Patent Application of

Mark S. Gordon

for

GRIPPER FOR MANIPULATING PLANAR WORKPIECE IN TIGHT-FITTING RECEPTACLE

CROSS REFERENCES TO RELATED APPLICATIONS

This application is a continuation-in-part of application number 14986093.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT:

Not applicable to this application.

FIELD OF THE INVENTION

The present invention relates to a gripper for manipulating planar workpieces that reside temporarily during use in a tight-fitting slot or receptacle. This temporary aspect of planar workpiece use means that they must be installed, manipulated, and/or removed with some regularity.

BACKGROUND OF THE INVENTION

Planar workpieces whose effective operation requires that they be housed in a tight-fitting receptacle can be difficult to install in, manipulate in, or remove from such a receptacle. Various fields of endeavor utilize or can utilize such planar workpieces including but not limited to technology component or subsystem hardware, medicine, the residential and commercial building trades, and manufacturing or industrial machinery. These planar workpieces could include, for example, boards bearing electronic components, medical or surgical objects or components, filter elements, and machinery components or subsystems.

One such application of a planar workpiece in a tight receptacle is the filter utilized in a commercial or residential forced air heating, ventilating, and air conditioning (HVAC) system. In this case the filter is an example of a planar workpiece and the slot holding the filter is an example of a tight-fitting receptacle. These replaceable filters remove particulate objects from recirculated air during operation. These filters are removed, discarded or cleaned, and then replaced on a regular basis because they become clogged with particulate matter. Such a filter is installed in a slot or receptacle that by design: 1) has little or no space or gap between the filter and the slot, 2) is sized so that when the filter is fully installed the filter top is recessed below or level with the receptacle frame edge and the frame outer edges and filter outer edges

overlap, 1) and 2) together helping to ensure that all recirculated air containing particles to be removed must pass through the filter and not around it through any gaps at the edges of the filter. This placement of the filter (planar workpiece) such that its top is recessed below or level with the receptacle frame edge represents the proper operational location for such a planar workpiece.

These filters are planar in shape, typically square or rectangular, and vary in size from a minimum of about 9 by 9 inches to over 25 by 25 inches. One commonly used type of HVAC filter is 1 inch thick. HVAC filters are often manufactured of cardboard or another semi-rigid material for a frame and of filtration materials including but not limited to fiberglass, paper, foam, polyester, cloth, etc.

While in use HVAC filters often become deformed due to the pressure of air passing through them. This deformation process may be hastened if a filter is not replaced after it becomes clogged.

The slot or receptacle that holds an HVAC filter is an integral part of an air handling system comprising ducts typically fabricated from sheet metal at the point holding the filter. These slots are typically installed manually by an HVAC technician during the HVAC system installation process. The result is variation in the precise width, depth and thickness of slots that are ostensibly the same size. In other words some slots designed for a 20X20X1 inch filter will be a tight fit along the edges for a filter of that size, others will be just right, while others will fit loosely. In addition, since the depth of the slot may vary, a filter may drop to the bottom of the filter slot and be below the outer edge of the air handling duct of which the slot is a part, making access for the purpose of filter removal difficult.

As a result, the installation and/or removal of HVAC filters can be difficult for one or more of the following reasons:

a. The fit between filter and filter slot may be tight, making it difficult to push the filter into the slot on installation and pull the filter from the slot on removal.
b. The outer edge of the filter may, when fully installed in the slot, be below the outer edge of the duct containing the filter slot, making it impossible to access the edges of the filter with human fingers during the removal process.
c. The filter may have become deformed during use, making it impossible to access the edges of the filter with human fingers during the removal process and/or difficult to remove due to the deformation.

d. The gap between the edges of the filter and the edges of the filter slot may be too small to permit human fingers or a tool such as pliers to grasp the filter during the removal process.
e. The space above and/or around the filter slot through which a filter being installed or removed must pass may be difficult to access with human hands due to its location or may be partially obstructed by system components such as air ducts and/or gas or electrical lines.

The same difficulties discussed above for the HVAC filter example apply to other applications that utilize planar workpieces in tight-fitting slots.

SUMMARY OF THE INVENTION

The present invention relates to hand tools used for the insertion and/or removal of a planar workpiece from a slot or receptacle in which the planar workpiece fits tightly. A particular embodiment of the device is a tong-like or clamp-like apparatus with two arms pivoting at a single point near their longitudinal center, a comfortable, ergonomically-designed handle at one end of each of the arms, jaws for gripping the planar workpiece at the other end of the arms, a spring that biases the jaws toward the closed position, and an optional adjustment mechanism capable of setting the gap between the jaws.

