Sept. 17, 1968 C. E. CHRISTOPHERSEN 3,401,437

HOSE CLAMP

Filed May 10, 1967 2 Sheets-Sheet 1

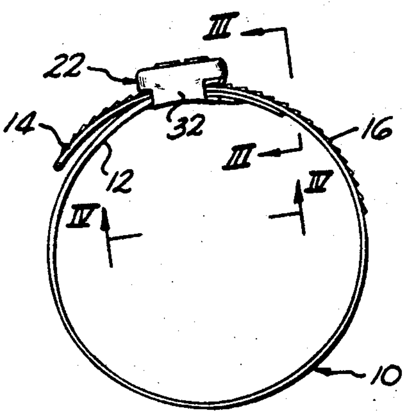

FIG. 1

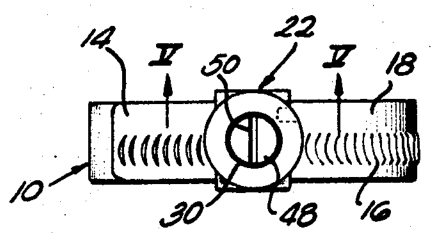

FIG. 2

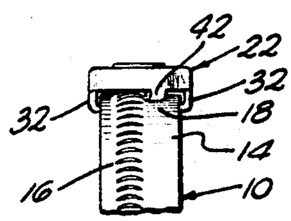

FIG. 3

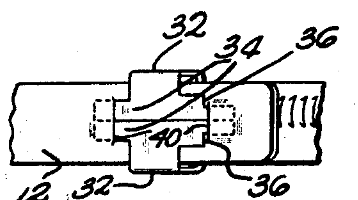

FIG. 4

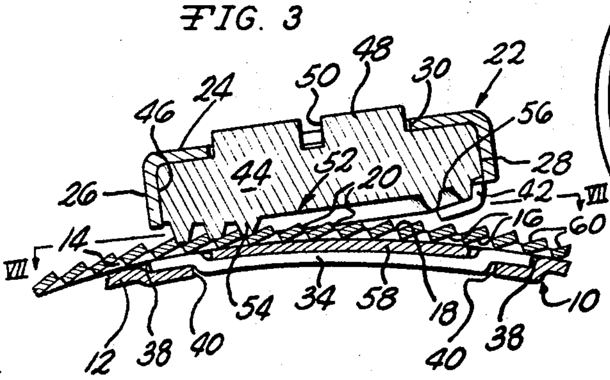

FIG. 5

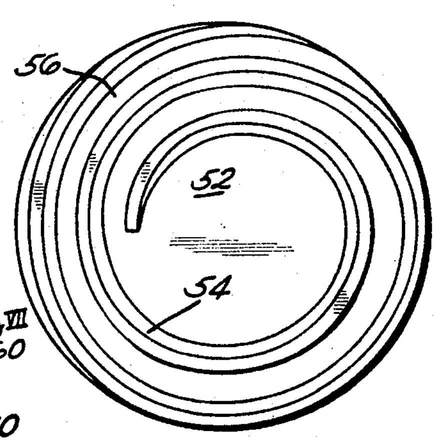

FIG. 6

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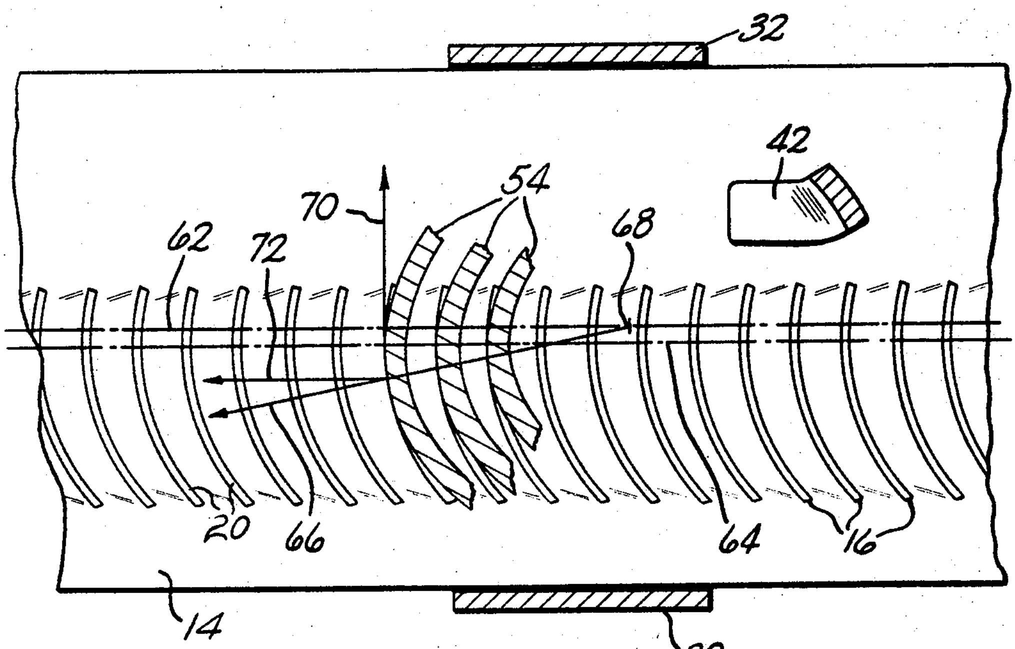

FIG. 7

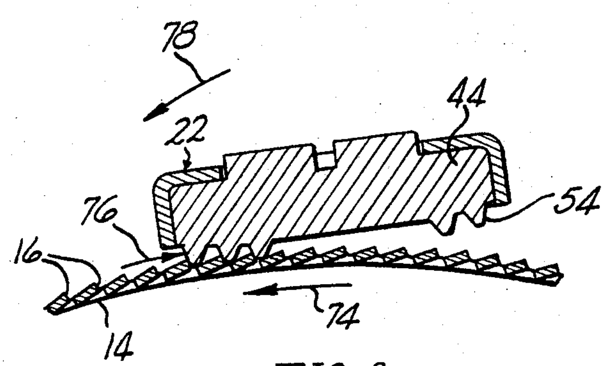

FIG. 8

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3,401,437
HOSE CLAMP

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ABSTRACT OF THE DISCLOSURE

A clamp of the circumferential type, such as commonly used with hose and flexible pipe, consisting of a flexible band having teeth formed therein, and scroll drive means mounted upon the band in engagement with the teeth to provide circumferential adjustment of the clamp.

Field of the invention

The invention pertains to the field of circumferential clamps utilizing scroll or spiral drive means for adjusting the circumference of the band. In the device of the invention a flexible band or strap having teeth formed thereon includes a scroll type cam mounted adjacent one end of the band which engages teeth defined adjacent the other end of the band. The end of the band in engagement with the scroll passes between the scroll and the other band end wherein the band is maintained and adjusted in an annular configuration.

Scroll drive circumferential clamps of the type previously known are shown in United States Patents 2,907,086, 3,035,319 and 3,276,090. Devices of the type disclosed in these patents have not enjoyed significant commercial success in that the construction of these patented clamps did not overcome several of the problems attendant with this type of clamp. For instance the scroll and band teeth engagement must be such that the forces transmitted between these components do not tend to separate the scroll and teeth, as is the case in clamps shown in Patents 3,035,319 and 3,276,090. Also with this type of clamp significant frictional forces are created between the band teeth and scroll in a direction tangential to the direction of scroll rotation and lateral to the longitudinal direction of movement of the band during tensioning. These frictional forces can cause the band, while being tightened, to be pushed to the side of the scroll support as it passes thereunder producing nonproductive resistance to scroll rotation and causing the band to "cock" relative to the desired plane of the clamp band. Such frictional forces tend to prevent the band from centrally passing through the scroll support and tightening "flat" upon the article being clamped, and adversely affect the efficiency of the clamping action produced.

Summary of the invention

The clamp of the invention utilizes a scroll or spiral cam to circumferentially adjust the band or strap, to obtain the advantages of this type of drive, while overcoming the disadvantages of prior scroll driven clamps as described above.

