# United States Patent

**Riddell**

[15] **3,668,783**

[45] **June 13, 1972**


## [54] SPLINE WEAR GAUGE


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[73] Assignee: **Thiokol Chemical Corporation,** Bristol, Pa.



[22] Filed: **March 5, 1970**

[21] Appl. No.: **16,668**

[52] **U.S. Cl.** .....**33/179.5 R**

[51] **Int. Cl.** .....**G01m 13/02**

[58] **Field of Search**.....33/174 A, 179.5 R, 179.5 A, 33/179.5 B, 179.5 C, DIG. 14



[56] **References Cited**

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| 2,849,802 | 9/1958 | Stapleton | 33/179.5 B |



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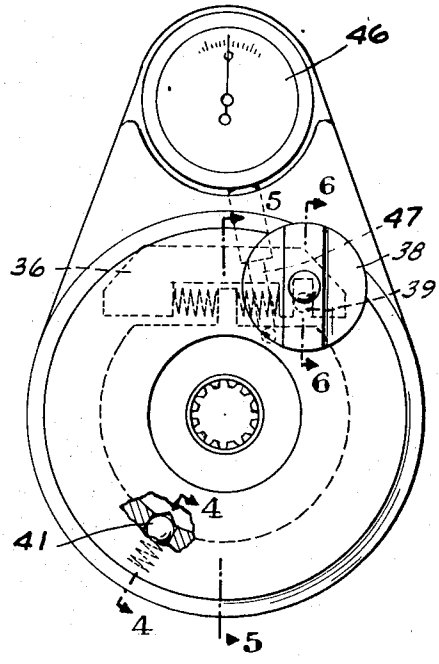
[57] **ABSTRACT**

The spline wear gauge disclosed herein comprises several forms which may be utilized for gauging external or internal splines. Each form comprises two gauge members having circumferentially spaced spline teeth, the teeth on one of the members having an addendum longer than the teeth on the other of the members. The members are rotatable relative to one another so that when they are brought into position adjacent the spline being gauged and rotated relative to one another, one of the members contacts the spline teeth of the spline being gauged at a different position when the other of the members. Any wear on the teeth will be evident by a relative rotational movement that is shown visually by a dial indicator on the gauge body.


