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Dhindsa

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(54) **ENDOSCOPIC STONE EXTRACTION DEVICE WITH IMPROVED BASKET**

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(52) **U.S. Cl.** **606/127**
(58) **Field of Search** 606/110, 113–115, 606/127, 200; 604/93

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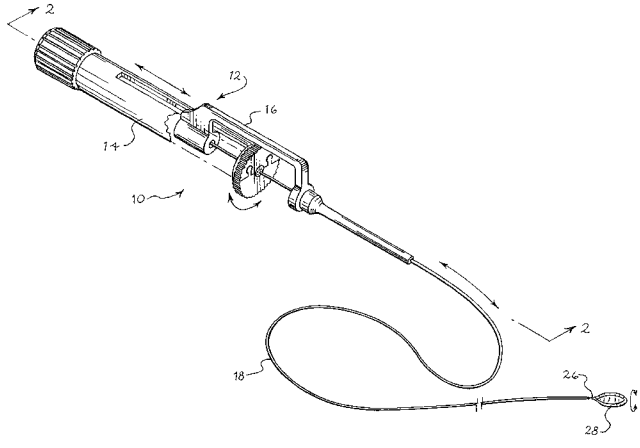
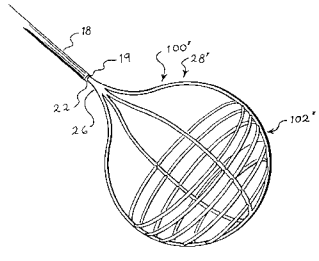
(57) **ABSTRACT**

An endoscopic stone extraction device includes a handle that supports a sheath, and a filament such as a wire slidably disposed in the sheath. One end of the wire is mounted to the handle for rotation with respect to the handle and the other end of the handle supports a stone extraction basket. A manipulator is provided on the wire to allow a user to rotate the filament and therefore the basket with respect to the handle. The basket can have a side-facing opening or a rear-facing opening. In either case, a stone retention region is provided with relatively small openings sized to retain stones smaller than two millimeters in diameter.

8 Claims, 4 Drawing Sheets





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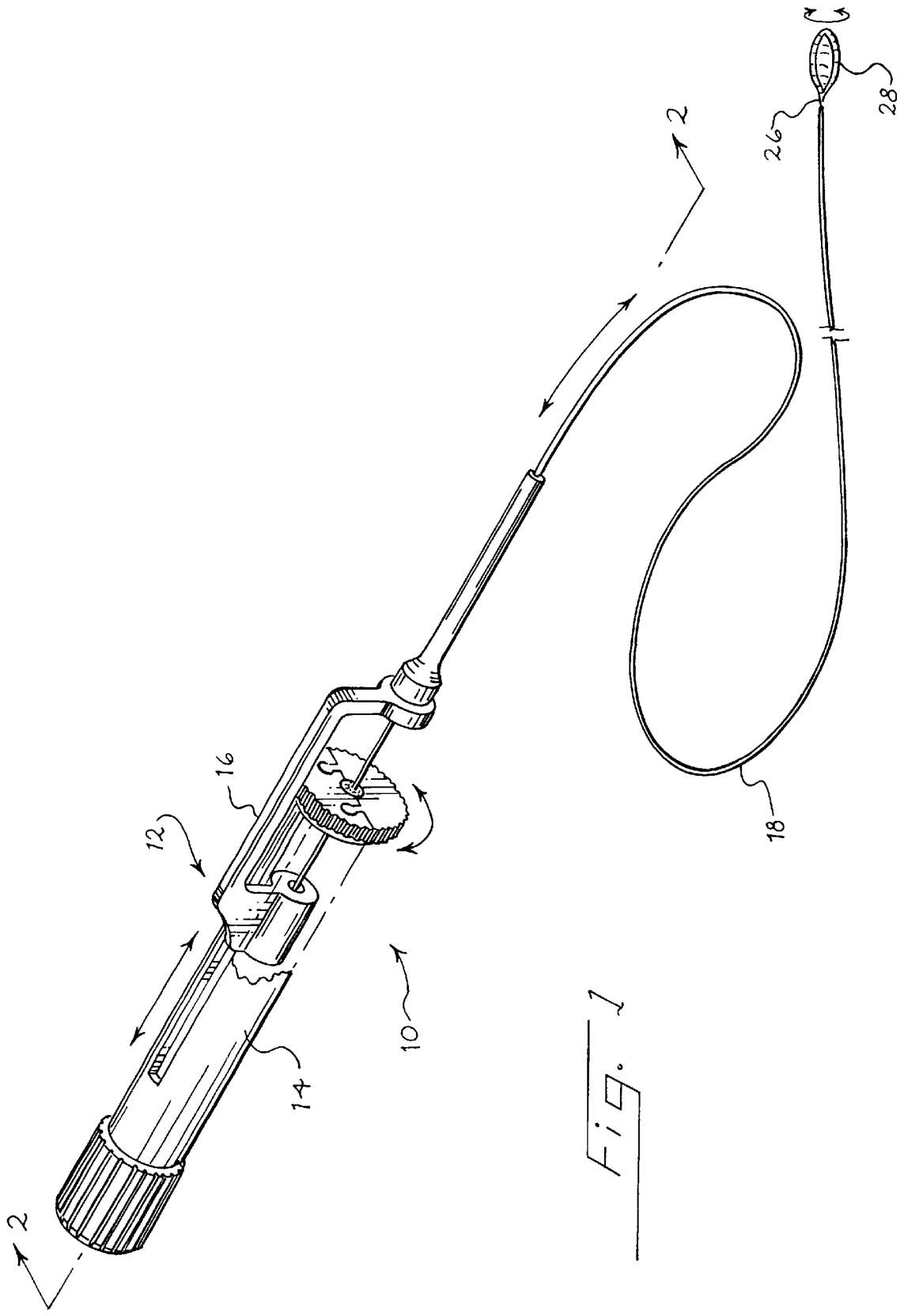


