

[0074] FIG. 47 shows a cross sectional view of the light projection element shown in FIGS. 43 & 44 taken at line 45-45 of FIG. 43;

[0075] FIG. 48 shows a top perspective view of a camera assembly on which the light projection element of FIG. 43 is mounted;

5 [0076] FIG. 63 shows a cross sectional view of an example camera assembly taken at line 61-61 of FIG. 24;

[0077] FIG. 64 shows a cross sectional view of an example camera assembly taken at line 62-62 of FIG. 34;

[0078] FIG. 65 shows a cross-section view of an example camera assembly taken at
10 line 62-62 of FIG. 34;

[0079] FIG. 66 depicts a representational illustration of a camera assembly at the distal tip of an endoscope in addition to an example sensor and number of example illumination sources;

[0080] FIG. 67 depicts a top down view of an example printed circuit board which
15 includes an extension portion for projection into an endoscope shaft;

[0081] FIG. 68 depicts a side view of an example printed circuit board including a projecting portion;

[0082] FIG. 69 depicts an example flowchart detailing a number of example steps which may be used to control, with a processor, at least one variable light source of an
20 endoscope based on received sensor data;

[0083] FIG. 70 shows a side view of a projecting portion of a printed circuit board having an example camera assembly, example sensor, and number of example light sources mounted thereto;

[0084] FIG. 71 shows a top down view of a distal tip of an example endoscope
25 including the example projecting portion of a printed circuit board shown in FIG. 70;

[0085] FIG. 72 shows a cross sectional view of the distal tip of an endoscope taken at line 72-72 of FIG. 71;

[0086] FIG. 72.1 shows a perspective view of the distal end of an endoscope shaft in which the light source is located on the shaft to project light in a direction generally away
30 from the field of view of the camera assembly;

[0088] FIG. 73 depicts an example endoscope and example calibration fixture;

1005 and flexible fiberoptic ribbon **1000** may be a single molded part.

[00278] Still referring to **FIG. 39** and **40**, the flexible ribbon **1000** may be coated
5 with a highly reflective material **376**. The bottom and side walls of the light projection
element **1005** may also be coated with a highly reflective material **376**. This may ensure that
light is only emitted from the non-coated top of the light projection element **1005** and into
the field of view of the lens assembly **354**. As show in **FIG. 40**, the light projection element
1005 or the flexible ribbon **1000** may include a coupling feature **1008**. The coupling feature
10 **1008** may allow the light projection element **1005** and flexible ribbon **1000** to be coupled
onto or into a camera assembly **350**. The coupling feature **1008** may be an integral part of
the light projection element **1005**.

[00279] **FIG. 41** and **FIG. 42** depict two example embodiments of a flexible ribbon
1000 which include light projection elements **1005**, which may be formed from a light
15 piping material. The light projection element **1005** in **FIG. 41** has a generally ring-like
shape while the light projection element **1005** in **FIG. 42** is generally crescent shaped,
although other shapes may be selected as desired. In the example embodiments in **FIGS. 41**
and **42** only the top surfaces of the light projection elements **1005** are left uncoated with a
highly reflective material **376**.

20 [00280] A light projection element **1005** may comprise one or a number of textures
1010 that help to direct the light emitted from the light projection elements **1005**. In some
embodiments, the texture **1010** or textures **1010** may be included to encourage light to be
emitted in a diffuse manner. The texture **1010** or textures **1010** may be created, for example,
during molding of the light projection element **1005**, or alternatively, the light piping
25 material forming the light projection element **1005** may include a fill material that
encourages light to be emitted from the light projection element **1005** in a diffuse manner.

[00281] **FIG. 43** and **44** respectively depict top and bottom perspective views of
another example embodiment of a light projection element **1005**. As shown, the light
projection element **1005** is ring-like in shape. The light projection element **1005** also
30 includes a coupling feature **1008** as shown in bottom perspective view in **FIG. 44**. The
coupling feature **1008** in **FIG. 44** is an integral part of the light projection element **1005**. In
the example embodiment, the coupling feature **1008** is a ledge or shelf. The ledge coupling
feature **1008** may help to locate and/or align the light projection element **1005** on another

may be mitigated. Such an illumination arrangement may help to provide more uniform lighting within the field of view of the camera assembly 350.