The description herein, including the use of HVAC filter elements as an example, is solely for orientation and ease of understanding and neither this summary nor any of the terms or phraseology used herein should be construed as limiting. Additional features, advantages and embodiments of the present invention will be presented hereinafter and will form the basis for the claims appended hereto. It is to be understood that the present invention is not limited by the descriptions or drawings of embodiments presented hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG **1.** is a top perspective view of one embodiment of the present invention.

FIG **2.** is a bottom perspective view of one embodiment of the present invention.

FIG **3.** is a side view of one embodiment of the present invention.

FIG **4.** is a top view of one embodiment of the present invention.

FIG **5.** is a bottom view of one embodiment of the present invention.

FIG **6.** is a side sectional view of one embodiment of the present invention in use.

FIG **7.** is a top perspective view of another embodiment of the present invention.

FIG **8.** is a bottom perspective view of another embodiment of the present invention.

FIG **9.** is a side sectional view of another embodiment of the present invention in use.

FIG **10.** is a top perspective view of a further embodiment of the present invention.

FIG **11.** is a bottom perspective view of a further embodiment of the present invention.

FIG **12.** is a side view of a further embodiment of the present invention.

FIG **13.** is a top view of a further embodiment of the present invention.

FIG **14.** is a side sectional view of a further embodiment of the present invention in use.

FIG **15.** is a top perspective view of a further embodiment of the present invention.

FIG **16.** is a bottom perspective view of a further embodiment of the present invention.

FIG **17.** is a side sectional view of a further embodiment of the present invention in use.

DRAWINGS – REFERENCE NUMERALS

Drawing	**Reference Numeral**	**Name**
1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	102	first arm
1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	104	second arm
1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	106	first handle end
1, 2, 3, 4. 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	107	second handle end
1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	108	first handle
1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	110	second handle
1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17	111	first linkage extension
1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17	112	first middle portion
1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17	113	second middle portion
1, 3, 4, 6, 7, 9, 10, 12, 13, 14, 15, 17	114	first jaw end
2, 3, 5, 6, 9, 11, 12, 14, 17	115	second jaw end
1, 2, 3, 4, 6, 10, 11, 12, 13, 14	116	first jaw
1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17	117	second linkage extension
1, 2, 3, 5, 6, 10, 11, 12, 14	118	second jaw
1, 4, 10, 13	119	first jaw insertion limit line
1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17	120	spring arm
1, 2, 3, 10, 11, 12	121	first jaw leading edge
1, 2, 7, 8, 10, 11, 15, 16	122	spring
1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17	124	pivot pin
1, 3, 4, 6, 7, 9	126	jaw gap adjuster
1, 7	128	adjuster hole
1, 3, 6, 7, 9	130	second threaded sleeve
1, 3, 6, 10, 12, 14	132	second gripping surface
1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 14	134	outer surface
1, 2, 3, 10, 11, 12	136	second jaw leading edge
2, 3, 6, 8, 9	202	first threaded sleeve
2, 5, 11	204	second jaw insertion limit line

Drawing	Reference Numeral	Name
2, 3, 6, 11, 12, 14	206	first gripping surface
6, 9, 14, 17	602	planar workpiece
6, 9, 14, 17	604	receptacle
6, 9, 14, 17	606	receptacle frame
6, 9, 14, 17	608	receptacle frame edge
7, 8, 9, 15, 16, 17	702	first offset jaw
7, 9, 15, 17	704	second offset jaw
7, 8, 15, 16	706	first offset jaw top step
7, 8, 15, 16	708	first offset jaw riser
7, 8, 15, 16	710	first jaw
7, 15	712	first jaw insertion limit line
7, 8, 15, 16	714	second offset jaw top step
7, 8, 15, 16	716	second offset jaw riser
7, 8, 15, 16	718	second jaw
7, 9, 15, 17	720	second gripping surface
7, 15	722	second jaw leading edge
8, 9, 16, 17	802	first gripping surface
8, 16	804	first jaw leading edge
8, 16	806	second jaw insertion limit line

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DETAILED DESCRIPTION OF THE FIRST EMBODIMENT

A. Overview of the First Embodiment

As depicted in FIGS. **1** through **6**, one embodiment of a gripper comprises a first arm **102** that extends from a first handle end **106** through a first handle **108** and a first middle portion **112** to a first jaw end **114**. Attached to the first jaw end **114** is a first jaw **116**. A second arm **104** extends from a second handle end **107** through a second handle **110** and a second middle portion **113** to a second jaw end **115**. Attached to the second jaw end **115** is a second jaw **118**. Protruding at approximately a right angle from the underside of the first middle portion **112** is a first linkage extension **111**. Protruding at approximately a right angle from the underside of the second middle portion **113** is a second linkage extension **117**. The first linkage extension **111** and the second linkage extension **117** partially overlap and are attached in this overlap area using a pivot pin **124** so that the first handle **108** and the second handle **110** can be actuated to vary the gap between the first jaw **116** and the second jaw **118**, permitting the operator to grasp and manipulate a planar workpiece **602**.