Fig. 1

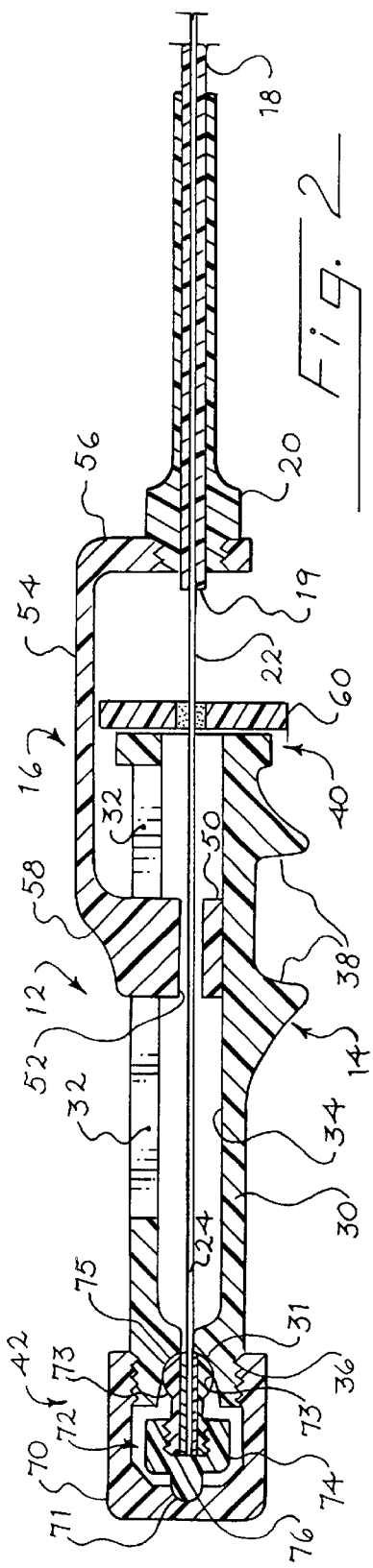


Fig. 2

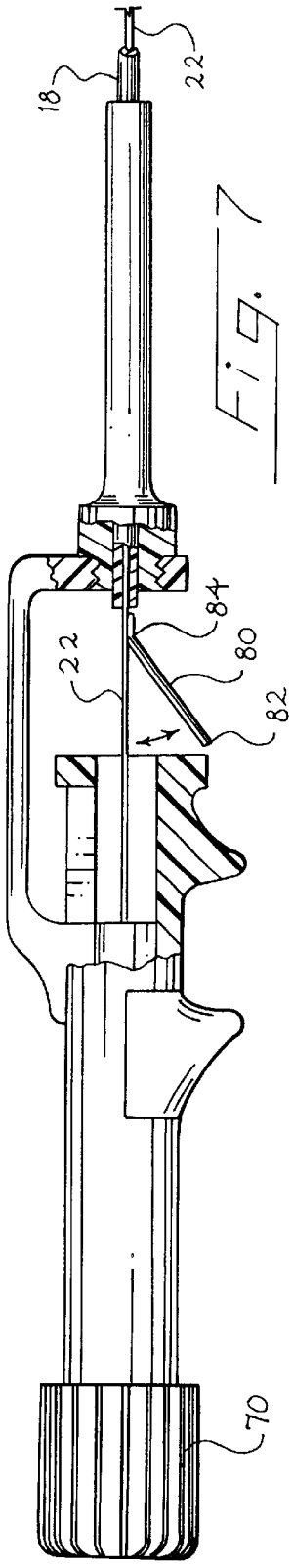


Fig. 7

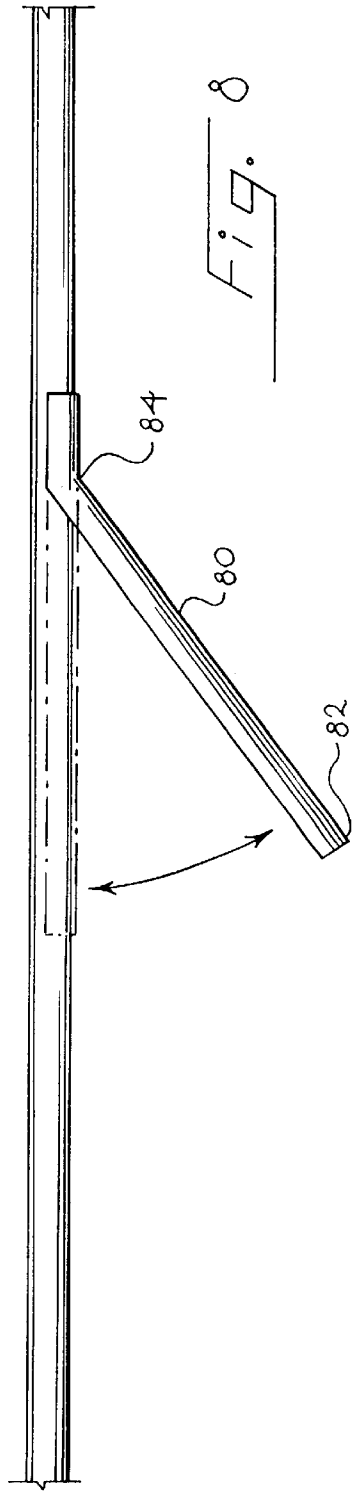
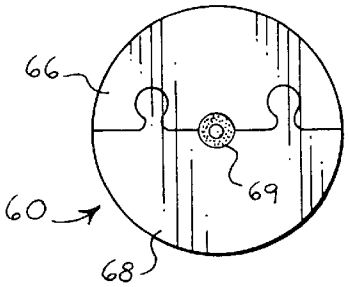


