(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 479 377 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.07.2012 Bulletin 2012/30

(51) Int Cl.:
F01D 5/02 *(2006.01)* ***F01D 5/06*** *(2006.01)*

(21) Application number: **11195293.3**

(22) Date of filing: **22.12.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **06.01.2011 US 985508**

(71) Applicant: **General Electric Company**
Schenectady, NY 12345 (US)

(72) Inventors:
- **Parashar, Duttatrey**
  560066 Bangalore, Karnataka (IN)
- **Kumar, Sandeep**
  560066 Bangalore, Karnataka (IN)

(74) Representative: **Cleary, Fidelma**
GE International Inc.
Global Patent Operation-Europe
15 John Adam Street
London WC2N 6LU (GB)

(54) Steam turbine rotor with mechanically coupled high and low temperature sections using different materials

(57) A turbine rotor including an elongated shaft having at least an HP region 12, the HP region having a first section supporting a stage 1 rotor wheel 14 and a second section supporting a stage 2 rotor wheel 16, the first section formed of a relatively higher-temperature-capability material and the second section formed of a relatively lower-temperature-capability material. Various mechanical couplings 26, 28, 30, 32 are described for securing the first and second sections.

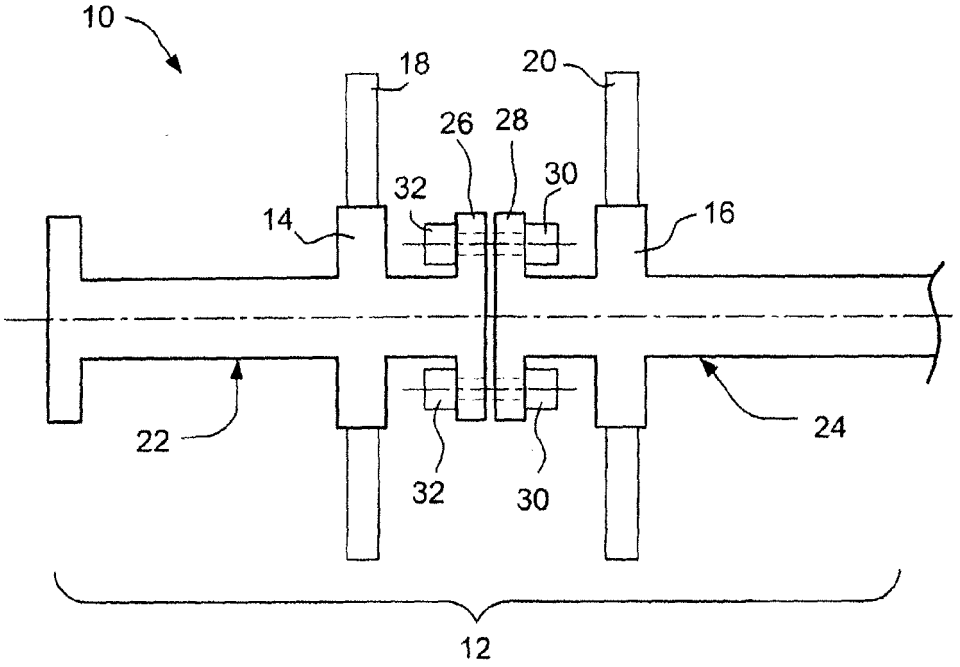

FIG. 1

EP 2 479 377 A2

Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to rotors for turbomachines and, more specifically, to the construction of rotors in axial sections of different materials.

[0002] In a recent steam turbine rotor, and following a tendency to high temperatures for steam, a12% chromium steel is used, as it is excellent in high temperature strength and toughness. In such a rotor, both for a high temperature portion exposed to a high temperature steam and a low temperature portion exposed to a low temperature steam, the same 12% chromium steel is used. But as rotors have become larger in recent years, it is becoming difficult and expensive to manufacture the rotor so as to satisfy characteristics both of the high temperature portion and the low temperature portion with one material.

[0003] While the expensive 12% chromium steel satisfies the required heat resistance, creep characteristics, etc. of the portion exposed to the high temperature steam, it is not necessary to use such an expensive material for the low temperature portion, so long as the requisite toughness is retained. In order to meet these problems it has attempted to join rotor portions of different materials together by welding to make a single rotor.