B. Detailed Description of the First Embodiment

As shown in FIG. **1** and FIG. **3**, a first arm **102** extends from a first handle end **106** through a first handle **108** and a first middle portion **112** to a first jaw end **114**. Directly attached to the first jaw end **114** is a first jaw **116**. Protruding at approximately a right angle from the underside of the first middle portion **112** is a first linkage extension **111**.

As depicted in FIG. **1**, the first jaw **116** extends parallel to the longitudinal axis of the first handle **108** from the first jaw end **114** in a direction opposite from the direction of the first arm **102** and laterally to either side of the first jaw end **114** so that the first jaw **116** forms a flat plate of uniform thickness. In this context the phrase “longitudinal axis of the first handle **108**” refers to a straight line drawn from substantially the lateral center of the first handle end **106** to substantially the lateral center of the first middle portion **112**, this line running parallel to the centerline of the first arm **102**, and “uniform” means a thickness variation across the plate surface of no more than approximately 10%. The edge of the first jaw **116** farthest from the first jaw end **114** is the first jaw leading edge **121**. The first jaw insertion limit line **119** is the endpoint for insertion of the first jaw **116** into the receptacle **604**. For the first embodiment the first jaw insertion limit line **119** is the forward attachment point of the first jaw **116** to the first jaw end **114**, “forward” meaning in a direction opposite to the first handle **108**. The insertion distance into the receptacle **604** of the first jaw **116** is the distance from the first jaw leading edge **121** to the

first jaw insertion limit line **119**, this insertion distance being represented in FIG. **1** by the letter **L**.

As illustrated in FIG. **2** and FIG. **3**, a second arm **104** extends from a second handle end **107** through a second handle **110** and a second middle portion **113** to a second jaw end **115**. Directly attached to the second jaw end **115** is a second jaw **118**. Protruding at approximately a right angle from the underside of the second middle portion **113** is a second linkage extension **117**.

As depicted in FIG. **2**, the second jaw **118** extends parallel to the longitudinal axis of the second handle **110** from the second jaw end **115** in a direction opposite from the direction of the second arm **104** and laterally to either side of the second jaw end **115** so that the second jaw **118** forms a flat plate of uniform thickness. In this context the phrase “longitudinal axis of the second handle **110**” refers to a straight line drawn from substantially the lateral center of the second handle end **107** to substantially the lateral center of the second middle portion **113**, this line running parallel to the centerline of the second arm **104**, and “uniform” means a thickness variation across the plate surface of no more than approximately 10%. The edge of the second jaw **118** farthest from the second jaw end **115** is the second jaw leading edge **136**. For the first embodiment the second jaw insertion limit line **204** is the forward attachment point of the second jaw **118** to the second jaw end **115**, “forward” meaning in a direction opposite to the second handle **110**. The insertion distance into the receptacle **604** of the second jaw **118** is the distance from the second jaw leading edge **136** to the second jaw insertion limit line **204**, this insertion distance being represented in FIG. **2** by the letter **L**.

First and second arms **102**, **104** may be formed of metal such as aluminum or steel, molded plastic, carbon fiber, or other materials. First and second arms **102**, **104** length is sufficient to operate comfortably with one hand, for example in this embodiment approximately six inches. First and second handles **108**, **110**, as shown in FIGS. **1** through **3**, may be ergonomically shaped. Other embodiments may use different materials of manufacture and/or different size and/or different shape configurations.

As depicted in FIGS. **1** through **3**, and FIG. **6**, the first linkage extension **111** and the second linkage extension **117** overlap and are attached in the overlap area by a pivot pin **124**. Connecting the first arm **102** and the second arm **104** in this manner permits an operator of this embodiment to alter the gap between the first jaw **116** and the second jaw **118** by actuating the first handle **108** and the second handle **110** and thereby operate in a tong-like fashion this apparatus. Though the first arm **102** and the second arm **104** are shown as unitary structures of

a particular shape in the referenced figures, they may be shaped differently in other embodiments and their representation herein should not be considered a limitation. Similarly, overlap and connection by the pivot pin **124** of the first linkage extension **111** and the second linkage extension **117** may be arranged differently in other embodiments and their presentation herein should not be considered a limitation.

As shown in FIG. **1** and FIG. **2**, a spring **122** is mounted on the pivot pin **124**. Integral to the spring **122** are two spring arms **120**, which apply pressure to the first arm **102** and the second arm **104**, thereby biasing the first jaw **116** and the second jaw **118** toward the closed position.

