Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2327341 C 2003/04/29

(11)(21) 2 327 341

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2000/02/07
(87) Date publication PCT/PCT Publication Date: 2000/08/17
(45) Date de délivrance/Issue Date: 2003/04/29
(85) Entrée phase nationale/National Entry: 2000/10/03
(86) N° demande PCT/PCT Application No.: US 2000/003075
(87) N° publication PCT/PCT Publication No.: 2000/047428
(30) Priorité/Priority: 1999/02/11 (09/248,301) US

(51) Cl.Int.^{7}/Int.Cl.^{7} B29C 73/02, B62D 55/32, B29C 73/20

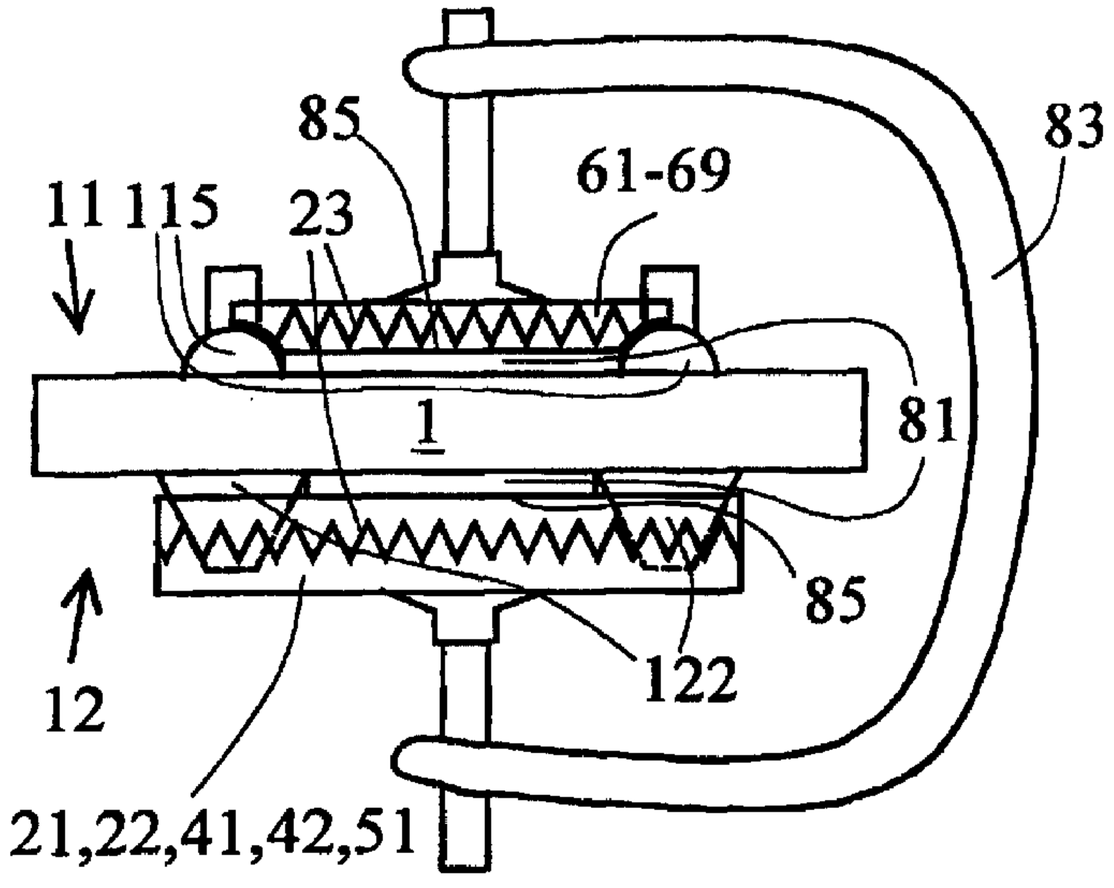
(72) Inventeurs/Inventors:
CARROLL, BRIAN E., US;
POUTRE, PETER F., US

(73) Propriétaire/Owner:
CARROLL TECH, INC., US

(74) Agent: BERESKIN & PARR

(54) Titre : SYSTEME, APPAREIL, PROCEDE ET PRODUIT DESTINES A LA REPARATION DE CHENILLES DE MOTONEIGE

(54) Title: SNOWMOBILE TRACK REPAIR SYSTEM, APPARATUS, METHOD AND PRODUCT



(57) Abrégé/Abstract:
A system, method and apparatus to repair a flexible endless track (1) of a track-driven vehicle such as a snowmobile increases the usable life of the track and avoids its disposal. In the preferred embodiment, a worn section of a snowmobile track (1) is first prepared for repair by cleaning, grinding and tack gluing. Next, suitable hot vulcanizing repair materials (81) are placed over the worn spot. Finally, a number of tools (21, 22, 41, 42, 51, 61-69, 86) according to the invention are used to press these materials (81) into place, and necessary heat (23) and pressure is applied for the necessary length of time to complete the repair process.

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : B60C	A2	(11) International Publication Number: WO 00/47428
		(43) International Publication Date: 17 August 2000 (17.08.00)

(21) International Application Number: PCT/US00/03075

(22) International Filing Date: 7 February 2000 (07.02.00)

(30) Priority Data:
09/248,301 11 February 1999 (11.02.99) US

(63) Related by Continuation (CON) or Continuation-in-Part (CIP) to Earlier Application
US 09/248,301 (CON)
Filed on 11 February 1999 (11.02.99)

(71) Applicant *(for all designated States except US)*: CARROLL TECH, INC. [US/US]; 37 Jones Drive, Niskayuna, NY 12309 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: CARROLL, Brian, E. [US/US]; 37 Jones Drive, Niskayuna, NY 12309 (US). POUTRE, Peter, F. [US/US]; 54 Russell Road, Albany, NY 12205 (US).

(74) Agent: YABLON, Jay, R.; 910 Northumberland Drive, Schenectady, NY 12309–2814 (US).

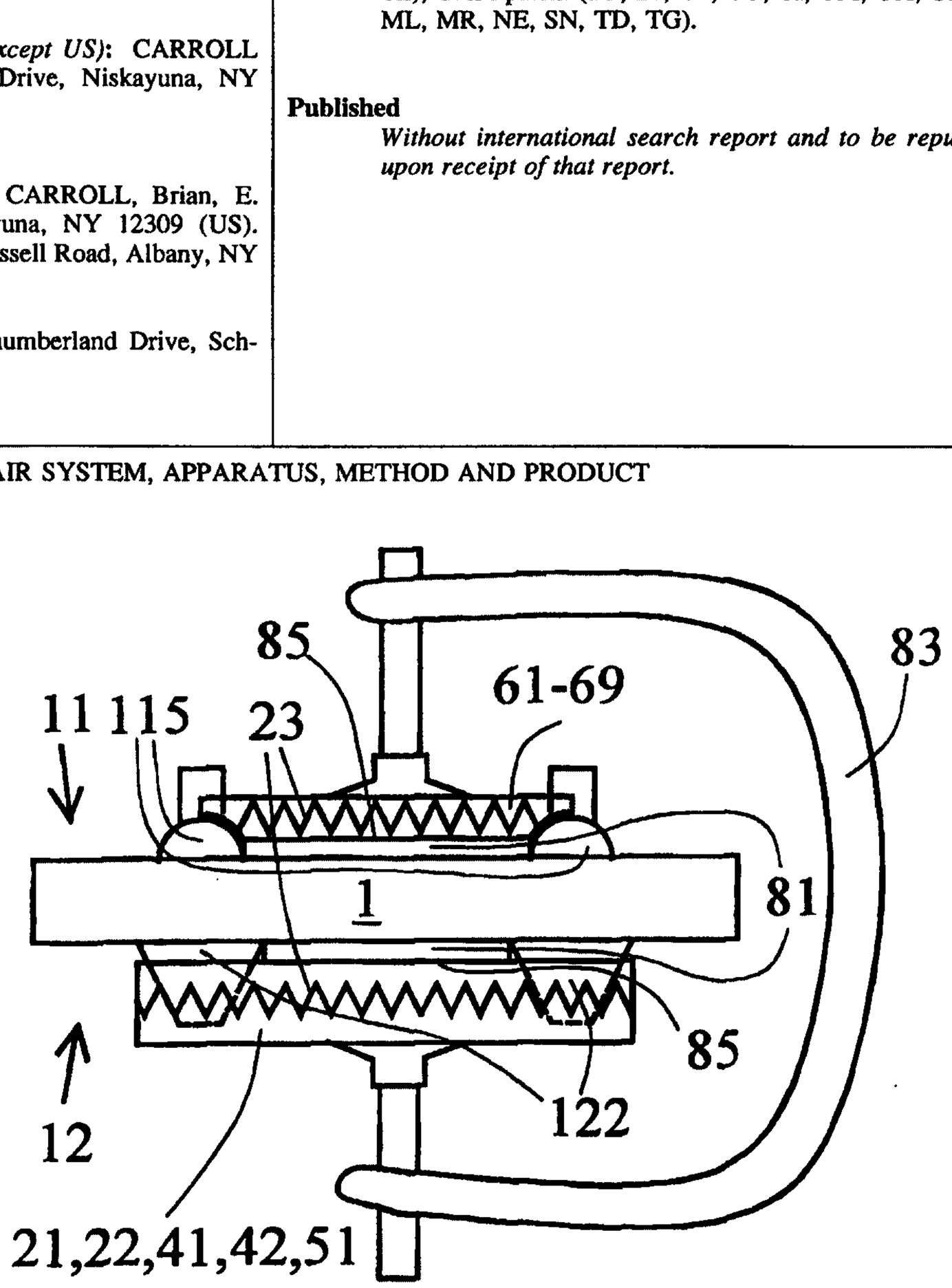
(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), DM, EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KR (Utility model), KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: SNOWMOBILE TRACK REPAIR SYSTEM, APPARATUS, METHOD AND PRODUCT

(57) Abstract

A system, method and apparatus to repair a flexible endless track (1) of a track–driven vehicle such as a snowmobile increases the usable life of the track and avoids its disposal. In the preferred embodiment, a worn section of a snowmobile track (1) is first prepared for repair by cleaning, grinding and tack gluing. Next, suitable hot vulcanizing repair materials (81) are placed over the worn spot. Finally, a number of tools (21, 22, 41, 42, 51, 61–69, 86) according to the invention are used to press these materials (81) into place, and necessary heat (23) and pressure is applied for the necessary length of time to complete the repair process.



SNOWMOBILE TRACK REPAIR SYSTEM, APPARATUS, METHOD AND PRODUCT

FIELD OF THE INVENTION

This invention relates generally to the repair of rubberized materials, and specifically, to the repair of endless belt tracks for track-driven vehicles such as a snowmobile.

BACKGROUND OF THE INVENTION

Snowmobiling has become an increasing-popular winter sport throughout the United States and abroad. Modern snowmobiles are driven by so-called "endless" tracks or belts, which are essentially conveyor belts integral with the snowmobile that engage the snow or ice surface below so as to propel the vehicle in a manner that is well known in the art. In this disclosure, the terms "track" and "belt" may be used interchangeably to refer to that component of the snowmobile which is used as this key propulsion element engaging the supporting snow surface. While this disclosure will refer throughout to a "snowmobile," it is understood that this disclosure applies generally to the repair not only of snowmobile belts / tracks, but to the repair of the belts / tracks used to propel any similar track-driven vehicle.

Snowmobile tracks frequently become damaged due to their heavy-duty abuse in harsh conditions and their contact with stones, branches, pavement, and other ground objects and surfaces during their use. This damage often appears in the form of holes in the track, breakage of "studs" that comprise part of the track as well as tearing of the rubber sections into which the studs are embedded, sections of the track wearing thin, etc. At present, there does not appear to be any system, apparatus or method used to repair these tracks at all. Rather, the snowmobile user must simply purchase a brand new track to replace the old track once a certain level of wear has occurred. Not only is this expensive for the user, but it is environmentally wasteful since the used track must then be disposed of, consuming valuable landfill or similar natural resource space. It would be preferable if a worn or damaged track could simply be repaired and then remain in continued use.

Hot vulcanization was first discovered by Goodyear in 1839. This process involves subjecting a rubberized compound to elevated temperature and pressure for a predetermined period of time in order to either form a molded rubberized product in the first instance, or to effectuate repair to a section of a preexisting rubberized product.

There are many known applications of hot vulcanization today. Some of the many U.S. patents that disclose various devices and methods of hot vulcanization in connection with vehicle tires or propulsion tracks include 4,234,369; 4,279,449; 4,284,451; 4,303,380; 4,347,096; 4,756,678; 4,917,741; 4,931,004; 4,978,403; 5,058,963; 5,133,653; 5,247,981; 5,296,173; 5,312,203; 5,492,464; and 5,536,464.

Despite the proliferation of prior art in this area, there does not appear to be any prior art that in any way discloses or suggests repairing worn sections of a snowmobile track using vulcanization or, indeed, any other method (e.g., cold vulcanization, chemical compound repair, patching, transplanting), rather than simply disposing of these worn tracks. Additionally, there does not appear to be any prior art that discloses or suggests any particular methods or tools that can be used to effectuate the repair of a snowmobile tracks using hot vulcanization or similar methods. Finally, there does not appear to be any prior art disclosing or suggesting how to repair raised sections of a snowmobile track such as drive or traction "lugs."

It would therefor be desirable to repair worn snowmobile (and track-driven vehicle) tracks so that these tracks do not have to be discarded and can instead be reused.

It would further be desirable to have an apparatus, system and method for so-repairing these worn snowmobile (and track-driven vehicle) tracks so that these tracks do not have to be discarded and can instead be repaired and reused.

It would further be desirable to have an apparatus, system and method for repairing raised surface features of a snowmobile track such as the drive lugs.

Since snowmobile tracks may vary somewhat from one vehicle or track design to the next, it would further be desirable to have an apparatus, system and method that can be used for snowmobile track repair generally, irrespective of the particular vehicle or its track design.

SUMMARY OF THE INVENTION

In the preferred embodiment, a worn section of drive track for a track-driven vehicle such as a snowmobile is first prepared for repair by cleaning, grinding and tack gluing. Next, suitable hot vulcanizing compounds are placed over the worn spot. Finally, a number of tools according to the invention are used to press these compounds into place with suitable pressure, and necessary heat is applied for an appropriate length of time to complete the repair process.

BRIEF DESCRIPTION OF THE DRAWING

The features of the invention believed to be novel are set forth in the appended claims. The invention, however, together with further objects and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawing(s) in which:

FIG. 1 illustrates a typical snowmobile track in perspective view, with a representative section of this track enlarged to illustrate the detailed surface configuration of the track on both its inner and outer track surfaces.

FIGS. 2 and 3 illustrate in perspective view, the two primary tool configurations used to apply heat and pressure to the edge regions and the center regions of the inner track surface according to the invention.

FIG. 4 illustrates in plan view, the application of the tools of FIGS. 2 and 3 to the edge regions and center regions of the inner track surface to apply heat and pressure according to the invention.

FIGS. 5 and 6 illustrate in perspective view, extensions of the primary tool configurations of FIGS. 2 and 3 to apply heat and pressure to a longer sections of the edge and center regions of the inner track surface according to the invention.

FIG. 7 illustrates in perspective view, a variation of the tool configurations of FIGS. 2 through 6 used to apply heat and pressure to the edge regions of the inner track surface according to the invention.

FIG. 8 illustrates in plan view, the application of various illustrative tools to apply heat and pressure to the outer track surface according to the invention.

