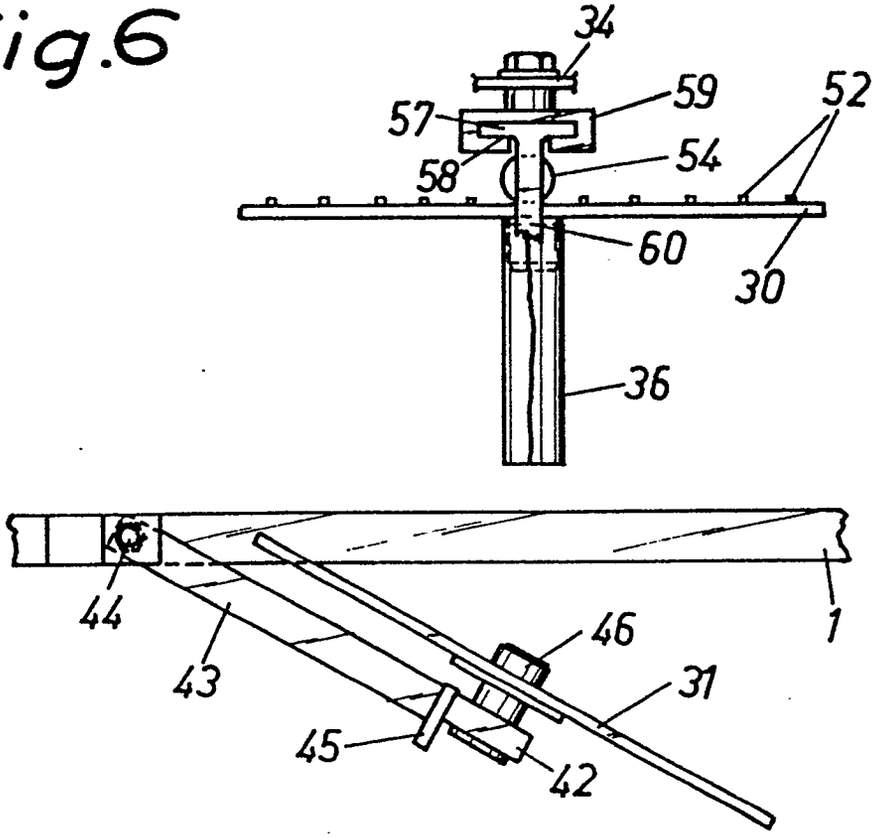
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Fig.7

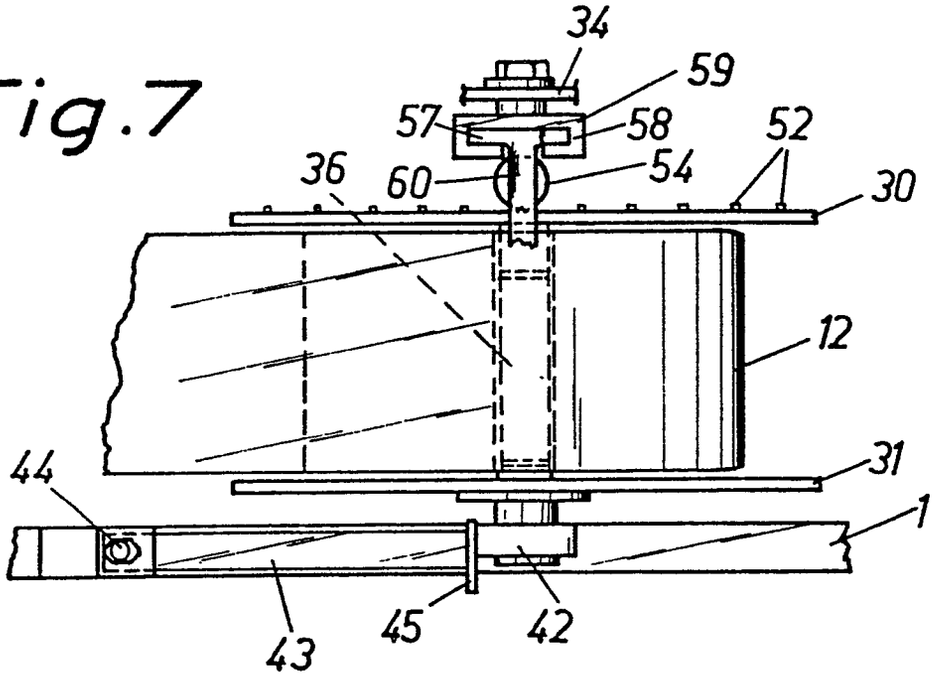
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Fig.10