As depicted in FIG. **3**, the first jaw **116** has an outer surface **134** and a first gripping surface **206**, and the second jaw **118** has an outer surface **134** and a second gripping surface **132**. The first jaw **116** and the second jaw **118** overlap one another and, in this embodiment, have coincident edges when viewed from a point six inches along an axis perpendicular to the plane of the first jaw **116** that extends outward from the first jaw **116** center point. The first jaw **116** and the second jaw **118** are substantially parallel to one another and, for the HVAC filter manipulation application discussed earlier, have an adjustable gap of approximately one inch between the first gripping surface **206** and the second gripping surface **132**. Other embodiments for different applications may have different jaw dimensions, jaw overlap, and gripping surface gap.

As illustrated in FIGS. **1** through **3**, a first threaded sleeve **202** (not visible in FIG. **1**) is attached to the underside of the first arm **102** between the first middle portion **112** and the first jaw end **114**. A second threaded sleeve **130** (not visible in FIG. **2**) is attached to the underside of the second arm **104** between the second middle portion **113** and the second jaw end **115**. A jaw gap adjuster **126** passes through an adjuster hole **128** (visible only in FIG. **1**) and the first threaded sleeve **202** then enters second threaded sleeve **130**. Turning the jaw gap adjuster **126** clockwise or counterclockwise provides a means for setting or varying the gap or space between the first gripping surface **206** and the second gripping surface **132**, this adjustment mechanism being such that the gap or space remains constant when the gripper is at rest without pressure on the first handle **108** or on the second handle **110**. The description presented here of a means for setting or varying the gap or space between the first gripping surface **206** and the second gripping surface **132** represents only one way to set this gap and this description should not to be considered a limitation; any mechanism known to one skilled in the art will suffice so long as the gap or space is maintained while the gripper is at rest.

The dimensions and material of manufacture for the first jaw **116** and the second jaw **118** can vary based on gripper application. For the application involving manipulation of HVAC filters discussed earlier, the width **W** of the first jaw **116**, as shown in FIG. **1**, may be two inches and the insertion distance **L** may be two inches or more. For the same HVAC filter manipulation application the width **W** of the second jaw **118**, as shown in FIG. **2**, may be two inches and the insertion distance **L** may be two inches or more. These first jaw **116** and second jaw **118** insertion distance and width dimensions will need to be substantially at least 1.25 inches to ensure sufficient gripping surface and depth of insertion into the receptacle **604**, the term "substantially at least 1.25 inches" meaning no less than 1.125 inches. One possible first jaw **116** and second jaw **118** material of manufacture in this HVAC filter manipulation application is 16 gauge cold-rolled steel (0.0598 inches thick). For applications using cold-rolled steel jaws as a material of manufacture, an anti-corrosion coating such as, but not limited to, zinc or paint may be applied. Other embodiments for this HVAC filter or different applications may use stainless steel, plastic, carbon fiber or other materials for jaws.

The thickness of the first jaw **116** and the second jaw **118** material must be less than approximately 0.075 inches, meaning that the thickness cannot exceed 0.080 inches. This minimal jaw thickness permits use of the gripper when a planar workpiece **602** fits tightly or is stuck in in its receptacle **604**, "fits tightly", "stuck in", and "fit tightly" being defined as one or more of the following conditions: a) less than approximately 0.25 inches of space between an outer edge of the planar workpiece **602** and an outer edge of the receptacle **604** on one or both sides of the planar workpiece **602**; b) a necessity to shake, oscillate, rock side-to-side or otherwise manipulate with force the planar workpiece **602** in order to free it from the receptacle **604** on removal or seat it fully into the receptacle **604** on insertion; c) insertion or removal requires damage or deformation of the planar workpiece **602**, "damage or deformation" being defined as an increase or decrease of one or more dimensions of the planar workpiece **602** – dimensions being length, width and thickness – of more than 5% of that dimension and/or the tearing, detachment or disassociation of planar workpiece **602** components such as, for example, planar workpiece **602** frame or border from other planar workpiece **602** material. Planar workpiece **602** as used herein refers to a mechanical object shaped as a rectangular cuboid.

A rigid material is required for the first jaw **116** and the second jaw **118**, "rigid material" being defined as one that can maintain planarity across its surface to within a deflection from flatness of no more than one-eighth inch along the unsupported edge when a weight of ten pounds is

applied to the unsupported edge of a 4 inch by 4 inch piece of this rigid material secured in a horizontal position such that a 2 by 4 inch dimension of this piece is cantilevered and thus unsupported. This measurement can be done by clamping to a flat-topped table one half of a 4 inch by 4 inch piece of the rigid material being tested so that the other half of the test material (a 2 inch by 4 inch section) is off the table top and thus unsupported. Then a ten pound weight is applied to the unsupported edge of the test material (farthest from the table edge) and the deflection of the weighted edge is measured with respect to the table edge.