BRIEF SUMMARY OF THE INVENTION

[0004] This invention resides in a turbine rotor comprising an elongated shaft including at least an HP region, the HP region having a first axial section supporting a stage 1 rotor wheel and a second axial section supporting a stage 2 rotor wheel, the first axial section formed of a relatively higher-temperature-capability material and the second axial section formed of a relatively lower-temperature-capability material; and means for mechanically coupling the first axial section and the second axial section.

[0005] The elongated shaft may include at least HP and IP regions, a combined HP/IP region having the at least first section supporting the stage 1 rotor wheel and the second section supporting the stage 2 rotor wheel.

[0006] The invention will now be described in connection with the drawings identified below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a schematic diagram of a turbine rotor region with mechanically-coupled sections in accordance with a first exemplary but nonlimiting embodiment;

Fig. 2 is a schematic diagram similar to Fig. 1 but with an alternative mechanical coupling between the turbine sections in accordance with an exemplary but nonlimiting embodiment;

Fig. 3 is a schematic diagram similar to Fig. 2 but with an alternative mechanical coupling between the turbine sections in accordance with an exemplary but nonlimiting embodiment;

Fig. 4 is a schematic diagram similar to Fig. 3 but with an alternative mechanical coupling between the turbine sections in accordance with an exemplary but nonlimiting embodiment;

Fig. 5 is a schematic diagram similar to Fig. 4 but with an alternative mechanical coupling between the turbine sections in accordance with an exemplary but nonlimiting embodiment; and

Fig. 6 is a schematic diagram similar to Fig. 5 but with an alternative mechanical coupling between the turbine sections in accordance with an exemplary but nonlimiting embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0008] With reference initially to Fig. 1, a steam turbine rotor 10 is shown in schematic from and includes at least a high pressure (HP) region (or combined HP and intermediate pressure (IP) region) 12 that is formed to include at least first and second stage rotor wheels 14, 16, each of which supports a row of buckets 18, 20, respectively. Within the HP or combined HP/IP region 12, the rotor 10 is formed in two axially-oriented and aligned sections 22, 24. Section 22 includes the first stage rotor wheel 14 while section 24 includes the second stage rotor wheel 16. It will be appreciated that section 22 is in a high temperature region, exposed to steam at temperatures of about and above 1050°F. Section 24, on the other hand, is in a lower temperature region, exposed to steam at a temperature of about and less than 1050°F.

[0009] The inventors have recognized that significant cost savings can be realized by using different materials for the rotor sections 22, 24 within the HP or combined HP/IP region 12.

[0010] For the rotor section 22, a more expensive 12% Cr material (e.g., ASTM A982, Grade B) is suitable while for section 24, a less expensive, lower % Cr material such as a Cr-MO-V material (e.g. ASTM A470, Grade D, Class 8) is suitable.

[0011] The rotor sections 22 and 24 are preferably joined together by any of several suitable mechanical coupling arrangements. In Fig. 1, for example, the rotor sections 22 and 24 are provided with (or formed with) facing radial flanges 26, 28, respectively, located between the first and second stage rotor wheels 14, 16 and joined by a circumferential array of axially-extending fasteners such as bolts 30 passing through the flanges and

secured by nuts 32.

[0012] Figure 2 illustrates an alternative coupling arrangement where the radial flange 28 is eliminated and flange 26 is bolted directly to a hub portion 15 of the rotor wheel 16 using similar fasteners 30, 32.

[0013] Fig. 3 illustrates another mechanical coupling arrangement between the rotor sections 22, 24. In this example embodiment, a reduced diameter end portion 34 of the section 24 is received within a blind bore 36 formed in section 22 axially between the rotor wheels 14, 16. The coupled sections are secured by two or three fasteners (e.g. bolts) 38 oriented radially with respect to the longitudinal axis of the rotor.