FIG. 9 illustrates the various illustrative tools of FIG. 8 in perspective view.

FIGS. 10 - 13 illustrate the vulcanization process according to the invention utilizing the various tools described in FIGS. 2 through 7. FIGS. 10 and 11 are in cross-sectional side view. FIGS. 12 and 13 are in

perspective view and particularly show lug repair.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates a snowmobile drive track **1** in perspective view. Track **1** is essentially an endless conveyor belt which is driven by the snowmobile and which engages the ground beneath the snowmobile to propel the snowmobile in a forward or backward direction, in a manner well-known in the art. Track 1 has both an outer track surface **11** and an inner track surface **12**, which are enlarged and shown in more detail, respectively, toward the top and bottom of FIG. 1. A strong vulcanized rubber compound such as a heavy-duty square-woven fabric is the primary material from which track **1** is typically fabricated.

Inner track surface **12** is the surface which engages the snowmobile itself, and is typically driven by the rotation of snowmobile drive wheels or cylinders **101** proximate two elongated ends of track **1** as illustrated, along with "cogs" or "sprockets" necessary to drive track **1**. Outer track surface **11** is the surface which engages the snow or ice surface beneath the snowmobile and by virtue of this, when track **1** is being driven, propels the snowmobile relative to the surface.

Inner surface **12**, as shown in the lower enlarged drawing of FIG. 1, typically comprises a plurality of drive apertures **102** running through track **1** between the inner and outer surface **12** and **11**, as well as a plurality of drive lugs **122**. These apertures **102** and lugs **122** engage and mate with "negative" corresponding elements on drive wheels **101** and possibly other internal driving components (e.g., cogs and sprockets) of the snowmobile so that the belt is firmly and securely driven by the snowmobile. In other words, these are the "frictional" elements as between the track **1** and the other snowmobile components. Typically, connecting bars **121** surrounding drive apertures **102** on at least two of their four sides are reinforced with metal or a similar hard substance (often in the form of "track clips"), since connecting bars **121** are located at the point of maximum stress where the drive mechanisms within the snowmobile directly engage track **1** in order to drive it. The illustrated inner track surface configuration **12** of drive apertures **102** and drive lugs **122** has become a *de facto* industry standard for the inner surface **12** of most snowmobiles presently manufactured, and so this configuration has been chosen for illustration. But it is understood that a broad range of other conceivable inner surface **12** configurations can be repaired according to the invention within the scope of this disclosure and its associated claims. It is to be noted that the inner track surface has two predominant types of regions, namely, the center region denoted by **124** which resides generally between the two columns of drive apertures **102**, and the two edge regions denoted by **123** which reside generally outside of the two columns of drive apertures **102**, as shown.

Outer surface **11** shown in the upper enlarged drawing of FIG. 1, is the surface that contacts the snow or ice to propel the snowmobile, and so this surface typically comprises a plurality of traction lugs **110** of various shapes and configurations such as, for example, lug configurations **111** (z-lug), **112** (w-lug), and **113** (v-lug). Outer surface **11** also typically comprises a plurality of (typically metallic) traction studs **114**. Traction lugs **110** are generally located atop a plurality of cross ribs **115** which bound drive apertures **102** on the same two of their four sides as connecting bars **121**. Since cross ribs **115**, which include connecting bars **121** when viewed from the inner surface **12**, also run through that region of the track **1** where the drive mechanisms within the snowmobile directly engage track **1** in order to drive it, these are typically reinforced throughout with a reinforcement bar fabricated within the track rubber, typically made of a strong yet flexible material such as

fiberglass or Kevlar®. This is in addition to any track clips as noted above. The outer surface **11** illustrated herein is typical of many snowmobile tracks **1**, though there are variations that frequently occur as between particular track manufacturers and / or models. Again, it is understood that this configuration has been chosen for illustration, but that a broad range of other conceivable outer surface **11** configurations can be repaired according to the invention within the scope of this disclosure and its associated claims.

In use, snowmobile tracks **1** typically become damaged. Track sections become worn, traction studs **114** are torn out leaving holes in the track, and in general, it is commonplace for a used track to exhibit a fair number of holes and / or worn regions. While the usual practice is for the snowmobile user to simply purchase a new replacement track, a much preferable and less costly approach is to simply repair the worn or missing section using a vulcanizing process and associated tools as will now be described.

The vulcanizing system, apparatus and method according to the preferred embodiment of the invention involves preparing the worn track **1** section or sections, placing repair material **81** (see FIGS. 10-13) in the preferred form of one or more vulcanizing patches over the worn spot on both the inner **12** and outer **11** track surfaces, and then using a set of tools according to the invention to apply pressure to, and to heat, repair material **81** on both the inner and **12** and outer **11** track surfaces, for an appropriate length of time until vulcanization forms a complete repair.

As illustrated in FIG. 2, two primary tool configurations are used to apply heat and pressure to the inner track surface **11**. Inner track edge tool **21** is used to apply heat and pressure to the edge regions **123** of inner track surface **11**, and inner track center tool **22** is used to apply heat and pressure to the center region **124** of inner track surface **11**. Each of inner track tools **21** and **22** is fabricated from hard, highly heat-conductive material such as metal. In the preferred embodiment, each of these tools has heating element means **23** embedded within as schematically represented in FIGS. 2 and 3, so that they can be heated to the temperature necessary to facilitate vulcanization by connection to a power source, for example, via a conventional outlet plug **24**. In an alternative embodiment (see, e.g. FIG. 11), the heating element is not included within tools **21** and **22**, but rather is applied to these tools by a separate heating device applying necessary heat which is then transferred to repair material **81** due to the heat-conducting composition of these tools.

Inner track edge tool **21** comprises an inner track edge pressure region **211**, an inner track edge inter-drive lug pressure region **212**, an inner track edge periphery clamping region **213** with one or more periphery clamping means **214** such as the illustrated adjustable screws, an inner track edge drive aperture pressure region **215**, and an inner track edge drive aperture clamping region **216** connected to drive aperture pressure region **215** via drive aperture clamping means **217** such as the illustrated adjustable bolt. Several hidden surfaces are illustrated in dashed lines. Inner track center tool **22** comprises a plurality of drive lug receptacles **221**, and an inner track center pressure region **222** over its entire surface area.

FIG. 4 illustrates the placement of inner track edge tool **21** over an inner track surface edge region **123** of inner track surface **12**, and of inner track center tool **22** over an inner track surface center region **124** of inner track surface **12**. Whereas FIG. 2 illustrated inner track edge tool **21** from above and to the side, this is illustrated from below (the opposite side) in FIG. 4, so the hidden lines are reversed.

For inner track edge tool **21**, periphery clamping region **213** resides outside (along the periphery of) inner track surface edge region **123**, and inner track edge drive aperture clamping region **216** resides inside a

drive aperture **102**. By tightening periphery clamping means **214** and drive aperture clamping means **217**, the entire inner track edge tool **21** is secured in place over repair material **81** at the repair site. The upward protrusions of periphery clamping region **213** and of inner track edge drive aperture clamping region **216** illustrated in FIG. 2 thus engage the outer edge of the inner track surface **12** and an edge of a selected drive aperture **102**, operating together as the two engaging surfaces of a clamp or vice. Once this occurs, inner track edge pressure region **211** applies pressure and heat over inner track surface edge region **123**, edge inter-drive lug pressure region **212** applies pressure and heat in the region between two adjacent drive lugs **122** as shown, and inner track edge drive aperture pressure region **215** applies pressure and heat to the region of inner track surface **12** most proximate the outer edge, and just to the side, of drive aperture **102**, as shown.

For inner track center tool **22**, drive lugs **122** protrude through drive lug receptacles **221** as shown, and inner track center pressure region **222** covers and is used to apply pressure and heat to entire inner track center region **124** and any repair material **81** placed thereon, except for where drive lugs **122** protrude through drive lug receptacles **221**. Drive lug receptacles **221** are thus used to enable inner track center pressure region **222** to make the necessary pressurized contact with the surface of inner track center region **124** so that vulcanizing can take place. While drive lug receptacles **221** are illustrated as apertures, it is understood that that any type of recesses upon inner track center tool **22** that accommodate drive lugs **122** and allow center pressure region **222** to provide suitable pressure against inner track center region **124** are acceptable substitutes / equivalents for the illustrated drive lug receptacles **221**.

In essence, inner track edge tool **21**, inner track center tool **22**, and the other tools to be similarly described below, operate as "molds" designed to provide a "negative" image of various topological surface features of snowmobile track **1**, which are used to press a repair material **81** against the repair site so that appropriate heat and pressure can be applied for vulcanizing repair. The particular configurations described above for inner track edge tool **21** and inner track center tool **22** are thus determined in reference to, and so as to provide a "negative mold" for, the particular inner track surface **12** shown in FIG. 1, which again, is presently an industry standard. But it is understood that the development of other tools similarly designed as negative vulcanizing repair molds for inner track surface **12**, whether they be for the surface illustrated in FIG. 1 or for another non-standard inner track surface, is an obvious substitution for and a full equivalent of the inner track edge tool **21** and inner track center tool **22** shown and described above, and is thus within the scope of this disclosure and its associated claims.

FIGS. 5 through 7 in fact illustrate particularly useful variations of the tools illustrated and described in FIGS. 2 and 3, which in particular, enable vulcanizing to be performed over a longer region of snowmobile track **1**. FIG. 5 illustrates an extended inner track edge tool **41** which simply comprises a plurality (in this exemplary illustration, six) of inner track edge tool **21** sections (one such section is highlighted by dashed lines) conjoined in series as shown. This tool is used to easily repair longer sections of inner track edge **123**, and in its preferred embodiment also comprises powered (**24**) heating elements **23** within, as earlier shown and described. FIG. 6 illustrates an extended inner track center tool **42** which simply comprises a plurality (in this exemplary illustration, three) of inner track center tool **22** sections (one such section similarly illustrated by dashed lines) also conjoined in series as shown. This tool is also used to easily repair longer sections of the inner track center **124**, and in its preferred embodiment also comprises powered (**24**) heating elements **23** within, as earlier shown

and described.

FIG. 7 illustrates a dual inner edge tool **51**, in which a pair of extended inner track edge tools **41** each with a plurality (in this exemplary illustration, three) of inner track edge tool **21** sections is joined together by a plurality of inner **52** and outer **53** adjustable edge connectors such as the illustrated bars. In use, one of these extended inner track edge tools **41** is placed along an inner track edge region **123** as earlier shown and described, and the other is placed against the second (opposite) inner track edge region **123**. Then inner edge connectors **52** are used to connect the two inner track edge tools **41** together astride the inner track surface **12**, while outer edge connectors **53** are used to connect the two inner track edge tools **41** together astride the outer track surface **11**. Heat and pressure are then applied to any repair material **81** on inner track surface **12**, as earlier described.

Again, FIGS. 2 through 7 are simply illustrative of the types of tools that can be used to apply heat and pressure to inner track surface **12** for vulcanizing repair, and not by any means exhaustive. Many modifications and changes will occur to those skilled in the art which are intended to fall within the scope of this disclosure and its associated claims.

FIG. 8 illustrates in plan view, the application of various pre-contoured tools (heat and pressure plates) to apply heat and pressure to outer track surface **11** according to the invention. Because the surface topology of outer track surface **11** varies considerably more than that that of inner track surface **12**, the application of vulcanizing pressure and heat to outer track surface **11** is achieved with a wider range of tools that, similarly to what was done for inner track surface **12**, are configured as "negative molds" for various regions of outer track surface **11**. FIG. 9 illustrates these same tools as FIG. 8, but in perspective view, and independently of their application to outer track surface **11**. In the preferred embodiment, similarly to the earlier-discussed inner surface tools **21** and **22**, each of these tools is fabricated from a highly heat-conductive material such as metal, and has a powered (**24**) heating element **23** within as in FIG. 2, though to eliminate unnecessary clutter from the drawings, these are not expressly shown here. FIG. 9 illustrates the part of these tools that contacts outer track surface **11**, and it is understood that a thicker housing than is illustrated here may be needed to enclose heating elements **23**. In an alternative embodiment (e.g. FIG. 11), as noted above, an external heat source is applied to these tools.

Referring to FIGS. 8 and 9, cross rib and track repair tool **61** is molded to, and is used to repair, a damaged cross rib **115** region without any other topological features, i.e., without any traction lugs **110**, as well as the outer track region on either side of cross rib **115**. This is also be used where one or more traction lugs **110** have been torn off a cross rib **115**, to first repair damaged cross rib **115** prior to later repair of the missing lug(s) **110**. Inner v-lug track repair tool **62** and outer v-lug track repair tool **63** are molded to and respectively used to repair a damaged section of outer track surface **11** proximate the inner and outer region of a v-shaped traction lug **113**, as shown. V/w-lug track repair tool **64** is molded to and respectively used to repair a damaged section of outer track surface **11** between a v-shaped traction lug **113** and an w-shaped traction lug **112**, as shown. W/z-lug track repair tools **65** and **66** are molded to and respectively used to repair a damaged section of outer track surface **11** between a w-shaped traction lug **112** and an z-shaped traction lug **111**, as shown. Since repair tools **62** and **63** are used to repair track surfaces adjacent to drive lugs **110** proximate one side only, and do not have "cuts" for drive lugs **110** on opposite sides, this type of tool will be referred to as a single-side lug track repair tool. Since repair tools **64**, **65**, and **66** have cuts on opposite sides to repair the track surface between lugs **110**

on adjacent cross ribs **115**, i.e., between lugs **110** on both sides, this type of tool will be referred to an inter-lug track repair tool. Finally, z (**67**), w (**68**) and v (**69**) lug repair tools (molds) are respectively molded directly to and used to repair each of z (**111**), w (**112**), and v (**113**) shaped traction lugs, by stacking a plurality of layers of repair material **81** and then applying heat and pressure to vulcanize, as will be described shortly in further detail.

Insofar as traction studs **114** are concerned, it is quite common for these to already be missing from the section of outer track surface **1** to be repaired before repair begins, since it is in fact the tearing out of a stud **114** and the adjacent track **1** surface that is often the direct cause of the need for repairs. Thus, all of the track repair tools **61** through **66** and any similar tools that might become apparent to one of ordinary skill do not have any holes therein, in the preferred embodiment. However, for the situation where a stud **114** is intact proximate a region to be repaired, and if it is desired to not purposefully remove that stud **114** prior to repair, then each of track repair tools **61** through **66** and any similar tools that might become apparent to one of ordinary skill can also be provided with appropriate stud receptacles **651**, such as has been shown for v/w-lug track repair tool **64** and w/z-lug track repair tool **65**. It is understood that while stud receptacles **651** are illustrated as apertures, any suitable configuration for stud receptacles **651** that avoids interference by studs **114** with the application of pressure by the pertinent track repair tool is fully within the scope of this disclosure and its associated claims.

Again, many variations of the configuration of these tools may occur to someone of ordinary skill within the scope of this disclosure and its associated claims. And, since the outer track surfaces **12** of snowmobile tracks **1** may vary somewhat and do not typically follow a particular industry standard, it is understood that all of the outer track repair tools **61** through **69** are illustrative only, and that the development by someone of ordinary skill of variations on these tools in order to accommodate a particular outer track surface **12** topology is fully contemplated by this disclosure and its associated claims.