In the construction of the clamp of the invention the scroll and its support are of a concise configuration which results in a clamp of only slight radial projection beyond the shape of the article being clamped. The scroll includes means to be engaged by a tool, usually a screwdriver, which is so located that the force imposed on the scroll by the tool, to maintain engagement therebetween, is in a substantially radial direction with respect to the clamp configuration and hose or pipe being clamped. Thus, the tool does not tend to rotate the clamp about the hose during tightening, as with worm drive hose clamps and the scroll permits a high mechanical advantage to be produced which results in effective clamping forces.

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The clamp of the invention provides a more effective scroll-band teeth relationship than prior devices in that the scroll is related to the configuration of the band portion upon which the teeth are formed such that the circumferential forces produced in the clamp tend to keep the scroll and teeth engaged and, in fact, increase the effectiveness of the engagement of the scroll and teeth, rather than permitting these forces to tend to disengage the band teeth from the scroll. This advantage of the invention is accomplished by engaging the band teeth with the outer edge of the scroll cam and tilting the scroll such that the reaction forces imposed on the scroll by the band teeth tend to pivot the scroll into engagement with the teeth and toward the band. Additionally, the scroll tends to "push" the clamp band in the band take-up or tensioning direction, rather than "pull," and the "push" force includes vectors disposed toward the band teeth, rather than away from the teeth.

An additional feature of the invention lies in the shape of the scroll cam wherein at least two portions of the scroll cam will always be in engagement with two band teeth. This arrangement prevents excessive forces being produced at any single band tooth, such as would cause deformation or galling.

Another unique feature of the invention resides in the manner in which the teeth are formed on the clamp band or strap, and the manner in which these teeth relate to the scroll cam. The band teeth are of a concave arcuate configuration as to correspond as closely as possible to the shape of the scroll cam. However, the teeth are asymmetric with respect to the width of the band portion on which they are formed. The band teeth are offset with respect to the longitudinal center of the associated band a sufficient distance to compensate for lateral or tangential frictional forces occurring between the scroll and the teeth engaged thereby during tightening of the clamp. Thus, the direction of the static force between engaged band teeth and scroll may be to the left of the band longitudinal axis. However, during rotation of the scroll during tensioning of the clamp, the frictional engagement between the teeth and scroll causes a force on teeth tangential to the scroll cam and to the right of the band axis. The configuration of the band teeth, and their relationship to the band axis, is predetermined such that the resultant kinetic force on the teeth and band during tensioning of the clamp is substantially parallel to the band axis. Thus, "cocking" of the band during tightening is prevented as no lateral shifting of the band occurs. The band is able to readily pass under the scroll and through the scroll support in the direction of its axis and will lie "flat" on the article clamped such that effective clamping is assured.

Brief description of the drawing

The above and other advantages of the invention arising from the details and relationships of the components of an embodiment thereof will be apparent from the following description and accompanying drawing wherein:

FIG. 1 is an elevational view of a circumferential clamp in accord with the invention,

FIG. 2 is a plan view of the clamp of FIG. 1,

FIG. 3 is a detail, elevational view of the clamp of FIG. 1, as taken along section III—III thereof,

FIG. 4 is an underside view of the retainer and inner end of the clamp as taken along section IV—IV of FIG. 1,

FIG. 5 is an enlarged, detail, diametrical, sectional, elevational view of the retainer, scroll body member, scroll projection, and band, as taken along section V—V of FIG. 2,

FIG. 6 is an enlarged bottom view of the scoll body member, illustrating the configuration of the scroll projection or cam,

FIG. 7 is an enlarged sectional view of the band, teeth and scroll as taken along section VII—VII of FIG. 5, and

FIG. 8 is a diagrammatical, sectional, elevational view of the scroll and the band teeth.

The circumferential clamp illustrated includes a flexible band or strap **10** which is normally formed of steel. The band is flexible enough to permit radial contracting of the circle defined by the band during tensioning without producing undue resistance. The band includes an inner end portion **12** and an outer end portion **14**. In the illustrated embodiment, the outer end portion **14** is provided with a plurality of teeth **16** which are spaced in the longitudinal direction of the band and define a track thereon. The teeth **16** do not define a track extending the entire length of the band, i.e., the circumference thereof. However, the teeth may exist over the length of the band, if desired. Preferably, the teeth **16** are formed by a lancing operation from the metal of the strap and are deflected from the configuration of the strap in the direction of the strap outersurface **18** to define edges **20**. The teeth are evenly spaced and, as will be apparent from FIGS. 2, 3 and 7 are offset with respect to the width of the band as will be described later in greater detail. It is desired that the teeth be of an arcuate configuration substantially corresponding to the maximum radial configuration of the scroll cam or projection with which they engage, as will later be apparent.