[0014] Fig. 4 illustrates another example embodiment wherein a partially-threaded stud 40 extends between the rotor sections 22, 24. Specifically, a threaded, blind bore 42 is formed in the end of rotor section 24, aligned with a smooth through-bore 44 formed in rotor section 22. The stud 40 is inserted through the smooth through-bore 44 and the threaded end 46 of the stud is threaded into the blind bore 42. A threaded opposite end 48 of the stud 40 projects from the rotor section 22 and a nut 50 is applied there to lock the stud 40 in place, with sections 22, 24 joined together axially between the rotor wheels 14, 16. Alternatively, the smooth portion of the stud 40 could terminate short of the flange 51 and a separate bolt could be threaded into the end of the bore 44 to lock the stud in place.

[0015] Fig. 5 illustrates yet another exemplary mechanical coupling utilizing a spline arrangement. Specifically, a reduced-diameter male spline 52 is formed at one end of the rotor section 24. A female spline 54 is formed in the rotor section 22, with elongated slots (i.e., complimentary spline slots) 56 aligned to receive the elongated ribs 58 of the male spline 52. As in the previously described embodiments, the coupling occurs between the rotor wheels 14, 16.

[0016] Fig. 6 illustrates a variation of the spline coupling of Fig. 5. Here, the male spline 60 of the rotor section 24 is in a cross-shape, with four equally-spaced ribs 62. Similarly, the female spline 64 in rotor section 22 is formed with four aligned slots 66 that receive the ribs 62.

[0017] For the embodiments illustrated in Figs. 5 and 6, it will be appreciated that the spline arrangements may be reversed, with the male spline in rotor section 22 and the female spline on rotor section 24.

[0018] Other mechanical coupling arrangements are within the scope of the invention. In all cases, secure axial coupling that prevents relative rotation of the rotor sections is required.

[0019] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

Claims

1. A turbine rotor (10) comprising:

   an elongated shaft including at least an HP region (12), the HP region having a first axial section supporting a stage 1 rotor wheel (14) and a second axial section supporting a stage (2) rotor wheel (16), said first axial section formed of a relatively higher-temperature-capability material and said second axial section formed of a relatively lower-temperature-capability material; and

   means (26,28,30,32) for mechanically coupling said first axial section and said second axial section.

2. The turbine rotor of claim 1 wherein said relatively higher-temperature-capability material comprises a 12% Cr material.

3. The turbine rotor of claim 1 wherein said relatively lower-temperature-capability material comprises a CrMoV material.

4. The turbine rotor of claim 2 wherein said relatively lower-temperature-capability material comprises a CrMoV material.

5. The turbine rotor of claim 1 wherein said first axial section and said second axial section are coupled between said stage 1 and stage 2 rotor wheels (14,16).

6. The turbine rotor of any preceding claim, wherein the elongated shaft (10) including at least HP and IP regions, a combined HP/IP region (12) having the first section supporting the stage 1 rotor wheel (14) and the second section supporting a stage (2) rotor wheel (16).

7. The turbine rotor of any of claims 1 to 6, wherein said means for mechanical coupling comprises abutting flanges (26,28) on said first and second sections and plural bolts (30) passing through said abutting flanges.

8. The turbine rotor of claim 7 wherein said means for mechanical coupling comprises a flange (26) on said first section engaged with a hub (15) of said stage 2 rotor wheel 16, and plural bolts (30) passing through said flange and said hub.

9. The turbine rotor of claim 7 wherein said means for mechanical coupling comprises a reduced diameter end (34) of one of said first and second sections received in a blind bore (36) in the other of said first and second sections.

10. The turbine rotor of claim 7 wherein said means for mechanical coupling comprises a first bore (44) through said first section and a second blind bore (42) on said second section, with a stud (40) extending between said first bore and said second blind bore.

11. The turbine rotor of claim 10 wherein said stud (40) is threaded into said blind bore (42).

12. The turbine rotor of any of claims 1 to 6, wherein said means for mechanical coupling comprises a male spline (52) extending from said second section and received in a female spline (54) in said first section.

13. The turbine rotor of claim 12 wherein said mail spline (60) is formed with four radially projecting teeth (62), spaced substantially 90° apart about an axis of rotation of said turbine rotor.