**7 Claims, 14 Drawing Figures**



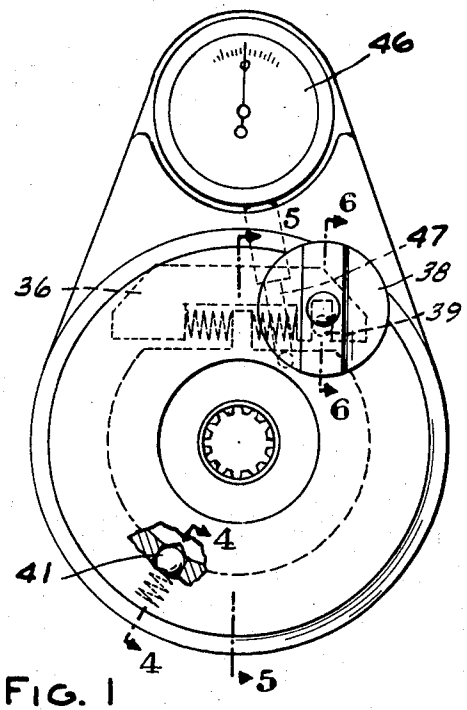



FIG. 1

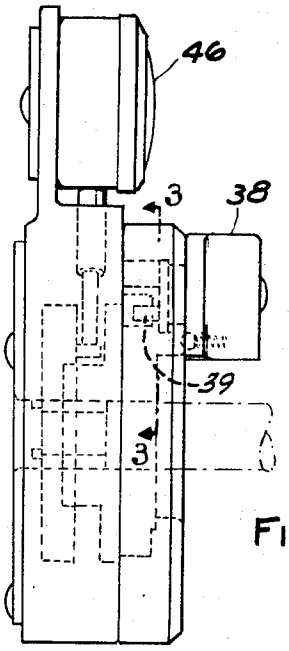



FIG. 2

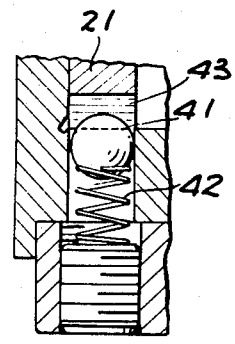



FIG. 4

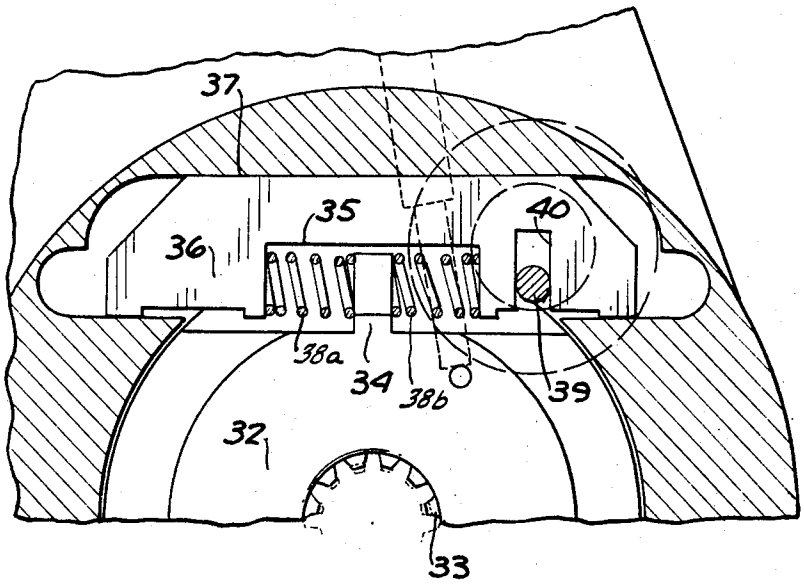



FIG. 3

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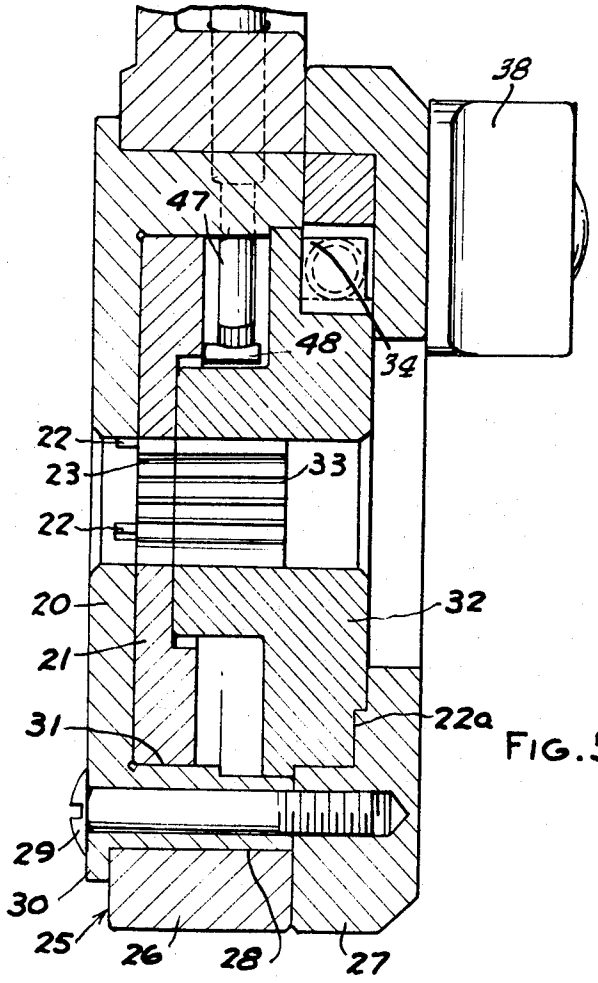