C. Operation of the First Embodiment

FIG. **6** shows the gripper in operation. The operator first turns the jaw gap adjuster **126** until the gap between the first jaw **116** and the second jaw **118** is slightly less than the thickness of the planar workpiece **602** to be manipulated. In the case of planar workpiece **602** removal, the operator then squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **116** and the second jaw **118** until it equals the width of the receptacle **604**. The operator then inserts the first jaw **116** and the second jaw **118** into the receptacle **604** so that first gripping surface **206** and the second gripping surface **132** overlap the planar workpiece **602**, then the operator releases the first handle **108** and the second handle **110**. The resulting tension applied by the spring **122** and the spring arms **120** presses together the first jaw **116** and the second jaw **118** until the stopping point set with the jaw gap adjuster **126**. This pressing together of the first jaw **116** and the second jaw **118** causes gripping of the planar workpiece **602** by the first gripping surface **206** and the second gripping surface **132**. Once gripped, the planar workpiece **602** can be manipulated as necessary to free its edges from a receptacle frame **606** present on either side of the planar workpiece **602** and then removed.

Planar workpiece **602** insertion is the opposite of removal. The operator first turns the jaw gap adjuster **126** until the gap between the first jaw **116** and the second jaw **118** is set to be slightly less than the thickness of the planar workpiece **602** to be manipulated. The operator then squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **116** and the second jaw **118** until it exceeds the width of the planar workpiece **602**. The operator then slides the outer edge of the planar workpiece **602** between the first gripping surface **206** and the second gripping surface **132** and releases the first handle **108** and the second handle **110** so that the tension applied by the spring **122** and the spring arms **120** presses together the first jaw **116** and the second jaw **118** until the stopping point set with the jaw gap adjuster **126**. The gripper now firmly holds the planar workpiece **602**. The operator then inserts the planar workpiece **602** into the receptacle **604**. Once partially inserted

in the receptacle **604**, the planar workpiece **602** can be manipulated as necessary to slide it fully into the receptacle **604**. After full insertion of the planar workpiece **602** into the receptacle **604**, the operator squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **116** and the second jaw **118** until it exceeds the width of the planar workpiece **602**, then the operator withdraws the gripper from the receptacle **604**.

In FIG. **6** the planar workpiece **602** is shown as recessed below a receptacle frame edge **608**, which is a common occurrence either because the receptacle **604** is deeper than the planar workpiece **602** or because the planar workpiece **602** has become deformed during use. The planar workpiece **602** can be removed from the receptacle **604** in only one direction because the receptacle frame **606** is closed at the other end of the receptacle **604** (bottom of receptacle **604** is not shown in FIG. **6**). This placement of the planar workpiece **602** recessed below (or level with) the receptacle frame edge **608** represents the proper operational location for such a planar workpiece **602**.

The components depicted in FIG. **6** including but not limited to the receptacle **604**, the receptacle frame **606**, and the receptacle frame edge **608** are an example of a mechanical system whose operation requires insertion and removal of a planar workpiece **602** that resides in a receptacle **604** during normal operation. The representation of FIG. **6** is for reference only; other arrangements are possible that utilize a planar workpiece **602** whose insertion and removal may require a specialized tool such as the currently described gripper.

DETAILED DESCRIPTION OF AN ALTERNATIVE EMBODIMENT

A. Overview of an Alternative Embodiment

A modification of the gripper embodiment depicted in FIGS. **1** through **5** is presented in FIGS. **7** and **8**, wherein the gripper has a first offset jaw **702** and a second offset jaw **704** that are step-shaped rather than flat. In this alternative embodiment, the first offset jaw **702** adds a first offset jaw top step **706**, and a first offset jaw riser **708**, while the second offset jaw **704** of this alternative embodiment adds a second offset jaw top step **714**, and a second offset jaw riser **716**. In addition, for this alternative embodiment the numbering for certain elements changes as follows:

Element Name	First Embodiment Numeral	Alternative Embodiment Numeral
first jaw	116	710
second jaw	118	718
first gripping surface	206	802
second gripping surface	132	720
first jaw insertion limit line	119	712
first jaw leading edge	121	804
second jaw insertion limit line	204	806
second jaw leading edge	136	722

With the exception of these aforesaid jaw and gripping surface elements, the gripper first embodiment of FIGS. **1** through **5** and the gripper alternative embodiment of FIGS. **7** and **8** are identical. As such this section will describe only the step-shaped offset jaws of this alternative embodiment, their orientation, their attachment, and their operation, and the earlier description of all gripper components other than the jaws and gripping surfaces applies equally to this alternative embodiment.