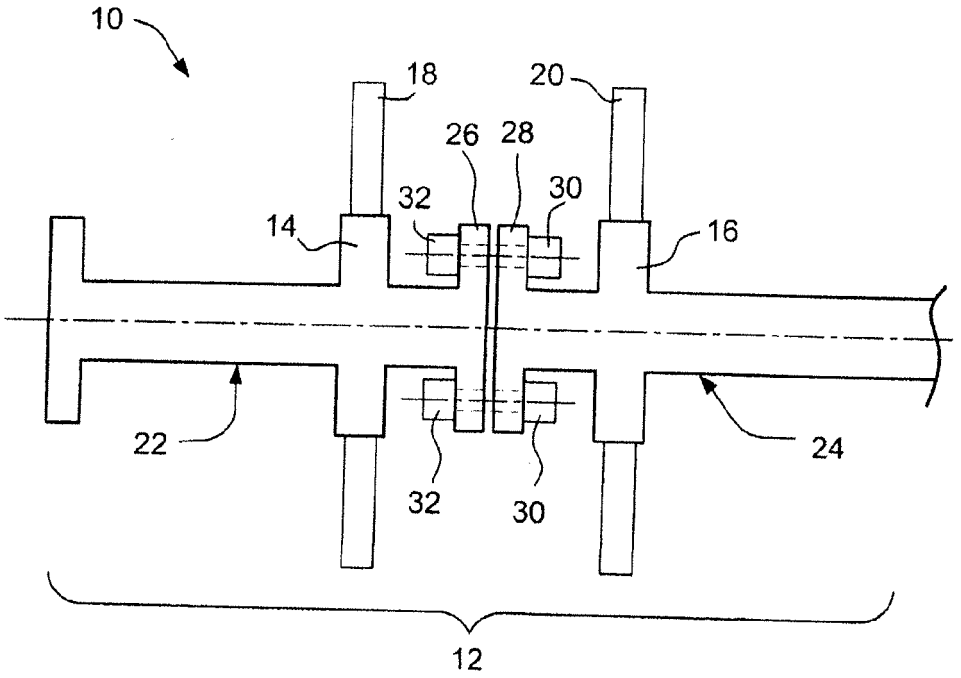
10
18
20
26
28
30
32
14
16
22
24
32
30
12

FIG. 1

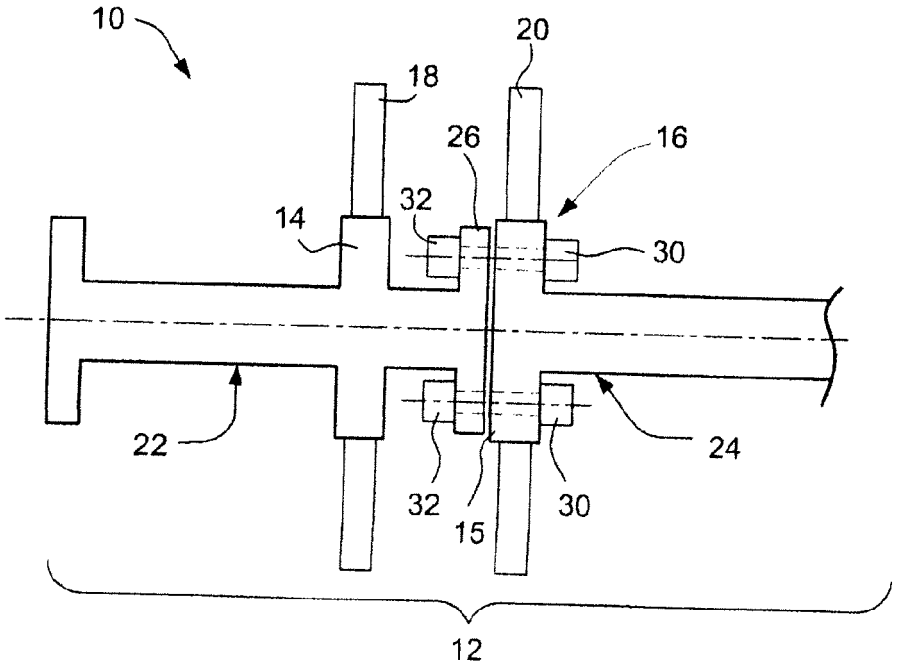
10
20
18
26
16
32
14
30
22
24
32
15
30
12