Fig. 8

Fig. 3



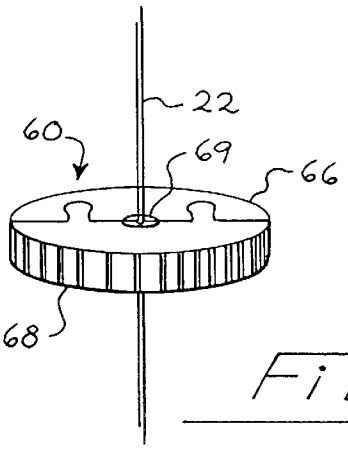


Fig. 5

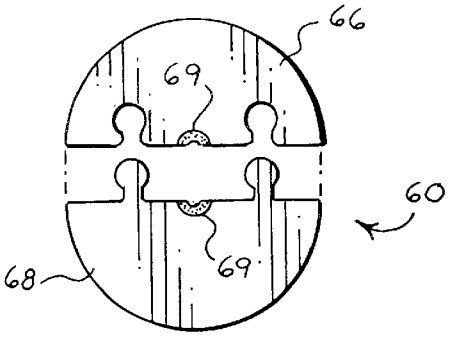


Fig. 4

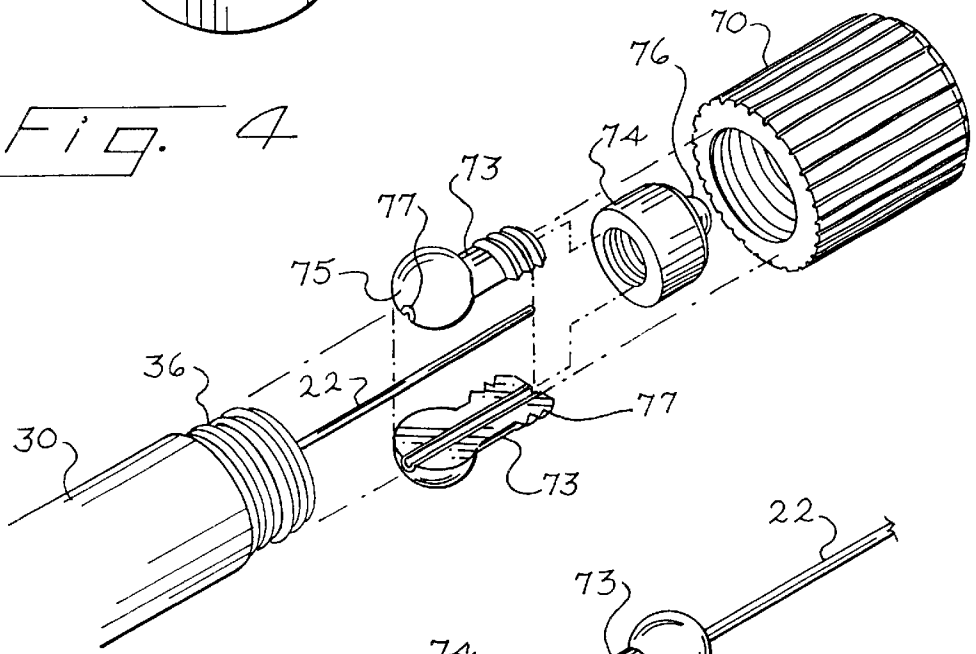


Fig. 6

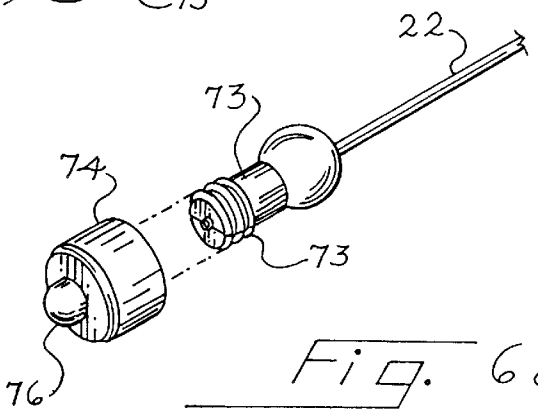


Fig. 6a

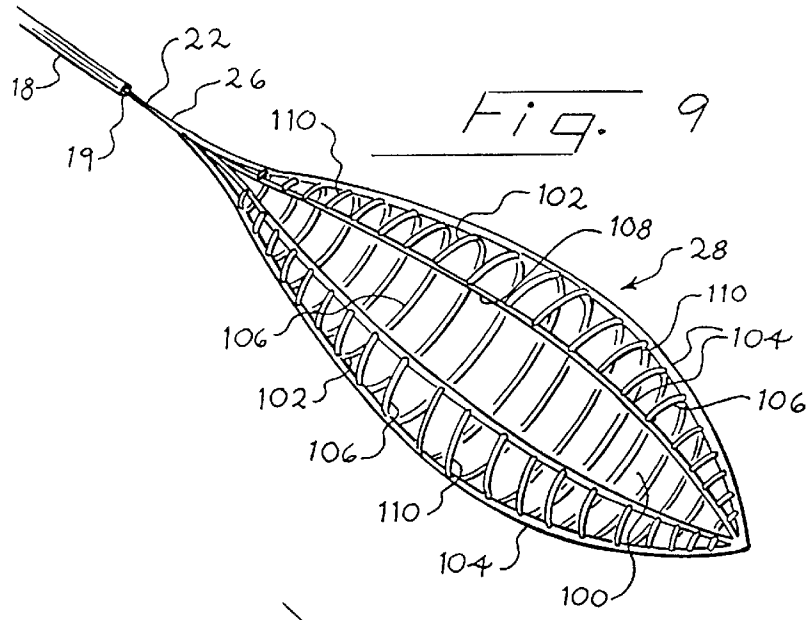


Fig. 9

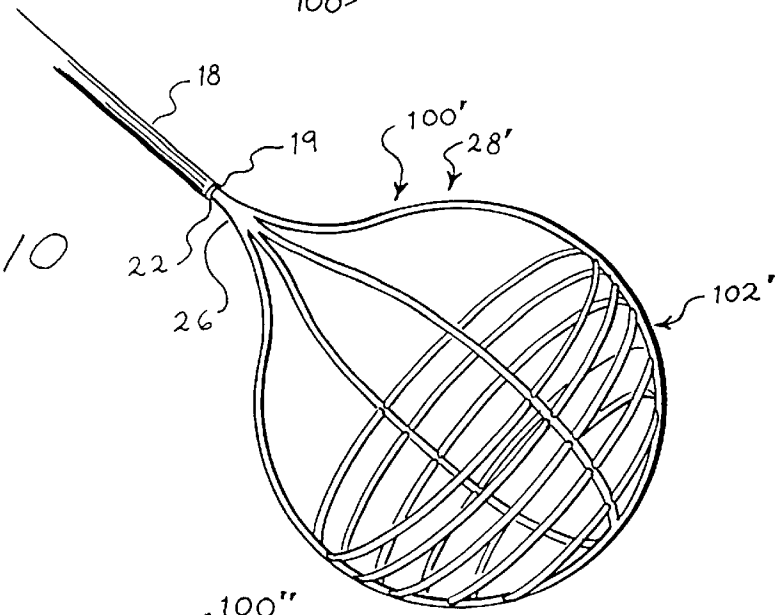


Fig. 10

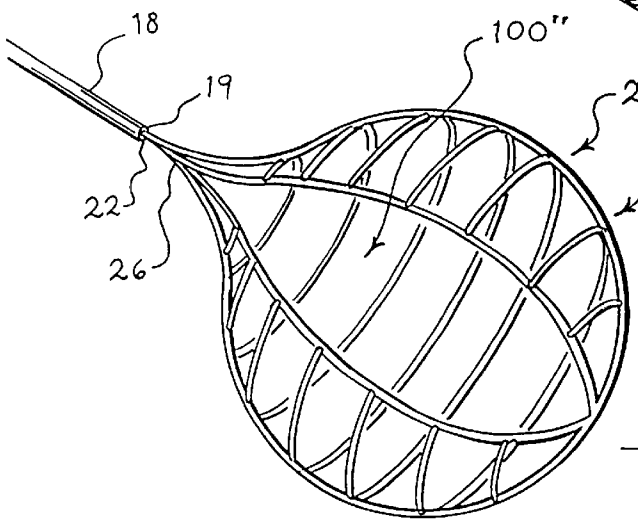


Fig. 11

ENDOSCOPIC STONE EXTRACTION DEVICE WITH IMPROVED BASKET

BACKGROUND

The present invention relates to basket-type devices for extracting stones such as ureteral stones, calaceal stones and other calculus and the like from the renal or biliary systems.

Various types of stone extraction baskets have been used in the past to extract stones and stone fragments from various biological systems. See for example the devices shown in the following U.S. Patents: Bates U.S. Pat. No. 6,099,534, Okada U.S. Pat. No. 6,093,196, Ouchi U.S. Pat. No. 6,077,274, Bilitz U.S. Pat. No. 6,059,796, Foster U.S. Pat. No. 5,989,266, Bates U.S. Pat. No. 5,957,932, Bates U.S. Pat. No. 5,788,710, Bates U.S. Pat. No. 5,496,330, Dormia U.S. Pat. No. 4,612,931, and Segura U.S. Pat. No. 4,590,938.

A typical stone extraction basket includes a wire basket carried by one end of a wire that is received within the lumen of a sheath. The end of the wire opposite the basket is secured to a handle that is used to slide the sheath over the wire, thereby moving the basket into and out of the lumen of the sheath. When the basket is out of the sheath, it expands to receive a stone. The sheath is then moved toward the basket to reduce the size of the basket openings, and the basket and the enclosed stone are removed from the body.