FIG. 5

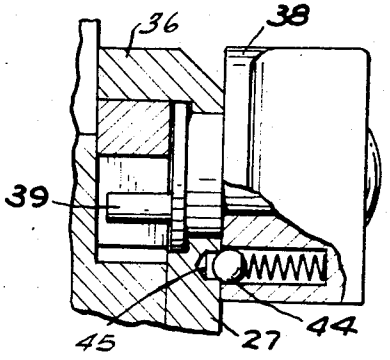


FIG. 6

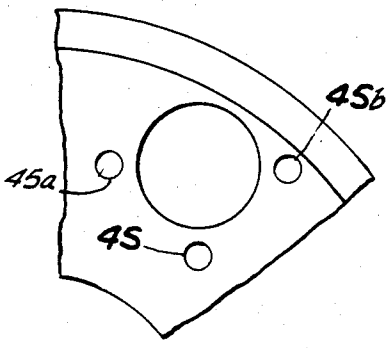


FIG. 7

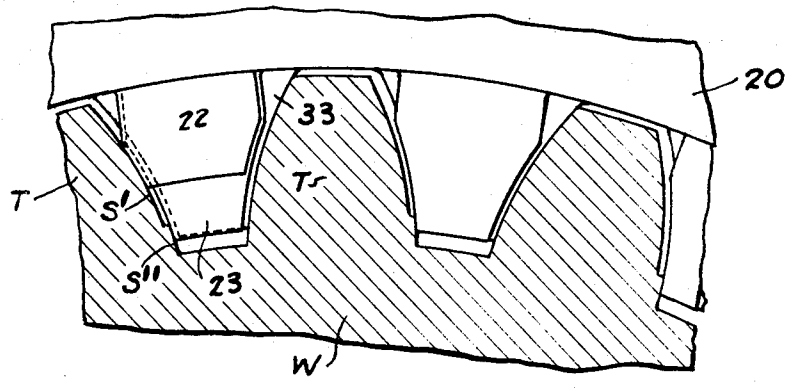


FIG. 8

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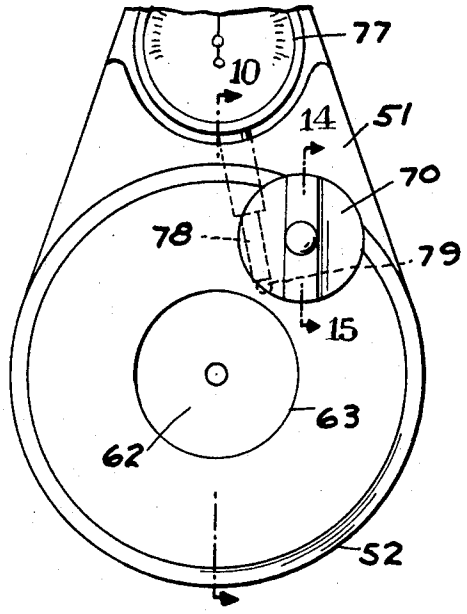


FIG. 9




FIG. 10




FIG. 11

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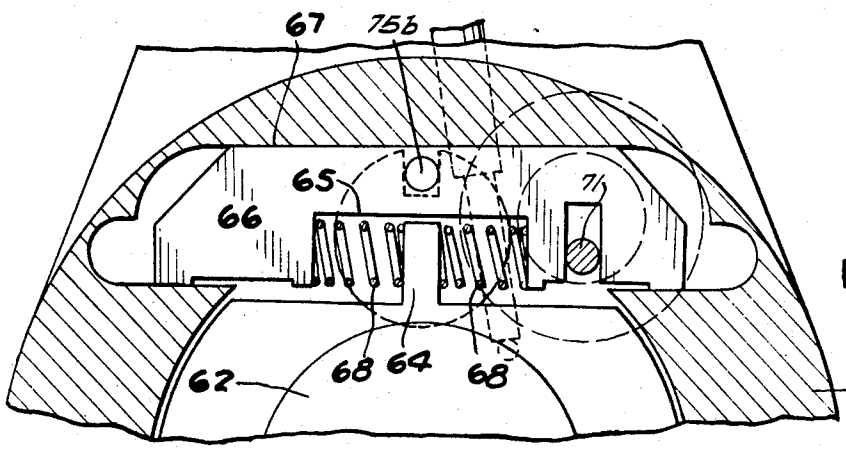


