A resettable torque limiter in which major components are cast from stainless steel in order to minimize material requirements and which are thereafter annealed to provide corrosion resistance in service.
WASTE WATER SAFETY ELEMENT TORQUE LIMITER AND METHOD OF CONSTRUCTION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional application No. 61/279,134 filed Oct. 16, 2009, incorporated by reference herein.

BACKGROUND OF THE INVENTION

[0002] The present invention concerns safely torque limiters used in waste water treatment facilities.

[0003] Such facilities typically include rectangular settling tanks which have scrapers or flights connected by a drag chain which are driven by electric motors and reducers. Safety overload torque limiters are incorporated in the drive to protect the drive equipment in case a jam condition develops.

[0004] Simple shear pin designs are in wide use but are less reliable and more labor intensive to maintain and create longer down times since they must be replaced when sheared. Failures due to the corrosive environment have often occurred with other designs.

[0005] A superior resettable torque limiter design has been developed for this application, using a drive ball which is spring urged into a position by a plunger where it creates a driving connection between two rotary members in the torque limiter. The driveball is driven out of a receiving recess in one member to overrun when the torque exceeds a preset maximum. The drive ball will not resume its driving position when the torque level declines due to an arrangement which prevents the spring force from being active once an overturning event has occurred. The torque limiter is reset by repositioning the drive ball into its driving position as by tapping the plunger with a hammer or mallet.

[0006] Such torque limiters have operated very reliably over many years in service which is important as the waste treatment equipment is costly and must be kept operational at all times.

[0007] The corrosive environment in which these torque limiters operate has dictated that stainless steel be used in the manufacture of its components and this causes that limiter to be relatively costly to manufacture due to the considerable amount of expensive stainless steel which is required to manufacture these torque limiters.

[0008] Such torque limiters have conventionally been constructed from stainless steel bar stock which is rolled when produced, which rolling develops a metallurgy in the material which is highly corrosion resistant. Thus, use of bar stock for the torque limiter parts results in highly corrosion resistant parts and provides a very good long term service performance.

[0009] Using stainless steel castings has been regarded as unsatisfactory for applications subjecting parts to corrosion as being much more subject to corrosion due to the different metallurgy produced by the casting process. Such parts are likely to fail in a relatively short time when used in water treatment facilities.

[0010] There is considerable stainless steel material lost in the machining of these large parts from bar stock, since it requires extensive machining away of the material, causing substantial waste of stainless steel in their manufacture. The need for such extensive machining of those parts also adds significantly to the cost of such torque limiters.

[0011] It is an object of the present invention to provide a corrosion resistant resettable safety torque limiter for waste water treatment facilities of the type described which is highly corrosion resistant to be well suited to waste water treatment applications but which can be manufactured at significantly lower cost.

SUMMARY OF THE INVENTION

[0012] The above recited object and other objects which will be understood upon a reading of the following specification and claims are achieved by precision casting the major torque limiter rotary components from stainless steel, which allows the components to be cast close to their final dimensions, eliminating the extensive machining operations which were previously required to produce such components and the waste of stainless steel metal which is machined away.

[0013] In addition, recess features are preferably molded into these components at locations which will not affect their proper performance during the service life of the torque limiter to achieve additional material savings.

[0014] The stainless steel alloy used is a low carbon alloy, i.e., 0.03% carbon 316L (CF3M) stainless steel.

[0015] In order to achieve the necessary corrosion resistance, the cast components are annealed after casting by being heated to a temperature in the range of 1850°F to 2050°F in an oxygen free atmosphere provided by a vacuum furnace, with subsequent rapid quenching as in a sand bed fluidized with nitrogen gas, preferably in a multiple chamber furnace to achieve sufficiently rapid quenching.

[0016] This annealing process largely eliminates precipitate carbon which is believed to make the cast material subject to corrosion, and have produced corrosion resistant parts.

DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a sectional view through a safety element torque limiter of type which the present invention is concerned.

[0018] FIG. 1A is a fragmentary enlarged view of a portion of the torque limiter shown in FIG. 1.

[0019] FIG. 2 is an exploded pictorial view of the torque limiter shown in FIG. 1.

[0020] FIG. 3 is an enlarged pictorial view of a module carrier hub component included in the torque limiter shown in FIG. 1.

[0021] FIG. 4 is a pictorial view of a detent pocket plate included in the torque limiter shown in FIG. 1.

[0022] FIG. 5 is a pictorial view of a retaining plate included in the torque limiter shown in FIG. 1.

DETAILED DESCRIPTION

[0023] In the following detailed description, certain specific terminology will be employed for the sake of clarity and a particular embodiment described in accordance with the requirements of 35 USC 112, but it is to be understood that the same is not intended to be limiting and should not be so construed inasmuch as the invention is capable of taking many forms and variations within the scope of the appended claims.
Referring to the drawings, and in particular FIGS. 1 and 2, a resettable torque limiter 10 is shown of the type described in U.S. 2010/0224713A1, incorporated herein by reference.

A carrier hub 12 has a relatively rotatable pocket plate 14 supported thereon.

A retainer plate 16 is affixed to one end of the carrier hub 12 and together with a flange on the other end of the carrier hub 12 axially captures the pocket plate 14 on the carrier hub 12.

A drive shaft (not shown) is received in a common bore 18 machined to the size of a shaft to be received therein (not shown) in the retaining plate 16 and carrier hub 12, with a key groove 20 and set screw hole 22 also provided in the well known manner.

An output member 24 is connected to be driven by the pocket plate 14.