Recently, ultrasonic, laser, and electro-hydraulic techniques have been used to fragment stones in situ. Typically, the stone fragments are left in the body to be excreted. However, in some cases stone fragments may not be excreted as quickly or as completely as desired. Conventional stone extraction baskets are not optimized for the extraction of shattered stone fragments. Thus, a need presently exists for an improved endoscopic stone extraction device that is easier to use and better suited for the extraction of stone fragments.

SUMMARY

The preferred embodiments described below include a new type of stone extraction basket that is well suited to the collection of small stone fragments.

In one embodiment, the stone extraction basket has a large, side-facing opening to admit stones and stone fragments into the interior of the basket, and over half of the surface area of the basket is provided with relatively small openings adapted to retain stones and stone fragments in the basket. In another embodiment, the large openings of the basket are oriented to face the sheath, and the stone retention portion of the basket is disposed opposite the sheath.

The handle described below allows the basket to be rotated inside the body, as for example to orient the basket to admit a stone into the basket. The improved basket designs described below facilitate the retention and extraction of small stone fragments.

The foregoing section has been provided by way of general introduction, and it should not be used to narrow the scope of the following claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an endoscopic stone extraction device that incorporates a preferred embodiment of this invention.

FIG. **2** is a cross-sectional view taken along line **2**—**2** of FIG. **1**.

FIGS. **3**, **4** and **5** are detailed views of a thumb wheel included in the embodiment of FIGS. **1** and **2**.

FIG. **6** is an exploded perspective view of a portion of the handle and the end portion of the wire of the embodiment of FIGS. **1** and **2**.

FIG. **6***a* is an exploded perspective view of the elements **73**, **74** of FIG. **6** from another viewing angle.

FIG. **7** is a cross-sectional view corresponding to that of FIG. **2** of a second preferred embodiment of this invention.

FIG. **8** is a fragmentary side view of selected elements of the embodiment of FIG. **7**.

FIGS. **9**, **10** and **11** are enlarged perspective views of three stone retention baskets suitable for use in the embodiments of FIGS. **1**–**8**.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

Turning now to the drawings, FIG. **1** shows an endoscopic stone extraction device **10** that incorporates a preferred embodiment of this invention. The device **10** includes a handle **12** that in turn includes a grip **14** and a slide **16**. As explained in greater detail below, the slide **16** is mounted to slide longitudinally along the length of the grip **14**.

