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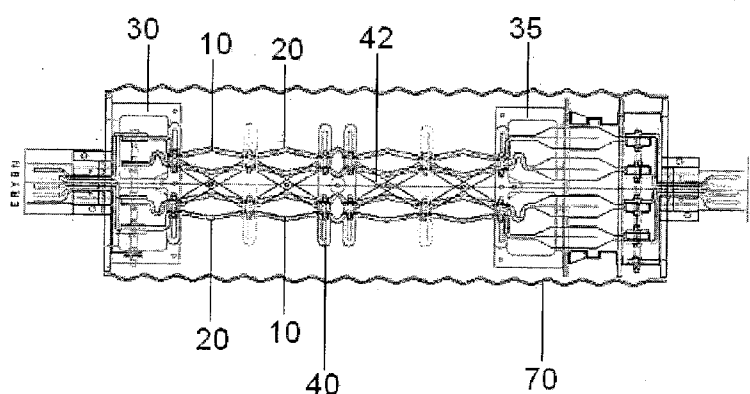


Figure 2

(57) Abstract: A flexible bus duct allowing longitudinal expansion and contraction as well as lateral deflection comprising: a flexible conductor (10) comprising a plurality of conductive strands bound together and providing substantially constant electrical conduction during expansion, contraction or other movement of the bus duct; flexible insulation (20) enclosing the conductor (10) and providing electrical insulation to the conductor (10) and able to expand, contract, and otherwise move proportionally with said conductor (10); a pair of feeder flanges (30, 35) each said feeder flange (30, 35) connecting each end of the conductor (10) to adjacent bus ducts or other electrical transmission devices; a scissor assembly (40) comprising a series of plates (42) forming a scissor like mechanism providing support to the conductor (10) and insulation (20) during expansion and contraction; and a pulley (50) comprising a roller shaft (852) around which the conductor (10) and insulation (20) is bent so as to allow lateral deflection of the conductor (10) and insulation (20).



FLEXIBLE BUS DUCT

FIELD OF INVENTION

The present invention relates generally to electricity supply devices and more particularly to a flexible bus duct.

5 BACKGROUND OF INVENTION

In power transmission applications a big problem is coordination and installation of electrical lines as most buildings and facilities have unique installation requirements. One solution is to have flexible bus ducts capable of conforming to various lengths and angles thus allowing easy on-site installation.

- 10 Currently there are known flexible bus ducts for use with electrical distribution systems and in particular, flexible conductive tracks. One such conductor is disclosed in international application PCT/AU92/00414 wherein there is disclosed an insulating housing able to travel around curves and comers without the need to provide comer junctions or adaptors. This flexible conductor comprises a solid
- 15 copper wire supporting a conductive blade which has a series of cut outs along its length. It was found that this track did not perform to expectation in that it was not wholly conducive to bending and in fact sometimes resulted in damage to the conductive elements.

US Patent 2,105,833 - Feuer, et al shows a track which comprises a flexible

20 moulding having two slits with a wire embedded in each slit. Again only a "point contact" with a tine of a power take off device would occur. Further the moulding does not appear to be able to bend laterally to the slits.

US Patent 2, 175,245 - Brockman whilst showing a flexible track, requires that the contacts are in the form of separate jaws, and also only shows a shape of housing which does not permit bending of the track laterally, but only allows bending with the ingress to the contacts being internal or external to the bend direction.

- 5 In US Patent 2,240,180 - Frank this describes a flexible track. But does not show a track which can bend laterally. Further the contacts have individual jaws to assist bending with the ingress to the contacts being internal or external to the bend direction.

Another patent application discloses an elongate flexible conductor assembly
10 located in a longitudinally extending slot in a housing for use in an electrical bus distributor. The conductor comprises a coiled hollow conductor located in slots provided in the elongate flexible insulated housing. In order to effect engagement between the conductor and the electrical plug, pins on the plug were adapted with connector sockets formed by a bifurcated member which upon engagement with the
15 continuous conducting element spread apart and engaged the conductor on either side. In use, it is predictable that the electrical contact between the connector sockets and the conductor will sometimes be compromised as the sockets after continued use begin to loose their elastic memory upon which reliance was placed to effect proper electrical connection.

- 20 What is desired in the art is a flexible bus duct which is flexible in the longitudinal (expansion) and lateral (deflection) directions, allowing a much more versatile connection angle between rigid bus ducts.

What is also desired is a flexible bus duct that is robust and resisting to heavy movements such as earthquakes.

SUMMARY OF INVENTION

The present invention seeks to ameliorate the aforementioned disadvantages by providing a flexible conductive strip capable of deflection, extension and contraction in three dimensions thus allowing ease of on-site installation.

- 5 This invention relates to a flexible conductor that can deflect and fold with ease and yet transmit electricity like a regular copper bar.

This invention further relates to a flexible bus duct allowing longitudinal expansion and contraction as well as lateral deflection comprising: a length of flexible conductor having two ends and comprising a plurality of conductive strands bound
10 together and providing substantially constant electrical conduction during expansion, contraction or other movement of the bus duct; flexible insulation enclosing the said conductor and providing electrical insulation to the said conductor and able to expand, contract, and otherwise move proportionally with said conductor; a pair of feeder flanges, each said feeder flange connecting each end
15 of the conductor and insulation, to adjacent bus ducts or other electrical transmission devices; and a scissor assembly comprising a series of plates forming a scissor like mechanism providing support to the conductor and insulation during expansion and contraction; a pulley comprising a roller shaft around which the conductor and insulation is bent so as to allow lateral deflection of the conductor
20 and insulation. In a preferred embodiment, there is provided a rubberized housing within which the internal assembly of the conductor, insulation, pair of feeder flanges, scissor assembly, and pulley is housed, and said rubberized housing is able to expand and contract proportionally to said internal assembly. The flexible conductor is prefabricated into a zigzag configuration to allow for longitudinal
25 expansion and contraction thereof.