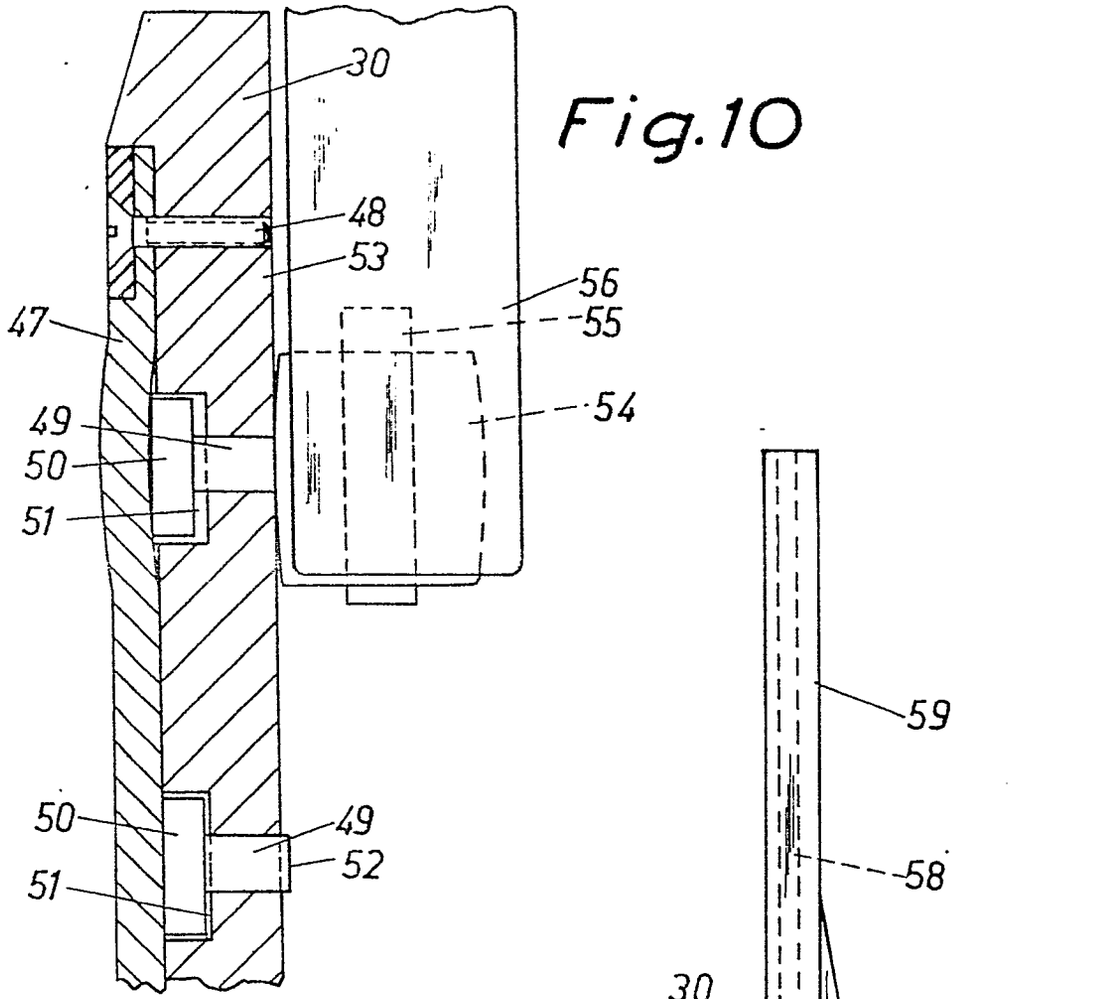

Fig.8