FIG. 2

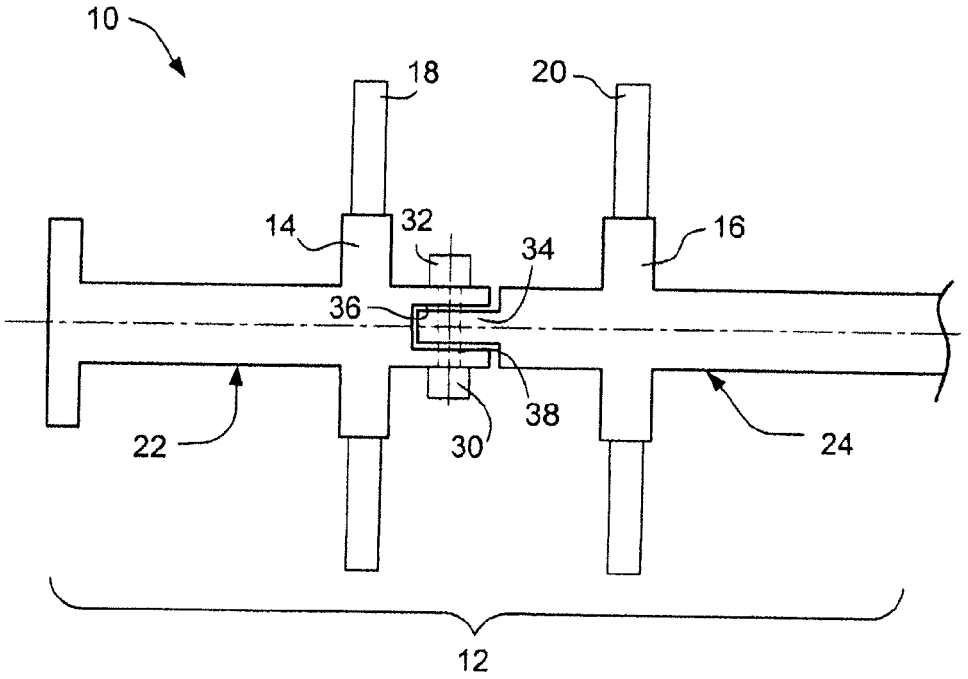
10
18
20
14
32
34
16
36
38
22
30
24
12

FIG. 3

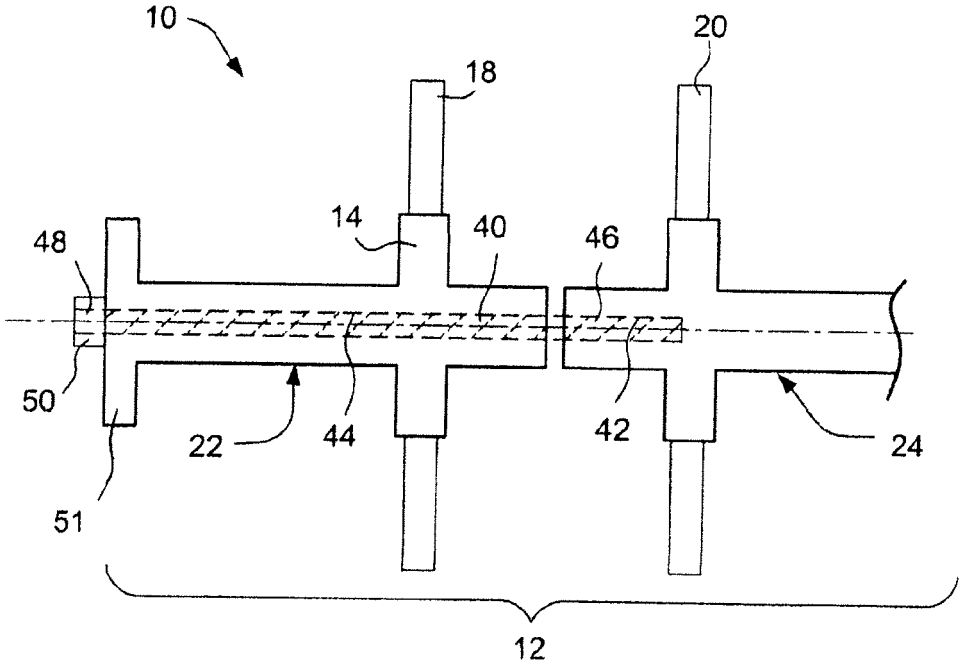
10
20
18
14
40
46
48
50
22
44
42
24
51
12