B. Detailed Description of an Alternative Embodiment

As depicted in FIGS. **7** and **8**, the first offset jaw **702** comprises three planar surfaces connected to form the equivalent of two horizontal and parallel but non-overlapping steps that are attached to one another by a connecting vertical riser. A first offset jaw top step **706** forms the first such planar surface. The longitudinal axis of the first offset jaw top step **706** is oriented parallel to the longitudinal axis of the gripper and is attached to the underside of the first jaw end **114**. A first offset jaw riser **708** forms the second such planar surface. The first offset jaw riser **708** is attached to the edge of the first offset jaw top step **706** opposite the first jaw end **114** and is oriented at a right angle to the first offset jaw top step **706** so as to form a downward-oriented riser component in relation to the first offset jaw top step **706**. A first jaw **710** forms the third such planar surface. The first jaw **710** is attached to the bottom edge of the first offset jaw riser **708** and extends parallel to the longitudinal axis of the first handle **108** from the first offset jaw

riser **708** in a direction opposite from the direction of the first arm **102** and laterally to either side so that the first jaw **710** forms a flat plate of uniform thickness. In this context the phrase "longitudinal axis of the first handle **108**" refers to a straight line drawn from substantially the lateral center of the first handle end **106** to substantially the lateral center of the first middle portion **112**, this line running parallel to the centerline of the first arm **102**, and "uniform" means a thickness variation across the plate surface of no more than approximately 10%. The edge of the first jaw **710** farthest from the first offset jaw riser **708** is the first jaw leading edge **804**. The first jaw insertion limit line **712** is the endpoint for insertion of the first jaw **710** into the receptacle **604**. For the alternative embodiment the first jaw insertion limit line **712** is the attachment point of the first jaw **710** to the first offset jaw riser **708**. The insertion distance into the receptacle **604** of the first jaw **710** is the distance from the first jaw leading edge **804** (visible in FIG. **8** but not in FIG. **7)** to the first jaw insertion limit line **712**, this insertion distance being represented in FIG. **7** by the designation **L1**. A first gripping surface **802** (visible in FIG. **8** but not in FIG. **7**) is located on the underside of the first jaw **710**. The two steps and riser of the first offset jaw **702** may be a unitary structure.

Continuing with FIGS. **7** and **8**, the second offset jaw **704** comprises three planar surfaces connected to form two horizontal and parallel but non-overlapping steps that are attached to one another by a connecting vertical riser to form a unitary structure. A second offset jaw top step **714** forms the first such planar surface. The longitudinal axis of the second offset jaw top step **714** is oriented parallel to the longitudinal axis of the gripper and is attached to the underside of the second jaw end **115**. A second offset jaw riser **716** forms the second such planar surface. The second offset jaw riser **716** is attached to the edge of the second offset jaw top step **714** opposite the second jaw end **115** and is oriented at a right angle to the second offset jaw top step **714** so as to form a downward-oriented riser component in relation to the second offset jaw top step **714**. A second jaw **718** forms the third such planar surface. The second jaw **718** is attached to the bottom edge of the second offset jaw riser **716** and extends parallel to the longitudinal axis of the second handle **110** from the second offset jaw riser **716** in a direction opposite from the direction of the second arm **104** and laterally to either side so that the second jaw **718** forms a flat plate of uniform thickness. In this context the phrase "longitudinal axis of the second handle **110**" refers to a straight line drawn from substantially the lateral center of the second handle end **107** to substantially the lateral center of the second middle portion **113**, this line running parallel to the centerline of the second arm **104**, and "uniform" means a thickness variation across the plate surface of no more than approximately 10%. The edge of the second jaw **718** farthest from the second offset jaw riser **716** is the second jaw leading edge **722**. The

second jaw insertion limit line **806** is the endpoint for insertion of the second jaw **718** into the receptacle **604**. For the alternative embodiment the second jaw insertion limit line **806** is the attachment point of the second jaw **718** to the second offset jaw riser **716**. The insertion distance into the receptacle **604** of the second jaw **718** is the distance from the second jaw leading edge **722** (visible in FIG. **7** but not in FIG. **8)** to the second jaw insertion limit line **806**, this insertion distance being represented in FIG. **8** by the designation **L1**. A second gripping surface **720** (visible in FIG. **7** but not in FIG. **8**) is located on the top side of the second jaw **718**. The two steps and riser of the second offset jaw **704** may be a unitary structure.

As depicted in FIGS. **7** and **8**, the first jaw **710** and the second jaw **718** overlap one another. The first offset jaw **702** has an outer surface **134** and a first gripping surface **802**, and the second offset jaw **704** has an outer surface **134** and a second gripping surface **720**. The first gripping surface **802** and the second gripping surface **720** face one another and, in this embodiment, have coincident edges when viewed from a point six inches along an axis perpendicular to the plane of the first gripping surface **802** that extends outward from the first jaw **710** center point. The first gripping surface **802** and the second gripping surface **720** are substantially parallel to one another and, for the HVAC filter manipulation application discussed earlier, have an adjustable gap of approximately one inch between the first gripping surface **802** and the second gripping surface **720**. Other embodiments for different applications may have different jaw dimensions, jaw overlap, and gripping surface gap.