While the teeth **16** are shown as formed by a lancing operation, it will be appreciated that suitable teeth can be formed by coining or similar well-known manufacturing processes. It would also be possible to practice the concept of the invention by forming the teeth as a plurality of evenly spaced holes defined in the band, as is often employed with conventional worm drive hose clamps.

A scroll support or retainer **22** of a stamped steel construction is affixed to the band adjacent the inner end **12**. The retainer includes an inverted cup-shaped portion defied by a base portion **24** and a substantially cylindrical wall **26**, the inner surface **28** of which forms a bearing surface for the scoll body member containing the scroll cam. A cylindrical opening **30** is defined in the portion **24** concentric with the cylindrical wall **26**.

A pair of tabs **32** are formed on the retainer **22** located at substantially diametrical positions, whereby the tabs may project parallel to the wall **26** and then be bent under the band inner end **12**, FIG. 4. The ends of the tabs **32** are provided with elongated portions **34** which include shoulders **36**. The ends of the elongated portions **34** are received within recesses **38** defined in the band inner end through openings or slots **40** defined in the band, as will be apparent from FIG. 5. The axial width of the right slot **40**, FIG. 4, is such that the shoulders **36** will engage the band adjacent the slot and, thus, prevent movement of the retainer in the axial direction of the band to the right as viewed in FIGS. 1, 4 and 5 during tensioning of the band. Therefore, it is appreciated that the retainer **22** is firmly affixed to the band inner end in an economical manner requiring no extra components.

As apparent from FIGS. 1 and 5, the retainer cup-shaped portion defined by base **24** and walls **26** is obliquely related to the circular configuration defined by the band **10** and this oblique relationship is such that the portion of the wall **26** disposed in the direction of band movement during take-up or tensioning, i.e., toward the left, FIG. 5, is closest to the center of the circle defined by the band **10**.

A generally cylindrical scroll body member **44** is re-

tained and rotatably supported within the retainer **22** on bearing surfaces disposed adjacent the body member periphery, as is apparent from FIG. 5. The body member **44** includes a cylindrical surface **46** which is adapted to rotatably cooperate with the retainer inner surface **28**, whereby the member **44** will be rotatably located in the body member in the desired angular relationship to the clamp components. A tab **42** extends from wall **26** and is bent under member **44** to maintain member **44** in the oblique relationship of the retainer and up against base **24**.

The body member **44** includes a cylindrical boss **48** which extends through the retainer opening **30** and includes a screw-driver-receiving slot **50**. Preferably, the slot **50** is of such depth that the edge of the opening **30** will serve as a guide to maintain a screwdriver within the slot during operation of the clamp.

The surface **52** of the body member **44** disposed toward the band inner end **12** is formed with a spiral scroll cam or projection **54**, the configuration of which will be appreciated from FIGS. 5 and 6. The central portion of the lower surface **52** of the body member is open and the scroll cam does not extend to the center of the body member. However, in the illustrated embodiment, the scroll cam is of such configuration that approximately 2¼ turns are provided. Referring to FIG. 5, the surface **52** is beveled at **56** with respect to the axis of rotation of the body member whereby the depth of the scroll cam will remain substantially constant and, yet, the most desirable relationship between the scroll projection and the band teeth can be maintained. The tab **42** is closely related to the scroll projection to hold the member **44** in the retainer, yet does not interfere with the rotation of the scroll member **44**.

With the components in the relationship shown in FIG. 5, it will be noted that the oblique angle of the axis of the retainer cup portion and body member, with respect to the curvature of the band outer end **14** and band teeth, insures that the scroll cam **54** will only engage the teeth **16** on one "side" of the axis of rotation of the scroll body member **44** and scroll cam, and that the other "side" of the scroll cam will be out of engagement with the band teeth. In FIG. 5 the configuration of the teeth **16** is somewhat exaggerated for purposes of illustration.

