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(54) **JAW TIPS AND JAW TIP ASSEMBLIES FOR PARTS GRIPPERS**

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Publication Classification

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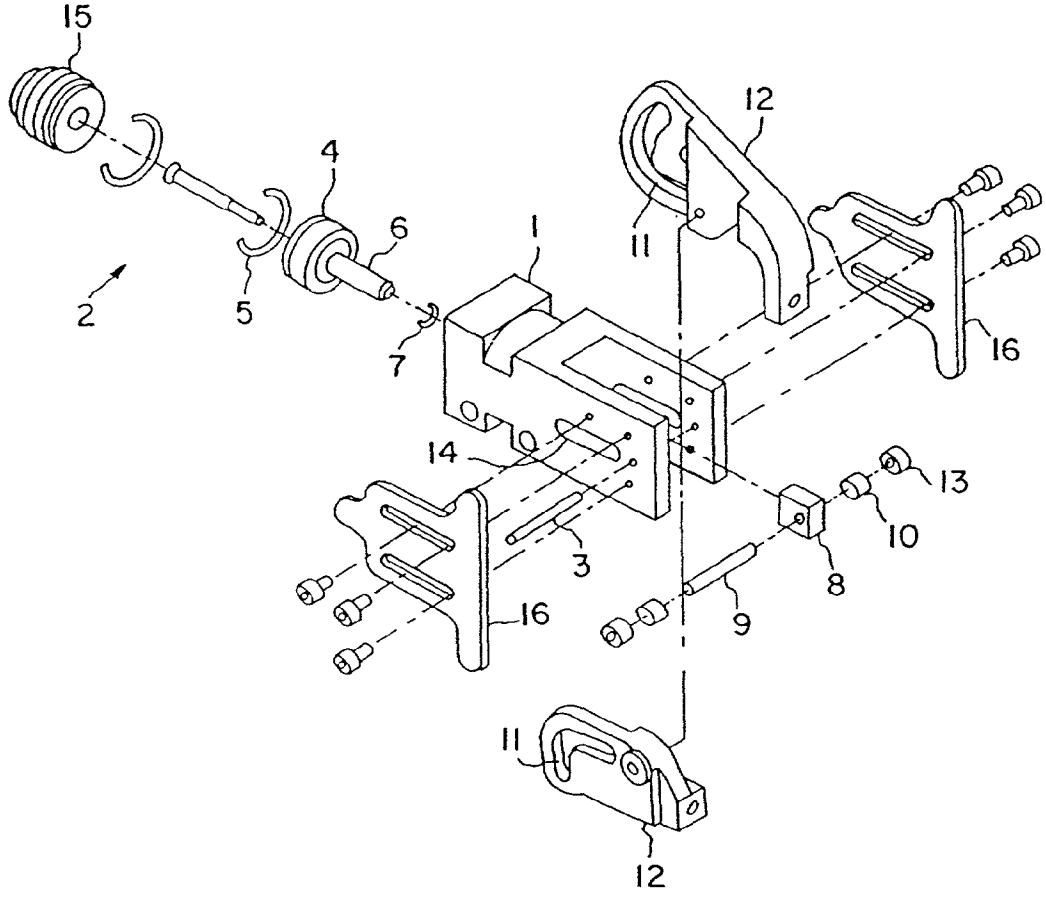
(52) **U.S. Cl.** **294/88**

(57) **ABSTRACT**

An opposable gripper jaw tip attached to a piston actuated parts gripper is provided. The opposable gripper jaw tip has abase and a body. The base is attachable to the piston actuated parts gripper. The body is attached to the base and also has a gripping surface which has a tread.