Finally, FIGS. 10 - 13 illustrate the method by which these tools are used to repair endless belt tracks **1** for a track-driven vehicle such as a snowmobile. FIG. 10 shows this method in the preferred embodiment wherein the various tools described in connection with FIGS. 2 through 9 comprise their own internal heating element **23**. FIG. 11 shows this method in the alternative embodiment where separate vulcanizing heating blocks **82** comprising their own heating elements **23** are used to supply heat.

First, the track **1** surface area or areas to be repaired are cleaned with any appropriate commercially-available rubber cleaning fluid, then dried, and then ground using a grinding tool to rough up the surface. Next, any appropriate rubber adhesive compound such as glue or cement known in the art is applied to the area to fill in microscopic gaps in the roughed up area, and is allowed to dry to a light tack for about 10 to 20 minutes. This completes the preparation of the surface(s) to be repaired.

Next, repair material **81** is put in place over the area to be repaired. In the preferred embodiment, repair material **81** is a hot vulcanizing patch with heavy-duty internal square stitched / woven fabric for added strength, cut to the required shape and size. For example only, and not limiting, a suitable material for repair material **81** might typically have a specified cure rate of approximately 30 to 40 minutes at approximately 280 degrees Fahrenheit, with a high-tensile nylon cord fabric in a 840/2 & 1260/2 Leno Weave, 300% modulus of approximately 1250 psi, tensile strength of 2750 psi, and 450% elongation at breakpoint. (It is to be noted that the curing time according to the repair material **81** technical specifications may not be the optimal curing time according to the invention, as this depends on the specific track repair work being done and such factors as the

size of the repair and how much repair material **81** needs to be applied.) Repair material **81** might also include a hot vulcanizing patch of any other technical specification as well, so long as it provides the durability necessary for endless belt tracks **1** for a track-driven vehicle such as a snowmobile. Fiber gums, cushion gums, tread gums, and all-purpose repair cords are other examples of suitable, though less-preferred repair materials. Chemical patching (including A+B type cure gums) and cold vulcanization using the tools and methods disclosed herein are also within the scope of the invention, though again, are less preferred. Even a transplant of a track section, "sutured" to the track **1** using the tools and method of this invention, is within the scope of the invention, though again, this is also less preferred.

If the repair material **81** used is indeed some variety of heavy-duty square-woven fabric as is preferred, then it is to be noted that the loose fabric ends of this type of material can fray over time during repeated snowmobile (or tracked vehicle) use. Thus, once repair material **81** is in place, an optional coating of finishing compound **85** such as standard cushion gum or similar compound over repair material **81** is also advised. Once vulcanizing is complete, finishing compound **85** will provide a smoother overall finish, and will better bind the fabric ends of repair material **81** thereby avoiding degradation of repair material **81** over time due to fraying at it ends.

Once repair material **81** and any finishing compound **85** thereover is thus in place, the various tools described in FIGS. 2 through 7, as appropriate, are placed on opposite side of track **1**, namely, outer track surface **11** and inner track surface **12**, applying pressure directly to repair material **81** and finishing compound **85**, in the manner earlier described in detail. One or more of the inner surface tools **21**, **22**, **41**, **42**, **51** or suitable variations thereof are utilized for inner surface **12**. One or more of the contoured outer surface tools **61** through **69** or suitable variations thereof are utilized for outer surface 11. These are then pressed firmly into place using pressure (clamping / vice) means such as the illustrated c-clamp **83** so as to apply suitable pressure for the vulcanizing process. Finally, heat is applied from heating elements **23**, and the repair material **81** and any finishing compound **85** is "cooked" (and generally cured for non-heat processes) for a suitable length of time, typically anywhere from 20 minutes to 3 or more hours, usually from 30 minutes to 2.5 hours, or from 1 to 2 hours, and on average, for about 1.5 hours. The exact time length depends on such factors as the size of the area being repaired and the quantity of repair material **81** that needs to be cooked, as well as the technical cook time specifications of repair material **81**. Thereafter, the vulcanizing repair process is complete. After the various tools of FIGS. 2 through 13 are removed, track **1** is once again ready for use.

Finally, it is helpful to describe the applications of the tools and processes according to the invention to special situations that may be encountered in the repair process.

First, as noted above, a common cause of holes in track **1** is the tearing out of a stud **114**. To repair this track tear and replace the stud, it is necessary to first repair the torn track 1 section using the tools and methods described above. Then a replacement stud **114**, if desired, can be affixed to the repaired section using techniques known in the art for attaching studs to a snowmobile track.

Second, in the event a stud **114** is intact but the area proximate that stud **114** needs repair, there are two options. Stud **114** can be left in place as is, and a pre-contoured repair tool such as tools **61** through **69** elaborated in FIGS. 8 and 9 is used, including stud receptacles **651** such as were illustrated for tools **64** and **65**. Alternatively, stud **114** can be purposefully extracted using pliers or similar extraction tools, and then the entire

area proximate the removed stud is repaired using a pre-contoured repair tool **61** through **69** without any stud receptacle **651**. Thus will fill the original location of stud **114** as well. Then, removed stud **114** is replaced as outlined in the preceding paragraph.

Third, to repair or replace a torn off traction lug **110**, the first step is to repair any damage to the underlying cross rib **115** upon which the damaged lug **110** was seated. This would employ using cross rib and track repair tool **61** or some variation of that tool to repair the damaged section of cross rib **115**, according to the methods and using the tools heretofore described. If there is no damage to the cross rib, or only nominal damage which can be addressed during the rebuilding of the traction lug, then it is not necessary to repair cross rib **115** separately from lug **110**.

To rebuild traction lug **110**, after preparing the repair site as earlier described, one cuts one or more pieces of repair material **81** into the shape of the traction lug **110** to be repaired or replaced. FIG. 12 illustrates this for v-shaped lug **113** as an example, but this discussion applies to any traction lug **110** (or drive lug **122**) of any shape whatsoever. These repair material **81** pieces are then stacked atop one another as illustrated, an optional finishing compound **85** is added to cover repair material **81** as earlier described and thus avert fraying, and these pieces are then packed (**84**) into a matching lug repair tool such as z, w and v-shaped tools **67**, **68** and **69** respectively. FIG. 12 of course uses v-shaped tool **69** since the chosen example is lug **113**. Again, lug repair tools of this nature may be designed for any lug shape (including drive lugs **122**) within the scope of this disclosure and its associated claims. The number of repair material **81** pieces used is determined so as to enable these pieces to be tightly packed into the lug repair tool (**69** in this example), which will in turn enable proper pressure to be applied during vulcanizing. If the lug is only partially damaged, less pieces will be needed than if the entire lug needs to be rebuilt. Once repair material pieces **81** are packed into the lug repair tool and optional finishing compound **85** is added to cover repair material **81** as earlier described, this tool in combination with the repair material **81** pieces therein is placed upon the appropriate cross rib **115**, at the appropriate location. In the event only nominal repair is needed to cross rib **115**, an additional patch of repair material **81** is placed under the repair material pieces of FIG. 12 which will serve to repair the cross rib itself during vulcanizing. Note that lug repair tools **67**, **68**, and **69** have a curved bottom surface that mates with the cross rib **115** shape and can thus be used for this purpose. Vulcanizing pressure and heat are then applied as earlier described. In essence, these lug repair tools **67**, **68** and **69** act as lug molds. Once the vulcanizing is complete, the tools are removed, and the rebuilt lug is available for use.

It is important to again keep in mind that the particular repair tool configurations illustrated throughout this disclosure are examples of the types of tools that one would use to repair the track **1** of a track-driven vehicle such as a snowmobile. While many different tracks share common topological surface features and can thus be repaired with a common set of repair tools, the specific tool configurations for any particular set of repairs will depend upon the precise surface topology of the particular track **1** being repaired. The repair tools herein disclosed are fundamentally designed to provide a "negative mold" for the track section to be repaired, with additional functions (e.g. clamping, heating elements) included such as previously discussed. Thus, it is fully within the scope of this invention to design tools not expressly illustrated herein, but which embody a "negative mold" of, i.e., which mate with, the particular surface features being repaired, to repair tracks with any particular set of topological surface features, irrespective of the precise shape and size of these surface features.

It is also understood that, for example, if a damaged lug **110** is to be replaced, it is perfectly acceptable to replace the original lug with a lug of a somewhat different shape and size, so long as this does not compromise the strength or drive effectiveness of track **1**. Thus, the number of different shapes and sizes of repair tools can be limited by recognizing that a damaged track section need not always be repaired to precisely replicate its original visual appearance; it need only be repaired to restore its strength and it driving effectiveness.

For example, the above is to be noted in particular, as regards the repair of drive lugs **122**. Other than the fact that these are located upon inner track surface **12** rather than outer track surface **11**, these are repaired using a virtually identical process to that described above in connection with FIG. 12 for traction lug **110** repair. An appropriate drive lug tool (mold) **86** illustrated in FIG. 13, similar to traction lug repair tools (molds) **67**, **68** and **69** is used, but it is configured as the "negative" of a drive lug **122.** Sheets of repair material **81** are cut into shapes suitable for a drive lug **122** and then stacked together such as in FIG. 12 and packed into drive lug repair mold **86**. This is all placed on inner track surface **12** rather than outer track surface **11** at the necessary location(s), appropriate pressure and heat is applied, tools are removed, and the drive lug **122** repair is complete.

It is also to be noted that the term "track repair tool" as used in this disclosure is intended to apply generally to any and all of the various heat and pressure tools **21**, **22**, **41**, **42**, **51**, and **61** through **69** as discussed above, as well as to any similar tools that may be designed by someone of ordinary skill for the same purpose as these aforementioned tools. Although each of these tools has been referred to by different names herein to describe their particular, specific repair function, they are all share the common feature and inventive principle of being general track repair tools that are molded to a section of track 1 to deliver pressure (and heat for hot vulcanizing) to a repair material **81** placed on that section of track **1**, for the purpose of effectuating track repair.

As observed in the background of the invention, there does not appear to be any prior art that in any way discloses or suggests repairing worn sections of a snowmobile track using vulcanization or, indeed, any other method (e.g., cold vulcanization, chemical compound repair, patching, transplanting), rather than simply disposing of these worn tracks. While the preferred embodiment of the invention uses hot pressurized vulcanization processes, it is understood that that alternative embodiments would include any other patching method such as the aforementioned cold vulcanization, chemical compound repair, patching, transplanting. These are, however, less preferred, as they do not posses the strength and durability of hot vulcanization.

While only certain preferred features of the invention have been illustrated and described, many modifications, changes and substitutions will occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

1. A method for repairing a drive track of a track-driven vehicle, said drive track comprising an inner track surface and an outer track surface, comprising the steps of:

applying repair materials comprising a hot vulcanizing compound over at least one repair location of said drive track;

placing at least one track repair tool over said repair materials, said at least one track repair tool fitted to mate with the at least one repair location proximate to which it is so-placed;

applying pressure with said at least one track repair tool, to said repair materials, for a predetermined period of cure time, until said repair materials have appropriately cured;

applying heat in addition to said pressure with said at least one track repair tool, to said repair materials, for said predetermined period of cure time, until said repair materials have appropriately cured;

applying said pressure to an edge region of said inner track surface using an inner track edge pressure region of an inner track edge tool; and

simultaneously applying said pressure to a region between two adjacent drive lugs of said inner track surface using an inner track edge inter-drive lug pressure region of said inner track edge tool.

2. The method of claim 1, said repair materials further comprising a hot vulcanizing compound comprising heavy-duty internal woven fabric, whereby:

said heavy-duty internal woven fabric provides added durability to said drive track once repaired.

3. The method of claim 2, further comprising the step of:

applying a finishing compound over said repair materials prior to so-applying said heat and pressure to said repair materials; whereby:

after applying heat in addition to said pressure with said at least one track repair tools, said finishing compound provides a smoother finish and binds fabric ends of said repair material to avoid degradation.

4. The method of claim 1, further comprising the step of preparing said at least one repair location prior to so-applying said repair materials, comprising the further steps of:

cleaning said at least one repair location with rubber cleaner;

allowing said rubber cleaner to dry;

grinding said at least one repair location to rough up corresponding surfaces thereof;

applying a rubber adhesive compound to the roughed up surfaces; and

allowing said rubber adhesive compound to dry to a light tack.

5. The method of claim 1, comprising the further step of providing said heat using heating elements comprising part of at least one of said at least one track repair tools.

6. The method of claim 1, said step of applying said repair materials further comprising the step of applying said repair materials over a snowmobile drive track.

7. The method of claim 1, comprising the further step of simultaneously applying said pressure and said heat with said at least one track repair tool without interference by a stud of said outer track surface, using at least one stud receptacle of said at least one track repair tool.

8. The method of claim 1, omitting a step of creating said track repair tool by casting molten metal against a section of said drive track and cooling said molten metal until it hardens into said track repair tool.

9. The method of claim 1, further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track surface and said inner track edge tool; and

applying said pressure and said heat to said repair materials applied between said inner track surface and said

inner track edge tool, using said inner track edge tool.

10. The method of claim 1, further comprising the step of simultaneously applying said pressure to a region of said inner track surface proximate an outer edge of a drive aperture of said track using an inner track edge drive aperture pressure region of said inner track edge tool.

11. The method of claim 1, further comprising the step of clamping and securing said inner track edge tool in place over said regions of said inner track surface using an inner track edge periphery clamping region opposing an inner track edge drive aperture clamping region of said inner track edge tool, without piercing said drive track.

12. The method of claim 1, further comprising the step of simultaneously applying said pressure to a larger region of said edge region of said inner track surface than the region to which pressure is applied by a single said inner track edge tool, using an extended inner track edge tool comprising a plurality of said inner track edge tools conjoined in series.

13. The method of claim 12, further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track surface and said extended inner track edge tool; and

applying said pressure and said heat to said repair

materials applied between said inner track surface and said extended inner track edge tool, using said extended inner track edge tool.

14. The method of claim 12, further comprising the step of simultaneously applying said pressure to said edge region of said inner track surface, and also to a second, opposite edge region of said inner track surface, using a dual inner track edge tool comprising two of said extended inner track edge tools.

15. The method of claim 1, further comprising the steps of:

applying said pressure to a center region of said inner track surface using an inner track center pressure region substantially over an entire surface area of an inner track center tool; and

simultaneously applying said pressure between adjacent drive lugs of said center region of said inner track surface using a plurality of drive lug receptacles of said inner tack center tool receiving said drive lugs of said inner track surface.

16. The method of claim 15, further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track surface and said inner track center tool; and

applying said pressure and said heat to said repair materials applied between said inner track surface and said inner track center tool, using said inner track center tool.

17. The method of claim 15, further comprising the step of simultaneously applying said pressure to a larger region of said center region of said inner track surface than the region to which pressure is applied by a single said inner track center tool, using an extended inner track center tool comprising a plurality of said inner track center tools conjoined in series.

18. The method of claim 15, further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track surface and said extended inner track center tool; and

applying said pressure and said heat to said repair materials applied between said inner track surface and said extended inner track center tool, using said extended inner track center tool.

19. The method of claim 1, further comprising the step of simultaneously applying said pressure to a drive lug of said inner track surface, using a drive lug repair mold tool.

20. The method of claim 1, further comprising the step of applying said pressure and said heat to repair materials applied to said inner track surface to build and form said repair

materials into a drive lug, using a drive lug repair mold tool.

21. The method of claim 1, further comprising the step of simultaneously applying said pressure to a traction lug of said outer track surface, using a traction lug repair mold tool

22. The method of claim 1, further comprising the step of applying said pressure and said heat to repair materials applied to said outer track surface to build and form said repair materials into a traction lug, using a traction lug repair mold tool.