A tubular sheath **18** is secured to the slide **16**. The sheath **18** defines a lumen **19**, and the sheath **18** can be formed of any suitable flexible material, including the materials described in the above-identified prior-art patents. A strain relief collar **20** is provided at the point where the sheath **18** is secured to the slide **16** to reduce the incidence of kinking.

The device also includes a filament **22** having a first end **24** (FIG. **2**) and a second end **26** (FIG. **1**). The first end **24** is rotatably secured to the grip **14** (FIG. **2**), and the second end **26** supports a stone extraction basket. The filament **22** can be formed of any suitable material, and is typically formed of a flexible metallic wire. Preferably, the first end **24** is thicker and stiffer than the second end **26** to facilitate insertion and manipulation of the basket **28**.

The following sections will first describe the handle **12** in greater detail, before turning to alternative forms of the basket **28**.

The Handle **12**

As best shown in FIG. **2**, the handle **12** includes a tube **30** that defines a longitudinally extending slot **32**. The tube **30** forms a bore **34** and terminates at one end in external threads **36**. Protruding elements **38** extend away from the perimeter of the tube **30** to facilitate the grasping of the tube **30** by a physician during use. For purposes of discussion, the portion of the tube **30** adjacent the external threads **36** will be referred to as the rear portion **42**, and the opposite end of the tube **30** will be referred as the front portion **40**. The tube **30** may for example be formed of any suitable, moldable thermoplastic material, though the widest variety of materials can be adapted for use with this invention.

Continuing with FIG. **2**, the slide **16** includes a guide cylinder **50** sized to slide along the bore **34** of the tube **30**. This guide cylinder **50** defines a central opening **52** sized to pass the filament **22** with little or no friction therebetween. The slide **16** also includes an arm **54** that extends from the guide cylinder **50** through the slot **32** to a plate **56**. The arm **54** holds the plate **56** in alignment with the centerline of the tube **30**. The slide **16** includes a gripping portion **58** that can be pushed or pulled by a physician during use to move the slide **16** along the longitudinal axis of the tube **30**. As before, a wide range of materials can be used for the slide **16**, including any suitable thermoplastic material.

As shown in FIGS. **1–5**, a disk **60** is provided. This disk **60** is positioned adjacent the front portion **40** of the tube **30**. The disk **60** is clamped onto the filament **22**, and the disk **60** is rotatable with respect to both the tube **30** and the slide **16**. As shown in FIGS. **3–5**, the disk **60** includes half-disks **66**, **68** that snap together in a releasable manner. The half-disks **66**, **68** carry respective elastomeric gripping portions **69** designed to grip the filament **22** therebetween when the half-disks **66**, **67** are snapped together.

As best shown in FIGS. **1**, **2**, **6** and **6***a*, the handle **12** carries a threaded cap **70** that defines a set of internal threads sized to mate with the external threads **36**. The cap **70** includes a socket **71** that bears on a chuck **72**. When the cap **70** is tightened in place, the chuck **72** is held between the socket **71** and an internal socket **31** formed by the tube **30**. The chuck **72** is free to rotate but not to translate with respect to the tube **30**.

The chuck **72** includes two parts **73**, each having a central groove **77** sized to clamp against the filament **22**. The groove **77** may be lined with an elastometric layer to ensure good frictional contact between the chuck **72** and the filament **22**. Each part **73** defines external threads, and the parts **73** are clamped against the filament by a cap nut **74** such that the chuck **72** rotates and translates in unison with the filament **22**. The chuck **72** forms a convex surface **75** that engages the socket **31**, and a convex surface **76** that engages the socket **71**. The surfaces **75**, **76** are shaped to allow low-friction rotation of the chuck **72** and the filament **22** relative to the tube **30**. Thus, the chuck **72** and associated elements carried by the tube **30** form a rotational joint. Other types of rotational joints may be used, including ball-and-socket joints. For example, a ball-and-socket joint may be included in the filament **22** near the first end **24**, and the first end **24** may be fixed to the tube **30**. Also, the filament may have an enlarged end that forms part of the rotational joint, and the enlarged end may be sized to fit through the lumen of the sheath **18**. Alternatively, the enlarged end may be too large to fit through the lumen of the sheath, and may be removable from the body of the filament **22**, e.g. by disassembling the enlarged end from the filament **22**.

In use, the device **10** is assembled as shown in FIGS. **1** and **2**. Initially, the slide **16** is advanced (i.e. moved to the right in the view of FIG. **2**) to move the sheath **18** over the basket **28**. This reduces the cross-sectional dimensions of the basket **28** and facilitates insertion of the basket **28** into a region of the body adjacent to the stone to be removed. The slide **16** is then moved to the left in the view of FIG. **2** to expose the basket **28**, which resiliently assumes an enlarged operational shape. As described in greater detail in the following section relating to the basket, the basket defines one or more large, stone-receiving openings, and in some embodiments the stone-receiving openings are laterally facing. The physician can position the basket as desired by manipulating the disk **60**, thereby rotating the filament **22** and the attached basket **28**.