A disconnectable drive unit 26 is mounted on a hub of the carrier hub 12 and includes a primary drive ball 28 urged against a seat 30 carried by the pocket plate 14 by a spring loaded plunger 32 so that the drive ball 28 is positioned partially within aligned recesses in the carrier hub 12 and the pocket plate 14 to establish a rotary drive connection between the carrier hub 12 and pocket plate 14.

The torque transmitted from the carrier hub 12 through the drive ball 28 to the pocket plate 14 tends to cam the drive ball 28 out of the recess in the pocket plate 14 and back into the recess in the carrier hub 12 since the center of the ball 28 lies within the recess in the carrier hub 12 when on the seat 30. This movement is resisted by the Belleville springs 40 urging the plunger 32 and engaged drive ball 28 to the left.

There is a counterforce acting on the plunger 32 tending to move the plunger 32 back to the right generated by the torque transmitted by the drive ball 28. When a predetermined maximum load is exceeded, a set of secondary balls 34 are moved by the force acting on the plunger 32 to ride out on ramp ring 36 to an overrunning position on an outside diameter 38 of the plunger 32, releasing the spring force normally exerted on the ball 28 by the Belleville springs 40 (FIG. 1A).

This allows the drive ball 28 to be moved completely to the right out of the recess in the pocket plate 14 by the reaction to the torque acting between these components to disconnect the drive between the carrier hub 12 and pocket plate 14. This continues until the drive unit 26 is reset by driving the plunger 32 to the left to cause the balls 34 to re-enter the space between the ramp 36 and facing ring 37.

The major components of the torque limiter 10 are the carrier hub 12, the pocket plate 14 and the retainer plate 16, and each have portions thereof that are only light stressed in service.

According to the invention, these parts are cast from an austenitic stainless steel, using a precision casting process such as investment casting to minimize the material to be machined away, saving on material and machining time. The cast material is rendered corrosion resistant by a subsequent annealing process, known per se but not heretofore applied to this application. A preferable material austenitic stainless steel is low carbon 316L stainless steel (CF3M), i.e. containing approximately 0.03% carbon. The composition is as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>ASTM 351/316L (CF3M)</th>
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<tbody>
<tr>
<td>C</td>
<td>&lt;0.03%</td>
</tr>
<tr>
<td>Mn</td>
<td>&lt;1.50%</td>
</tr>
<tr>
<td>Si</td>
<td>&lt;0.03%</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.04%</td>
</tr>
<tr>
<td>S</td>
<td>&lt;0.04%</td>
</tr>
<tr>
<td>Cr</td>
<td>18.00%-21.00%</td>
</tr>
<tr>
<td>Ni</td>
<td>9.00%-12.00%</td>
</tr>
<tr>
<td>Mo</td>
<td>2.00%-3.00%</td>
</tr>
</tbody>
</table>

In the as cast state, carbon tends to be precipitated and forms localized areas subject to initiation of corrosion.

By heating the casting to approximately 1900° F. (1850-2050° F.) the carbon precipitate is largely eliminated by causing the carbon to re-enter solution.

The parts are then quenched to prevent the carbon from again precipitating.

The quenching is preferably carried in a sand bed fluidized by nitrogen gas, in a two or three chamber vacuum nitrogen back fill.

In FIG. 3, the carrier hub 12 is shown having two voids 42 cast therein intermediate the two holes 44 provided to accept the overload release units 26 (only one can be provided and one hole 44 covered by a cover plate 46). Full thickness material is maintained in the area surrounding these holes 44.

In FIG. 4, the pocket plate 14 has four cast in voids 48 located between bolt holes 50 except where the pockets 56 (FIG. 1A) are formed (on the opposite side) to receive the drive ball 28 and seat 30.

FIG. 5 shows voids 58 cast in between the bolt holes 60 except in the location aligned with the key way 20 and set screw hole 22.

Accordingly, a torque limiter suitable for waste water treatment drive equipment can be provided at a substantially lower cost than previous designs of such devices while insuring an extended service life.

1. A method of manufacturing a safety element torque limiter including:
   - a carrier hub;
   - a pocket plate rotatable on said carrier hub;
   - a retainer plate fixed to said carrier hub and together with a flange on said carrier hub confining said pocket plate axially on said carrier hub;
   - a drive ball held on a seat in a recess formed in said pocket plate by an aligned spring loaded plunger mounted on a hub of said carrier hub so as to create a spring force acting on said plunger to thereby hold said drive ball on said seat, said drive ball positioned partially within said recess in said pocket plate and a normally aligned recess in said carrier hub, said spring acting on said drive ball through a ramp ring and a set of interposed secondary drive balls which are moved up and past said ramp as onto an outside diameter of said plunger when torque exceeds a predetermined maximum level to discontinue exertion of said spring force on said plunger and allow
said drive ball to be forced out of said recess in said pocket plate and disconnect drive between said pocket plate and said carrier hub;

wherein said retainer plate, said carrier hub and said pocket plate are each precision cast from a low carbon stainless steel and thereafter annealed by heating to a temperature in the range of 1850° to 2050° F. and thereafter rapidly quenched.

2. The method according to claim 1 wherein said quenching is carried out in sand fluidized by nitrogen gas.

3. The method according to claim 1 wherein 316L stainless steel with 0.03% carbon is used in casting said retainer plate, carrier hub and pocket plate.

4. The method according to claim 3 wherein a series of voids are in cast into each of said retainer plate, carrier hub and pocket plate intermediate holes therein.

5. The torque limiter made by the method of claim 1.

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