23. The method of claim 1, further comprising the step of simultaneously applying said pressure to a cross rib region of said outer track surface, using a cross rib and track repair tool.

24. The method of claim 1, further comprising the step of applying said pressure and said heat to repair materials applied to a cross rib region of said outer track surface, using a cross rib and track repair tool.

25. The method of claim 1, further comprising the step of simultaneously applying said pressure to a region of said outer track surface adjacent to a single traction lug of said outer track surface, using a single-side lug track repair tool.

26. The method of claim 1, further comprising the step of applying said pressure and said heat to repair materials applied

to a region of said outer track surface adjacent to a single traction lug of said outer track surface, using a single-side lug track repair tool.

27. The method of claim 1, further comprising the step of simultaneously applying said pressure to a region of said outer track surface between traction lugs of said outer track surface, using an inter-lug track repair tool.

28. The method of claim 1, further comprising the steps of applying said pressure and said heat to repair materials applied to a region of said outer track surface between traction lugs of said outer track surface, using an inter-lug track repair tool.

29. A method for repairing a drive track of a track-driven vehicle, said drive track comprising an inner track surface and an outer track surface, comprising the steps of:

applying repair materials comprising a hot vulcanizing compound over at least one repair location of said drive track;

placing at least one track repair tool over said repair materials, said at least one track repair tool fitted to mate with the at least one repair location proximate to which it is so-placed;

applying pressure with said at least one track repair tool, to said repair materials, for a predetermined period of cure time, until said repair materials have appropriately cured;

applying heat in addition to said pressure with said at least one track repair tool, to said repair materials, for said predetermined period of cure time, until said repair materials have appropriately cured; and

applying a finishing compound over said repair materials prior to so-applying said heat and pressure to said repair materials;

said repair materials further comprising a hot vulcanizing compound comprising heavy-duty internal woven fabric, whereby:

said heavy-duty internal woven fabric provides added durability to said drive track once repaired; and

after applying heat in addition to pressure with said at least one track repair tools, said finishing compound provides a smoother finish and binds fabric ends of said repair material to avoid degradation.

30. The method of claim 29, further comprising the steps of:

applying said pressure to an edge region of said inner track surface using an inner track edge pressure region of an inner track edge tool; and

simultaneously applying said pressure to a region between two adjacent drive lugs of said inner track surface using an inner track edge inter-drive lug pressure region of said inner track edge tool.

31. The method of claim 29, further comprising the step of preparing said at least one repair location prior to so-applying said repair materials, comprising the further steps of:

cleaning said at least one repair location with rubber cleaner;

allowing said rubber cleaner to dry;

grinding said at least one repair location to rough up corresponding surfaces thereof;

applying a rubber adhesive compound to the roughed up surfaces; and

allowing said rubber adhesive compound to dry to a light tack.

32. The method of claim 29, comprising the further step of providing said heat using heating elements comprising part of at least one of said at least one track repair tools.

33. The method of claim 29, said step of applying said repair materials further comprising the step of applying said repair materials over a snowmobile drive track.

34. The method of claim 29, comprising the further step of simultaneously applying said pressure and said heat with said at least one track repair tool without interference by a stud of said outer track surface, using at least one stud receptacle of said at least one track repair tool.

35. The method of claim 29, omitting a step of creating said track repair tool by casting molten metal against a section of said drive track and cooling said molten metal until it hardens into said track repair tool.

36. The method of claim 30, further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track surface and said inner track edge tool; and

applying said pressure and said heat to said repair materials applied between said inner track surface and said inner track edge tool, using said inner track edge tool.

37. The method of claim 30, further comprising the step of simultaneously applying said pressure to a region of said inner track surface proximate an outer edge of a drive aperture of said track using an inner track edge drive aperture pressure region of said inner track edge tool.

38. The method of claim 30, further comprising the step of clamping and securing said inner track edge tool in place over said regions of said inner track surface using an inner track edge periphery clamping region opposing an inner track edge drive aperture clamping region of said inner track edge tool, without piercing said drive track.

39. The method of claim 30, further comprising the step of

simultaneously applying said pressure to a larger region of said edge region of said inner track surface than the region to which pressure is applied by a single said inner track edge tool, using an extended inner track edge tool comprising a plurality of said inner track edge tools conjoined in series.

40. The method of claim 39, further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track surface and said extended inner track edge tool; and

applying said pressure and said heat to said repair materials applied between said inner track surface and said extended inner track edge tool, using said extended inner track edge tool.

41. The method of claim 39, further comprising the step of simultaneously applying said pressure to said edge region of said inner track surface, and also to a second, opposite edge region of said inner track surface, using a dual inner track edge tool comprising two of said extended inner track edge tools.

42. The method of claim 29, comprising the further steps of:

applying said pressure to a center region of said inner track surface using an inner track center pressure region substantially over an entire surface area of an inner track

center tool; and

simultaneously applying pressure between adjacent drive lugs of said center region of said inner track surface using a plurality of drive lug receptacles of said inner track center tool receiving said drive lugs of said inner track surface.

43. The method of claim 42, further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track surface and said inner track center tool; and

applying said pressure and said heat to said repair materials applied between said inner track surface and said inner track center tool, using said inner track center tool.

44. The method of claim 42, further comprising the step of simultaneously applying said pressure to a larger region of said center region of said inner track surface than the region to which pressure is applied by a single said inner track center tool, using an extended inner track center tool comprising a plurality of said inner track center tools conjoined in series.

45. The method of claim 42, further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track surface and said extended inner track center tool; and

applying said pressure and said heat to said repair

materials applied between said inner track surface and said extended inner track center tool, using said extended inner track center tool.

46. The method of claim 29, further comprising the step of simultaneously applying said pressure to a drive lug of said inner track surface, using a drive lug repair mold tool.

47. The method of claim 29, further comprising the step of applying said pressure and said heat to repair materials applied to said inner track surface to build and form said repair materials into a drive lug, using a drive lug repair mold tool.

48. The method of claim 29, further comprising the step of simultaneously applying said pressure to a traction lug of said outer track surface, using a traction lug repair mold tool

49. The method of claim 29, further comprising the step of applying said pressure and said heat to repair materials applied to said outer track surface to build and form said repair materials into a traction lug, using a traction lug repair mold tool.

50. The method of claim 29, further comprising the step of simultaneously applying said pressure to a cross rib region of said outer track surface, using a cross rib and track repair tool.

51. The method of claim 29, further comprising the step of

applying said pressure and said heat to repair materials applied to a cross rib region of said outer track surface, using a cross rib and track repair tool.

52. The method of claim 29, further comprising the step of simultaneously applying said pressure to a region of said outer track surface adjacent to a single traction lug of said outer track surface, using a single-side lug track repair tool.

53. The method of claim 29, further comprising the step of applying said pressure and said heat to repair materials applied to a region of said outer track surface adjacent to a single traction lug of said outer track surface, using a single-side lug track repair tool.

54. The method of claim 29, further comprising the step of simultaneously applying said pressure to a region of said outer track surface between traction lugs of said outer track surface, using an inter-lug track repair tool.

55. The method of claim 29, further comprising the step of applying said pressure and said heat to repair materials applied to a region of said outer track surface between traction lugs of said outer track surface, using an inter-lug track repair tool.

56. A system for repairing a drive track of a track-driven vehicle, said drive track comprising an inner track surface and an outer track surface, comprising:

repair materials comprising a hot vulcanizing compound applied over at least one repair location of said drive track;

at least one track repair tool placed over said repair materials, fitted to mate with the at least one repair location proximate to which it is so-placed;

pressure application means applying pressure with said at least one track repair tool, to said repair materials, for a predetermined period of cure time, until said repair materials have appropriately cured;

heating means applying heat in addition to said pressure with at least one of said track repair tools, to said repair materials, for said predetermined period of cure time, until said repair materials have appropriately cured; and

at least one of said track repair tools comprising an inner track edge tool comprising an inner track edge pressure region and an inner track edge inter-drive lug pressure region thereof, applying said pressure to an edge region of said inner track surface and simultaneously applying said pressure to a region between adjacent drive lugs of said inner track surface.

57. The system of claim 56, said repair materials further comprising:

a heavy-duty internal woven fabric, whereby:

said heavy-duty internal woven fabric provides added

durability to said drive track once repaired.

58. The system of claim 57, further comprising:

finishing compound applied over said repair materials prior to so-applying said heat and pressure to said repair materials; whereby:

after applying heat in addition to said pressure with said at least one track repair tools, said finishing compound provides a smoother finish and binds fabric ends of said repair material to avoid degradation.

59. The system of claim 56, further comprising repair preparation means for preparing said at least one repair location for applying said repair materials, said repair preparation means further comprising:

rubber cleaner for cleaning said at least one repair location with rubber cleaner;

grinding means for roughing up corresponding surfaces of said at least one repair location once said rubber cleaner has dried;

rubber adhesive compound applied to the roughed up surfaces, which is allowed to dry to a light tack before said repair materials are so-applied.

60. The system of claim 56, at least one of said track repair tools further comprising said heating means.

61. The system of claim 56, said track-driven vehicle comprising a snowmobile, and said drive track comprising a snowmobile drive track.

62. The system of claim 56, at least one of said track repair tools further comprising:

at least one stud receptacle applying said pressure and said heat with said at least one track repair tool without interference by a stud of said outer track surface.

63. The system of claim 56, wherein at least one of said track repair tools is not created by casting molten metal against a section of said drive track and cooling said molten metal until it hardens into said track repair tool.

64. The system of claim 56, wherein:

at least some of said repair materials are applied to a repair location of said inner track surface between said inner track surface and said inner track edge tool; and

said inner track edge tool applies said pressure and said heat to said repair materials applied between said inner track surface and said inner track edge tool.

65. The system of claim 56, said inner track edge tool further comprising:

an inner track edge drive aperture pressure region applying said pressure to a region of said inner track surface proximate

an outer edge of a drive aperture of said drive track.

66. The system of claim 56, said inner track edge tool further comprising:

an inner track edge periphery clamping region opposing an inner track edge drive aperture clamping region of said inner track edge tool, for clamping and securing said inner track edge tool in place over said regions of said inner track surface without piercing said drive track.

67. The system of claim 56, said inner track edge tool further comprising:

an extended inner track edge tool comprising a plurality of said inner track edge tools conjoined in series applying said pressure to a larger region of said edge region of said inner track surface than the region to which pressure is applied by a single said inner track edge tool.

68. The system of claim 67, wherein:

at least some of said repair materials are applied to a repair location of said inner track surface between said inner track surface and said extended inner track edge tool; and

said extended inner track edge tool applies said pressure and said heat to said repair materials applied between said inner track surface and said extended inner track edge tool.

69. The system of claim 67, said inner track edge tool further

comprising:

a dual inner track edge tool comprising two of said extended inner track edge tools applying said pressure to said edge region of said inner track surface, and also to a second, opposite edge region of said inner track surface.

70. The system of claim 56, at least one of said track repair tools comprising:

an inner track center tool comprising an inner track center pressure region substantially over an entire surface area thereof and a plurality of drive lug receptacles thereof receiving said drive lugs of said inner track surface, applying said pressure to a center region of said inner track surface and simultaneously applying said pressure between adjacent drive lugs of said center region.

71. The system of claim 70, wherein:

at least some of said repair materials are applied to a repair location of said inner track surface between said inner track surface and said inner track center tool; and

said inner track center tool applies said pressure and said heat to said repair materials applied between said inner track surface and said inner track center tool.

72. The system of claim 70, said inner track center tool further comprising:

an extended inner track center tool comprising a plurality of said inner track center tools conjoined in series applying said pressure to a larger region of said center region of said inner track surface than the region to which pressure is applied by a single said inner track center tool.

73. The system of claim 70, wherein:

at least some of said repair materials are applied to a repair location of said inner track surface between said inner track surface and said extended inner track center tool; and

said extended inner track center tool applies said pressure and said heat to said repair materials applied between said inner track surface and said extended inner track center tool.

74. The system of claim 56, at least one of said track repair tools comprising:

a drive lug repair mold tool applying said pressure to a drive lug of said inner track surface.

75. The system of claim 56, at least one of said track repair tools comprising:

a drive lug repair mold tool applying said pressure and said heat to repair materials applied to said inner track surface to build and form said repair materials into a drive lug.

76. The system of claim 56, at least one of said track repair

tools comprising:

a traction lug repair mold tool applying said pressure to a traction lug of said outer track surface.

77. The system of claim 56, at least one of said track repair tools comprising:

a traction lug repair mold tool applying said pressure and said heat to repair materials applied to said outer track surface to build and form said repair materials into a traction lug.

78. The system of claim 56, at least one of said track repair tools comprising:

a cross rib and track repair tool applying said pressure to a cross rib region of said outer track surface.

79. The system of claim 56, at least one of said track repair tools comprising:

a cross rib and track repair tool applying said pressure and said heat to repair materials applied to a cross rib region of said outer track surface.

80. The system of claim 56, at least one of said track repair tools comprising:

a single-side lug track repair tool applying said pressure to a region of said outer track surface adjacent to a single traction lug of said outer track surface.

81. The system of claim 56, at least one of said track repair tools comprising:

a single-side lug track repair tool applying said pressure and said heat to repair materials applied to a region of said outer track surface adjacent to a single traction lug of said outer track surface.

82. The system of claim 56, at least one of said track repair tools comprising:

an inter-lug track repair tool applying said pressure to a region of said outer track surface between traction lugs of said outer track surface.

83. The system of claim 56, at least one of said track repair tools comprising:

an inter-lug track repair tool applying said pressure and said heat to repair materials applied to a region of said outer track surface between traction lugs of said outer track surface.

84. A system for repairing a drive track of a track-driven vehicle, said drive track comprising an inner track surface and an outer track surface, comprising:

repair materials comprising:

a hot vulcanizing compound applied over at least one repair location of said drive track; and

a heavy-duty internal woven fabric;

at least one track repair tool placed over said repair materials, fitted to mate with the at least one repair location proximate to which it is so-placed;

pressure application means applying pressure with said at least one track repair tool, to said repair materials, for a predetermined period of cure time, until said repair materials have appropriately cured;

heating means applying heat in addition to said pressure with at least one of said track repair tools, to said repair materials, for said predetermined period of cure time, until said repair materials have appropriately cured; and

finishing compound applied over said repair materials prior to so-applying said heat and pressure to said repair materials;

whereby:

said heavy-duty internal woven fabric provides added durability to said drive track once repaired; and

after applying heat in addition to pressure with said at least one track repair tools, said finishing compound provides a smoother finish and binds fabric ends of said repair material to avoid degradation.

85. The system of claim 84, at least one of said track repair tools comprising:

an inner track edge tool comprising an inner track edge

pressure region and an inner track edge inter-drive lug pressure region thereof, applying said pressure to an edge region of said inner track surface and simultaneously applying said pressure to a region between adjacent drive lugs of said inner track surface.

86. The system of claim 84, further comprising repair preparation means for preparing said at least one repair location for applying said repair materials, said repair preparation means further comprising:

rubber cleaner for cleaning said at least one repair location with rubber cleaner;

grinding means for roughing up corresponding surfaces of said at least one repair location once said rubber cleaner has dried;

rubber adhesive compound applied to the roughed up surfaces, which is allowed to dry to a light tack before said repair materials are so-applied.

87. The system of claim 84, at least one of said track repair tools further comprising said heating means.

88. The system of claim 84, said track-driven vehicle comprising a snowmobile, and said drive track comprising a snowmobile drive track.

