

TITLE**LUBRICATION FREE CONNECTION****TECHNICAL FIELD**

This invention relates to the construction of a self lubricating shaft or pivot pin
5 suitable for operating at high temperatures such as in tenter frame apparatus.

BACKGROUND OF THE INVENTION

U.S. Patent number 5,067,214 issued November 26, 1991 to Christopher E.
Hosmer and John F. Whaley for a Tenter Framier Apparatus and Method shows a self-
lubricating bushing made of a polyamide resin.

10 U.S. Patent number 5,797,172 issued August 25, 1998 to Christopher Eugene
Hosmer for a Tenter Frame and Method discloses tenter frame apparatus of the type in
which this invention has particular application.

Conventional self lubricating friction or wear devices such as bushings and/or
plain bearings are typically composed of a metal housing in which a plain plastic
15 bushing is inserted and secured in a manner preventing rotation of the bushing.
Typically a metal shaft is carried in the interior diameter of the bushing. In the case of a
tenter frame clip jaw application the currently issued bushings result in the bushing
locking down on the metal shaft due to thermal expansion and the bushing wears out
prematurely or it locks up preventing the desired function of the jaw.

20 BRIEF SUMMARY OF THE INVENTION

Embodiments of the present invention describe an attachment of the self
lubricating plastic bushing which can be achieved by insert injection molding, at high
pressure and temperature, a thin, self lubricating plastic sleeve around the metal pin. To
enhance adhesion and provide sufficient material for wear, the plastic can be molded in
25 a groove or recess of a specific depth which has a roughed up or knurled surface. The
self lubricating bearing member is thus on the shaft which rotates in the metal housing.
Thermal expansion at elevated temperature results in expansion of the internal diameter
of the plastic sleeve; however, the roughed up surface prevents rotation of the plastic
sleeve. Expansion of the plastic bearing sleeve can be minimized by using a thin layer
30 of plastic which has a low coefficient of thermal expansion.

The process by which the hybrid steel and plastic pin can be produced is also
unique and very cost effective. Although CNC turning of the hybrid pin to the desired
outside diameter and dimensional tolerance is possible, a more cost effective and
dimensionally and surface finish superior part can be produced by centerless grinding
the outside diameter. The process of centerless grinding metal and plastic
simultaneously is unique and

preferably requires a plastic that is dimensionally stable and rigid enough to grind properly and not melt and smear or have metal particles in-bedded.

A polytetrafluoraethylene is preferred for use in tenter frame jaw pins for its physical, thermal and tribological properties which are required to achieve a long wearing, stable product with reliable performance.

In accordance with a first aspect of the present invention, there is provided a method of manufacturing a pivot pin for use in a high temperature environment comprising the steps of: machining a pin to a predetermined oversize diameter machining a pair of axially spaced relatively shallow reduced diameter recesses in said pin of an axial width suitable for registering with a pair of bearing surfaces of a member to which the pin is to be attached, knurling said recesses, applying a cylindrical bearing sleeve of self lubricating thermoplastic compound to each of said knurled recesses by injection molding, and finishing machining the outside diameter of said pin including said bearing sleeves to a finished diameter by centerless grinding.

In accordance with a second aspect of the present invention, there is provided a tenter clip comprising: a clip body having an open side with a flat surface for supporting web material being fed into said open side and a pair arms spaced above and extending over said flat surface each of said arms having a radially inward facing bearing surface, a jaw, a jaw pivot pin nonrotatably secured to said jaw and having an axially elongated knurled recess near each of its axially opposite ends, and a sleeve of self lubricating high temperature resistant plastic molded into each of said recesses, said sleeves presenting radially outward facing cylindrical bearing surfaces on said jaw pivot pin mating, respectively, with said bearing surfaces on said arms.

In accordance with a third aspect of the present invention, there is provided a cylindrical pivot pin comprising: a shallow recess formed near each end of said pin, each of said recesses having a radially outward facing cylindrical surface which has been knurled and a high temperature resistant, self lubricating plastic sleeve bonded to each of said knurled cylindrical

surfaces, each of said sleeves presenting a radially outward facing cylindrical bearing surface.

In accordance with a fourth aspect of the present invention, there is provided a bearing for a shaft component pivotally connecting a support component to a supported component, comprising: smooth radially confronting cylindrical surfaces on said components, a shallow annular recess formed in one of said cylindrical surfaces said recess presenting a rough radially facing surface, and a thin layer of self lubricating plastic pressure molded into said recess, said thin layer of plastic presenting one of said smooth cylindrical bearing surface in bearing engagement with the other of said cylindrical surfaces.