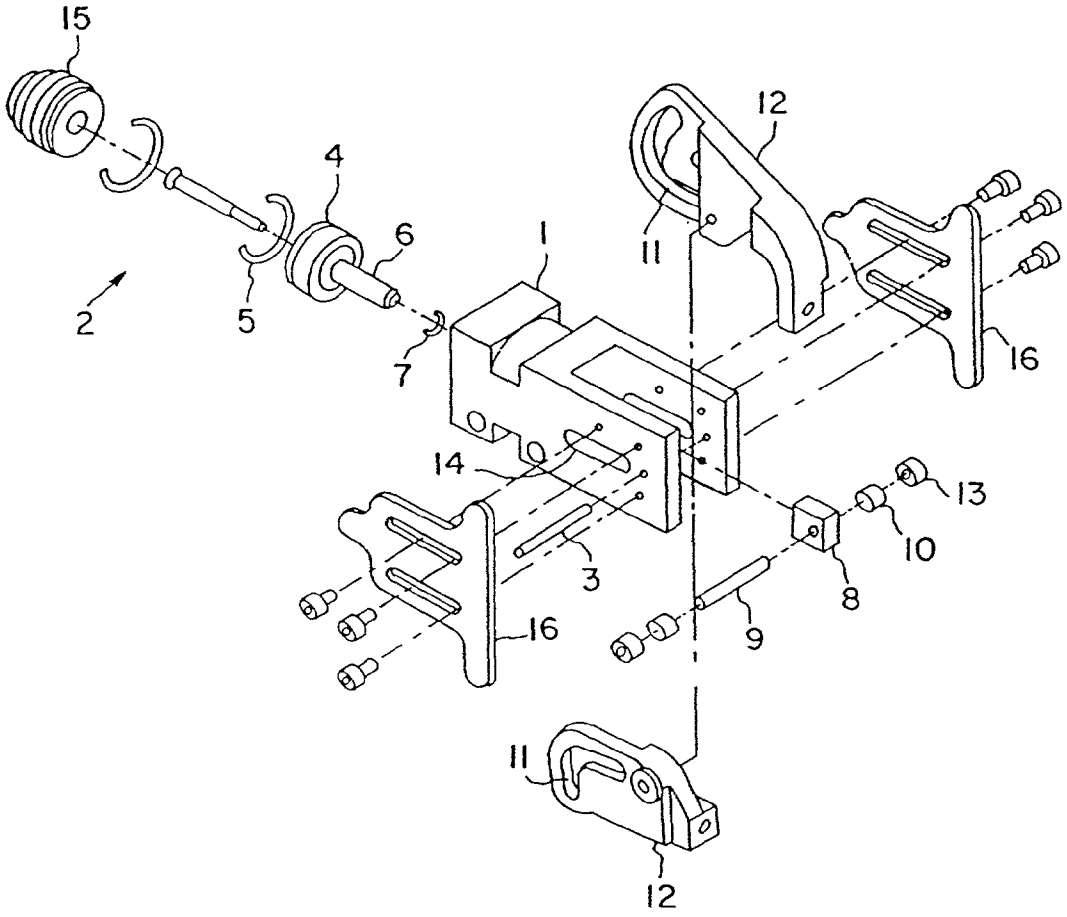


FIG. 1

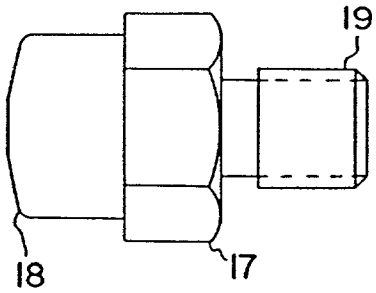


FIG. 2a

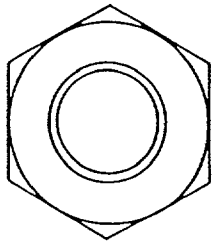


FIG. 2b

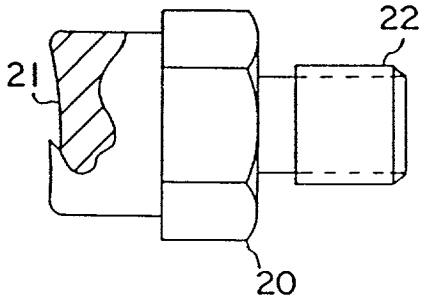


FIG. 3a

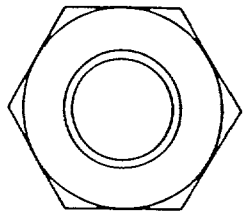


FIG. 3b

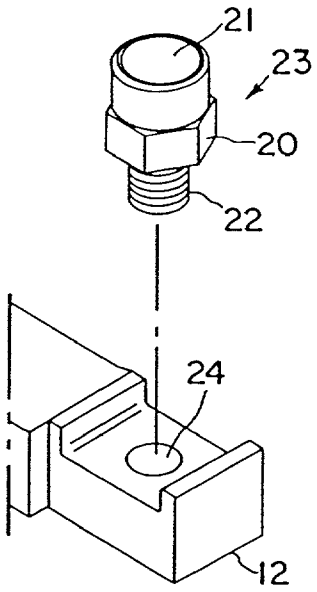


FIG. 4

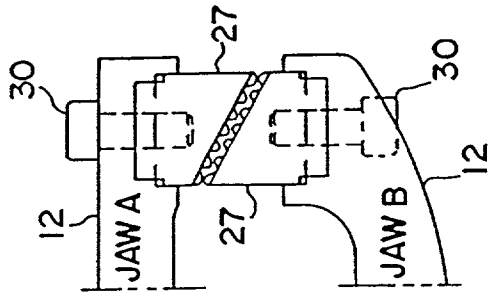


FIG. 6b

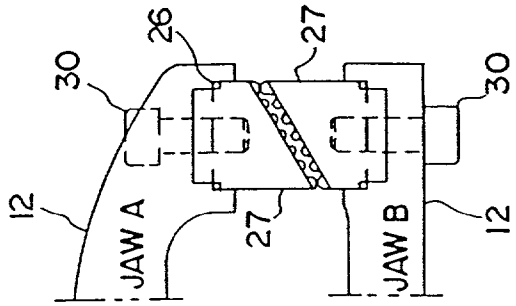


FIG. 6a

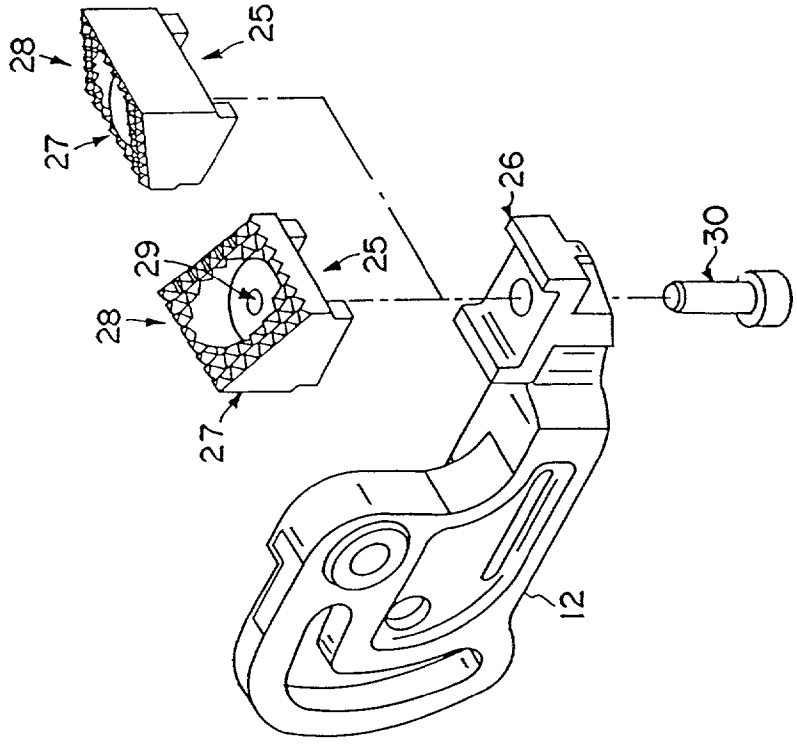


FIG. 5

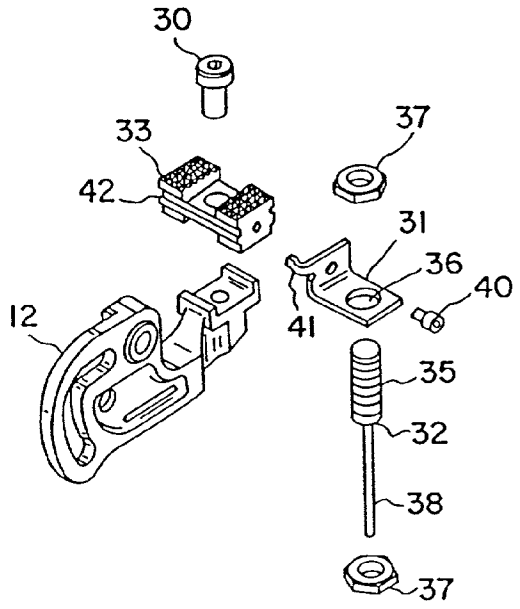


FIG. 7

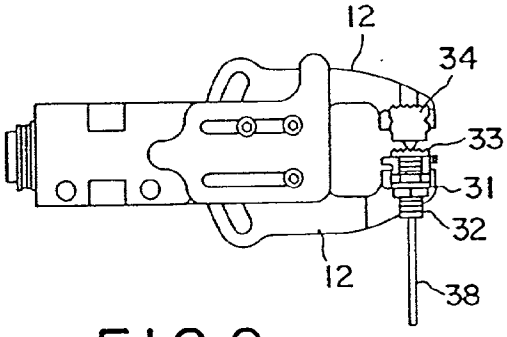


FIG. 8a

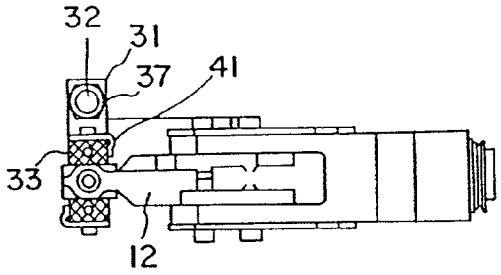