It should be apparent from the foregoing discussion that rotation of the disk **60** and the filament **22** occurs without rotation of the sheath **18**, the slide **16** or the handle **12**. This arrangement facilitates rotation of the filament **22** and the basket **28** inside the lumen of the body cavity in which it is inserted, since friction between the sheath **18** and the endoscopic device and between the sheath **18** and adjacent tissue do not impede rotation of the filament **22** and the basket **28**. Rotation of the filament **22** is guided by the rotational joint that includes the chuck **72**. Once a stone has been captured within the basket, the slide **16** is then moved to the right in the view of FIG. **2** to move the sheath over at least a portion of the basket, thereby securely capturing the stone in the basket for removal.

On occasion, it may be necessary to remove the handle **12**, the slide **16** and the sheath **18** while leaving the filament **22** and the basket **28** in place. This can readily be accomplished by unscrewing the cap **70** from the handle **12**, removing the cap nut **74** from the parts **73**, and then removing the parts **73**, handle **12**, slide **16** and sheath **18** from the filament **22**.

The disk **60** is an example of a manipulator used to rotate the filament **22** relative to the handle **12**. This manipulator can take other forms, including the form shown in FIGS. **7** and **8**. The embodiment of FIGS. **7** and **8** is similar to that of FIGS. **1** and **2**, except that the disk **60** has been replaced by a lever **80**. This lever **80** defines a free end **82** and hinged end **84**, and the free end **82** is positioned closer to the first end **24** of the filament **22** than is the hinged end **84**. During normal use, the lever **80** is positioned as shown in FIG. **7** in an extended position. In this position the user can apply torques to the lever **80** and therefore to the filament **22** to rotate the filament **22** as described above. The hinged end **84** is connected to the filament **22** at a hinged joint (e.g. a living hinge or a multiple-part hinge) and the lever **80** can be moved to the retracted position shown in dotted lines in FIG. **8**. In this retracted position, the lever **80** can be moved through the lumen of the sheath **18**, thereby allowing the handle, slide and sheath to be removed from the filament **22** as described above.

The Stone Extraction Basket **28**

The stone extraction basket **28** of FIG. **9** is well adapted for use as a calaceal stone extraction basket, and also in the ureter when appropriate. This basket includes a stone entrance region **100** and a stone retention region **102**. The retention region **102** extends over more than half the area of the basket. This basket is formed by a set of longitudinal basket wires **104** and a set of lateral basket wires **106**. The longitudinal basket wires **104** form a larger opening **108** in the stone entrance region **100**, and the basket wires **104**, **106** cooperate to form a number of smaller openings **110** in the stone retention region **102**. In this embodiment, the larger opening **108** is sized to admit a stone that is at least two millimeters in diameter, and the smaller openings **110** are sized to retain a stone smaller than two millimeters in diameter. In one example, the larger opening is sized to admit stones as large as 5 mm in diameter. The wires **104**, **106** are preferably small, flexible, kink-resistant wires that are capable of collapsing together to fit within the lumen **19**.

In FIG. **9** the basket is shown in its operational configuration in which the basket is fully outside of the lumen **19** of the sheath **18**. As described above, after a stone has been captured within the basket of FIG. **9**, the sheath **18** can be moved over part of the basket **28** to reduce the size of the larger opening **108**. The basket **28** can also be used to capture ureteral stone fragments.

It should be noted that the larger opening **108** faces laterally with respect to a longitudinal basket axis extending through the second end **26** of the filament **22**. Because the larger opening **108** is laterally facing, the filament rotating features of the handle **12** described above can be used to orient the larger opening **108** as desired to facilitate stone capture. Also, in the event a stone is captured that is too large to be removed from the body, the basket can be rotated to point the larger opening **108** downwardly. In this orientation, the weight of the stone tends to move it out of the basket. Once this occurs, the basket can be removed from the body and the stone fragmented using conventional lithothripsy techniques.

The basket **28'** of FIG. **10** is similar to the basket **28** of FIG. **9** except that the stone entrance region **100'** is positioned adjacent the second end **26** of the filament **22**, and the stone retention region **102'** is positioned opposite the second end **26** of the filament **22**. The basket **28'** is well suited for the collection of ureteral stone fragments after laser, ultrasonic, or electro-hydraulic lithothripsy. Also, the basket **28'** may be positioned proximally of a stone prior to lithothripsy to prevent stone fragments from migrating up the ureter. In use, the collapsed basket **28'** is moved past the stone or stones to be collected, then the sheath **18** is moved to allow the basket **28'** to expand to the operational configuration of FIG. **10**, and then the basket **28'** is moved to collect the stones in the stone retention region. At this point, the sheath **18** is moved over the filament **22** to collapse the basket **28'** partially, thereby retaining the captured stones in the stone retention region **102'**.