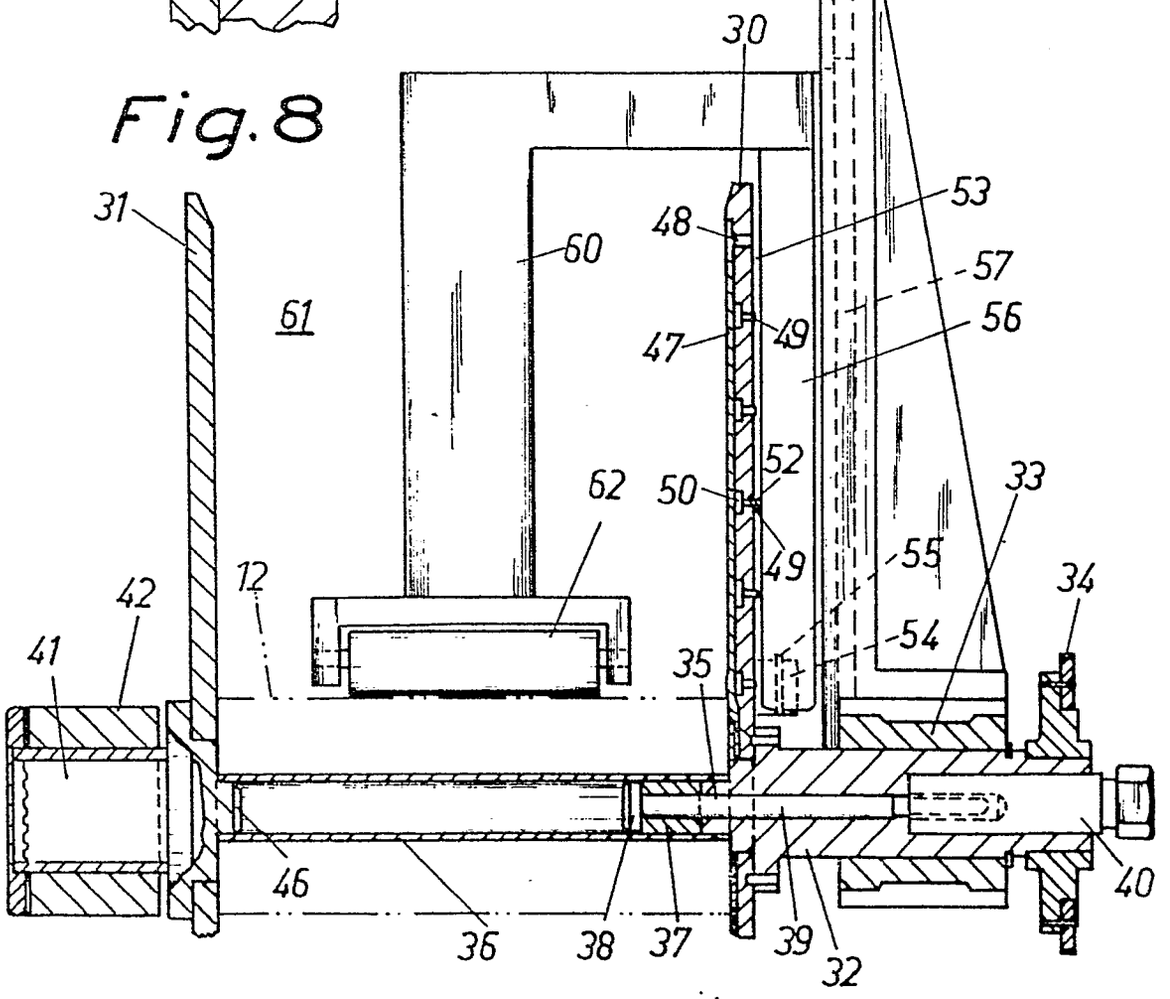

Fig.9

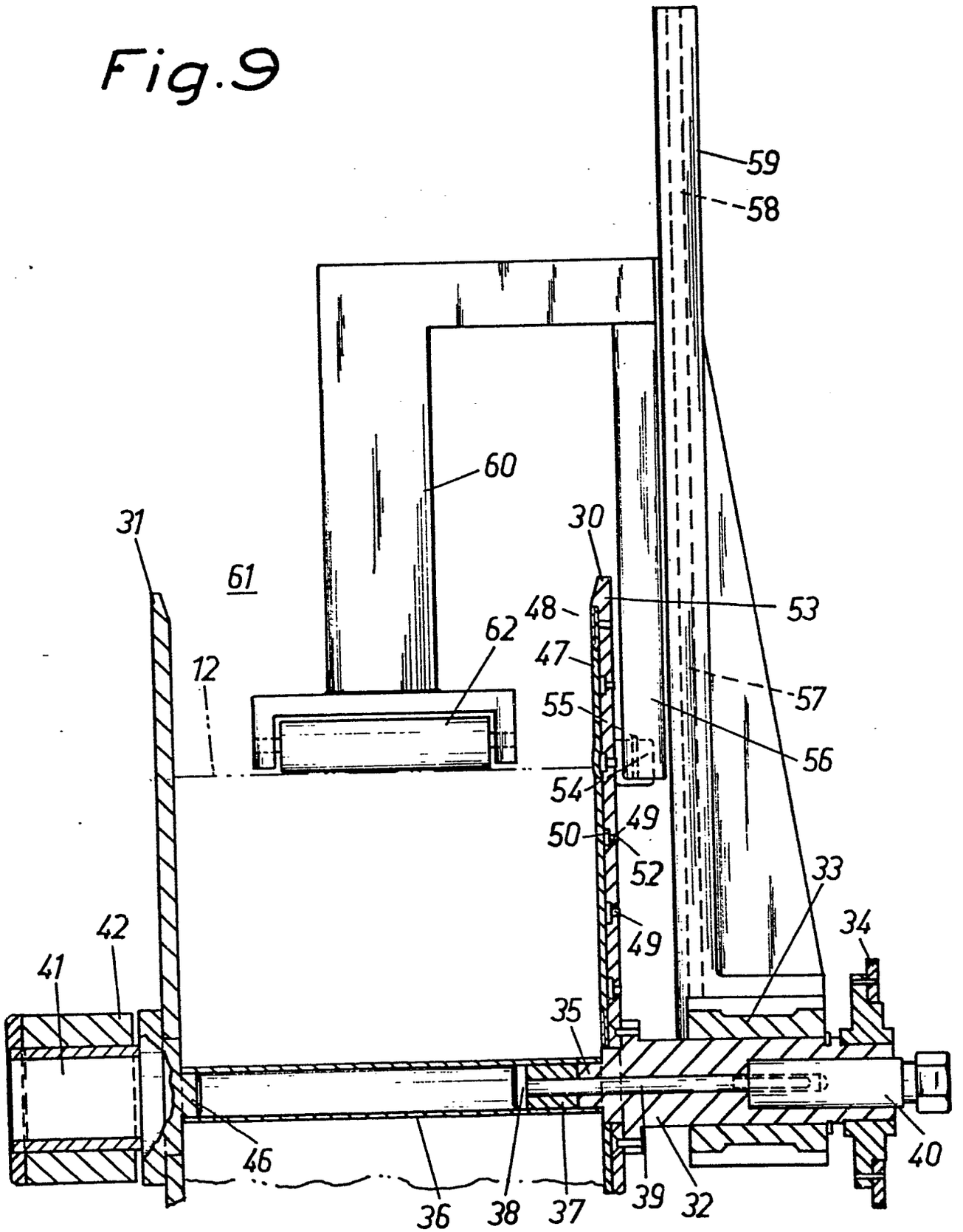
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Fig.13