89. The system of claim 84, at least one of said track repair

tools further comprising:

at least one stud receptacle applying said pressure and said heat with said at least one track repair tool without interference by a stud of said outer track surface.

90. The system of claim 84, wherein at least one of said track repair tools is not created by casting molten metal against a section of said drive track and cooling said molten metal until it hardens into said track repair tool.

91. The system of claim 85, wherein:

at least some of said repair materials are applied to a repair location of said inner track surface between said inner track surface and said inner track edge tool; and

said inner track edge tool applies said pressure and said heat to said repair materials applied between said inner track surface and said inner track edge tool.

92. The system of claim 85, said inner track edge tool further comprising:

an inner track edge drive aperture pressure region applying said pressure to a region of said inner track surface proximate an outer edge of a drive aperture of said drive track.

93. The system of claim 85, said inner track edge tool further comprising:

an inner track edge periphery clamping region opposing an

inner track edge drive aperture clamping region of said inner track edge tool, for clamping and securing said inner track edge tool in place over said regions of said inner track surface without piercing said drive track.

94. The system of claim 85, said inner track edge tool further comprising:

an extended inner track edge tool comprising a plurality of said inner track edge tools conjoined in series applying said pressure to a larger region of said edge region of said inner track surface than the region to which pressure is applied by a single said inner track edge tool.

95. The system of claim 94, wherein:

at least some of said repair materials are applied to a repair location of said inner track surface between said inner track surface and said extended inner track edge tool; and

said extended inner track edge tool applies said pressure and said heat to said repair materials applied between said inner track surface and said extended inner track edge tool.

96. The system of claim 94, said inner track edge tool further comprising:

a dual inner track edge tool comprising two of said extended inner track edge tools applying said pressure to said edge region of said inner track surface, and also to a second,

opposite edge region of said inner track surface.

97. The system of claim 84, at least one of said track repair tools comprising:

an inner track center tool comprising an inner track center pressure region substantially over an entire surface area thereof and a plurality of drive lug receptacles thereof receiving said drive lugs of said inner track surface, applying said pressure to a center region of said inner track surface and simultaneously applying said pressure between adjacent drive lugs of said center region.

98. The system of claim 97, wherein:

at least some of said repair materials are applied to a repair location of said inner track surface between said inner track surface and said inner track center tool; and

said inner track center tool applies said pressure and said heat to said repair materials applied between said inner track surface and said inner track center tool.

99. The system of claim 97, said inner track center tool further comprising:

an extended inner track center tool comprising a plurality of said inner track center tools conjoined in series applying said pressure to a larger region of said center region of said inner track surface than the region to which pressure is applied

by a single said inner track center tool.

100. The system of claim 97, wherein:

at least some of said repair materials are applied to a repair location of said inner track surface between said inner track surface and said extended inner track center tool; and

said extended inner track center tool applies said pressure and said heat to said repair materials applied between said inner track surface and said extended inner track center tool.

101. The system of claim 84, at least one of said track repair tools comprising:

a drive lug repair mold tool applying said pressure to a drive lug of said inner track surface.

102. The system of claim 84, at least one of said track repair tools comprising:

a drive lug repair mold tool applying said pressure and said heat to repair materials applied to said inner track surface to build and form said repair materials into a drive lug.

103. The system of claim 84, at least one of said track repair tools comprising:

a traction lug repair mold tool applying said pressure to a traction lug of said outer track surface.

104. The system of claim 84, at least one of said track repair

tools comprising:

a traction lug repair mold tool applying said pressure and said heat to repair materials applied to said outer track surface to build and form said repair materials into a traction lug.

105. The system of claim 84, at least one of said track repair tools comprising:

a cross rib and track repair tool applying said pressure to a cross rib region of said outer track surface.

106. The system of claim 84, at least one of said track repair tools comprising:

a cross rib and track repair tool applying said pressure and said heat to repair materials applied to a cross rib region of said outer track surface.

107. The system of claim 84, at least one of said track repair tools comprising:

a single-side lug track repair tool applying said pressure to a region of said outer track surface adjacent to a single traction lug of said outer track surface.

108. The system of claim 84, at least one of said track repair tools comprising:

a single-side lug track repair tool applying said pressure and said heat to repair materials applied to a region of said

outer track surface adjacent to a single traction lug of said outer track surface.

109. The system of claim 84, at least one of said track repair tools comprising:

an inter-lug track repair tool applying said pressure to a region of said outer track surface between traction lugs of said outer track surface.

110. The system of claim 84, at least one of said track repair tools comprising:

an inter-lug track repair tool applying said pressure and said heat to repair materials applied to a region of said outer track surface between traction lugs of said outer track surface.

111. An apparatus comprising at least one track repair tool for repairing a drive track of a track-driven vehicle, at least one of said track repair tools comprising:

an inner track edge tool comprising an inner track edge pressure region and an inner track edge inter-drive lug pressure region thereof, for applying pressure to an edge region of an inner track surface of said drive track and simultaneously applying said pressure to a region between adjacent drive lugs of said inner track surface.

112. The apparatus of claim 111, at least one of said track repair tools further comprising:

heating means for applying heat in addition to said pressure to repair materials applied over at least one repair location of said drive track, for a predetermined period of cure time, until said repair materials have appropriately cured.

113. The apparatus of claim 111, at least one of said track repair tools further comprising:

at least one stud receptacle for applying said pressure with said at least one track repair tool without interference by a stud of said outer track surface.

114. The apparatus of claim 111, wherein at least one of said track repair tools is not created by casting molten metal against a section of said drive track and cooling said molten metal until it hardens into said track repair tool.

115. The apparatus of claim 111, said inner track edge tool further comprising:

said inner track edge pressure region and said inner track edge inter-drive lug pressure region, for applying said pressure, and additionally for applying heat, to repair materials applied to a repair location of said inner track surface between said inner track surface and said inner track edge tool.

116. The apparatus of claim 111, said inner track edge tool further comprising:

an inner track edge drive aperture pressure region for applying said pressure to a region of said inner track surface proximate an outer edge of a drive aperture of said drive track.

117. The apparatus of claim 111, said inner track edge tool further comprising:

an inner track edge periphery clamping region opposing an inner track edge drive aperture clamping region of said inner track edge tool, for clamping and securing said inner track edge tool in place over said regions of said inner track surface without piercing said drive track.

118. The apparatus of claim 111, said inner track edge tool further comprising:

an extended inner track edge tool comprising a plurality of said inner track edge tools conjoined in series for applying said pressure to a larger region of said edge region of said inner track surface than the region to which pressure is applied by a single said inner track edge tool.

119. The apparatus of claim 118, said extended inner track edge tool further comprising:

said plurality of said inner track edge tools conjoined in series for applying said pressure, and additionally for applying heat, to repair materials applied between said inner track surface and said extended inner track edge tool.

120. The apparatus of claim 118, said inner track edge tool further comprising:

a dual inner track edge tool comprising two of said extended inner track edge tools for applying said pressure to said edge region of said inner track surface, and also to a second, opposite edge region of said inner track surface.

121. The apparatus of claim 111, at least one of said track repair tools comprising:

an inner track center tool comprising an inner track center pressure region substantially over an entire surface area thereof and a plurality of drive lug receptacles thereof receiving said drive lugs of said inner track surface, for applying said pressure to a center region of said inner track surface and simultaneously applying said pressure between adjacent drive lugs of said center region.

122. The apparatus of claim 121, said inner track center tool further comprising:

said inner track center pressure region and said plurality of drive lug receptacles thereof, for applying said pressure, and additionally for applying heat, to repair materials applied between said inner track surface and said inner track center tool.

123. The apparatus of claim 121, said inner track center tool

further comprising:

an extended inner track center tool comprising a plurality of said inner track center tools conjoined in series, for applying said pressure to a larger region of said center region of said inner track surface than the region to which pressure is applied by a single said inner track center tool.

124. The apparatus of claim 123, said extended inner track center tool further comprising:

said plurality of said inner track center tools conjoined in series, for applying said pressure, and additionally for applying heat, to repair materials applied between said inner track surface and said extended inner track center tool.

125. The apparatus of claim 111, at least one of said track repair tools comprising:

a drive lug repair mold tool for applying said pressure to a drive lug of said inner track surface.

126. The apparatus of claim 111, at least one of said track repair tools comprising:

a drive lug repair mold tool for applying said pressure, and additionally for applying heat, to repair materials applied to said inner track surface to build and form said repair materials into a drive lug.

127. The apparatus of claim 111, at least one of said track

repair tools comprising:

a traction lug repair mold tool for applying said pressure to a traction lug of an outer track surface of said drive track.

128. The apparatus of claim 111, at least one of said track repair tools comprising:

a traction lug repair mold tool for applying said pressure, and additionally for applying heat, to repair materials applied to an outer track surface of said drive track to build and form said repair materials into a traction lug.

129. The apparatus of claim 111, at least one of said track repair tools comprising:

a cross rib and track repair tool for applying said pressure to a cross rib region of an outer track surface of said drive track.

130. The apparatus of claim 111, at least one of said track repair tools comprising:

a cross rib and track repair tool for applying said pressure, and additionally for applying heat, to repair materials applied to a cross rib region of an outer track surface of said drive track.

131. The apparatus of claim 111, at least one of said track repair tools comprising:

a single-side lug track repair tool for applying said

pressure to a region of an outer track surface of said drive track adjacent to a single traction lug of said outer track surface.

132. The apparatus of claim 111, at least one of said track repair tools comprising:

a single-side lug track repair tool for applying said pressure, and additionally for applying heat, to repair materials applied to a region of an outer track surface of said drive track adjacent to a single traction lug of said outer track surface.

133. The apparatus of claim 111, at least one of said track repair tools comprising:

an inter-lug track repair tool for applying said pressure to a region of an outer track surface of said drive track between traction lugs of said outer track surface.

134. The apparatus of claim 111, at least one of said track repair tools comprising:

an inter-lug track repair tool for applying said pressure, and additionally for applying heat, to repair materials applied to a region of an outer track surface of said drive track between traction lugs of said outer track surface.

135. A repaired drive track product of a track-driven vehicle, said drive track comprising an inner track surface and an outer

track surface, produced using a process for repairing said drive track, said repair process comprising the steps of:

applying repair materials comprising a hot vulcanizing compound over at least one repair location of said drive track;

placing at least one track repair tool over said repair materials, said at least one track repair tool fitted to mate with the at least one repair location proximate to which it is so-placed;

applying pressure with said at least one track repair tool, to said repair materials, for a predetermined period of cure time, until said repair materials have appropriately cured;

applying heat in addition to said pressure with said at least one track repair tool, to said repair materials, for said predetermined period of cure time, until said repair materials have appropriately cured; and

applying a finishing compound over said repair materials prior to so-applying said heat and pressure to said repair materials;

said repair materials further comprising a hot vulcanizing compound comprising heavy-duty internal woven fabric, whereby:

said heavy-duty internal woven fabric provides added durability to said drive track once repaired; and

after applying heat in addition to pressure with said at

least one track repair tools, said finishing compound provides a smoother finish and binds fabric ends of said repair material to avoid degradation.

136. The repaired drive track product of claim 135, said repair process further comprising the steps of:

applying said pressure to an edge region of said inner track surface using an inner track edge pressure region of an inner track edge tool; and

simultaneously applying said pressure to a region between two adjacent drive lugs of said inner track surface using an inner track edge inter-drive lug pressure region of said inner track edge tool.

137. The repaired drive track product of claim 135, said repair process further comprising the step of preparing said at least one repair location prior to so-applying said repair materials, comprising the further steps of:

cleaning said at least one repair location with rubber cleaner;

allowing said rubber cleaner to dry;

grinding said at least one repair location to rough up corresponding surfaces thereof;

applying a rubber adhesive compound to the roughed up surfaces; and

allowing said rubber adhesive compound to dry to a light tack.

138. The repaired drive track product of claim 135, said repair process further comprising the step of providing said heat using heating elements comprising part of at least one of said at least one track repair tools.

139. The repaired drive track product of claim 135, said step of applying said repair materials further comprising the step of applying said repair materials over a snowmobile drive track.

140. The repaired drive track product of claim 135, said repair process further comprising the step of simultaneously applying said pressure and said heat with said at least one track repair tool without interference by a stud of said outer track surface, using at least one stud receptacle of said at least one track repair tool.

141. The repaired drive track product of claim 135, said repair process further comprising omitting a step of creating said track repair tool by casting molten metal against a section of said drive track and cooling said molten metal until it hardens into said track repair tool.

142. The repaired drive track product of claim 136, said repair process further comprising the steps of:

applying at least some of said repair materials to a repair

location of said inner track surface between said inner track surface and said inner track edge tool; and

applying said pressure and said heat to said repair materials applied between said inner track surface and said inner track edge tool, using said inner track edge tool.

143. The repaired drive track product of claim 136, said repair process further comprising the step of simultaneously applying said pressure to a region of said inner track surface proximate an outer edge of a drive aperture of said track using an inner track edge drive aperture pressure region of said inner track edge tool.

144. The repaired drive track product of claim 136, said repair process further comprising the step of clamping and securing said inner track edge tool in place over said regions of said inner track surface using an inner track edge periphery clamping region opposing an inner track edge drive aperture clamping region of said inner track edge tool, without piercing said drive track.

145. The repaired drive track product of claim 136, said repair process further comprising the step of simultaneously applying said pressure to a larger region of said edge region of said inner track surface than the region to which pressure is applied by a single said inner track edge tool, using an extended inner

track edge tool comprising a plurality of said inner track edge tools conjoined in series.

146. The repaired drive track product of claim 145, said repair process further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track surface and said extended inner track edge tool; and

applying said pressure and said heat to said repair materials applied between said inner track surface and said extended inner track edge tool, using said extended inner track edge tool.

147. The repaired drive track product of claim 145, said repair process further comprising the step of simultaneously applying said pressure to said edge region of said inner track surface, and also to a second, opposite edge region of said inner track surface, using a dual inner track edge tool comprising two of said extended inner track edge tools.

148. The repaired drive track product of claim 135, said repair process further comprising the steps of:

applying said pressure to a center region of said inner track surface using an inner track center pressure region substantially over an entire surface area of an inner track center tool; and

simultaneously applying pressure between adjacent drive lugs of said center region of said inner track surface using a plurality of drive lug receptacles of said inner track center tool receiving said drive lugs of said inner track surface.

149. The repaired drive track product of claim 148, said repair process further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track surface and said inner track center tool; and

applying said pressure and said heat to said repair materials applied between said inner track surface and said inner track center tool, using said inner track center tool.

150. The repaired drive track product of claim 148, said repair process further comprising the step of simultaneously applying said pressure to a larger region of said center region of said inner track surface than the region to which pressure is applied by a single said inner track center tool, using an extended inner track center tool comprising a plurality of said inner track center tools conjoined in series.

151. The repaired drive track product of claim 148, said repair process further comprising the steps of:

applying at least some of said repair materials to a repair location of said inner track surface between said inner track

surface and said extended inner track center tool; and

applying said pressure and said heat to said repair materials applied between said inner track surface and said extended inner track center tool, using said extended inner track center tool.

152. The repaired drive track product of claim 135, said repair process further comprising the step of simultaneously applying said pressure to a drive lug of said inner track surface, using a drive lug repair mold tool.

153. The repaired drive track product of claim 135, said repair process further comprising the step of applying said pressure and said heat to repair materials applied to said inner track surface to build and form said repair materials into a drive lug, using a drive lug repair mold tool.