FIG. 12

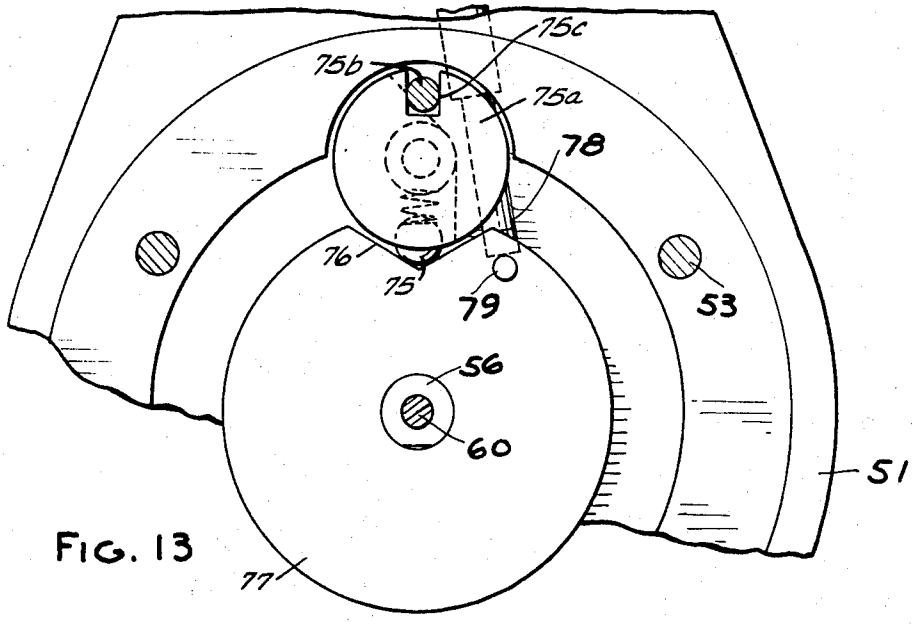


FIG. 13

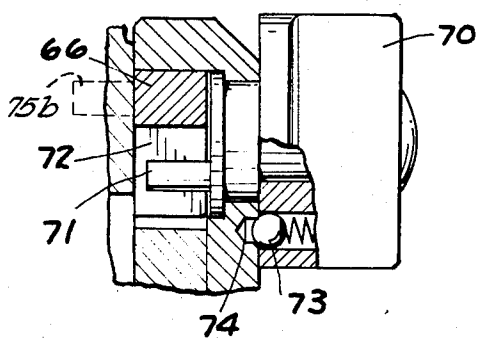


FIG. 14

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# SPLINE WEAR GAUGE

This invention relates to gauging splines and particularly to gauging splines for wear.

## BACKGROUND OF THE INVENTION

It is common to make splines with hardened teeth, the hardening being effective for a predetermined depth on the teeth. As the spline wears in use, the hardened surface wears away and eventually the spline has worn to a position wherein the surface of the teeth of the spline are no longer hardened. It is desirable to be able to sense or gauge the wear of the spline teeth and determine the depth of the wear as it occurs.

In the copending application of Michel P. Heldt and Vernon A. Riddell, Ser. No. 723,976, filed Apr. 22, 1968 titled "Spline Wear Gauge," and having a common assignee with the present application, there is disclosed and claimed a spline wear gauge comprising two gauge members having circumferentially spaced spline teeth, the teeth on one of the members having an addendum longer than the teeth on the other of the members. The members are rotatable relative to one another so that when they are brought into position adjacent the spline being gauged and rotated relative to one another, one of the members contacts the spline teeth of the spline being gauged at a different position than the other of the members. Any wear on the teeth will be evident by a relative rotational movement that is shown visually by a dial indicator on the gauge body.