FIG. **11** shows a basket **28"** that is similar to the basket **28** of FIG. **9** including a stone entrance region **100"** and a stone retention region **102"**. The main difference is that the basket **28"** is shaped differently as appropriate for use as a percutaneous stone extraction basket.

The wires **104**, **106** may be formed continuously with the filament **22**, or alternately they may be secured to the filament **22**. A variety of materials can be used for the wires **104**, **106**, but they should be sufficiently small in diameter, flexible and kink-resistant to allow the baskets **28**, **28'**, **28'** to be collapsed into the lumen **19**. Super-elastic alloys such as the shape memory metal alloys described in U.S. Pat. No. 5,989,266 are suitable. One such shape-memory material is nitinol, which can be annealed as described in this patent. Other materials known to those skilled in the art can readily be used to form the baskets **28**, **28'**, **28"**. The junction between adjacent wires in the baskets **28**, **28'**, **28"** can be secured in any suitable way, including sutures, adhesives, and knots of the type described in U.S. Pat. No. 5,989,266.

The number of longitudinal basket wires **104** can be varied with the application, and **2**, **3**, **4**, **5**, **6** or more longitudinal wires can be used.

For the reasons discussed above, it is preferred to use the baskets **28**, **28'**, **28"** with the handle **12** of FIGS. **1** and **2**. However, it should be clearly understood that the baskets of this invention are not limited to use with any particular handle, and a wide variety of handles can be used.

Conclusion

It should be apparent from the foregoing detailed description that improved endoscopic stone extraction devices have been described that are well suited to the collection of a wide variety of stones, including stone fragments. The stone extraction devices described above can be used with the widest variety of endoscopes, including ureteroscopes, nephroscopes and other endoscopic devices.

As used herein, the term "stone" is intended broadly to encompass a wide variety of biological stones, calculus and the like, including fragments of stones, calculus and the like formed by any of the techniques described above or other techniques developed in the future. Urinary tract stones and biliary tract stones are two examples.

The term "end portion" is intended broadly to encompass the end of structure such as a filament along with an adjacent portion of the structure.

The term "surface" is intended broadly to encompass perforated surfaces.

The foregoing detailed description has discussed only a few of the many forms that this invention can take. For this reason, this detailed description is intended by way of illustration and not limitation. It only the following claims, including all equivalents, that are intended to define the scope of this invention.

What is claimed is:

1. An endoscopic stone-extraction device comprising:

a support filament comprising a first end portion and a second end portion;

a sheath comprising a lumen, the support filament disposed in the lumen such that the sheath is slideable with respect to the support filament;

a collapsible stone-extraction basket carried by the first end portion of the support filament and receivable within the lumen of the sheath;

a handle comprising a sheath movement element, wherein movement of the sheath movement element in a first direction advances the sheath and causes the basket to at least partially collapse inside the lumen of the sheath, and wherein movement of the sheath movement element in a second direction retracts the sheath and causes the basket to expand to an operational shape outside the lumen of the sheath;

the basket, when expanded to the operation shape outside the lumen of the sheath, comprising a stone-entrance region and a stone-retention region, the stone-entrance region comprising a first opening sized to admit a stone into the basket, the stone-retention region comprising a plurality of second openings, all of the second openings being smaller than the first opening;

the first opening facing the first end portion of the support filament, the stone-retention region positioned on a side of the basket opposite the first end portion of the support filament;

wherein the basket comprises a set of longitudinal basket filaments radiating from the first end portion of the support filament and a set of lateral basket filaments extending between the longitudinal basket filaments, the lateral basket filaments positioned substantially entirely in the stone-retention region of the basket.

2. The invention of claim **1** wherein the stone-retention region defines an internally concave surface facing the first end portion of the support filament.

3. The invention of claim **1** wherein the second openings are all smaller than 2 mm in minimum dimension.

4. The invention of claim **3** wherein the first opening is larger than 2 mm in minimum dimension.

5. The invention of claim **1** wherein the support filament and basket are free of attachment to the sheath, such that the entire basket is movable into the lumen of the sheath.

6. The invention of claim **1** wherein the second openings are all smaller than 5 mm in minimum dimension.

7. The invention of claim **1**, wherein movement of the sheath movement element in the first direction causes the basket to completely collapse inside the lumen of the sheath.

8. The invention of claim **1**, wherein the sheath movement element comprises a slide, wherein the handle comprises a grip, and wherein the slide is mounted for translation relative to the grip.

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