154. The repaired drive track product of claim 135, said repair process further comprising the step of simultaneously applying said pressure to a traction lug of said outer track surface, using a traction lug repair mold tool

155. The repaired drive track product of claim 135, said repair process further comprising the step of applying said pressure and said heat to repair materials applied to said outer track surface to build and form said repair materials into a traction lug, using a traction lug repair mold tool.

156. The repaired drive track product of claim 135, said repair process further comprising the step of simultaneously applying said pressure to a cross rib region of said outer track surface, using a cross rib and track repair tool.

157. The repaired drive track product of claim 135, said repair process further comprising the step of applying said pressure and said heat to repair materials applied to a cross rib region of said outer track surface, using a cross rib and track repair tool.

158. The repaired drive track product of claim 135, said repair process further comprising the step of simultaneously applying said pressure to a region of said outer track surface adjacent to a single traction lug of said outer track surface, using a single-side lug track repair tool.

159. The repaired drive track product of claim 135, said repair process further comprising the step of applying said pressure and said heat to repair materials applied to a region of said outer track surface adjacent to a single traction lug of said outer track surface, using a single-side lug track repair tool.

160. The repaired drive track product of claim 135, said repair process further comprising the step of simultaneously applying said pressure to a region of said outer track surface between traction lugs of said outer track surface, using an inter-lug

track repair tool.

161. The repaired drive track product of claim 135, said repair process further comprising the step of applying said pressure and said heat to repair materials applied to a region of said outer track surface between traction lugs of said outer track surface, using an inter-lug track repair tool.