FIG. 8b

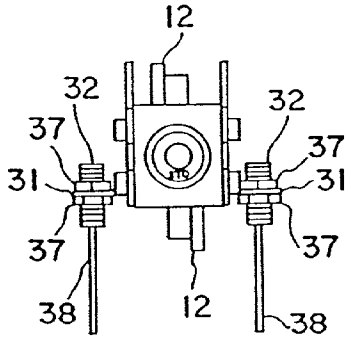


FIG. 8c

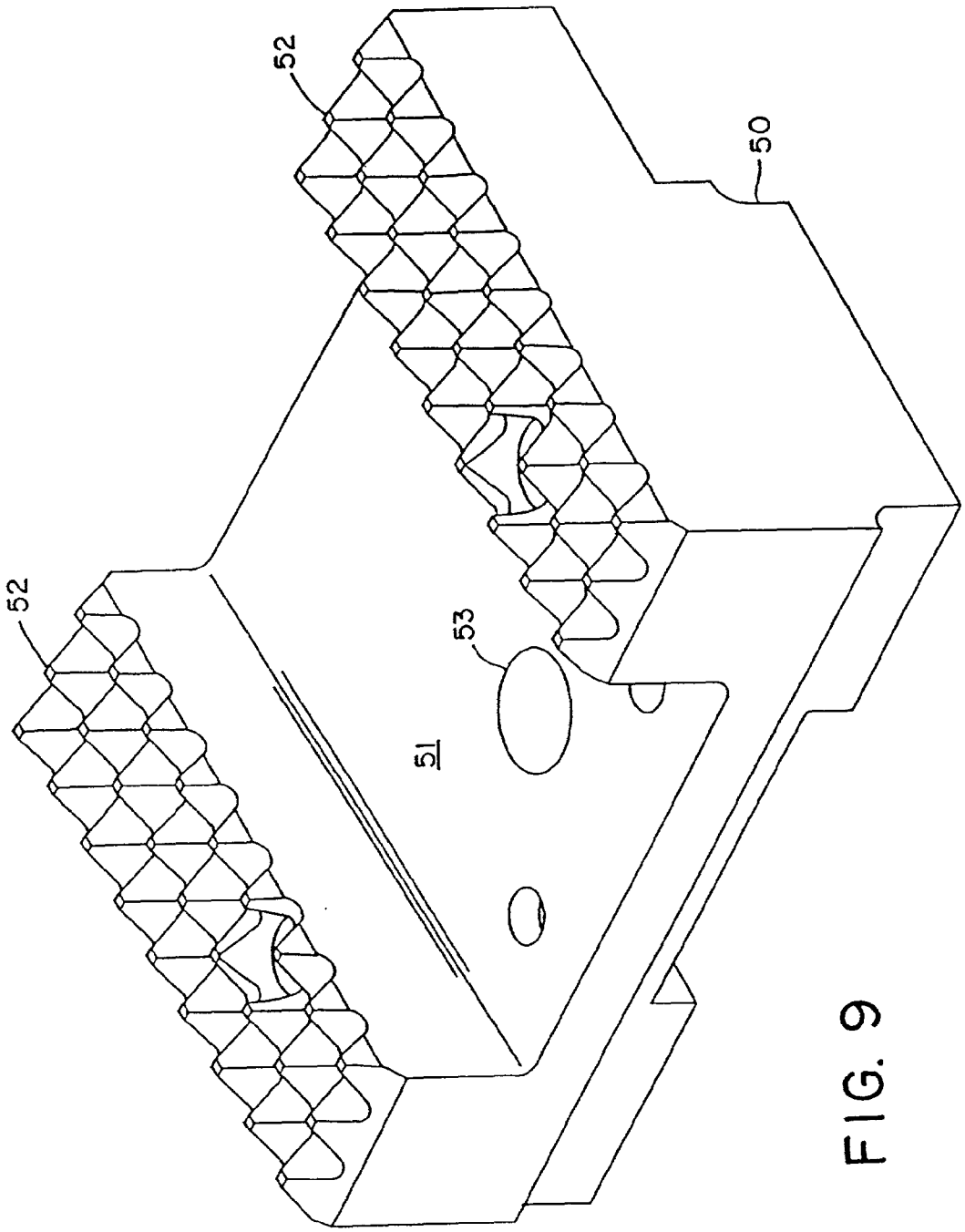


FIG. 9

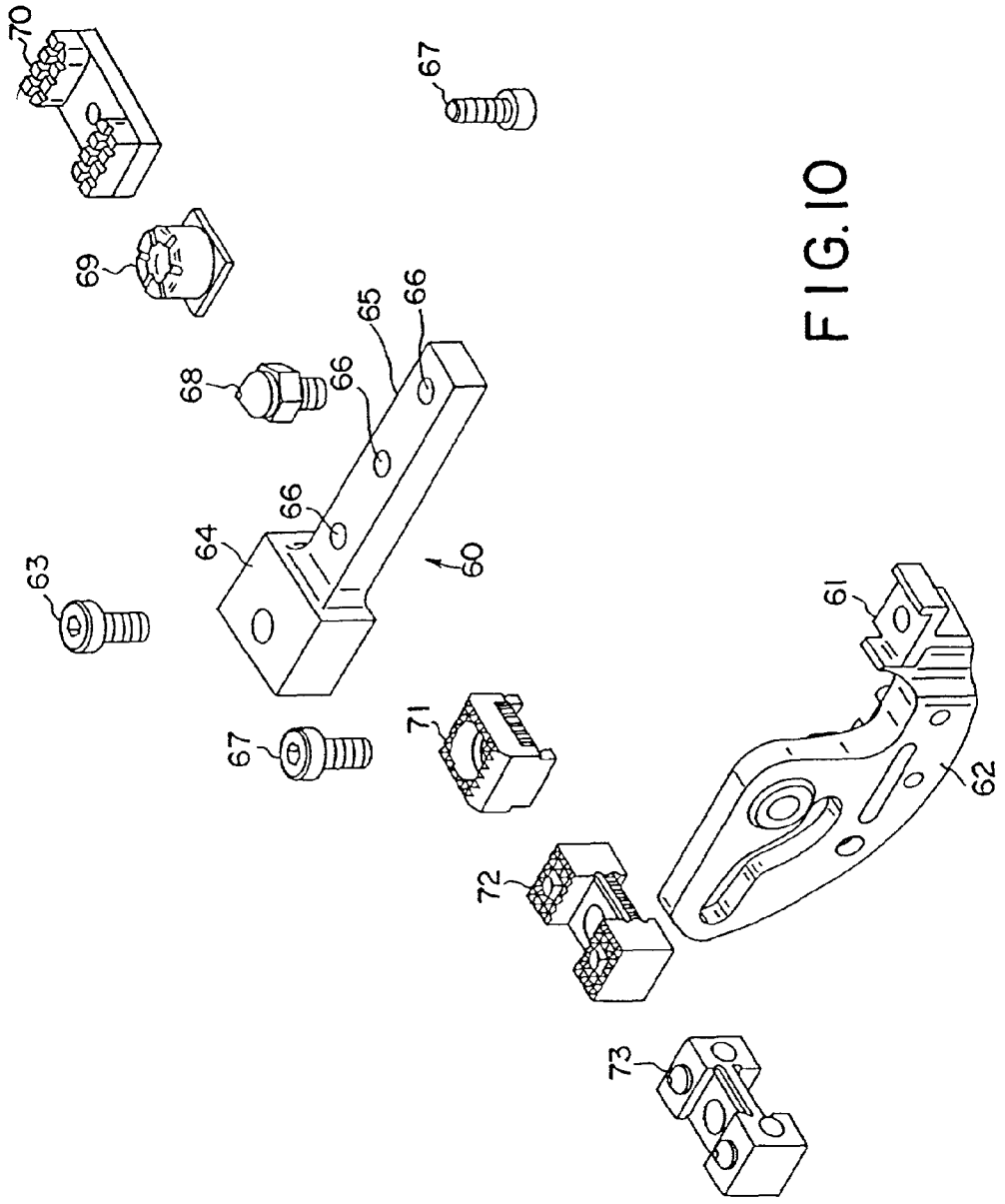


FIG. 10

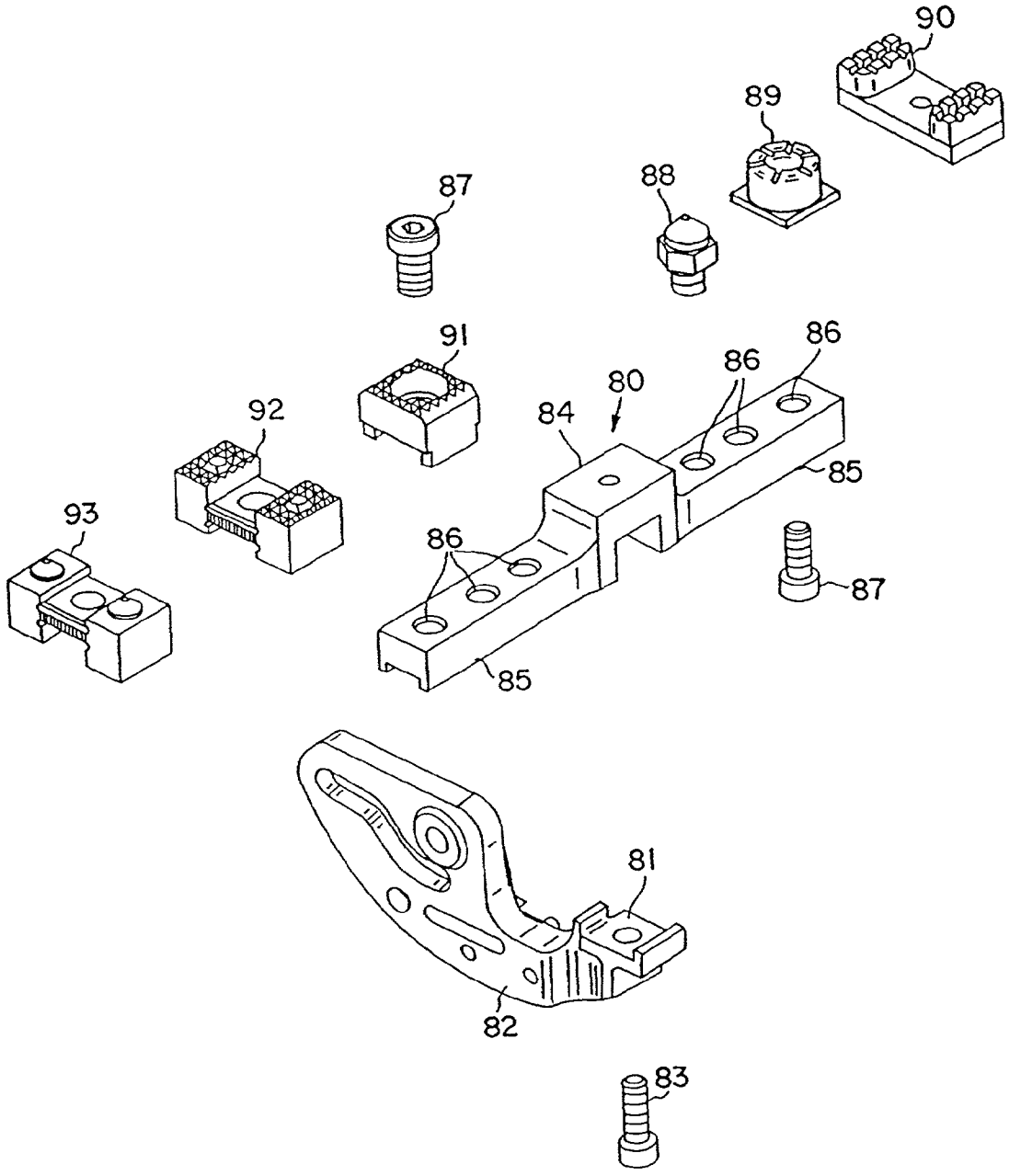


FIG. 11

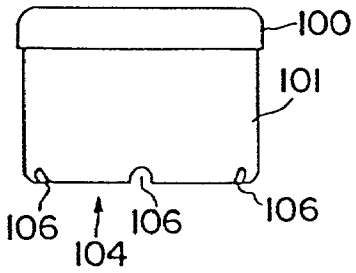


FIG. 12c

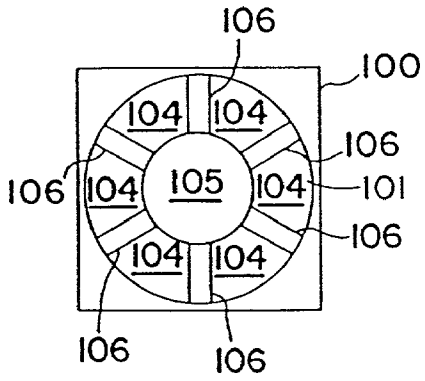


FIG. 12b

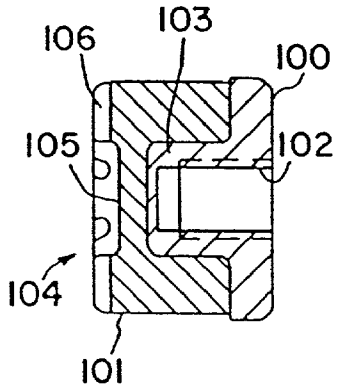


FIG. 12a

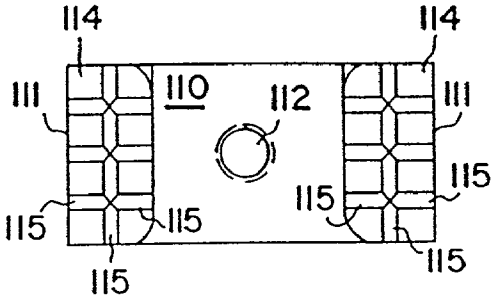


FIG. 13b

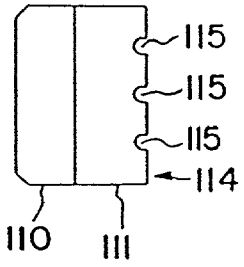


FIG. 13c

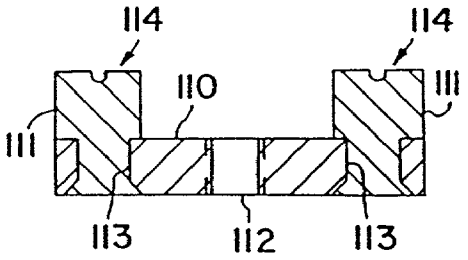


FIG. 13a

JAW TIPS AND JAW TIP ASSEMBLIES FOR PARTS GRIPPERS

RELATED APPLICATIONS

[0001] The present application is a Continuation of U.S. patent application Ser. No. 09/823,066 (filed Mar. 30, 2001) entitled Jaw Tips and Jaw Tip Assemblies for Parts Grippers, which is a Continuation of U.S. Utility application Ser. No. 09/345,031 (filed Jun. 30, 1999) entitled Jaw Tips and Jaw Tip Assemblies for Parts Gripper, which is related and claims priority to U.S. Provisional Patent Application Ser. No. 60/096232 (filed on Jun. 3, 1998). To the extent not included below, the subject matter disclosed in these applications is hereby expressly incorporated into the present application.