As illustrated in FIGS. **7** and **9**, a first threaded sleeve **202** (not visible in FIG. **7**) is attached to the underside of the first arm **102** between the first middle portion **112** and the first jaw end **114**. A second threaded sleeve **130** is attached to the underside of the second arm **104** between the second middle portion **113** and the second jaw end **115**. A jaw gap adjuster **126** passes through an adjuster hole **128** (visible only in FIG. **7**) and the first threaded sleeve **202** then enters second threaded sleeve **130**. Turning the jaw gap adjuster **126** clockwise or counterclockwise provides a means for setting or varying the gap or space between the first gripping surface **802** and the second gripping surface **720**, this adjustment mechanism being such that the gap or space remains constant when the gripper is at rest without pressure on the first handle **108** or second handle **110**. The description presented here of a means for setting or varying the gap or space between the first gripping surface **802** and the second gripping surface **720** represents only one way to set this gap and this description should not to be considered a limitation; any mechanism known to one skilled in the art will suffice so long as the gap or space is maintained while the gripper is at rest.

The dimensions and material of manufacture for the first offset jaw **702** and the second offset jaw **704** can vary based on gripper application. For the application involving manipulation of HVAC filters discussed earlier, the width **W1** of the first jaw **710**, shown in FIGS. **7** and **8**, may be two inches and the insertion distance **L1** may be two inches or more. For the same HVAC filter manipulation application the width **W1** of the second jaw **718**, as illustrated in FIGS. **7** and **8**, may be two inches and the insertion distance **L1** may be two inches or more. These first jaw **710** and second jaw **718** insertion distance and width dimensions will need to be substantially at least 1.25 inches to ensure sufficient gripping surface and depth of insertion into the receptacle **604**, the term “substantially at least 1.25 inches” meaning no less than 1.125 inches. One possible first offset jaw **702** and second offset jaw **704** material of manufacture in this HVAC filter manipulation application is 16 gauge cold-rolled steel (0.0598 inches thick). For applications using cold-rolled steel jaws as a material of manufacture, an anti-corrosion coating such as, but not limited to, zinc or paint may be applied. Other embodiments for this HVAC filter or different applications may use stainless steel, plastic, carbon fiber or other materials for jaws.

As illustrated in FIG. **9**, this alternative embodiment of the gripper is used when the receptacle frame **606** on one side of the receptacle **604** extends in the direction of insertion and removal of the planar workpiece **602** such that insertion of the gripper with flat jaws (FIGS. **1** through **5**) into the receptacle **604** is difficult or not possible.

Though the first offset jaw top step **706**, the first offset jaw riser **708**, and the first jaw **710** are shown as unitary structures in the referenced figures, they may be shaped or attached to one another and the first jaw end **114** differently in other embodiments and their representation herein should not be considered a limitation. Similarly, though second offset jaw top step **714**, the second offset jaw riser **716**, and the second jaw **718** are shown as unitary structures in the referenced figures, they may be shaped or attached to one another and the second jaw end **115** differently in other embodiments and their representation herein should not be considered a limitation.

The thickness of the first jaw **710** and the second jaw **718** material must be less than approximately 0.075 inches, meaning that the thickness cannot exceed 0.080 inches. This minimal jaw thickness permits use of the gripper when planar workpiece **602** fits tightly or is stuck in in its receptacle **604**, “fits tightly”, “stuck in”, and “fit tightly” being defined as one or more of the following conditions: a) less than approximately 0.25 inches of space between an outer edge of the planar workpiece **602** and an outer edge of the receptacle **604** on one or both sides of the planar workpiece **602**; b) a necessity to shake, oscillate, rock side-to-side or

otherwise manipulate with force the planar workpiece **602** in order to free it from the receptacle **604** on removal or seat it fully into the receptacle **604** on insertion; c) insertion or removal requires damage or deformation of the planar workpiece **602**, “damage or deformation” being defined as an increase or decrease of one or more dimensions of the planar workpiece **602** – dimensions being length, width and depth – of more than 5% of that dimension and/or the tearing, detachment or disassociation of planar workpiece **602** components such as, for example, planar workpiece **602** frame or border from other planar workpiece **602** material. Planar workpiece **602** as used herein refers to a mechanical object shaped as a rectangular cuboid.

A rigid material is required for the first jaw **710** and the second jaw **718**, “rigid material” being defined as one that can maintain planarity across its surface to within a deflection from flatness of no more than one-eighth inch along the unsupported edge when a weight of ten pounds is applied to the unsupported edge of a 4 inch by 4 inch piece of this rigid material secured in a horizontal position such that a 2 by 4 inch dimension of this piece is cantilevered and thus unsupported. This measurement can be done by clamping to a flat-topped table one half of a 4 inch by 4 inch piece of the rigid material being tested so that the other half of the test material (a 2 inch by 4 inch section) is off the table top and thus unsupported. Then a ten pound weight is applied to the unsupported edge of the test material (farthest from the table edge) and the deflection of the weighted edge is measured with respect to the table edge.