FIG. 4

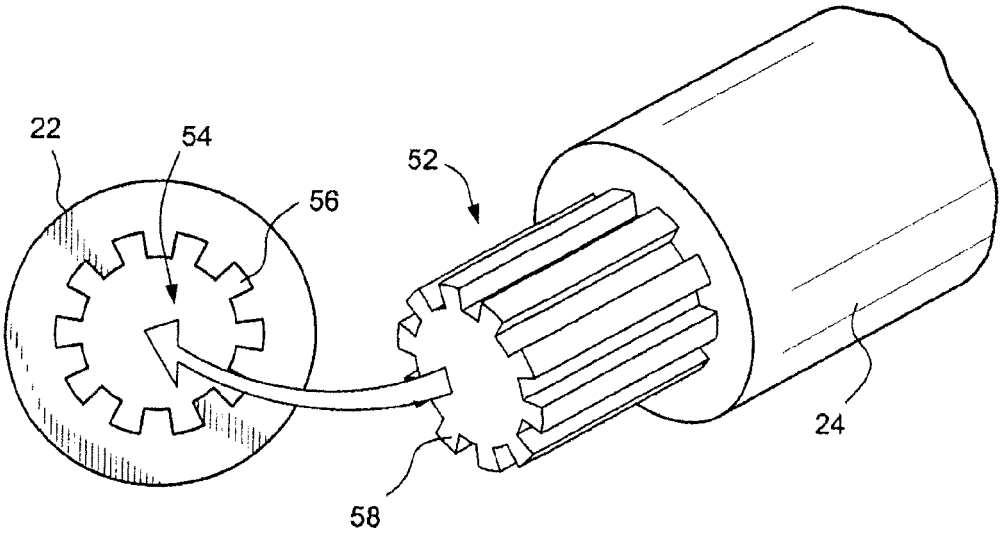

FIG. 5

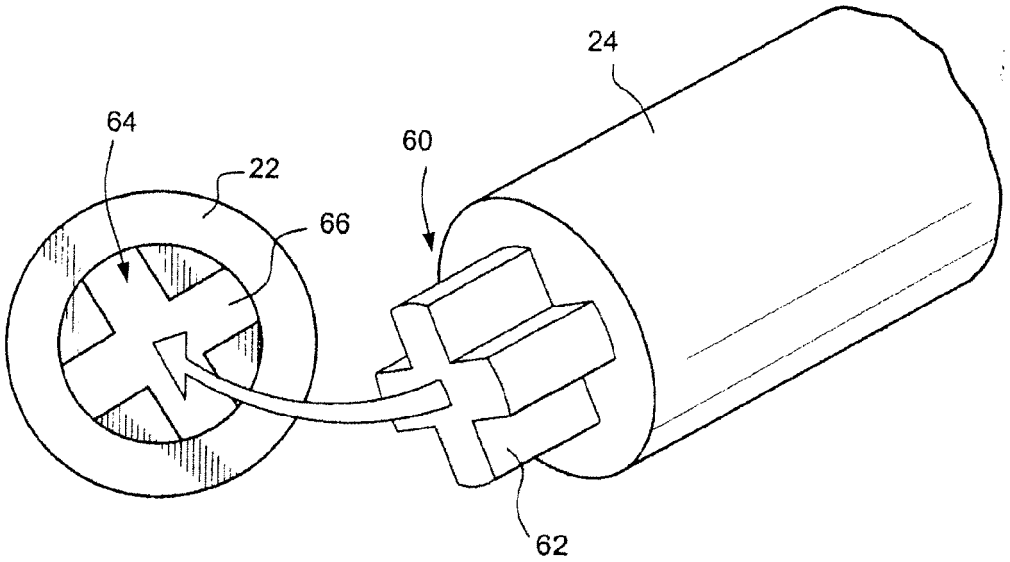

FIG. 6