Whilst having the flexibility, the flexible bus duct must comply with the international standard bodies like International Electrotechnical Commission (IEC), NEMA, Underwriters Laboratory (UL) and British Standard (BS). For instance in this case it complies with IEC 60439-2 latest edition.

- 5 Besides the use of flexible parts, a dampening system with shock absorbers can be added to the system for resisting heavy movement such as those experienced during earthquakes. This will allow the bus duct to transmit electricity as per normal even in an event of an earthquake.

Other objects and advantages will be more fully apparent from the following
10 disclosure and appended claims.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 shows an overall view of an embodiment of this invention.

Figure 2 shows a plan view of a flexible bus duct in an embodiment of this invention.

- 15 Figure 3 shows a plan view of a scissor assembly in an embodiment of this invention.

Figure 4 shows a plan view of a scissor assembly in a contracted state in an embodiment of this invention.

- Figure 5 shows a plan view of a scissor assembly in an extended state in an
20 embodiment of this invention.

Figure 6 shows a view of a clamp sub assembly in an embodiment of this invention.

Figure 7 shows a plan view of a flexible bus duct in a contracted state in an embodiment of this invention.

Figure 8 shows a side view of a flexible bus duct in an embodiment of this
5 invention.

Figure 9 shows a side view of a vertical pulley in an embodiment of this invention.

Figure 10 shows a side view of a vertical pulley in a mid position in an embodiment
of this invention.

Figure 11 shows a side view of a vertical pulley in a low position in an embodiment
10 of this invention.

Figure 12 shows a side view of a horizontal pulley in an embodiment of this
invention.

Figure 13 shows a side view of a horizontal pulley in a center position in an
embodiment of this invention.

15 Figure 14 shows a side view of a horizontal pulley in an extended state in an
embodiment of this invention.

Figure 15 shows a side view of a horizontal pulley in a state of positive deflection in
an embodiment of this invention.

Figure 16 shows a side view of a horizontal pulley in a state of negative deflection in an embodiment of this invention.

Figure 17a shows a front view of a flexible bus duct in a second embodiment of this invention.

5 Figure 17b shows a side view of a flexible bus duct in a second embodiment of this invention.

Figure 18a shows a perspective view of a ball joint in an embodiment of this invention.

Figure 18b shows a perspective view of a ball joint in an embodiment of this
10 invention.

Figure 18c shows a perspective view of a ball joint in an embodiment of this invention.

Figure 18d shows a perspective view of a ball joint in an embodiment of this invention.

15 DETAILED DESCRIPTION OF INVENTION

It should be noted that the following detailed description is directed to a flexible bus duct and is not limited to any particular size or configuration but in fact a multitude of sizes and configurations within the general scope of the following description.

Referring to Figure 1, there is shown a flexible bus duct (1) joining adjacent rigid
20 bus ducts (80) in a typical electrical transmission line, such as from a transformer to

a switchboard layout. The flexible bus duct (1) is designed to extend and contract in a longitudinal direction, as well as deflect in both a vertical and horizontal lateral direction. In other words, the flexible bus duct (1) is capable of adjustments along 3 axes or dimensions.

- 5 A more detailed view of the bus duct is shown in Figures 2, where there can be seen a flexible bus duct (1) allowing longitudinal expansion and contraction as well as lateral deflection comprising a flexible conductor (10) comprising a plurality of conductive strands bound together and providing substantially constant electrical conduction during expansion, contraction or other movement of the bus duct;
- 10 flexible insulation (20) enclosing the said conductor and providing electrical insulation to the said conductor (10) and able to expand, contract, and otherwise move proportionally with said conductor (10); a pair of feeder flanges (30, 35), each said feeder flange connecting each end of the conductor (10) to adjacent bus ducts (80) or other electrical transmission devices; a scissor assembly (40) comprising a
- 15 series of scissor plates (42) forming a scissor like mechanism providing support to the conductor and insulation during expansion and contraction; and a pulley (not shown) comprising a roller shaft around which the conductor and insulation is bent so as to allow lateral deflection of the conductor and insulation. The said conductor (10) is specially made from pure copper or aluminum and conducts electric current
- 20 while maintaining flexibility to extend and contract.

Still referring to Figures 2, 2a and 2b, the flexible conductor (10) can be made of copper or aluminum in preferred embodiments. It can be made in rectangular, cylindrical or tube cross section and then formed into a zig zag or wave like configuration. This flexible conductor (10) comprises many fine strands bound

25 together, which is mechanically and electrically different from a cable. This flexible conductor (10) has a current capacity of between 200 to 10,000 amperes. The objective of this conductor is to conduct electricity efficiently without any

deterioration during movements of expansion, contraction and lateral deflection. The flexible insulation (20) is made from a material that provides good electrical insulation while having good mechanical properties where it can withstand heat and open flame, and is flexible to expand and contract proportionally to the flexible
5 conductor (10). The insulation is mainly to insulate the conductor phases to avoid a short circuit.

The feeder flanges (30, 35) are made of copper or aluminum conductors acting as an interface to connect onto adjacent rigid bus ducts (80) made up of rigid rectangular conductors. One feeder flange (30, 35) is attached to each end of the flexible
10 conductor (10) to allow connection onto the rest of the bus duct routing (see figure 1).

Covering the internal assembly of the bus duct is a pleated rubberized or silicon housing (70) the function of which is to avoid ingress of water and dust. The pleated design allows it to expand and contract proportionally to the internal assembly. This
15 rubber housing (70) is made of special rubber to withstand heat, UV resistance while maintaining the flexibility.