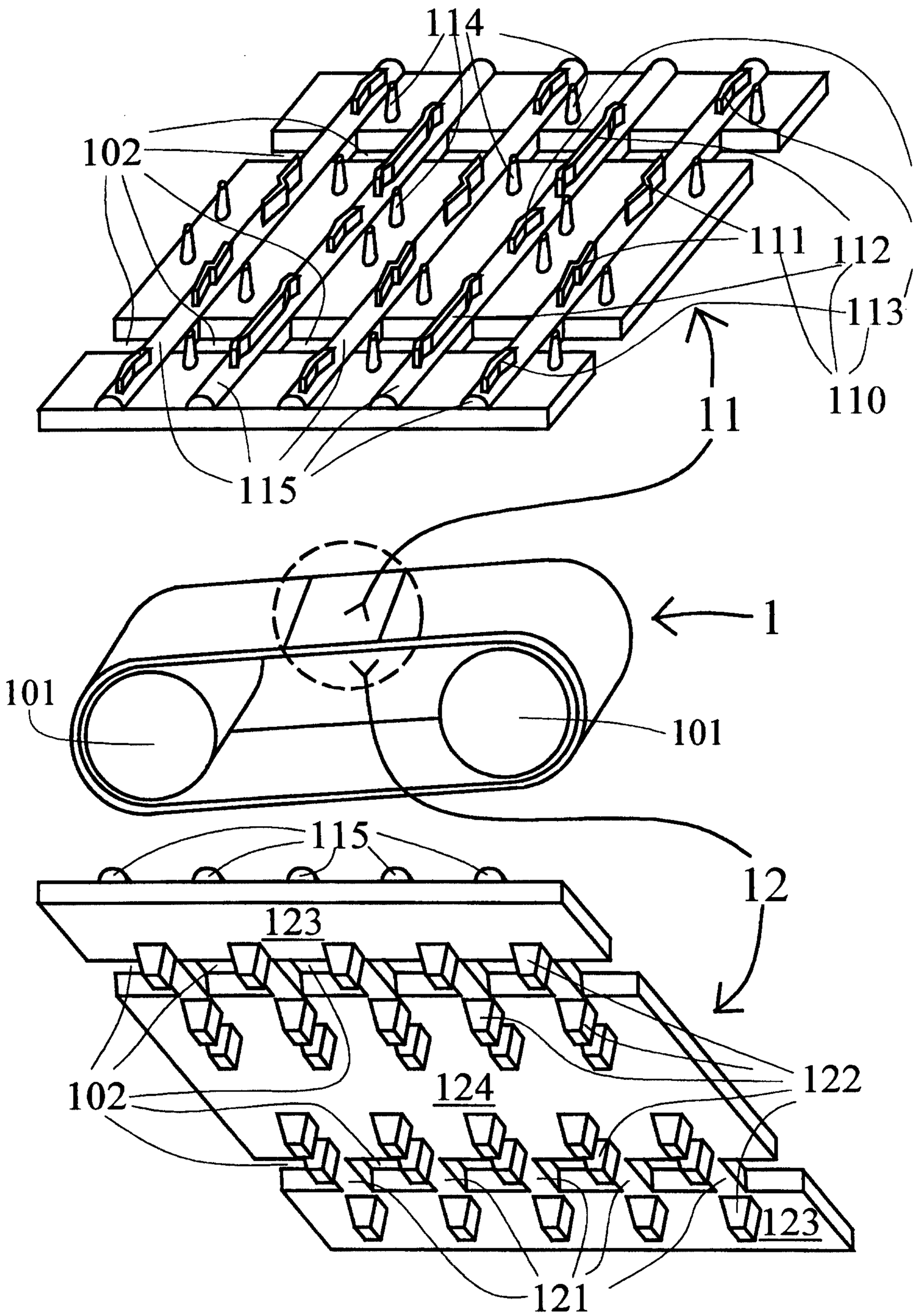

114
102
111
112
113
110
11
115
1
101
101
115
12
123
122
102
124
123
121

FIG. 1

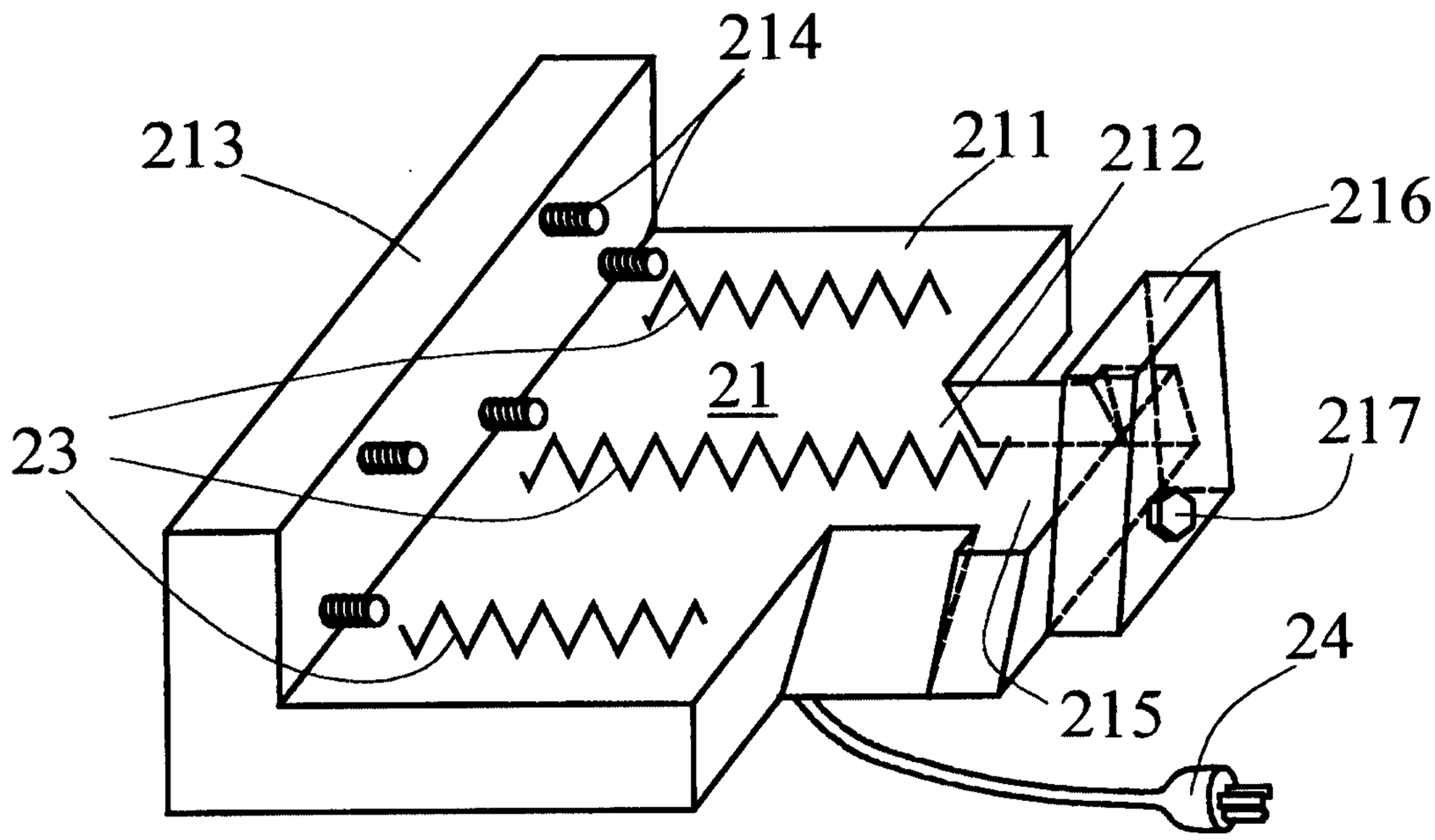


FIG. 2

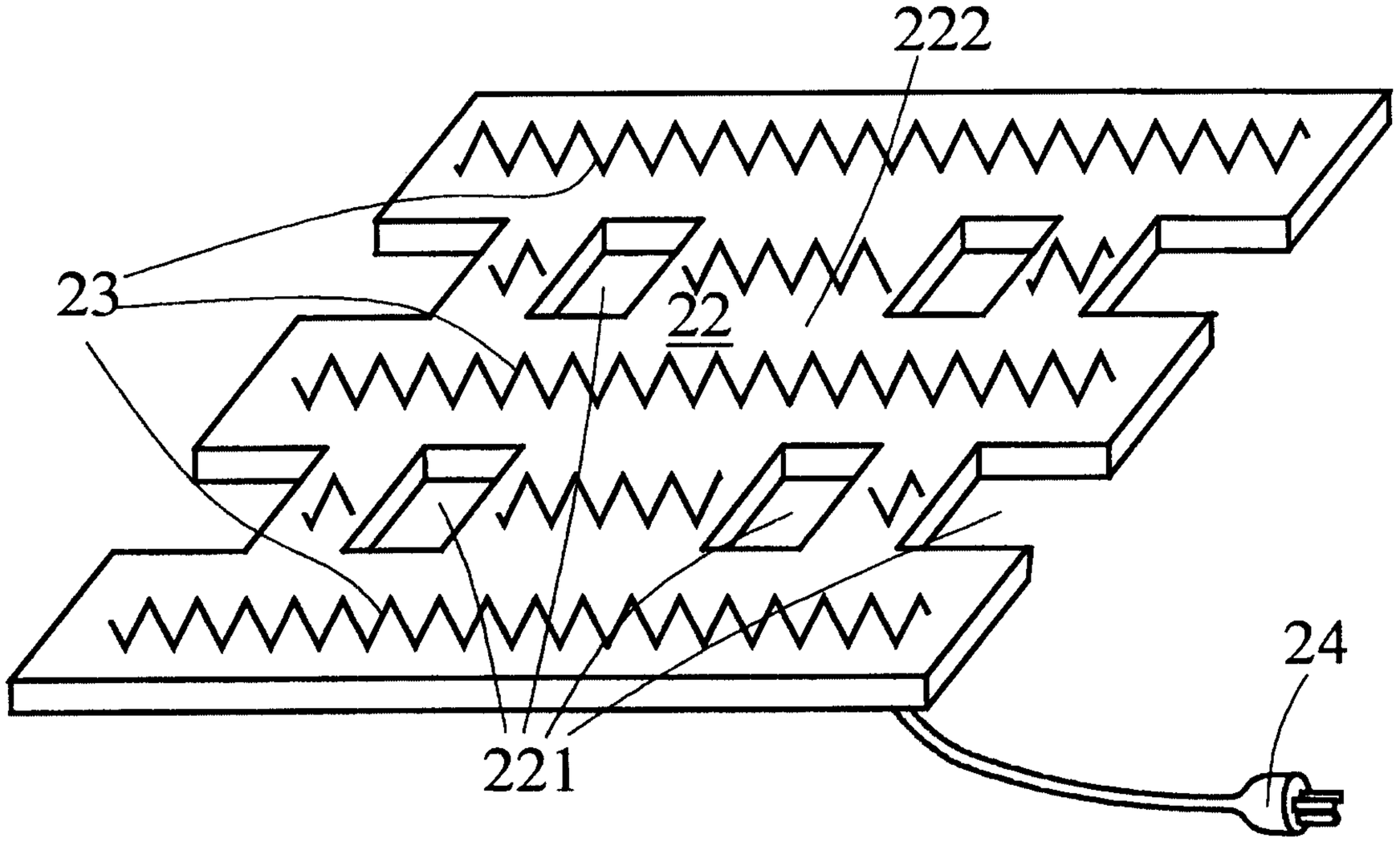


FIG. 3

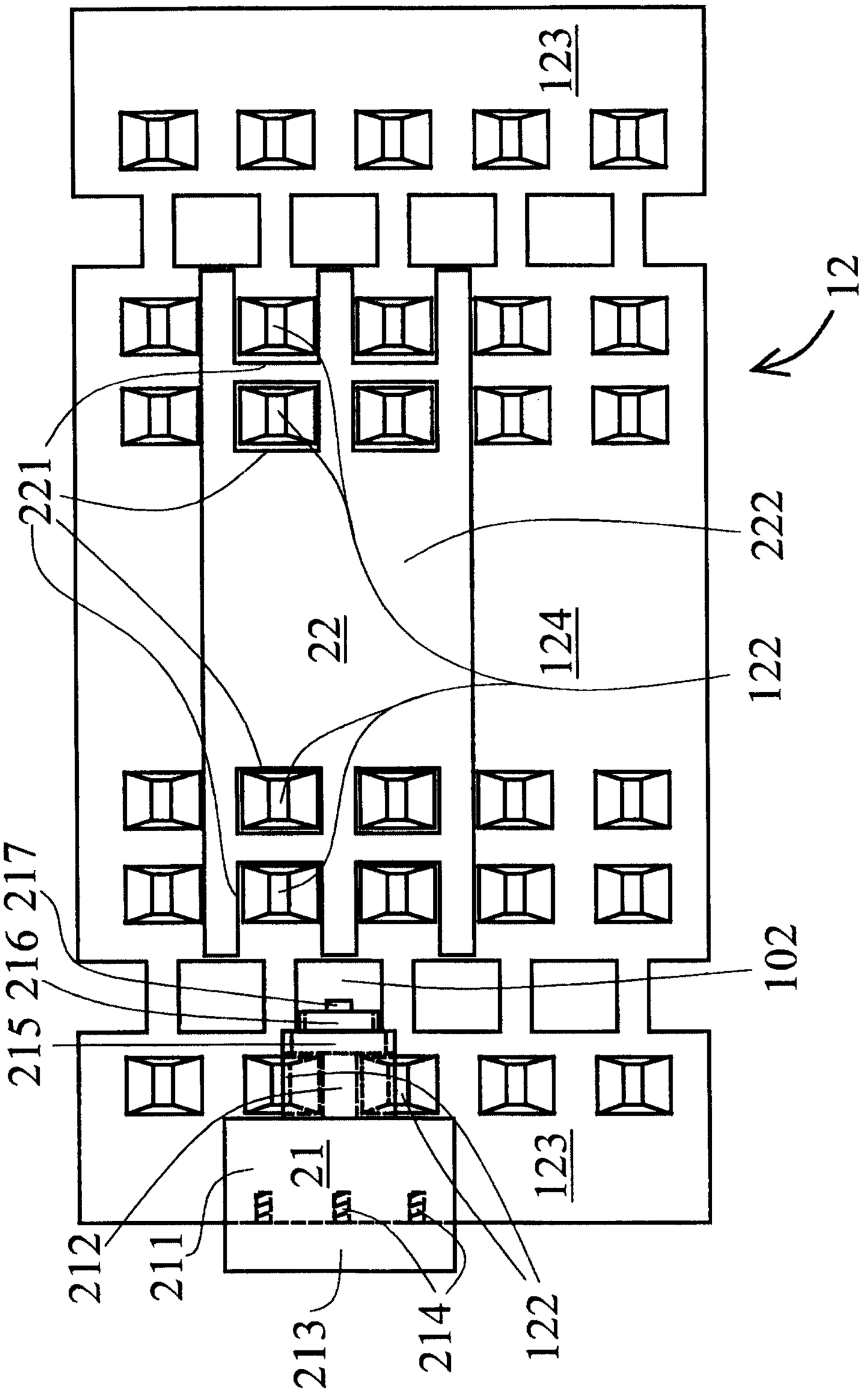

123
12
221
222
22
124
122
215 216 217
102
123
21
212
211
213
214
122

FIG. 4

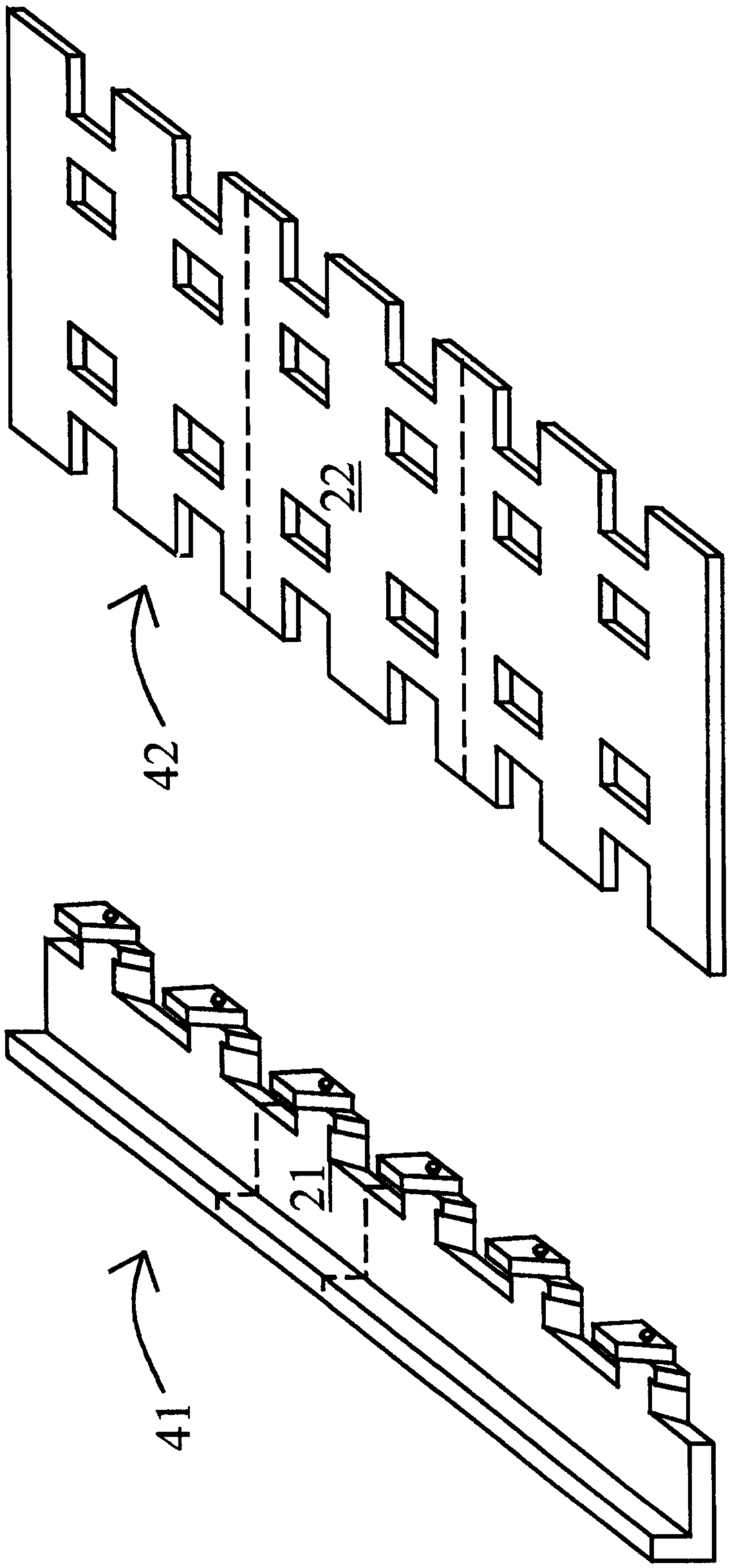


FIG. 6

FIG. 5

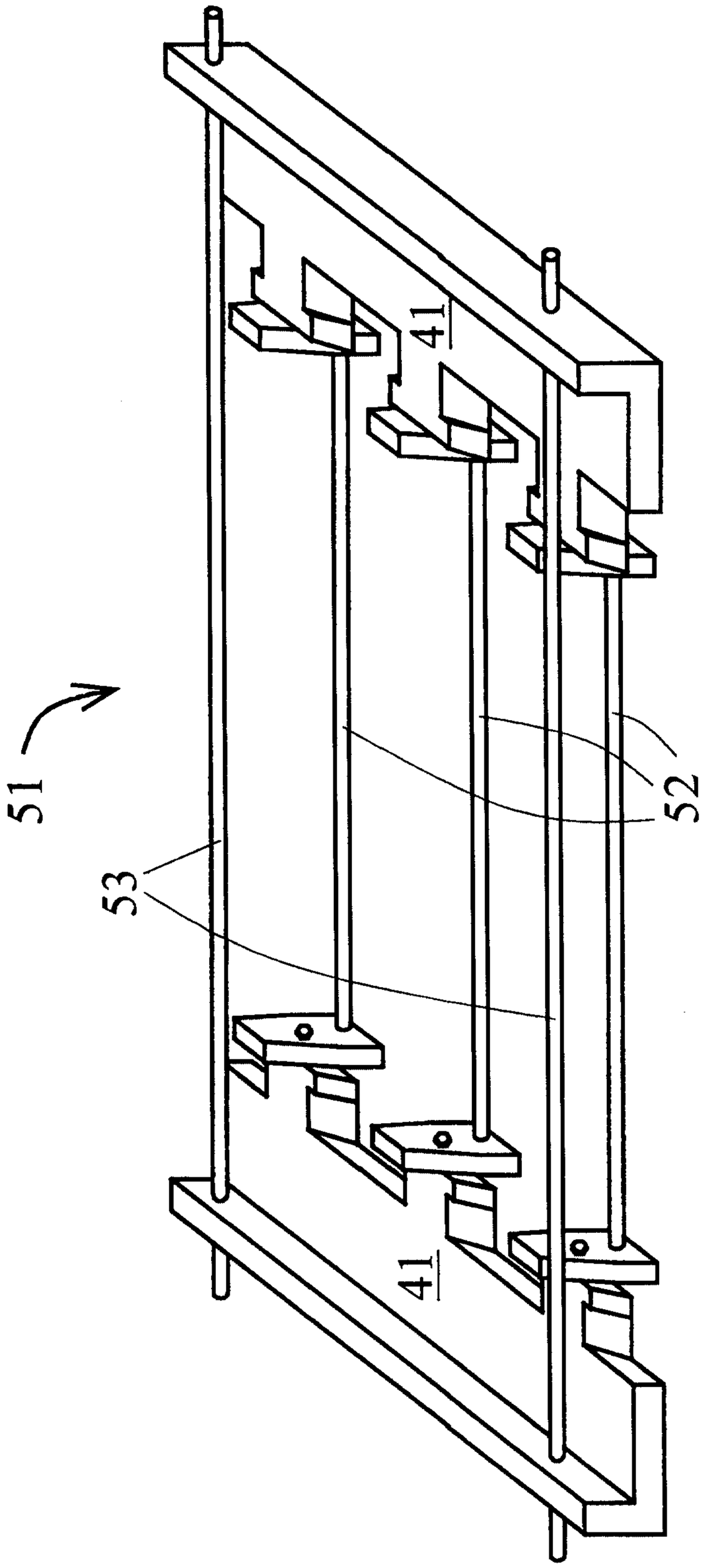


FIG. 7