[00294] A representational embodiment of an illumination arrangement in which light may be emitted from a number of light sources 702a-d to areas inside and outside of a field of view 700 of a camera assembly 350 is shown in FIG. 66. As shown, an extension 430h of a printed circuit board in the endoscope handle is shown extending to the camera assembly 350. The printed circuit board extension 430h may provide power and data communication pathways to various components in the insertion section 14. In some embodiments, a ribbon or flex cable 250 (see, e.g., FIG. 14) may be used instead of a printed circuit board extension 430h. A number of components are mounted to the printed circuit board extension 430h. These components may be any or a variety of different components such as a sensors, light emitters, etc. In the example embodiment, the components are described as light sources 702a-d. The light sources 702a-d may be any suitable light source, such as but not limited to, fiber optic cables, light projecting elements 2005, LEDs, or arrays of LEDs.

[00295] Use of LEDs may be desirable in some specific embodiments for a variety of reasons. For example, use of LEDs may obviate the need for a bundle/ribbon of illumination fibers, some specific embodiments. Some optical fibers may degrade when subjected to prolonged bending during usage and may be prone to light loss when bent. LEDs are long lasting and do not require a lengthy bundle of fibers which a subject to bending. Use of LEDs may also minimize the number of pass-through elements between a dry section (e.g. a handle 12) of an endoscope and a wet section of an endoscope (e.g. insertion section 14). Additionally, by omitting optical fibers less of the cross-sectional area of a fluid conduit in an insertion section 14 may be obstructed or filled. This may allow for increased flow rates of irrigation fluid through an insertion section 14. LEDs may also help to simplify or increase ease of manufacturing.

[00296] As shown, a first light source 702a is disposed such that it may project light generally toward the field of view 700 of the camera assembly 350. Such a light source 702a may generally provide direct lighting of the field of view 700. In some embodiments, a direct light source 702a may be omitted or may be accompanied by one or more other indirect lighting sources, such as, for example, any or a combination of light sources 702b-d. In embodiments where a direct lighting source 702a is included in conjunction with one or more indirect lighting source, the direct lighting source 702a may provide light at a lower

CLAIMS

1. A printed circuit board for use in an endoscope comprising:
a base portion of the printed circuit board configured to reside within a handle of the endoscope;
wherein one or more elongate extension portions of the printed circuit board are configured to extend from the base portion of the printed circuit board in the handle through a shaft of the endoscope, and terminating at a distal insertion end of the shaft.
2. The printed circuit board of claim 1, wherein the base portion is a composite of a flexible board mated to a rigid board, and wherein at least one of the one or more extension portions comprises a flexible board extension.
3. The printed circuit board of claim 1, wherein the base portion is a composite of a flexible board mated to a rigid board, and wherein at least one of the one or more extension portions comprises a rigid board extension.
4. The printed circuit board of claim 1, wherein the base portion is a composite of a flexible board mated to a rigid board, and wherein a first one of the one or more extension portions comprises a flexible board extension, and a second one of the one or more extension portions comprises a rigid board extension.
5. The printed circuit board of claim 4, wherein the flexible board extension and the rigid board extension emerge from the base portion adjacent to each other, wherein a proximal leg of the flexible board extension extends away from the rigid board extension at an angle of approximately 90 degrees from the rigid board extension, and wherein a distal leg of the flexible board extension extends away from the base portion parallel to the rigid board extension.

6. The printed circuit board of claim 5, wherein the proximal leg of the flexible board extension is folded to permit the distal leg of the flexible board extension to be aligned parallel to and adjacent to the rigid board extension through the shaft of the endoscope.
7. The printed circuit board of claim 4, wherein the rigid board extension and the flexible board extension extend through a lumen of the endoscope shaft.
8. The printed circuit board of claim 7, wherein the base portion of the printed circuit board, the rigid board extension, and the flexible board extension are coated with a water resistant coating or membrane.
9. The printed circuit board of claim 8, wherein the rigid board extension and the flexible board extension extend through a fluid-carrying lumen of the endoscope shaft.
10. The printed circuit board of claim 4, wherein the rigid board extension carries electrical lines connected to one or more light sources at the insertion end of the endoscope shaft.
11. The printed circuit board of claim 4, wherein the flexible board extension carries communication lines connected to an image sensor at the insertion end of the endoscope shaft.
12. The printed circuit board of claim 11, wherein the image sensor is a CCD or CMOS sensor.
13. The printed circuit board of claim 12, wherein the flexible board extension is configured to permit the image sensor to rotate about an axis generally perpendicular to an axis of the endoscope shaft.