The teeth **16** are of an arcuate form which substantially corresponds to the maximum arcuate configuration of the scroll cam **54**, FIG. 7, and the angle of the body member bevel **56** is such that the degree of radial intermeshing between the engaged scroll cam and teeth is substantially equal at the locations of engagement, as shown in FIG. 5. Thus, the forces being transmitted between the scroll cam and the teeth **16** are divided between several teeth, always at least two, minimizing any tendency to over-stress or gall a band tooth.

In operation the circumferential clamp will be of a diameter larger than the hose, pipe, or other cylindrical article to be clamped and, therefore, may be slipped over the end of the article to be clamped. In some cases, where it is not possible to slip the clamp endwise over the hose, the clamp may be fully opened wherein the teeth **16** are removed from engagement with the scroll cam and the band opened up to encompass the article and thereupon the band outer end **14** may be reinserted between the body member **44** and the band inner end **12** until the band teeth engage the scroll cam **54**.

Upon placing a screwdriver in the slot **50** and rotating the body member **44** in a clockwise direction, FIG. 2, the outer surfaces of the scroll cam **54** will mesh with and engage the teeth **16** and push the band outer end **14** to the left, FIG. 5. The portion **58** of the band inner end **12** between the slots **40** forms a back-up portion for the outer end of the band and, thus, maintains the band teeth in a position to be engaged by the scroll cam.The configuration of the scroll cam **54** provides a high mechanical advantage between the rotation of the body member **44** and the rate of translation of the band outer end **14**, thus permitting a high degree of tensioning of the band **10**. Upon the desired degree of tension being produced in the band **10**, the screwdriver is removed from the slot **50** and the clamping operation is complete.

When it is desired to remove the clamp from the article being clamped, a screwdriver is again inserted in the slot **50** and the scroll body member **44** and scroll cam are rotated in the counterclockwise direction, FIG. 2, to cause the scroll cam to engage the rear surface **60** of the teeth **16** and translate the band outer end **14** to the right, FIG. 5.

The advantages derived from the configuration and relationship of the band teeth **16** relative to the scroll cam **54** are best apparent from FIG. 7. In FIG. 7 the longitudinal axis of the band portion **14** is represented at **62** and the off-set relationship of the teeth **16** relative to the axis **62** will be readily appreciated. Preferably, the centers of the circular segments forming teeth **16** are displaced slightly with respect to axis **62** and the center of the teeth occur on line **64** which is displaced from axis **62** in the direction of the main configuration of the teeth. In one embodiment of the invention the distance separating lines **62** and **64** is .015 inch.

As the arc of teeth **16** is substantially equal to the maximum arc of the scroll cam **54** the engagement between the scroll cam and the teeth will occur at a limited area of the cam and teeth to substantially produce point contact between the cam and teeth, except when the maximum radius of the cam is engaging a tooth. Thus, due to the spiral configuration of the scroll cam, the shape of the teeth **16** and the placement of the teeth on the band portion **14** the contact between the cam scroll and teeth will occur along line **66**, where the center of the scroll cam **54** is represented at **68**.

Rotation of the scroll body **44** is in a clockwise, or band tension direction, will produce a lateral force on the band portion **14** in the direction of the arrow **70** due to the friction existing between scroll cam **54** and the engaged teeth **16** as the cam is "wiped" across the teeth. Normally, the existence of the frictional forces in the direction of arrow **70** would cause the band portion **14** to be shifted into engagement with the "upper" tab **32**, FIG. 7, which would produce a very objectionable resistance to tightening of the clamp, as well as possibly cause the band to "cock" on the article being clamped and not lie flat thereon. However, as the radial force exerted on the band portion **14** by the scroll cam **54** occurs along line **66**, rather than parallel to the axis **62** of the band, the resultant of the forces exerted by the scroll cam on the teeth **16** in the indicated directions of lines **66** and **70** occurs along line **72** which is parallel to axis **62**. Thus, the band portion **14** will stay centered between tabs **32** as the clamp is tightened and unnecessary frictional losses are prevented and the band will remain properly oriented to the article being clamped.