In accordance with fifth aspect of the present invention, there is provided a pivot connection between a shaft and a pair of axially spaced supports comprising: a pair of aligned radially inward facing cylindrical surfaces on said supports; a pair of radially outward facing cylindrical surfaces on said pin in confronting relation to said radially inward facing cylindrical surfaces a recess formed in each of one of said pairs of cylindrical surfaces, said recesses presenting a roughed up surface and a thin cylindrical layer of self lubricating plastic molded in said recesses presenting cylindrical bearing surfaces in radially confronting and bearing engagement with the other of said pairs of cylindrical surfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

One embodiment of the invention is illustrated in the drawings in which:

Figure 1 is a perspective view of a tenter frame with parts separated and broken away for illustration purposes;

Figure 2 is an end view of the tenter frame in an assembled condition;

Figure 3 is a side view of a metal pivot shaft initially machined to provide two reduced diameter recesses;

Figure 4 is a side view of the shaft after the recessed areas of the shaft have been knurled;

Figure 5 is a side view of the shaft after a plastic material has been applied to the recessed areas by injection molding;

Figure 6 is a side view of the shaft after it has been machined by centerless grinding;

Figure 7 is a section view taken along the line VII – VII in Figure 6;

Figure 8 is a side view of a centerless grinding apparatus, and

Figure 9 is a top view of the apparatus shown in Figure 8.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figures 1 and 2, the invention is illustrated in a tenter clip 11 which with other clips, are connected in series by a link chain 12 thus providing a tenter chain 13. Tenter chains are provided in opposing pairs to grip the edge of a continuous web of flat material such as woven cloth and to simultaneously stretch the material in a transverse direction while conveying it through a process oven as a finishing operation to its manufacture.

The tenter clip 11 is a clamping device which includes a clip body 14 which is open on one side with a surface 16 for supporting web material being fed into it. The clip body 14 includes a pair of support arms 17, 18 pivotally supporting a pivot pin 21 for a jaw 22. The pivotable jaw 22 is operated by an external mechanism, not shown, to allow entry and exit of the web material. The jaw 22, and the clip 11, are designed to automatically clamp and hold the web material. The jaws movement is a limited pivotal

movement about the axis 23 of the jaw pivot pin 21 which is nonrotatably secured to the jaw 22 by a transverse pin 24 extending through aligned bores in the pin 21 and the jaw 22.

Referring to Figures 3 – 7 the process for manufacture of the jaw pivot pin 22 is illustrated by showing the steps of manufacture.

Figure 3 shows the pin 22 after the pin is rough finished to a predetermined oversize diameter and a pair of reduced diameter recesses 31, 32 are formed near its axially opposite ends. The recesses 31, 32 having an axial dimension matching the bearing surfaces of the arms 17, 18 of the tender clip 11.

Figure 4 shows the pin 22 after the reduced diameter surface of the recesses 31, 32 have been knurled.

Figure 5 shows the pin 22 after sleeves 34, 36 of high temperature resistant plastic, such as polytetraflouraethylene has been applied by injection molding to the reduced diameter areas 31, 32 of the pin 22. The oversized pin 22 is next machined by centerless grinding to a desired finished diameter as illustrated in Figures 6 and 7.

Figures 8 and 9 illustrate the centerless grinding step. The shaft 22 is supported by a work blade 41 and is sandwiched between a grinding wheel 42 and a regulating wheel 43. As shown in Figure 9 the pin 22 is guided by work rest guides 46, 47, 48, 49 during a machining operation.

PRACTICAL APPLICATION OF THE INVENTION

This application has particular application in tenter clips which are connected in series by a chain to form a tenter chain. Tenter chains are used in opposing pairs to grip opposite edges of a continuous web of flat material, such as a woven cloth, and simultaneously stretch the material in opposite directions while conveying it through a relatively high temperature process oven as a finishing operation in the manufacture of the processed material.

Wear on the bearing surfaces has long been a problem in tenter clip design because lubrication of the bearing surfaces is impractical, mainly because the bearing surfaces are above the web material and it is virtually impossible to lubricate the bearing surfaces without lubrication spilling onto the web material. Since these bearing surfaces are typically not lubricated, they are made of metal which resists high temperature and are expected to wear significantly. Frequent repair of the clip is required to keep the clips within operating tolerances. The repair of some clip designs require reboring the pivot pin hole and a new larger diameter pivot pin. The repair of clips using replaceable

steel bushing are repaired by replacing the bushing and it is often to replace the pin as well.