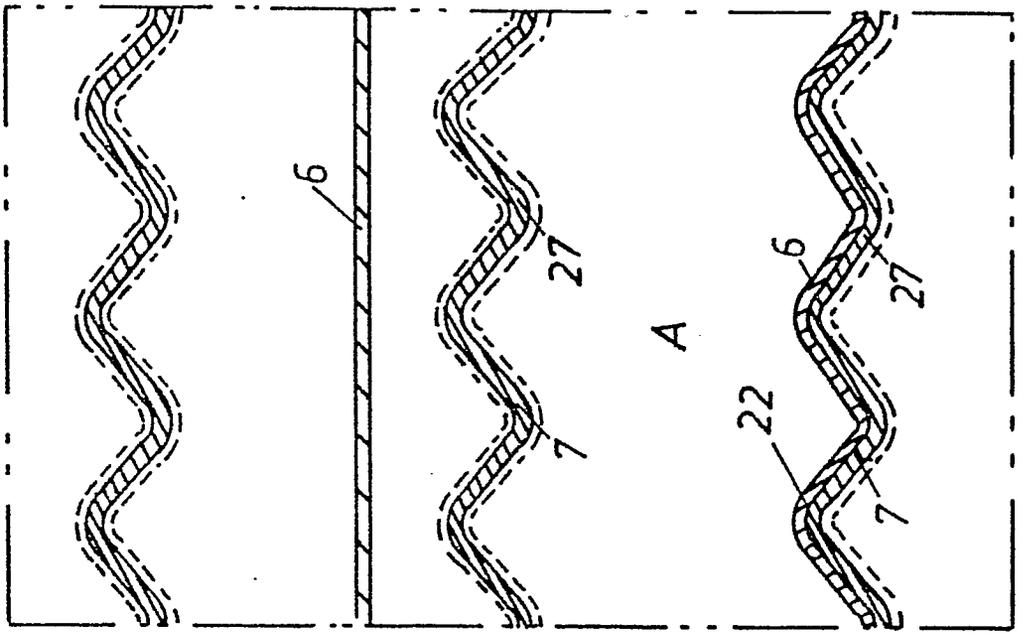

Fig.12

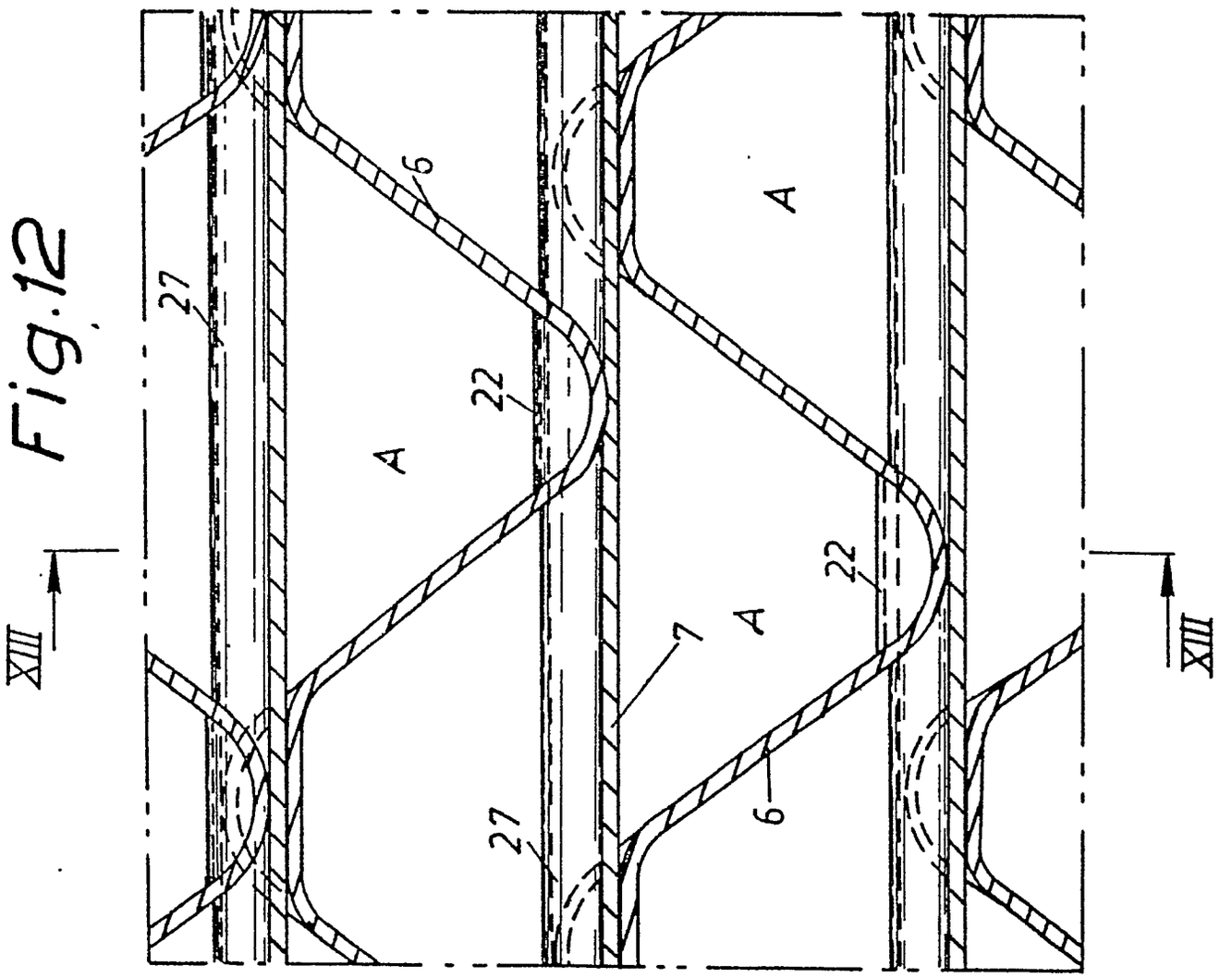

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Fig. 14