In FIG. 8 a diagramatic representation of the band portion **14** and the scroll body **44** is presented to illustrate the advantage of inclining the body **44** in the direction of band movement during tensioning, and using the "outside" surface of the scroll cam to "push," rather than "pull" against the band teeth **16**.

Band movement during tensioning is represented by arrow **74**, therefore, the reaction force of the band teeth on the scroll cam will be in the direction of arrow **76**. As the body **44** is supported by the retainer **22** at a greater radial distance from the center of the article being clamped than force **76**, and as the body **44** is tilted toward the direction of band movement during tensioning, the tendency of force **76** is to twist the body **44** in the direction indicated by arrow **78**. This tendency to twist body **44** in the direction **78** will force the scroll cam **54** portions in engagement with teeth **16** toward the engaged teeth and thereby increase, rather than decrease, the extent and efficiency of the engagement between the scroll cam and engaged band teeth.

The use of the scroll projection drive permits the body member **44** and the retainer **22** to be of a very concise configuration and the radial dimension of the band tensioning means is considerably less than the radial dimension of the more conventional worm drive tensioning means. An additional advantage arising from the use of the scroll drive as utilized in the illustrated arrangement lies in the fact that when using a screwdriver to rotate the body member **44**, the force exerted on the screwdriver to maintain the engagement with the slot **50** does not tend to cause the clamp to slip around the article being clamped, as with a conventional worm drive-type hose clamp. With the invention, the force applied to the screwdriver to maintain engagement with the slot **50** is substantially radial and, thus, there is no tendency for the clamp to be pushed around the hose during tightening.

It will be appreciated that rather than employing a screw slot **50**, the boss **48** could extend far enough from the retainer portion **24** to permit a wrench to be applied thereto upon the provision of flats or a hexagonal configuration on the boss.

Other modifications to the inventive concept may be apparent to those skilled in the art without departing from the spirit and scope of the invention and it is intended that the invention be defined only by the following claims.

What is claimed is:

1. A circumferential clamp comprising, in combination, an elongated flexible tension member adapted to circumscribe the article to be clamped, said tension member including first and second spaced portions, said second portion having a longitudinally extending central axis, a plurality of teeth defined on said tension member second portion evenly spaced in the longitudinal direction thereof and asymmetrically related to said longitudinal axis, a retainer fixed relative to said tension member first portion and overlying said member second portion and teeth, a scroll body member rotatably supported and retained in said retainer, means defined on said body member for rotating said body member, a scroll cam defined on said body member having an axis coincident with the axis of rotation thereof, said scroll cam engaging at least one of said teeth whereby rotation of said body member and cam translates said second portion in a tensioning direction, said teeth being so disposed on said second portion such that the radial force on the engaged tooth resulting from engagement with the scroll cam is laterally and obliquely disposed of said second portion longitudinal axis on the lateral side of said axis opposite to the relative direction of rotation of said scroll cam and the engaged tooth when said flexible member is being tensioned whereby the combination of the radial and lateral frictional forces imposed on the engaged tooth by said scroll cam results in a kinetic force imposed on the engaged tooth substantially parallel to said second portion longitudinal axis.

2. A circumferential clamp as in claim **1** wherein said teeth are of an arcuate concave configuration having a radius substantially corresponding to the maximum radius of said scroll cam.

3. A circumferential clamp as in claim **2** wherein said teeth are of a concave cylindrical segment configuration and the center of generation of said teeth lies on a line longitudinally disposed on said flexible member second portion and laterally off-set with respect to said axis on the same side of said axis as related to the location of the major portion of said teeth relative to said axis.

4. A circumferential clamp as in claim **1** wherein said scroll cam consists of at least two complete convolutions and at least two teeth are engaged by said cam during tensioning of said clamp.

5. A circumferential clamp as in claim **4** wherein said scroll cam includes a radially outwardly facing surface, and means maintaining said retainer and body member obliquely disposed to said tension member second portion in the direction of the length and inclined toward the direction of movement of said second portion relative to said retainer during tensioning of said flexible member whereby said scroll cam outwardly facing surface engages at least two of said teeth in the direction of movement of said second portion during tensioning of said flexible member and reaction forces between said teeth and scroll cam tend to bias the teeth engaged portion of the scroll cam toward the engaged teeth.

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