Among the objects of the present invention are to provide an improved spline wear gauge of the type in the aforementioned patent application which will effectively gauge the wear of the spline teeth, which is relatively simple, low in cost, easily manipulated, and portable.

## DESCRIPTION OF THE DRAWINGS

FIG. 1 is a part sectional plan view of a gauge embodying the invention.

FIG. 2 is a side elevational view of the gauge shown in FIG. 1.

FIG. 3 is a fragmentary sectional view taken along the line 3—3 in FIG. 2.

FIG. 4 is a fragmentary sectional view taken along the line 4—4 in FIG. 1.

FIG. 5 is a fragmentary sectional view taken along the line 5—5 in FIG. 1.

FIG. 6 is a fragmentary sectional view taken along the line 6—6 in FIG. 1.

FIG. 7 is a fragmentary plan view of a portion of the gauge shown in FIG. 6.

FIG. 8 is a partly diagrammatic view on an enlarged scale of the relative positions of the teeth during gauging of a spline.

FIG. 9 is a part sectional front view of a modified form of a gauge.

FIG. 10 is a sectional view taken along the line 10—10 in FIG. 9.

FIG. 11 is a fragmentary end view of the gauge shown in FIG. 9.

FIG. 12 is a fragmentary sectional view taken along the line 12—12 in FIG. 10.

FIG. 13 is a fragmentary sectional view taken along the line 13—13 in FIG. 10.

FIG. 14 is a fragmentary sectional view taken along the line 14—14 in FIG. 9.

## DESCRIPTION

Referring to FIG. 8, the problem to which the applicant's invention is directed may be better understood by describing a portion of a workpiece W having spline teeth T, the wear of which is to be gauged. In use the surfaces S of the teeth which are normally hardened wear, the wear occurring because of the intermeshing of the teeth of the spline with the teeth of a mating spline member. As shown in exaggerated form in FIG. 8, the surface S' wears in use with respect to a portion of the tooth near the base thereof S''.



The splines conventionally have convolute configurations in accordance with generally accepted standards wherein the shaped portion of the teeth extend radially beyond the pitch diameter to insure good tooth contact throughout.

In accordance with conventional design of spline teeth, the portion S'' is of correct configuration and therefore the displacement angularly between the surfaces S'' and S' is a measure of the wear on the teeth.

In accordance with the invention, the wear is measured by providing two gauge members **20, 21**, that are coaxial and have teeth **22, 23**, respectively, the addendum on the teeth **22** being shorter than the addendum on the teeth **23**. When the gauge members **20, 21** which normally have their teeth axially aligned are brought into position adjacent the spline of the workpiece W which is to be gauged and they are rotated relative to one another, the surface of the teeth **22** will engage the surfaces S' and the surface of the teeth **23** will engage the surface S'' producing a relative displacement between the two members **20, 21** as a measure of the amount of wear of the spline teeth.

As shown in FIGS. **1–7**, the gauging members **20, 21** are mounted in a body **25** that includes two sections **26, 27**. As shown in FIG. **5**, gauging member **20** is telescoped within an opening **27** in body section **26** and a screw **28** extends through the gauging member **20** into engagement with an opening in the body section **27**. A flange **30** on the body section **26** engages the body section **26** to clamp the body section **26** against the body section **27**.

Gauging member **21** is rotatably mounted in a cavity **31** in gauging member **20**. A pushing gauging member **32** is rotatably mounted in a cavity **27*a*** in body section **27** and in fixed gauging member **20**. Gauging member **32** includes spline teeth **33** having a length substantially equal to the length of the teeth **22**, namely, having a shorter addendum.

As shown in FIG. **3**, pushing gauging member **32** includes a radial projection **34**. Projection **34** extends into a cavity **35** of a slide **36** that is adapted to be moved transversely in an opening **37**. Springs **38*a*, 38*b*** are interposed between the projection **34** and the ends of the cavity **35**. The position of the slide **36** is controlled by a knob **38**. Knob **38** is rotatably mounted in body section **27** and actuates an eccentric pin **39** supported thereon that extends into a slot **40** in the slide. In the position shown in FIGS. **1** and **3**, the pin **39** maintains the slide **36** and, in turn, the pushing gauging member **32** in a centered position wherein the teeth **33** of the pusher are axially aligned with the teeth **22, 23** of the gauging members **20, 21**.