Referring now to Figures 3, 4 and 5, the longitudinal extension and contraction mechanism of the flexible bus duct (1) is illustrated. The flexible conductor (10) is wrapped by a layer of insulation (20) and prefabricated into a zigzag arrangement to
20 allow its structure to expand and contract. This flexible conductor (10) will be responsible to transmit electricity while the scissor assembly (40) guides its movement along the longitudinal direction. In order for the flexible conductor (10) to expand and contract in an orderly and predictable manner, a scissor assembly (40) guides and supports the flexible conductor (10) in position during movements of the
25 bus duct. A series of cross-linked rectangular steel scissor plates (42) forming a scissor like configuration and bolted at the center allowing it to extend and contract

along with the flexible conductor (10) while supporting it. This mechanical expansion and contraction must be proportional to the flexible conductor (10). The ends of the scissor plate (42) are bolted onto a U clamp sub assembly (44) which then slides along the slots (45) available on the pivot plate (46) and sliding plate 5 (48). This scissor assembly (40) is then connected in series to form a mechanism that allows for extension and contraction of the flexible conductor (10) in an orderly manner to which the flexible conductors (10) can be bolted. Estimated extension and contraction in total is between 100mm to 2000mm.

The slots (45) are made as a junction for the U sub assembly (44) and the scissor 10 plate (42) to be bolted on perpendicularly to allow proper sliding during extension and contraction. At the center of the pivot plate (46) there is a rod acting as a shaft bolted to allow free movement to tilt allowing the swinging in the left and right direction. Estimated total swing to left and right is from 100mm to 600mm.

Figure 6 shows how the U clamp sub assembly (44) is clamped onto the flexible 15 conductor (10). The function of the U sub assembly (44) is to clamp onto the flexible conductor (10) firmly while the ends are bolted to the pivot plate (46) and scissor plate (42) along the scissor assembly (40). The U sub assembly (44) consists of 2 insulated rods (47) clamping onto the flexible conductor (10) by U brackets and tightened by bolts installed side ways. Both ends have the same arrangement and the 20 insulated rods (47) are then bolted on the slots on the sliding plates (48) for free sliding. With the flexible conductor (10) formed in a mechanical zigzag or wave shape, every pitch will be mounted with a U sub assembly (44) holding the flexible conductor (10) in position. Furthermore the U sub assembly (44) must be able to 25 withstand mechanical shocks in an event of heavy movement such as in the event of earthquakes, electrical short circuits or any other means of large external mechanical forces.

Figure 7 shows the flexible bus duct (1) in a contracted state. As the entire bus duct contracts, the scissor assembly (40), flexible conductor (10) and rubberized housing (70) all contract linearly. The rubberized housing (70) is mounted onto the frames of feeder flanges (30, 35) by steel belts.

- 5 Referring now to Figures 8 through 11, the vertical deflection of the bus duct (1) is illustrated along with the following description. As the flexible conductor (10) connects to the feeder flanges (30, 35), the conductor (10) is formed into an edgewise manner. The insulator rods (47) will clamp the conductor (10) down and hold it in an edgewise manner to be aligned with a pulley system (50). At the end of
10 this flexible conductor (10) is a connector piece (37) which bolts onto the feeder flange rectangular solid conductor (30, 35).

The flexible bus duct (1) is able to deflect in a vertical direction within a range of 100mm to 1000mm. The flexible conductor (10) wrapped in insulation (20) will be shape in a U bend rolling over a roller shaft (52). Each end of the U bend (54, 56)
15 will be connected to the scissor assembly (40) and feeder flange (30, 35). As the feeder flange (35) moves upwards, the roller shaft will slide upwards together with the feeder flange (35) and hence one side of the U bend will be elongated and the other side becomes shorter. Similarly if the feeder flange (35) slides downwards, the U bend attached to the feeder flange (35) side will get elongated and the other side
20 will be shorter.

Figures 12 through 14 show an alternate embodiment where a similar pulley system used for the lateral deflection is employed for the longitudinal extension and contraction with the pulley system rotated at 90°.

Figures 15 through 16 show yet another alternate embodiment where a modified pulley system is used for both the lateral deflection and the longitudinal extension and contraction.

Now referring to Figures 17a and 17b, there is seen a flexible bus duct in a second embodiment of this invention. The flange end busduct (310) is a common part that would be use to connect the adjacent feeder or plug in busducts. It is made by rigid copper or aluminum conductor and ranging from 200 amperes to 10,000 amperes. On the conductor end it will be spread out to connect to the flexible conductor. A pair of mounting block (320) connects the steel bracket (330) to flexible housing (70). The mounting block (320) is use to house the external flexible rubber housing (70). The said flexible rubber housing (70) is flexible and flame retardant serves the purpose of contraction, expansion and deflection. A steel bracket (330) is attached with the mounting block (320) and a ball joint swing arm (90). The steel brackets (330) allow ball joint swing arm (90) to move freely on the Y-axis. The steel brackets (330) at both ends of the busduct is attached to the mounting block (320). These brackets (330) are the main mechanism connecting the flexible housing (70) to the flange end busduct (310).

The ball joint swing arm (90) is attached with the steel bracket (330), and is able to swing 180° on Y-axis. The ball joint end (92) provides a swing of 30° in the Y and Z-axis. At the end of each swing arm (90) there is a ball joint (92) allowing it to swing up down and left right. The swing arm (90) will be responsible for contraction and extension. Connecting bars (94) connects the ball joint swing arm (90) and the twin headed ball joint arm (96). Similarly to the ball joint swing arm (90), the connecting bars (94) and twin headed ball joint arm (96) that connects to other swing arm provides a complete swing mechanism that allows movement 3 dimensionally.