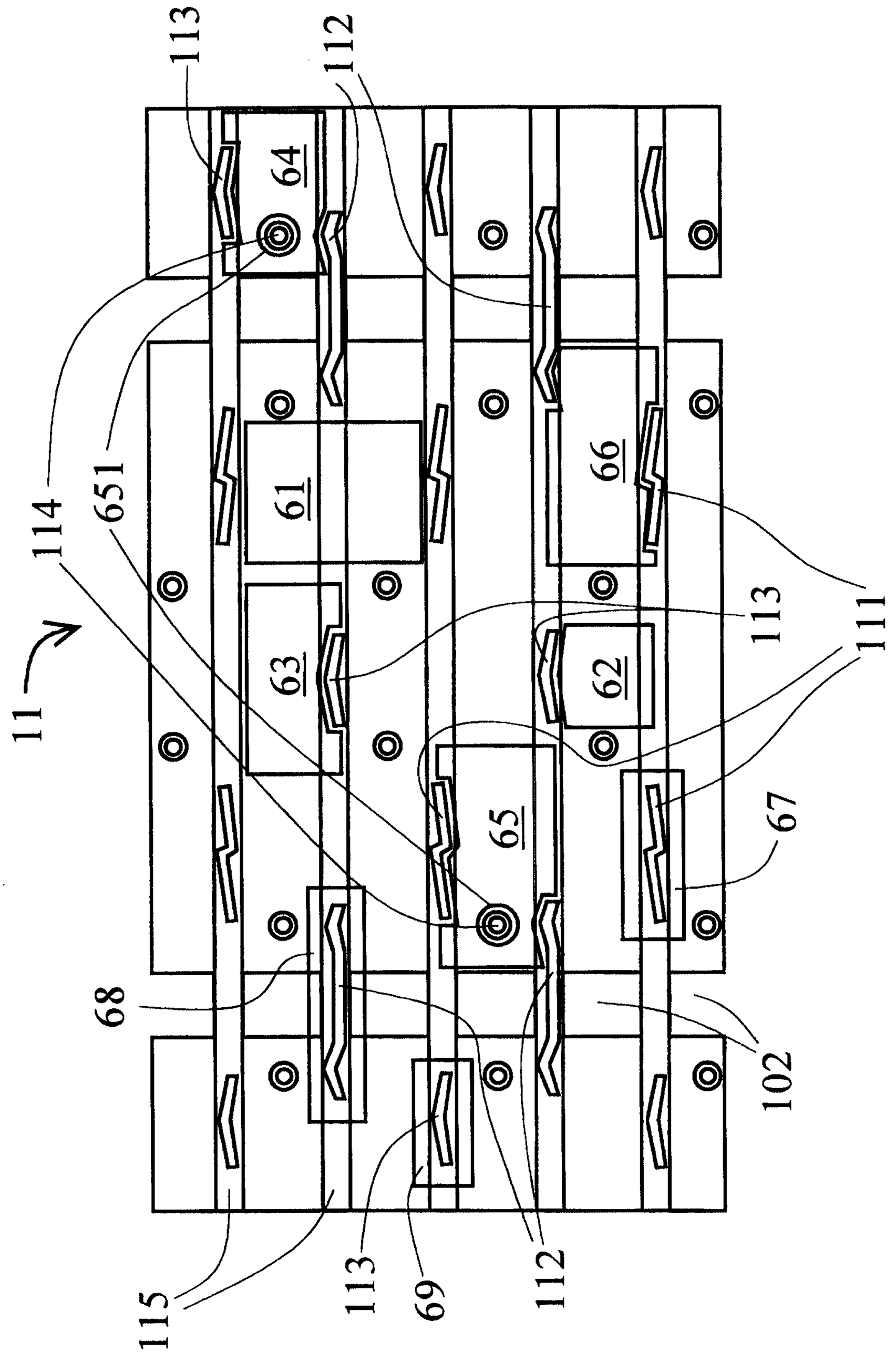

113
112
64
651
114
11
61
66
63
62
111
113
111
65
67
68
102
115
113
69
112

FIG. 8

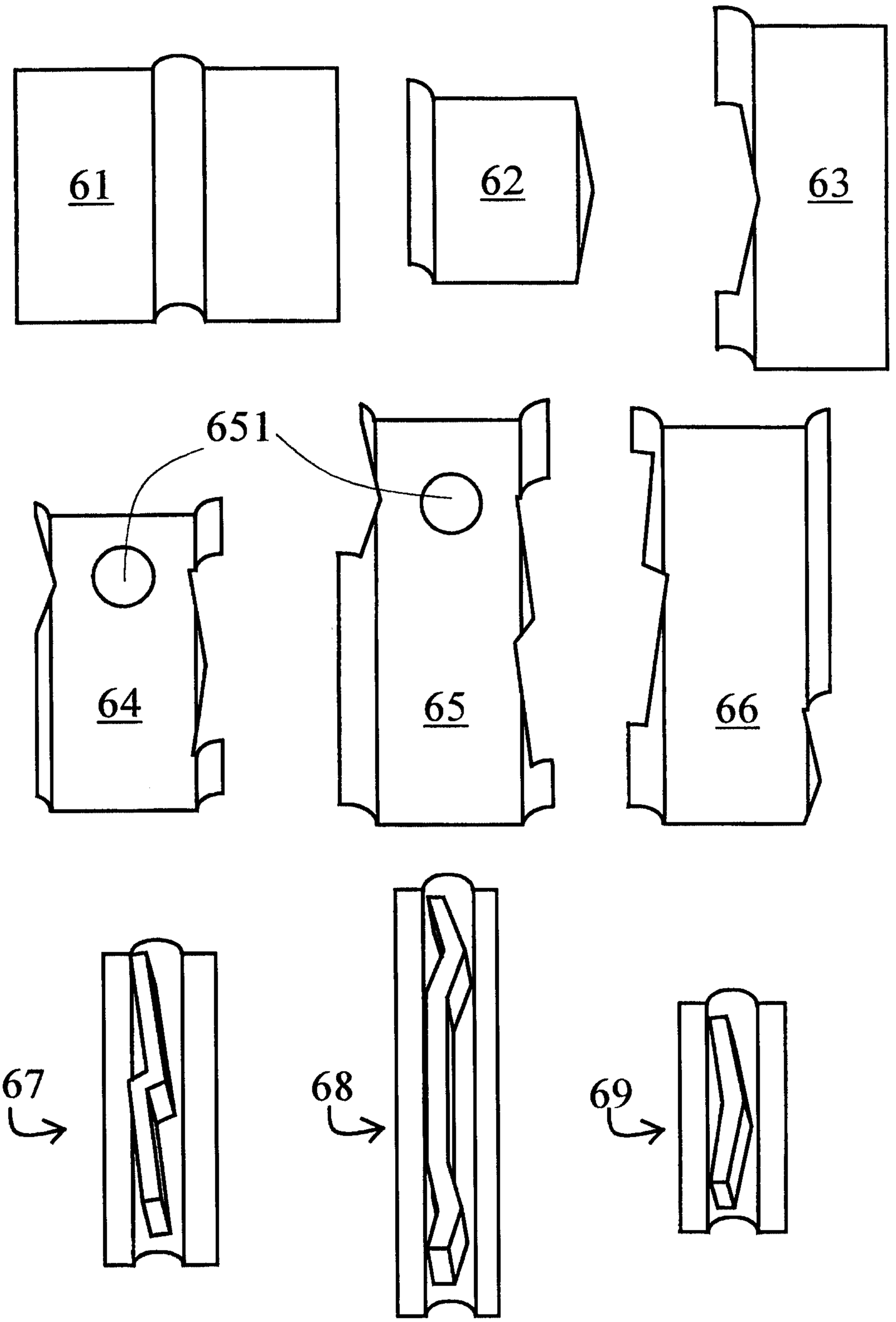


FIG. 9

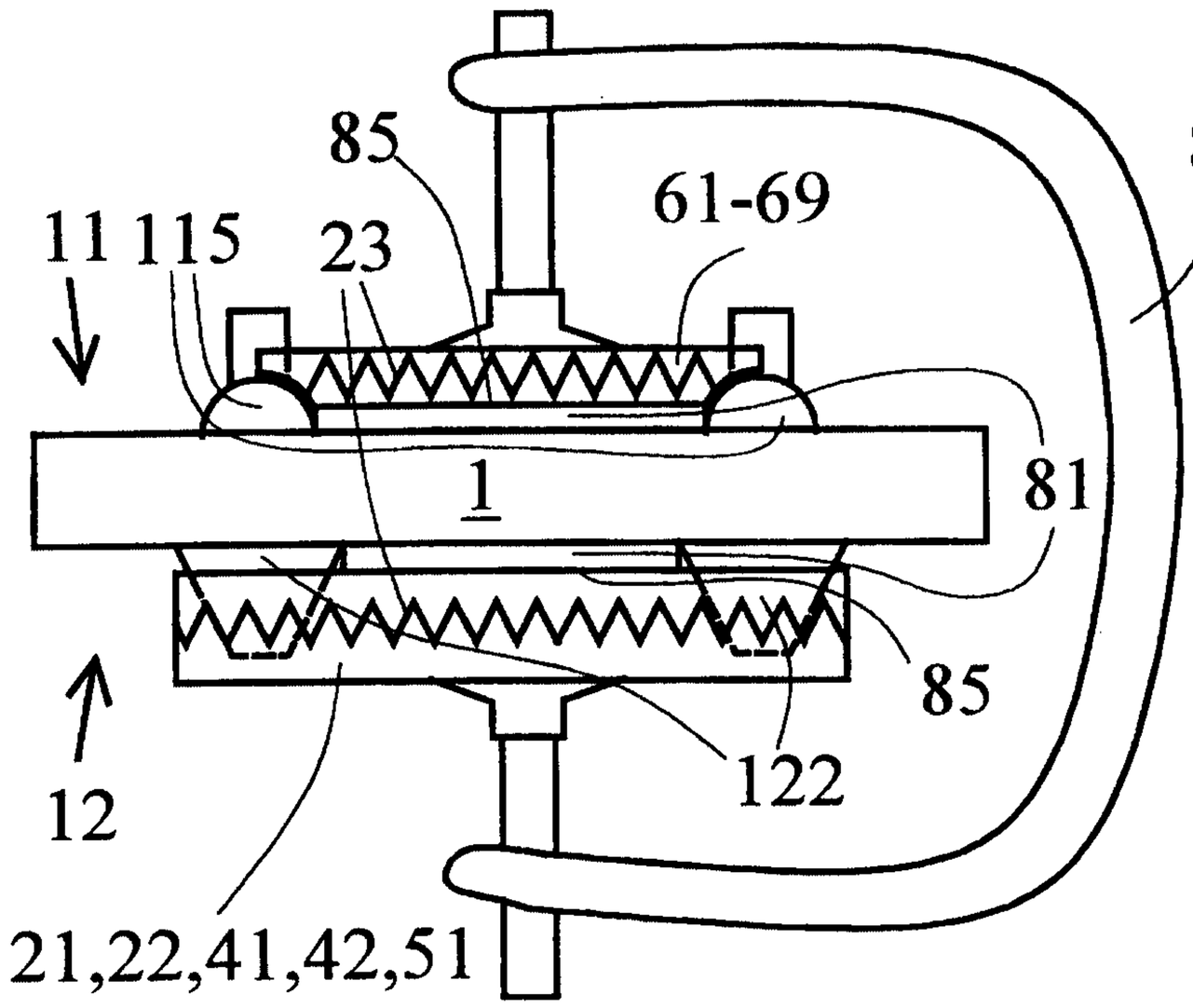


FIG. 10

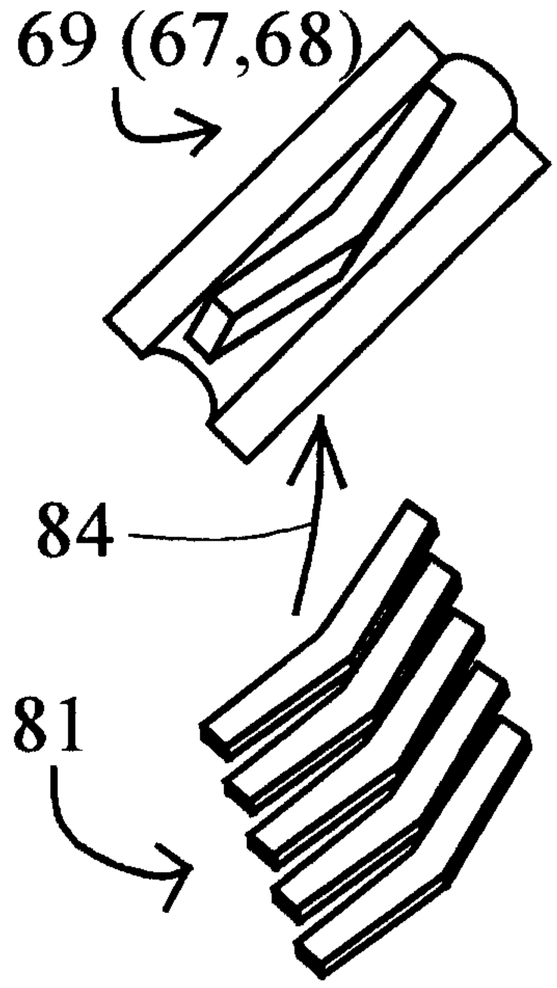


FIG. 12

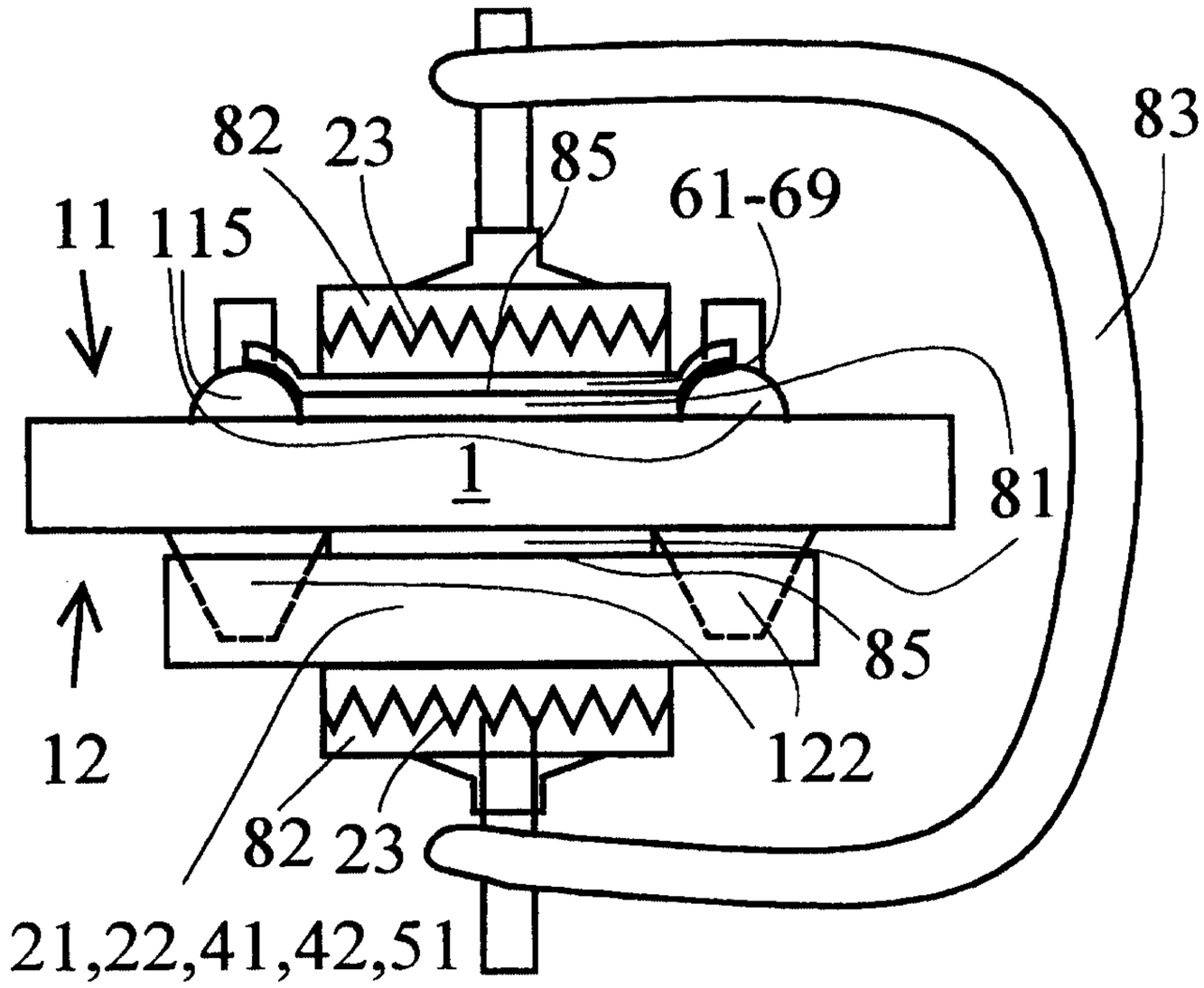


FIG. 11

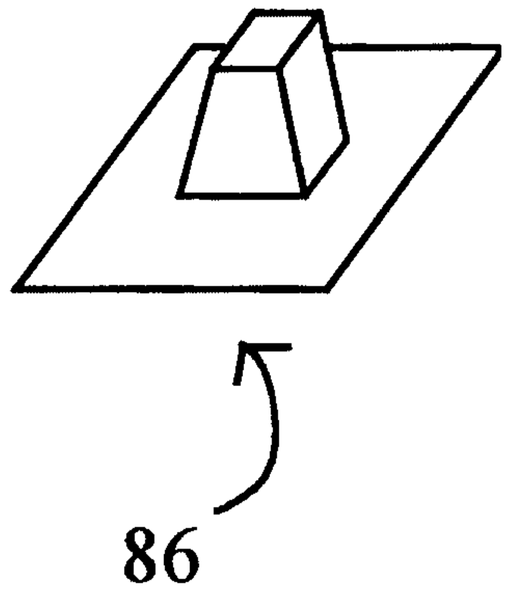
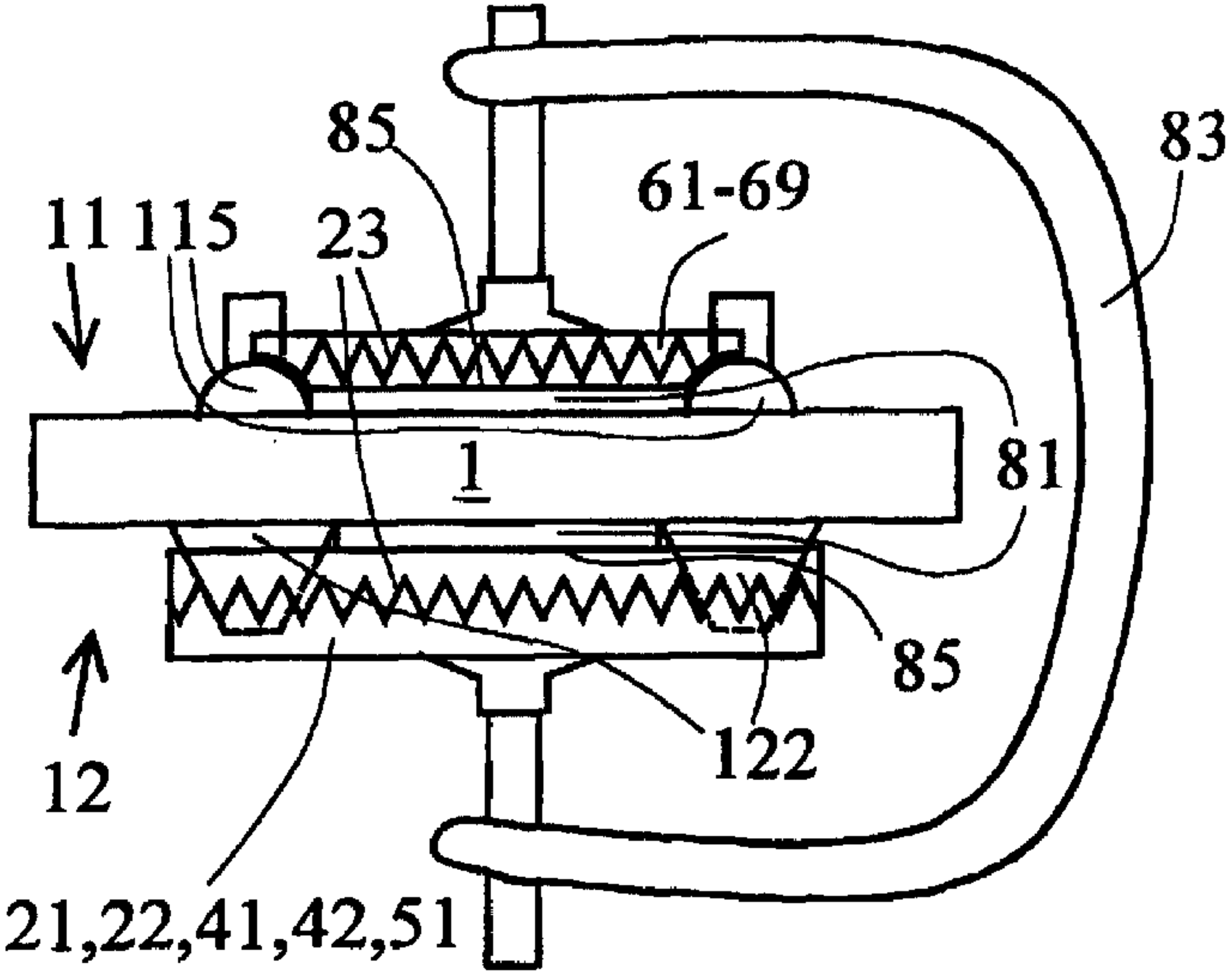


FIG. 13


85
83
61-69
11 115
23
1
81
85
122
12
21,22,41,42,51