TECHNICAL FIELD

[0002] The present invention relates to fluid pressure actuated grippers of the type employed in automated workpiece handling devices which clampingly grip and transfer a workpiece from one station to another. More particularly, the present invention relates to jaw tip designs and jaws tip assemblies for fluid pressure actuated grippers.

BACKGROUND AND SUMMARY

[0003] Fluid pressure actuated grippers are widely employed and typically take the form of a pneumatic or hydraulic differential motor whose cylinder is fixedly mounted to a transfer device. At the forward or rod end of the cylinder housing, a gripper jaw mounting structure is fixedly mounted on the cylinder to pivotally support a pair of opposed gripper jaws which are coupled to the piston rod of the motor by a linkage so arranged that upon movement of the piston in one direction, the jaws are pivoted to an open position, and upon movement of the piston in the opposite direction, the jaws are driven to a closed workpiece gripping position.

[0004] In typical operation, the gripper jaws will be closed upon a workpiece near the edge of the workpiece, and the gripper will be advanced to position the gripped workpiece in operative relationship with a work station. The gripper will then be opened to release the workpiece, and the transfer device will retract the gripper from the work station while the work operation is performed. At the conclusion of the work operation, the gripper will then advance back into the work station, and the jaws will again close upon the workpiece and carry it away from the work station. Opening and closing the gripper jaws thus takes place when the gripper is in its closest proximity to tooling at the work station.

[0005] Fluid pressure actuated grippers are generally designed for use with particular workpieces to be transferred and with specific work stations. For example, some workpieces and/or work stations may require wider or narrower gripper jaws, different types of gripper jaws, gripper jaws that open at different angles, different clearance requirements, etc.

[0006] The present disclosure is directed to gripper jaw tips and jaw tip assemblies for fluid pressure actuated grippers which allow for the gripping, sensing, and transferring of a variety of workpieces.

[0007] Accordingly, an illustrative embodiment of the present disclosure provides an opposable gripper jaw tip attached to a piston actuated parts gripper. The opposable gripper jaw tip comprises a base and a body. The base is attachable to the piston actuated parts gripper. The body is attached to the base and comprises a gripping surface which comprises a tread.

[0008] Other illustrative embodiments may include the tread extending radially on the gripping surface, the body made from a resilient material which can be selected from a group comprising a rubber material, a polymeric material, and a plastic material, the tread being a plurality of treads and extending radially and is U-shaped on the gripping surface.

[0009] Another embodiment of the disclosure provides for an opposable gripper jaw tip attached to a piston actuated parts gripper. The opposable gripper jaw tip further comprises a fluid cavity disposed thereon. Other illustrative embodiments may include an opening of the cavity adjacent a gripping surface and a second opening of the cavity adjacent a peripheral surface of the opposable gripper jaw tip.

[0010] Additional features and advantages of the opposable gripper jaw tip will become apparent to those skilled in the art upon consideration of the following detailed description of the preferred embodiment exemplifying the best mode of carrying out the opposable gripper jaw tip as presently perceived.

BRIEF DESCRIPTION OF DRAWINGS

[0011] The present invention will be described hereafter with reference to the attached drawings which are given as non-limiting examples only, in which:

[0012] **FIG. 1** is an exploded perspective view of a fluid actuated gripper assembly.

[0013] **FIGS. 2***a* and **2***b* are side and end views of a convex gripper jaw tip according to one embodiment of the present invention.

[0014] **FIGS. 3***a* and **3***b* are side and end views of a concave gripper jaw tip according to one embodiment of the present invention.

[0015] **FIG. 4** is a perspective view of a concave gripper jaw tip which depicts how the tip is received in a gripper jaw member.

[0016] **FIG. 5** is a perspective view of angled gripper jaw tips which depicts how the tips are received in a gripper jaw member.

[0017] **FIGS. 6***a* and **6***b* are side views of the gripper jaw tips of **FIG. 5** which depict alternative ways of aligning the gripper jaw tips.

[0018] **FIG. 7** is an exploded view of a gripper tip assembly which includes a workpiece sensor.

[0019] **FIG. 8***a* is a side view of a gripper assembly having the workpiece sensor of **FIG. 7**.

[0020] **FIG. 8***b* is a top view of a gripper assembly having the workpiece sensor of **FIG. 7**.

[0021] **FIG. 8***c* is an end view of a gripper assembly having the workpiece sensor of **FIG. 7**.

[0022] **FIG. 9** is a perspective view of a gripper tip which has been notched out and configured to receive a sensor in the face thereof.

[0023] **FIG. 10** is an exploded view of a gripper jaw tip assembly which includes a tip extender that can be used to extend the working length of gripper tips.

[0024] **FIG. 11** is an exploded view of a gripper jaw tip assembly which includes a tip extender that can be used to extend the working width of gripper tips.

[0025] **FIG. 12***a* is a cross-sectional side view of a padded gripper tip having fluid expelling channels.

[0026] **FIG. 12***b* is an end view of the padded gripper tip of **FIG. 12***a*.

[0027] **FIG. 12***c* is a side view of the padded gripper tip of **FIG. 12***a*.

[0028] **FIG. 13 a** is a cross-sectional side view of another padded gripper tip having fluid expelling channels.

[0029] **FIG. 13***b* is an end view of the padded gripper tip of **FIG. 13***a*.

[0030] **FIG. 13***c* is a side view of the padded gripper tip of **FIG. 13***a*.

DETAILED DESCRIPTION OF DRAWINGS

[0031] The present invention is directed to jaw tips and jaw tip assemblies for fluid pressure actuated grippers which allow for the gripping, sensing, and transferring of a variety of workpieces. The jaw tips of the present invention are designed to allow for the gripping, transportation, and handling of workpieces that are flat or planar, or which have other than flat or planar shapes, including complex bent or curved shapes. The jaw tips of the present invention are particularly useful for gripping, transporting, and handling stamped or molded workpieces, although not limited for use therewith.

[0032] The present invention is also directed to gripper jaw tips which are designed to prevent or reduce the formation of particulate that tend to flake or peel off workpieces at or near the site they are gripped. Such flaking or peeling can occur due to deformation of a workpiece.

[0033] The present invention is further directed to gripper jaw tip assemblies which include sensors that can be used to sense the presence or absence of a workpiece. Such sensors can be mounted adjacent or within the gripper jaw tips or the gripper jaw itself. Suitable sensors include mechanical sensors, magnetic sensors, optical sensors, and sensors which detect electrical properties. Mechanical sensors that are tripped or otherwise moved when contacting a workpiece, and optical sensors can be used in conjunction with metal and non-metal workpieces. Magnet sensors and sensors that detect electrical properties such as conductance can be used in conjunction with workpieces that are made from metal, magnetizable materials, and electrically conductive materials.

[0034] The present invention is also directed to extenders for gripper jaw tips which can be used to extend the reach of gripper jaw tips. The tip extenders include bases which are configured to be coupled to tip seats of gripper jaw members, and one or more arm members which extend from the bases. The arm members include through-bores by which various gripper jaw tips can be coupled to the tip extenders. According to one embodiment, the tip extenders are configured so that the arm members thereof will extend forward of gripper jaw members, thus, increasing the forward reach of the gripper jaw members. According to another embodiment, the tip extenders are configured so that the arm members thereof will extend outward from the sides of gripper jaw members, thus, increasing the sideways reach of the gripper jaw members. In further embodiments, the tip extenders are configured so that the arm members thereof extend from their respective bases in any desired direction.