Figures 18a through 18d show the said ball joint (92) with the ball stud able to deflect in 3 possible movements at maximum 30° on X, Y and Z-axis to allow for the 3 dimensional movement of the busduct. A ball stud (921) sits within a ball seat (922) and said ball stud (921) is able to move in 3 distinct directions. The ball seat
5 (922) is connected to a bracket (923).

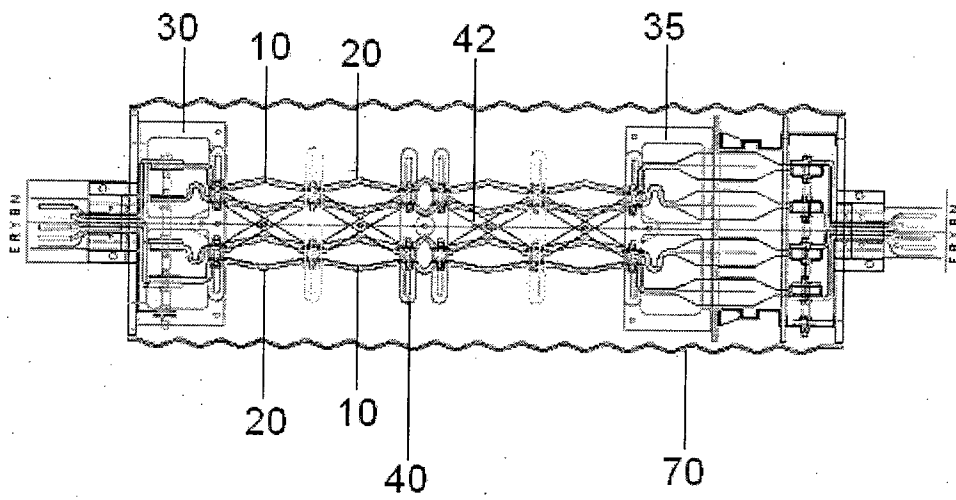
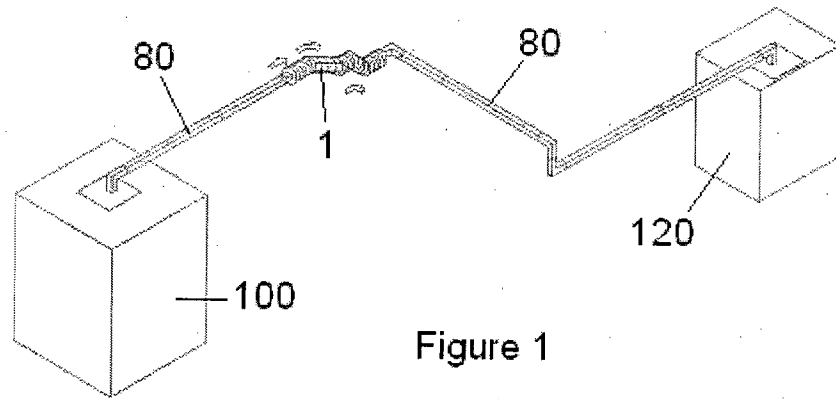
While several particularly preferred embodiments of the present invention have been described and illustrated, it should now be apparent to those skilled in the art that various changes and modifications can be made without departing from the spirit and scope of the invention. Accordingly, the following claims are intended to
10 embrace such changes, modifications, and areas of application that are within the spirit and scope of this invention.

CLAIMS

1. A flexible bus duct allowing longitudinal expansion and contraction as well as lateral deflection comprising:
a length of flexible conductor (10) having two ends and comprising a plurality of
5 conductive strands bound together and providing substantially constant electrical conduction during expansion, contraction or other movement of the bus duct;
flexible insulation (20) enclosing the said conductor (10) and providing electrical insulation to the said conductor (10) and able to expand, contract, and otherwise move proportionally with said conductor (10);
10 a pair of feeder flanges (30, 35), each said feeder flange connecting each end of the conductor (10) and insulation (20), to adjacent bus ducts (80) or other electrical transmission devices;
a scissor assembly (40) comprising a series of plates (42) forming a scissor like mechanism providing support to the conductor (10) and insulation (20) during
15 expansion and contraction; and
a pulley system (50) comprising a roller shaft (52) around which the conductor (10) and insulation (20) is bent so as to allow lateral deflection of the conductor (10) and insulation (20).
2. A flexible bus duct according to claim 1, further comprising a rubberized housing
20 (70) within which the internal assembly of the conductor (10), insulation (20), pair of feeder flanges (30, 35), scissor assembly (40), and pulley (50) is housed, and said rubberized housing (70) is able to expand and contract proportionally to said internal assembly.
3. A flexible bus duct according to claims 1 or 2, wherein said flexible conductor
25 (10) is prefabricated into a zigzag configuration to allow for longitudinal expansion and contraction thereof.

4. A flexible bus duct according to any one of the preceding claims, wherein said scissor assembly (40) is mounted at one end to said feeder flange (30, 35) and at the other end to an insulator plate frame.
5. A flexible bus duct according to any one of the preceding claims, wherein said
5 scissor assembly (40) is bolted onto said conductor (10) by a clamp (44).
6. A flexible bus duct allowing 3-dimensional expansion and contraction comprising:
a length of flexible conductor (10) having two ends and comprising a plurality of
conductive strands bound together and providing substantially constant electrical
10 conduction during expansion, contraction or other movement of the bus duct;
flexible insulation (20) enclosing the said conductor (10) and providing electrical
insulation to the said conductor (10) and able to expand, contract, and otherwise
move proportionally with said conductor (10); and
a steel bracket (330) attached to a ball joint swing arm (90);
15 a ball joint (92) attached to the ball joint swing arm (90), said ball joint (92) able to
move in 3 directions.
7. A flexible bus duct allowing 3-dimensional expansion and contraction according
to claim 6, wherein the ball joint (92) comprises a ball stud (921), said ball stud able
to move relative to said ball joint (92) in 3 directions at an angle of 30°.
- 20 8. A flexible bus duct allowing 3-dimensional expansion and contraction according
to claim 7, wherein the ball stud (921) sits within a ball seat (922) and the ball seat
(922) is connected to a bracket (923).