Various plastic materials with improved strength and wear characteristics and the ability to withstand high temperature have been developed. They have been tried
5 and tested with limited success. Very close tolerances are necessary for proper operation of a tenter clip. Steel bushings for tenter clips are commonly ground on their outside diameter and honed on their inside diameter to achieve the required tolerances. It is difficult and expensive to obtain these desired tolerances with plastic bushings. Most plastic materials have a much higher coefficient of thermal expansion than metals
10 used in tenter clip components. This tends to cause the bushings to lose clearance and lock on the pin preventing rotation. Increasing the cold clearance solves this problem but creates manufacturing and functional problems.

The normal method of installation of bushings is by interference press fit. Plastic bushings tend to deform when press fit, thereby losing most of the interference
15 press fit holding ability. This allows rotation and or axial movement of the bushing, which is unacceptable.

The tenter pin of this invention solves all the beforementioned problems in a cost effective manner. Tolerances are not a problem because the plastic bearing material is molded into a groove or recess in the pin and the pin and the plastic inserts are
20 centerless ground as a unit. By molding the plastic into a recess with a knurled bottom surface the plastic insert is restrained from rotation and axial movement relative to the pin. Thermal expansion of the plastic insert is minimized because the plastic insert is radially thinner than that of a stand alone plastic bushing. By forming the thin plastic bearing in recesses in the pin, the pin and inserts can be centerless ground as a unit to a
25 final diameter. This facilitates manufacture and pin installation.

What is claimed is:

1. A method of manufacturing a pivot pin for use in a high temperature environment comprising the steps of:

machining a pin to a predetermined oversize diameter

machining a pair of axially spaced relatively shallow reduced diameter recesses in said pin of an axial width suitable for registering with a pair of bearing surfaces of a member to which the pin is to be attached,

knurling said recesses,

applying a cylindrical bearing sleeve of self lubricating thermoplastic compound to each of said knurled recesses by injection molding, and

finishing machining the outside diameter of said pin including said bearing sleeves to a finished diameter by centerless grinding.

2. The method of claim 1 wherein said thermoplastic compound is polytetraflouraethylene.

3. The method of claim 1 wherein said thermoplastic compound has a melting point above 600 degrees F.

4. A tenter clip comprising:

a clip body having an open side with a flat surface for supporting web material being fed into said open side and a pair arms spaced above and extending over said flat surface each of said arms having a radially inward facing bearing surface,

a jaw,

a jaw pivot pin nonrotatably secured to said jaw and having an axially elongated knurled recess near each of its axially opposite ends, and

a sleeve of self lubricating high temperature resistant plastic molded into each of said recesses, said sleeves presenting radially outward facing cylindrical bearing surfaces on said jaw pivot pin mating, respectively, with said bearing surfaces on said arms.

5. The tenter clip of claim 4 wherein the outside diameter of said jaw pivot pin including said sleeves is machined to a uniform diameter.

6. The tenter clip of claim 4 wherein said high temperature resistant plastic has a melting point greater than 600 degrees F.

7. The tenter clip of claim 4 wherein said high temperature resistant plastic is polytetraflouraethylene.

8. A cylindrical pivot pin comprising:

a shallow recess formed near each end of said pin, each of said recesses having a radially outward facing cylindrical surface which has been knurled and

a high temperature resistant, self lubricating plastic sleeve bonded to each of said knurled cylindrical surfaces, each of said sleeves presenting a radially outward facing cylindrical bearing surface.

9. The pivot pin of claim 8 wherein said plastic is polytetraflouraethylene.

10. The pivot pin of claim 8 wherein the outer diameter of said pin including said sleeves is a uniform diameter.

11. A bearing for a shaft component pivotally connecting a support component to a supported component, comprising:

smooth radially confronting cylindrical surfaces on said components,

a shallow annular recess formed in one of said cylindrical surfaces said recess presenting a rough radially facing surface, and

a thin layer of self lubricating plastic pressure molded into said recess, said thin layer of plastic presenting one of said smooth cylindrical bearing surface in bearing engagement with the other of said cylindrical surfaces.

12. The bearing of claim 11 wherein said smooth cylindrical bearing surface on said thin layer of plastic faces radially outward.

13. A pivot connection between a shaft and a pair of axially spaced supports comprising:

a pair of aligned radially inward facing cylindrical surfaces on said supports;

a pair of radially outward facing cylindrical surfaces on said pin in confronting relation to said radially inward facing cylindrical surfaces

a recess formed in each of one of said pairs of cylindrical surfaces, said recesses presenting a roughed up surface and

a thin cylindrical layer of self lubricating plastic molded in said recesses presenting cylindrical bearing surfaces in radially confronting and bearing engagement with the other of said pairs of cylindrical surfaces.