[0035] The present invention is further directed to padded gripper jaw tips which are provided with fluid expelling channels in their faces. The fluid expelling channels are configured to direct fluids trapped between the faces of the padded jaw tips and a workpiece away from the contacting surfaces. During processing, some workpieces or portions thereof may be coated with fluids such as oils, cutting or machining fluids, corrosion protective coatings, etc. The use of fluid expelling channels according to the present invention will ensure that such fluid-coated workpieces are tightly or securely grasped, by forcing the fluid away from the contacting surfaces in much the same way as tire treads are designed to channel surface water away from between tires and road surfaces. The fluid expelling channels can have a number of configurations that are useful for round, square, and rectangular tip pads.

[0036] The gripper jaw tips and tip assemblies of the present invention will be described hereafter with reference to an exemplary gripper assembly that includes gripper jaws having stepped tip seats. It is to be understood that the gripper jaw tips and tip assemblies that include sensors and sensor mounts are not limited for use with any particular gripper assembly or any particular gripper jaw design.

[0037] **FIG. 1** is an exploded perspective view of a basic fluid actuated gripper assembly. The gripper assembly depicted in **FIG. 1** includes a body **1**, a piston assembly **2**, a jaw pivot pin **3**, and a jaw driver assembly. The piston assembly **2** includes piston **4**, piston seal **5**, piston shaft **6**, and piston shaft seal **7**. The jaw driver assembly includes cross piece **8** which is attached to piston shaft **6**, cam pin **9** which is coupled to cross piece **8**, jaw bushings **10** which are received in cam slots **11** of the jaw members **12**, and slider bushings **13** which are received in longitudinal slots **14** formed in the side walls of the yoke structure of the body **1**. The piston **4** is contained within a piston chamber that is formed in the base of body **1** and sealed by plug **15**. As the piston **4** moves under the influence of fluid pressure, the cam pin **9** slides along cam slots **11**, causing the jaw members **12** to either open or close. Impact plates **16** can be attached to the sides of the body **1** so that they extend beyond the front of the body **1**, and protect the body from impact damage. Although the two jaw members **12** depicted in **FIG. 1** are not the same, it is to be understood that other jaw members could be used, including similar jaw members. **FIG. 1** merely depicts the structure of a basic gripper assembly for illustrative purposes.

[0038] **FIGS. 2***a* and **2***b* are side and end views of a convex gripper jaw tip according to one embodiment of the

present invention. As depicted, the gripper tip of **FIG. 2***a* includes a base **17** which is depicted as having a hexagonal shape, a cylindrical portion which extends from base **17** and includes a convex face **18**, and a threaded stud **19** which extends from the base **17** on an opposite side from the convex face **18**. The convex face **18** has a partial spherical shape with a minimum radius of curvature of about 0.25 inches. In practice, there is no upper limit to the radius of curvature of the convex faces, so long as flat facial surfaces are avoided. A preferred minimum for the radius of curvature is about 0.40 to 0.50 inches. According to one embodiment which was found to be particularly useful for purposes of the present invention, convex faces having a radius of curvature of about 0.80 inches were employed. As depicted in **FIG. 2***a*, the radial center of the convex face **18** is located along the center line of the gripper jaw tip within the threaded stud **19**. It is to be understood that the radial center of the convex face **18** could be located along the center line of the gripper jaw tip at any location, including beyond the threaded stud **19** or beyond the cylindrical portion, so long as a convex face or spherical structure is produced.

[**0039**] **FIG. 2***b* depicts the hexagon shape of base **17**. According to alternative embodiments, base **17** can be of any desired shape such as square, rectangular, round, round with parallel flat sides, etc. The base **17** is used to tighten the threaded stud **19** into a corresponding threaded bore on the tips of a gripper jaw member. Accordingly, the periphery of the base **17** should include surfaces which can be easily gripped with a wrench or other tool for tightening purposes.

[**0040**] **FIGS. 3***a* and **3***b* are side and end views of a concave gripper jaw tip according to one embodiment of the present invention. As depicted, the gripper tip of **FIG. 2***a* includes a base **20** which is depicted as having a hexagonal shape, a cylindrical portion which extends from base **20** and includes a concave face **21**, and a threaded stud **22** which extends from the base **20** on an opposite side from the concave face **21**. The concave face **21** has a partial spherical concave shape that is complementary to the convex shape of the gripper jaw tips of **FIGS. 2***a* and **2***b* so that a workpiece can be gripped therebetween. It is noted that the concave face **21** need not form a spherical cavity to receive either a gripped tip with a convex face or partial spherical shape.

[**0041**] **FIG. 3***b* depicts the hexagon shape of base **20**. According to alternative embodiments, base **20** can be of any desired shape such as square, rectangular, round, round with parallel flat sides, etc. The base **20** is used to tighten the threaded stud **22** into a corresponding threaded bore on the tips of a gripper jaw member. Accordingly, the periphery of the base **20** should include surfaces which can be easily gripped with a wrench or other tool for tightening purposes.

[**0042**] In use, opposed jaws of a gripper assembly are provided with one convex gripper tip, as depicted in **FIGS. 2***a* and **2***b*, and a matching convex gripper tip, as depicted in **FIGS. 3***a* and **3***b*.

[**0043**] **FIG. 4** is a perspective view of a concave gripper jaw tip which depicts how the tip is received in a gripper jaw. As depicted, the threaded stud **22** of the concave gripper tip **23** is received in a threaded bore **24** provided in jaw member **12**. Although the jaw member **12** in **FIG. 4** is depicted as having a stepped tip seat, it is to be understood that such a tip seat is not required to receive the gripper tips of FIGS. **2-3**. As discussed above, the gripper tip **23** can be tightened into threaded bore **24** by use of a wrench or other tool that is designed to engage base **20**.

[**0044**] The convex and concave gripper tips of the present invention have been found to eliminate or reduce the formation of particulate that tend to flake or peel off workpieces at or near the site they are gripped by the tips. Such flaking or peeling is often attributed to the surface deformation of a workpiece. The gripper tips of the present invention reduce or eliminate the formation of particulates by avoiding sharp or abrupt edges where gripping forces are applied to a workpiece.

[**0045**] **FIG. 5** is a perspective view of angled gripper jaw tips which depicts how the tips are received in a gripper jaw. The gripper tips of **FIG. 5** include recessed or stepped bases **25** which are rectangular so as to be received and mated with a recessed or stepped tip seat **26** formed on a jaw member **12**. Once bases **25** of the gripper tips **27** are received in the tip seat **26** of the jaw members **12**, the overlapping edges which project from the recessed or stepped portions restrict lateral motion between the gripper tips **27** and the tip seats **26**.

[**0046**] The gripper tips **27** have workpiece gripping surfaces **28** which are formed at an acute angle with respect to their bases. The workpiece gripping surfaces **28** can be provided with a diamond point structure, as depicted, or any suitable surface structure, including a smooth surface. In addition, the workpiece gripping surface can be metal or formed of a polymeric or elastomeric material. The gripping surfaces **28** can be provided any standard angles with respect to the base of the gripper tip, including, for example, 10°, 15°, 20°, 25°, 30°, . . . 55°, 60°, 65°, 7°, 75°, etc. or at any angle in between.