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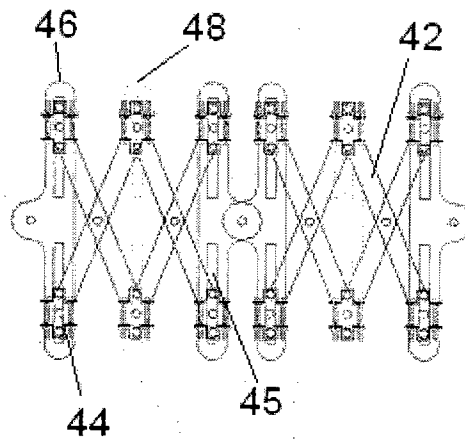


Figure 3

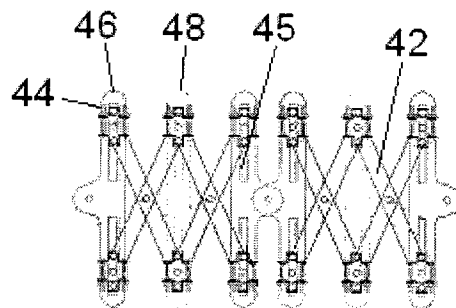


Figure 4

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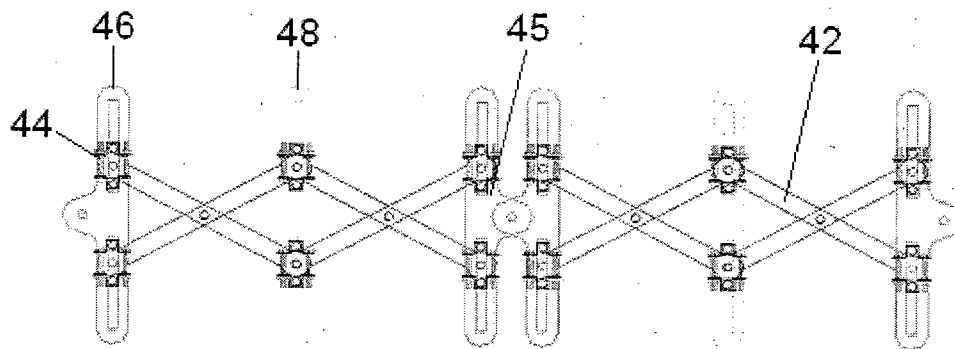


Figure 5

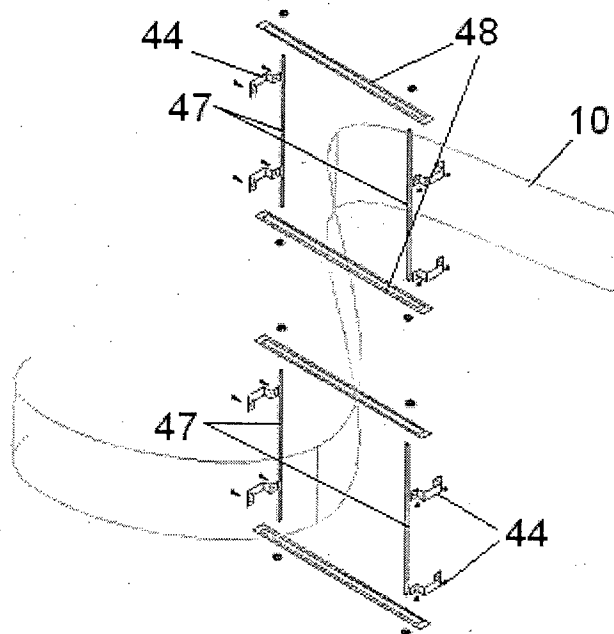


Figure 6

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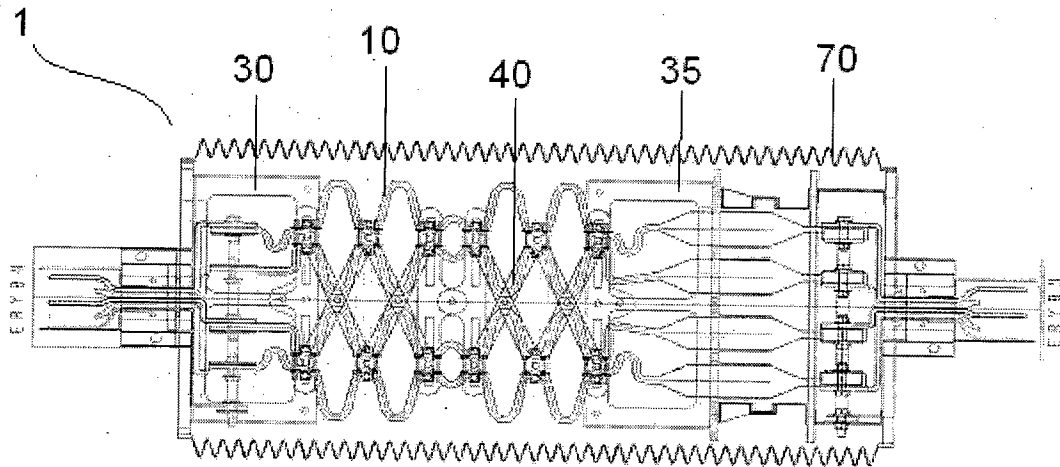