In this position, a spring-loaded ball **41** is urged by a spring **42** against a notch **43** in the periphery of the movable gauging member **21**, thereby tending to center the gauging member **21**.

As shown in FIGS. **6** and **7**, a spring-loaded detent ball **44** in the knob **38** is adapted to engage selectively openings or recesses **45, 45*a*, 45*b*** in the body section **27** so that the knob can be rotated in one direction or another bringing the detent **44** into engagement with one of the openings **45*a*, 45*b***. In each of these positions, the pin **39** is displaced causing the slide **36** to become displaced to the right or the left, as viewed in FIG. **3** against the action of one of the springs **38*b*, 38*a***.

The gauge further includes a dial indicator **46** of conventional construction having a plunger **47** that is adapted to engage a pin **48** on the movable gauging member **21** and move therewith to indicate the relative displacement of the gauging member **21** with respect to the gauging member **20**.

In use, the spline to be gauged is brought into position with the teeth of the spline being gauged adjacent the teeth **22, 23, 33**. The knob is then rotated in one direction or another to bring the detent **44** into engagement with one of the openings **45*a*, 45*b*** depending upon which side of teeth are to be gauged for wear. This moves the slide **36** through pin **39** yieldingly urging the pushing member **32** through one of the springs **38*a*, 38*b*** and projection **34** against one surface of the teeth of the spline being gauged. This produces a reaction force forcing the body and, in turn, the teeth **22, 23** into engagement with the opposite surfaces of the teeth of the spline being gauged.

Since the addendum of the teeth **23** is longer than the teeth **22**, the teeth **23** will engage the surfaces S'' adjacent the base of the teeth while the teeth **22** will engage the surfaces S'. If there is wear as viewed in FIG. **8**, there will be a relative rotational displacement between the members **20, 21** resulting in a visual indication on the gauge **46** that is directly related to the degree of wear between the surfaces S' and S''.

The form of the invention shown in FIGS. **9–14** is intended for gauging internal spline and comprises a body **50** made of two sections **51, 52** held in assembled relation by screws **53**. A first tubular gauging element **54** is fixed to the body section **51** and extends axially therefrom. The end of the section **54** is provided with circumferentially spaced spline teeth **55**. A second tubular gauging member **56** is rotatably mounted within the tubular member **54** and has radially extending teeth **57** adjacent to teeth **55**. A third pushing gauging member **58** having teeth **59** is fixed by a pin **59'** on a rod **60** which is concentric with the members **54, 56** and extends axially through a space **61** in the body section **51**. A bushing **62** is fixed on the rod **60** and is journalled in an opening **63** in the body section **51**.

Bushing **62** includes a radial projection **64** that extends into a cavity **65** of the slide **66** that is mounted for transverse movement in an opening **67**. As in the previous form of the invention, springs **68** interposed between the projection **44** and the end of slide **66** yieldingly urge the pushing gauging member **58** toward a central position with respect to the cavity. A knob **70** is journalled on the housing section **52** and is provided with an eccentric pin **71** thereon that extends into a slot **72** in the slide **66** to control the position of the slide. A spring-loaded ball **73** is adapted to engage one of several detents **74** to hold the knob in any adjusted position as in the previous form of the invention.

The rotatable gauging element **56** is releasably maintained in a neutral position under the action of a detent ball **75** engaging a V-shaped notch **76** in the periphery of a member **77** that is fixed on the end of the tubular member **56**. Ball **75** is mounted in a rotatable member **75***a* which is moved by a pin **75***b* on slide **66** extending into a slot **75***c* in member **75***a*.

As in the previous form of the invention, the dial gauge **77** having a plunger **78** is adapted to engage a pin **79** on the rotatable gauging member and moves therewith.