[**0047**] The gripper tips **27** are provided with counter-sunk threaded bores **29** which are provided to receive mechanical fasteners **30** that can be used to secure the gripper tips **27** to the jaw members **12**. Alternatively, the mechanical fasteners could be inserted through bores in the gripper tips and received in threaded bores in the jaw members.

[**0048**] **FIGS. 6***a* and **6***b* are side views of the gripper jaw tips of **FIG. 5** which depict alternative ways of aligning the gripper jaw tips. As can be understood from **FIGS. 6***a* and **6***b*, the recessed or stepped portion **25** of the gripper tips **27** cooperate with the recessed or stepped tip seat **26** in the jaw members so that the angled gripper tips **27** are properly aligned. The recessed or stepped portion **25** of the gripper tips **27** allow the gripper tips **27** to be attached to the jaw members **12** so that the angle at which opposed gripper tips **27** meet is aligned, as shown in either **FIG. 6***a* or **6***b*. It is to be understood that the structure of the recessed or stepped portions could be designed, e.g., notched, so as to allow the gripper tips **27** to be coupled to the tip seats **26** at four positions, instead of just the two positions depicted in **FIGS. 6***a* and **6***b*. Other engaging and position aligning structures could be provided on the base of the gripper tips **27** and the tip seats **26**. For example, the gripper tips **27** could be cylindrical and the tip seats **26** could have a cylindrical seat with cooperating aligning structures on the bottom of the gripper tips **27** and the bottom of the cylindrical seats **26**. Alignment structures could be eliminated. However, absent alignment structures, it would be necessary to align opposed gripper tips **27** and, thereafter, secure them tightly to the jaw

members **12**. It is also possible to provide gripper tips that have compound gripping surface angles or even curved surfaces that mate together.

[**0049**] **FIG. 7** is an exploded view of a gripper tip assembly which includes a workpiece sensor. The gripper tip assembly of **FIG. 7** includes a bracket **31** that can be used to support a sensor **32** adjacent one of an opposed pair of gripper tips **33**, **34**. In the embodiment depicted in **FIG. 7**, the sensor has an externally threaded portion **35** which can be received in a through-hole **36** in bracket **31**, and held in position by a pair of threaded nuts **37**. As can be understood, the position of the leading surface of the sensor **32** can be readily adjusted by loosening, positioning, and retightening the threaded nuts **37**. The lead **38** of the sensor **32** can be coupled to an audio or visual signaling device that will indicate the presence or absence of a workpiece between the gripper tips **33**, **34**. Alternatively, the sensor **32** could be coupled to an automatic counter or control device or system.

[**0050**] The bracket **31** can be coupled to one of the gripper tips **33** by a mechanical fastener **40**, such as a threaded screw or bolt. In order to maintain alignment of the bracket **31**, two or more mechanical fasteners could be used to secure the bracket **31** to the gripper tip **33**. Alternatively, the bracket **31** could be provided with a structure which engages a corresponding structure on the gripper tip **33** or a portion of the gripper jaw **12**. For example, as illustrated in **FIG. 7**, bracket **31** includes a projection **41** that engages a groove **42** provided on the gripper tip **33**. In other embodiments, the sensor bracket **31** can be welded to gripper tip **33**. As depicted, gripper tip **33** can be secured to gripper jaw **12** by a mechanical fastener **30**. It is noted that the embodiment of the invention depicted in **FIG. 7** and throughout, includes a jaw member having a recessed or stepped tip seat and a gripper tip that has a complimentarily recessed or stepped base. Using this similar recessed or stepped structural configuration allows for interchangeability of all the gripper tips with the jaw members.

[**0051**] **FIG. 8***a* is a side view of a gripper assembly having the workpiece sensor of **FIG. 7**. **FIG. 8***b* is a top view of a gripper assembly having the workpiece sensor of **FIG. 7**. **FIG. 8***c* is an end view of a gripper assembly having the workpiece sensor of **FIG. 7**. **FIGS. 8***a*-**8***c* depict how the tip assembly allows the leading edge of the sensor **32** to be positioned adjacent the closed gripper tips where it will sense the presence or absence of a workpiece. **FIG. 8***c* indicates how two sensor support brackets **31** can be used.

[**0052**] As discussed above, suitable sensors include mechanical sensors, magnetic sensors, optical sensors, and sensors which detect electrical properties. Mechanical sensors that are tripped or otherwise moved when contacting a workpiece and optical sensors can be used in conjunction with metal and non-metal workpieces. Magnet sensors and sensors that detect electrical properties, such as conductance, can be used in conjunction with workpieces that are made from metal, magnetizable materials, and electrically conductive materials.

[**0053**] According to another embodiment of the present invention, which is depicted in **FIG. 9, a** sensor can be fitted in the face of a gripper tip. **FIG. 9** is a perspective view of a gripper tip which has been notched out and configured to receive a sensor in the face thereof. This gripper tip **50** is similar to gripper tip **33** depicted in **FIG. 7**, but has been notched out and provided with a wider portion which serves as a base **51** upon which a flat sensor can be mounted between the adjacent workpiece gripping surfaces **52**. The sensor can be secured in place by mechanical fasteners or clips. Leads for the sensor can either pass through a hole(s) provided in base **51** or from an end of the sensor. The gripper tip **50** can include a threaded bore **53** by which it can be secured to a gripper jaw. In this case, a threaded fastener can be inserted though the back of a gripper jaw and received in the threaded bore **53** of the gripper tip.

[**0054**] **FIG. 10** is an exploded view of a gripper jaw tip assembly which includes a tip extender that can be used to extend the working length of gripper tips. The gripper jaw tip assembly of **FIG. 10** includes a tip extender **60** that can be coupled to the tip seat **61** of jaw member **62** by a suitable means, such as mechanical fastener **63**. The tip extender **60** includes a base portion **64** and an arm member **65**. Although not shown, the base portion **64** can include a cut-out structure (in the bottom, as depicted in **FIG. 10**) which is shaped complementary to the tip seat **61**. The inclusion of such a cut-out or shaped portion will ensure that the arm member **65** of the tip extender **60** of **FIG. 10** will be easily aligned with the jaw member **62** when coupled thereto. The tip extender **60** of **FIG. 10** can be aligned so that the axis of the arm member **65** is parallel to the axis of the jaw member **62**. Alternatively, the tip extender **60** of **FIG. 10** can be designed so that the arm member **65** of the tip extender **60** extends from the jaw member **62** at any desired angle. In other embodiments, a curved or angled arm member can be used.

[**0055**] The arm member **65** of tip extender **60** includes at least one through-bore **66**, which can be used to couple various jaw tips thereto. The through-bore(s) **66** can have internal threads into which jaw tips can be threaded or into which a threaded fastener **67** can be used to couple a jaw tip to the arm member **65** of the tip extender **60**. Alternatively, the through-bore(s) **66** can be non-threaded, and a threaded fastener **67** can be used to couple a jaw tip to the arm member **65** of the tip extender **60**.

[**0056**] **FIG. 10** depicts examples of various jaw tips **68**-**73** which can be coupled to and used in conjunction with the tip extender **60**. These include a single cone gripper tip **68**, a single padded gripper tip **69**, a double padded gripper tip **70**, a single diamond point pad gripper tip **71**, a double diamond point pad gripper tip **72**, and a double cone gripper tip **73**.