Figure 7

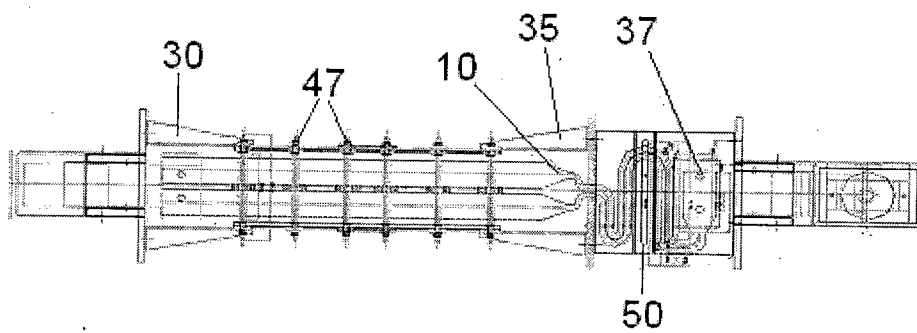


Figure 8

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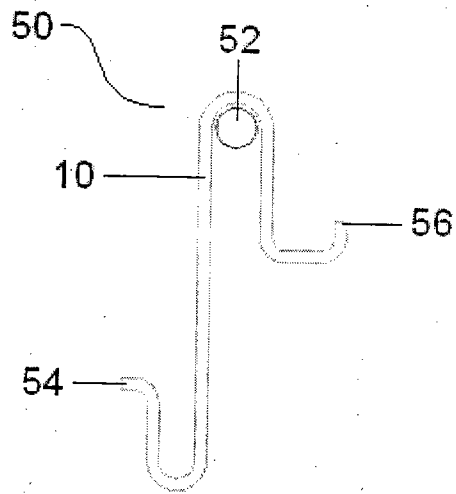


Figure 9

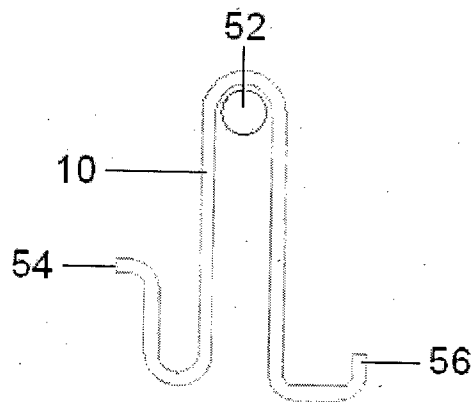


Figure 10

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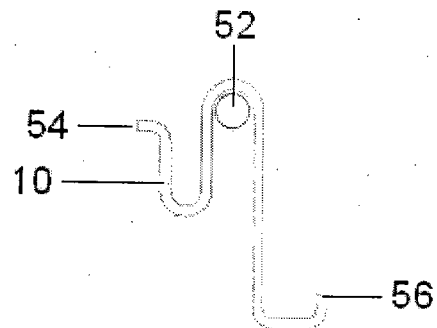


Figure 11

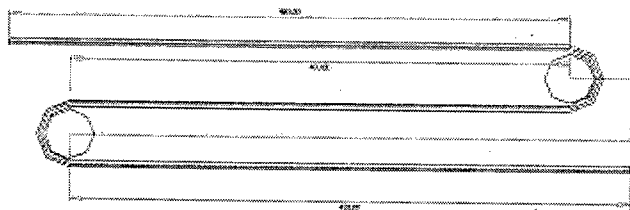


Figure 12

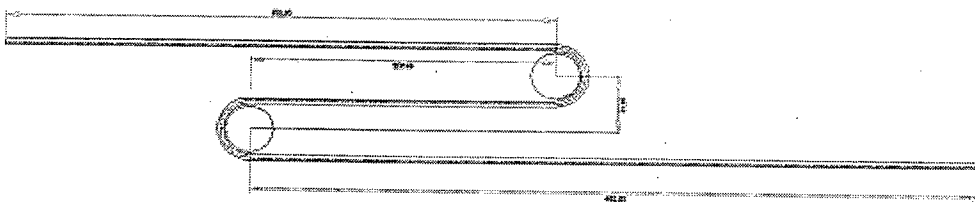


Figure 13

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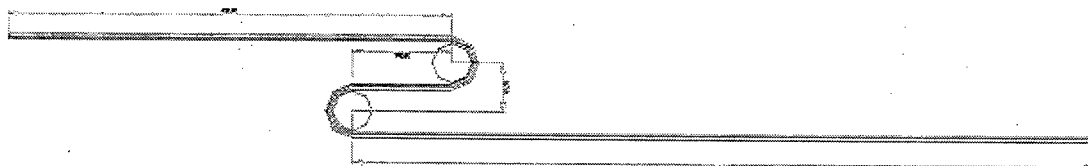