In each form of the invention, the positioning member moves along a line tangent to a circle having the axes of the gauging members as a center.

The spline wear gauge shown in FIGS. **9–14** is operated in substantially the same manner as that shown in FIGS. **1–8**. The spline to be gauged is brought into position with the teeth of the spline being gauged adjacent the teeth **55, 57, 59** when the teeth **55, 57, 59** are aligned. Knob **70** is then rotated to bring spring-loaded ball **73** into engagement with one or the other of the detents depending upon which side of the teeth of the spline is to be gauged. This causes pin **71** to move slide **66** and, in turn, yieldingly urge the pushing gauging member **58** which is fixed to bushing **62** against one surface of the teeth of the spline being gauged. This produces a reaction force forcing the body and, in turn, the teeth **55, 57** of the gauging members into engagement with the opposite surfaces of the teeth of the spline being gauged. Since the addendum of the teeth **55** is longer than the teeth **57**, the teeth **55** will engage the surfaces adjacent the base of the teeth while the teeth **57** will engage the surfaces spaced from the base of the teeth. If there is wear, there will be a relative rotational displacement between the members **54, 56** resulting in a visual indication on the gauge **77** that is directly related to the degree of wear.

I claim:

**1**. In a spline wear gauge, the combination comprising

a body,

a first gauge member having circumferentially spaced teeth on said body,

a second gauge member having circumferentially spaced teeth on said body,

the addendum on one of said teeth on one of said gauge members being longer than the addendum of the teeth on the other of said spline members,

a third gauge member having circumferentially spaced teeth and being rotatably mounted on said body,

the addendum of the teeth on said first and third gauge members being substantially equal,

the addendum of the teeth on said second gauge member being longer than the addendum of the teeth on said first and third gauge members,

said members being coaxially aligned and in one position having the teeth thereof axially aligned,

means for rotating said third gauge member relative to said first and second gauge members so that a reaction force is produced against one face of the teeth of the spline being gauged to urge the first and second gauge members against the opposite surfaces of at least some of the teeth of the spline member being gauged,

said last-mentioned means comprising a positioning member mounted for reciprocating movement in said body in a line generally tangent to a circle having the axes of said gauge members as a center,

first spring means between said positioning member and said third gauging member yieldingly urging said third gauging member in one direction,

second spring means between said positioning member and said third gauging member yieldably urging said third gauging member in an opposite direction,

said teeth of said third gauging member being normally aligned with the teeth of said first and second gauging members,

manually operable means on said body and engageable with said positioning member moving said positioning member between a normal position and positions to each side of a normal position,

said manually operable means including means for holding said manually operable means in each of said positions,

whereby when said gauge is brought into position adjacent a spline to be gauged and said positioning member is actuated by actuation of the manually operable means to one position or another from said normal position, the addendum of the teeth of one of said first and second gauge members will engage the teeth of the spline being gauged at one portion thereof and the addendum of the teeth on the other of said first and second gauge members will engage the teeth of the spline being gauged at another point radially of the teeth so that the relative displacement angularly of the first and second gauge members will be a measure of the wear of the teeth.

**2**. The combination set forth in claim **1** wherein said positioning member includes a slot,

said third gauging member includes a projection extending into said slot,

said first spring means being interposed between said projection and one end of said slot,

said second spring means being interposed between said projection and the other end of said slot.

**3**. The combination set forth in claim **1** wherein said manually operable means includes a knob rotatably mounted on said body, and means interconnecting said knob and said positioning member.

**4**. The combination set forth in claim **3** wherein said means interconnecting said knob and said positioning member comprises a pin on said knob and a slot in said positioning member.

**5**. The combination set forth in claim **1** wherein said teeth on said gauge members extend radially outwardly for gauging an internal spline.

**6**. The combination set forth in claim **1** wherein the teeth of said gauge members extend radially inwardly for gauging an external spline.

**7**. The combination set forth in claim **1** including gauge means on said body responsive to the movement of said

second gauge member with respect to said first gauge member.

* * * * *