[**0057**] **FIG. 11** is an exploded view of a gripper jaw tip assembly which includes a tip extender that can be used to extend the working width of gripper tips. The gripper jaw tip assembly of **FIG. 11** includes a tip extender **80** that can be coupled to the tip seat **81** of jaw member **82** by a suitable means such as mechanical fastener **83**. The tip extender **80** includes a base portion **84** and a pair of arm members **85**. Although not shown, the base portion **84** can include a cut-out structure (in the bottom, as depicted in **FIG. 11**) which is complementary to the tip seat **81**. The inclusion of such a cut-out or shaped portion will ensure that the arm members **85** of the tip extender **80** of **FIG. 11** will be easily aligned to be perpendicular with the jaw member **82** when coupled thereto. The tip extender **80** of **FIG. 11** is depicted as being aligned so that the arm members **85** are perpendicular to the axis of the jaw member **82**. Alternatively, the arm members **85** of the tip extender **80** of **FIG. 11** can be

aligned with the jaw member **82** at any suitable angle. In other embodiments, two or more straight, and/or curved and/or angled arm members can be used.

[**0058**] The arm members **85** of tip extender **80** each includes at least one though-bore **86**, which can be used to couple various jaw tips thereto. The through-bore(s) **86** can have internal threads into which jaw tips can be threaded or into which a threaded fastener **87** can be used to couple a jaw tip to the arm members **85** of the tip extender **80**. Alternatively, the through-bore(s) **86** can be non-threaded and a threaded fastener **87** can be used to couple a jaw tip to the arm member **85** of the tip extender **80**.

[**0059**] **FIG. 11** depicts examples of various jaw tips **88-93** which can be coupled to and used in conjunction with the tip extender **80**. These include a single cone gripper tip **88**, a single padded gripper tip **89**, a double padded gripper tip **90**, a single diamond point pad gripper tip **91**, a double diamond point pad gripper tip **92**, and a double cone gripper tip **93**.

[**0060**] **FIG. 12***a* is a cross-sectional side view of a padded gripper tip having fluid expelling channels. The padded gripper tip of **FIGS. 12***a*-**12***c* includes a base **100** which can be made of metal, and a pad portion **101** which can be made from a rubber material, polymeric material, plastic material, or other suitably resilient material. The base **100** includes an internally threaded bore **102** which extends within a projection **103** of the base **100**. As depicted, the internally threaded bore **102** can terminate at a bottom that is within the projection **103**. The pad portion **101** is secured, e.g., molded over or otherwise bonded on the projection **103**.

[**0061**] **FIG. 12***b* is an end view of the padded gripper tip of **FIG. 12***a*. As depicted in **FIG. 12***b*, the face **104** of the pad portion **101** includes a central recessed portion **105** and a plurality of channels **106** which are radially disposed with respect to the central recessed portion **105**. As depicted in **FIG. 12***a*, the central recessed portion **105** can have a depth which is greater than the depth of channels **106**.

[**0062**] **FIG. 12***c* is a side view of the padded gripper tip of **FIG. 12***a*. As illustratively depicted in **FIG. 12***c*, the channels can have U-shaped bottoms.

[**0063**] When the face of the padded gripper tip of **FIGS. 12***a*-**12***c* is pressed against a portion of a workpiece that has a liquid coating thereon, the liquid that might otherwise be trapped between the face **104** of the pad portion **101** of the tip and the workpiece surface is squeezed into the channels **106** and central recessed portion **105**. Excess fluid is expelled outward through the channels **106** as the pad portion **101** of the gripper tip is compressed against the surface of the workpiece.

[**0064**] It is to be understood that the present invention is not limited to the pattern formed by the central recess portion **105** and channels **106**, which is depicted in **FIGS. 12***a*-**12***c*. Other patterns which do not include channels that are blocked from communicating with the sides of the pad portion **101** can also be used.

[**0065**] The padded gripper tip of **FIGS. 12***a*-**12***c* can be attached to the tip seat of a jaw member of a gripper by use of a threaded fastener which can be passed through the tip seat of the jaw member and received in the internally threaded bore **102**. Alternatively, the padded gripper tip could include a threaded projection in place of the internally threaded bore, and the threaded projection could be driven into an internally threaded bore provided on the tip seat of a jaw member.

[**0066**] **FIG. 13***a* is a cross-sectional side view of another padded gripper tip having fluid expelling channels. The padded gripper tip of **FIGS. 13***a*-**13***c* includes a rectangular base **110** which can be made of metal and a pair of pad portions **111** which can be made from a rubber material, a polymeric material, a plastic material or other suitably resilient material. The base **110** includes an internally threaded bore **112** which extends therethrough. The base **110** includes a pair of through-bores **113** adjacent either end into which the pad portions **111** can be molded.

[**0067**] **FIG. 13***b* is an end view of the padded gripper tip of **FIG. 13***a*. As illustratively depicted in **FIG. 13***b*, the face **114** of each pad portion **111** includes a plurality of channels **115** which can be arranged in an array or grid pattern.

[**0068**] **FIG. 13***c* is a side view of the padded gripper tip of **FIG. 13***a*. As depicted in **FIGS. 13***a* and **13***c*, the channels **115** can have U-shaped bottoms.

[**0069**] It is to be understood that the present invention is not limited to the pattern formed by the channels **115**, which is depicted in **FIGS. 13***a*-**13***c*. Other patterns which do not include channels that are blocked from communicating with the sides of the pad portions **111** can also be used.

[**0070**] The padded gripper tip of **FIGS. 13***a*-**13***c* can be attached to the tip seat of a jaw member of a gripper by use of a threaded fastener which can be passed through the tip seat of the jaw member and received in the internally threaded bore **112**. Alternatively, the padded gripper tip could include a threaded projection in place of the internally threaded bore, and the threaded projection could be driven into an internally threaded bore provided on the tip seat of a jaw member, or a through-hole.

[**0071**] Although the present invention has been described with reference to particular means, materials and embodiments, from the foregoing description, one skilled in the art can easily ascertain the essential characteristics of the present invention and various changes and modifications may be made to adapt the various uses and characteristics without departing from the spirit and scope of the present invention as described by the claims which follow.

What is claimed is:

1. An opposable gripper jaw tip attached to a piston actuated parts gripper, the opposable gripper jaw tip comprising:

a base attachable to the piston actuated parts gripper;

a body attached to the base;

wherein the body comprises a gripping surface; and

wherein the gripping surface comprises a tread.

2. The opposable gripper jaw tip of claim 1, wherein the tread extends radially on the gripping surface.

3. The opposable gripper jaw tip of claim 1, wherein the body is made from a resilient material.

4. The opposable gripper jaw tip of claim 1, wherein the tread is a plurality of treads on the gripping surface.

5. The opposable gripper jaw tip of claim 2, wherein the tread that extends radially is a plurality of treads each extending radially on the gripping surface.

6. The opposable gripper jaw tip of claim 3, wherein the resilient material is selected from a group comprising a rubber material, a polymeric material, and a plastic material.

7. The opposable gripper jaw tip of claim 1, wherein the tread is a U-shaped tread.

8. An opposable gripper jaw tip attached to a piston actuated parts gripper, the opposable gripper jaw tip having a fluid cavity disposed thereon.

9. The opposable gripper jaw tip of claim 8, further comprising an opening of the cavity adjacent a gripping surface of the opposable gripper jaw tip.

10. The opposable gripper jaw tip of claim 9, further comprising a second opening of the cavity adjacent a peripheral surface of the opposable gripper jaw tip.

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