Figure 14

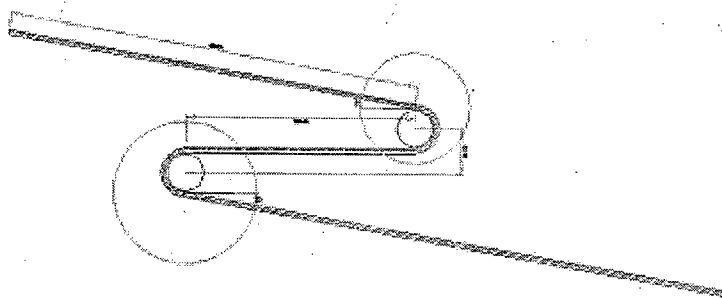


Figure 15

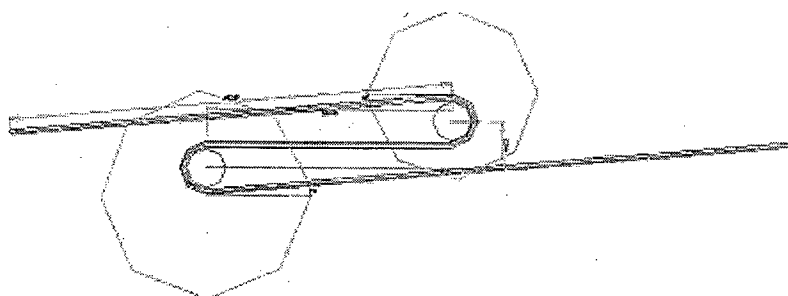


Figure 16

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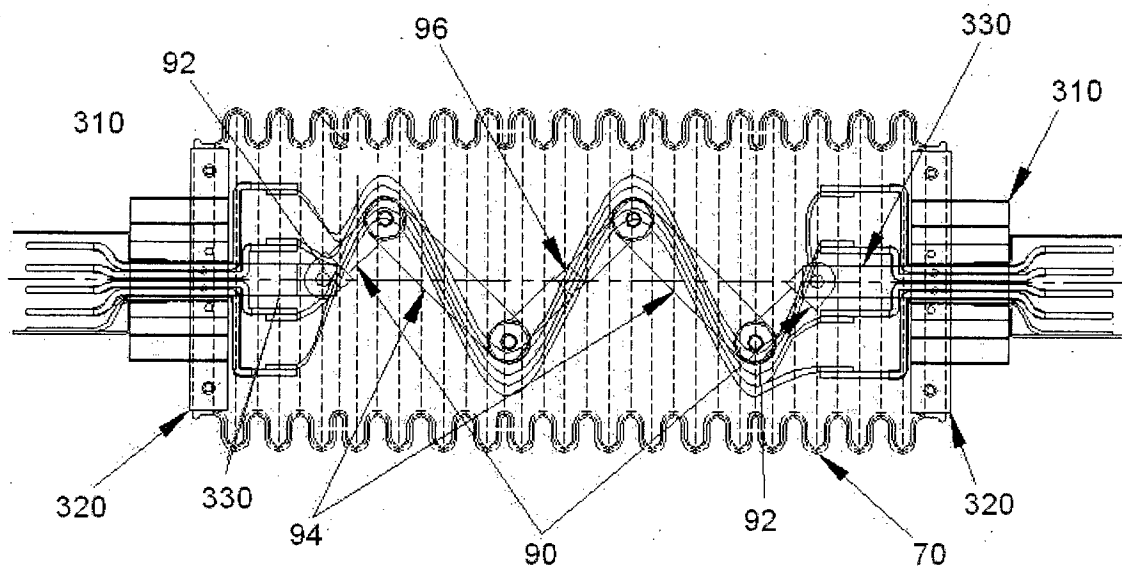


Figure 17a

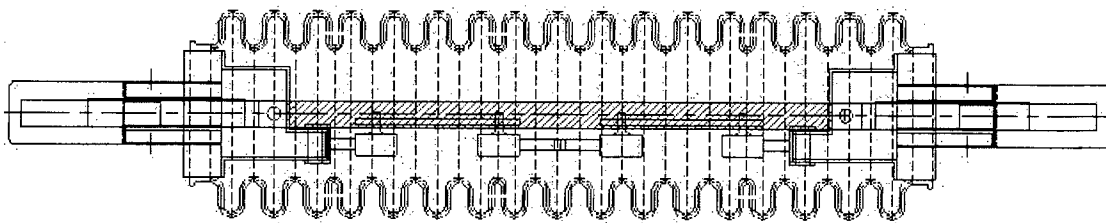


Figure 17b

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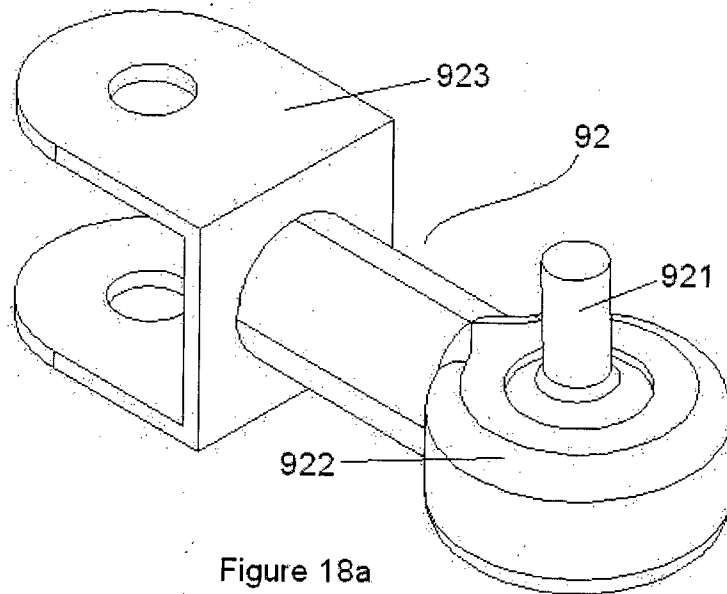


Figure 18a

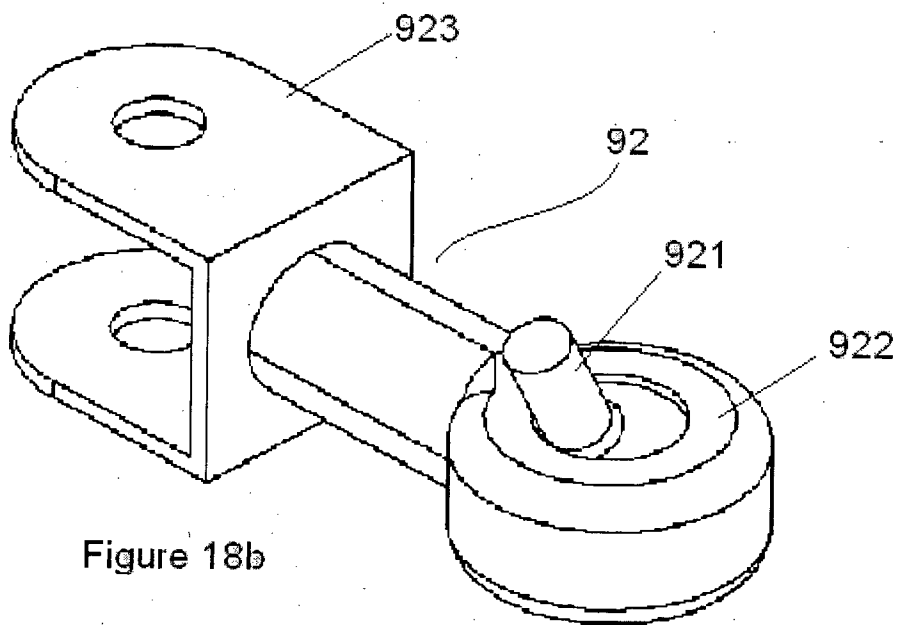


Figure 18b

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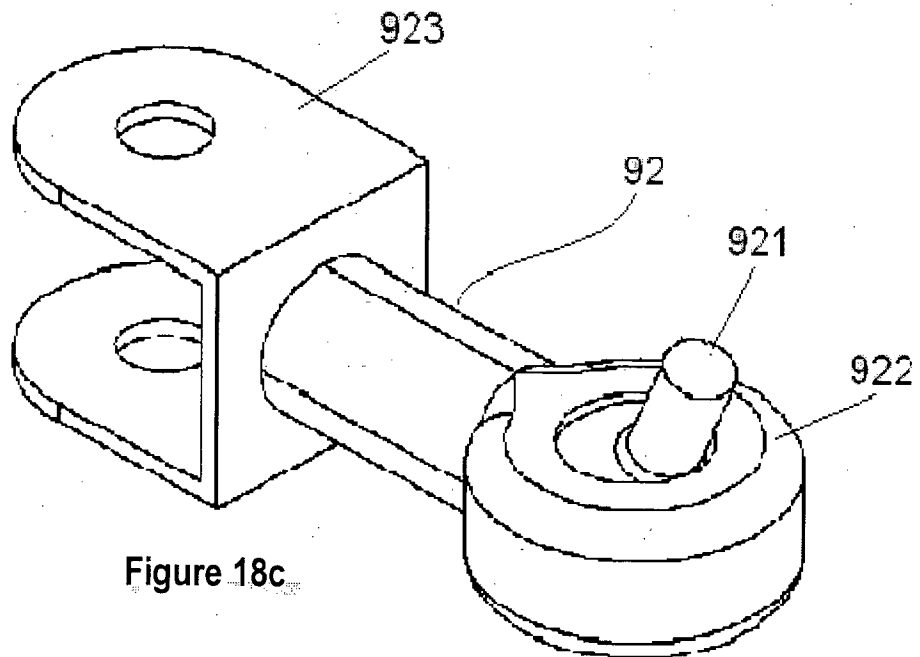


Figure 18c

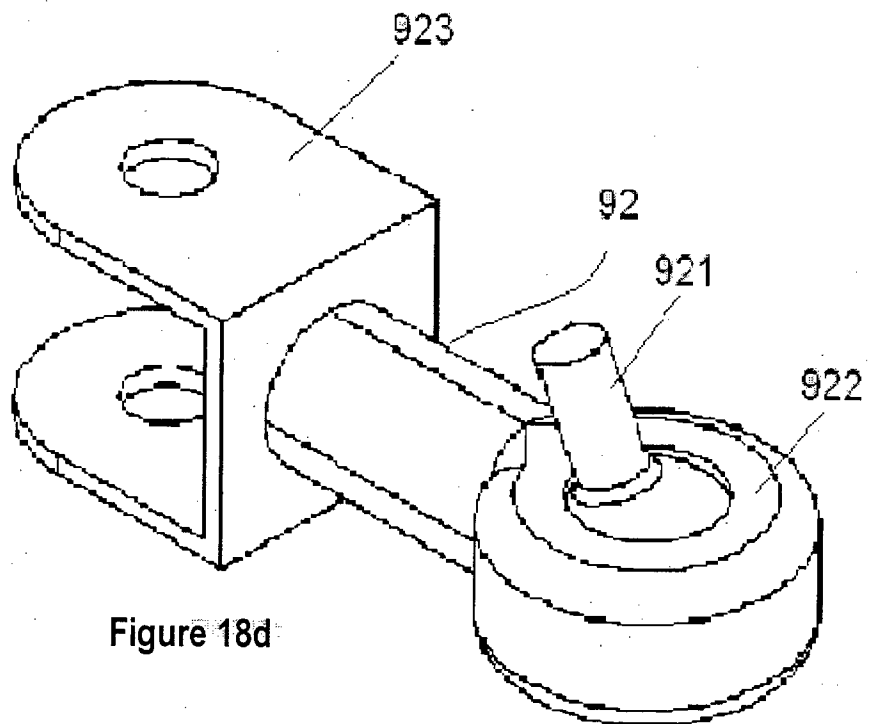


Figure 18d