C. Operation of an Alternative Embodiment

The alternative embodiment of the gripper presented in FIG. **9** operates similarly to the flat jaw gripper of FIGS. **1** through **5**. The operator first turns the jaw gap adjuster **126** until the gap between the first offset jaw **702** and the second offset jaw **704** is slightly less than the thickness of the planar workpiece **602** to be manipulated. In the case of planar workpiece **602** removal, the operator then squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **710** and the second jaw **718** until it equals the width of the receptacle **604**. The operator then inserts the first jaw **710** and the second jaw **718** into the receptacle **604** so that the first gripping surface **802** and the second gripping surface **720** overlap the planar workpiece **602**, then the operator releases the first handle **108** and the second handle **110**. The resulting tension applied by the spring **122** and the spring arms **120** presses together the first jaw **710** and the second jaw **718** until the stopping point set with the jaw gap adjuster **126**. This pressing together of the first jaw **710** and the second jaw **718** causes gripping of the planar workpiece **602** by the first gripping surface **802** and the second gripping

surface **720**. Once gripped, the planar workpiece **602** can be manipulated as necessary to free its edges from a receptacle frame **606** present on either side of the planar workpiece **602** and then removed.

Planar workpiece **602** insertion using the offset jaw embodiment of the gripper as depicted in FIG. **9** is the opposite of removal. The operator first turns the jaw gap adjuster **126** until the gap between the first jaw **710** and the second jaw **718** is set to be slightly less than the thickness of the planar workpiece **602** to be manipulated. The operator then squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **710** and the second jaw **718** until it exceeds the width of the planar workpiece **602**. The operator then slides the outer edge of the planar workpiece **602** between the first gripping surface **802** and the second gripping surface **720** and releases the first handle **108** and the second handle **110** so that the tension applied by the spring **122** and the spring arms **120** presses together the first jaw **710** and the second jaw **718** until the stopping point set with the jaw gap adjuster **126**. The gripper now firmly holds the planar workpiece **602**. The operator then inserts the planar workpiece **602** into the receptacle **604**. Once partially inserted in the receptacle **604**, the planar workpiece **602** can be manipulated as necessary to slide it fully into the receptacle **604**. After full insertion of the planar workpiece **602** into the receptacle **604**, the operator squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **710** and the second jaw **718** until it exceeds the width of the planar workpiece **602**, then the operator withdraws the gripper from the receptacle **604** leaving the planar workpiece **602** in place.

In FIG. **9** the planar workpiece **602** is shown as recessed below a receptacle frame edge **608**, which is a common occurrence either because the receptacle **604** is deeper than the planar workpiece **602** or because the planar workpiece **602** has become deformed during use. The planar workpiece **602** can be removed from the receptacle **604** in only one direction because the receptacle frame **606** is closed at the other end of the receptacle **604** (bottom of receptacle **604** is not shown in FIG. **9**). This placement of the planar workpiece recessed below (or level with) the receptacle frame edge represents the proper operational location for such a planar workpiece.

The components depicted in FIG. **9** including but not limited to the receptacle **604**, the receptacle frame **606**, and the receptacle frame edge **608** are an example of a mechanical system whose operation requires insertion and removal of a planar workpiece **602** that resides in a receptacle **604** during normal operation. The representation of FIG. **9** is for reference only;

other arrangements are possible that utilize a planar workpiece **602** whose insertion and removal may require a specialized tool such as the currently described gripper.

DETAILED DESCRIPTION OF FURTHER EMBODIMENTS

Further embodiments of the gripper described in this application are identical to the first embodiment and the alternative embodiment described earlier in this specification with the exception that these further embodiments do not have an adjustment mechanism capable of setting the gap between the jaws.

A. Overview of the First Further Embodiment

As depicted in FIGS. **10** through **14**, a first further embodiment of a gripper comprises a first arm **102** that extends from a first handle end **106** through a first handle **108** and a first middle portion **112** to a first jaw end **114**. Attached to the first jaw end **114** is a first jaw **116**. A second arm **104** extends from a second handle end **107** through a second handle **110** and a second middle portion **113** to a second jaw end **115**. Attached to the second jaw end **115** is a second jaw **118**. Protruding at approximately a right angle from the underside of the first middle portion **112** is a first linkage extension **111**. Protruding at approximately a right angle from the underside of the second middle portion **113** is a second linkage extension **117**. The first linkage extension **111** and the second linkage extension **117** partially overlap and are attached in this overlap area using a pivot pin **124** so that the first handle **108** and the second handle **110** can be actuated to vary the gap between the first jaw **116** and the second jaw **118**, permitting the operator to grasp and manipulate a planar workpiece **602**.

B. Detailed Description of the First Further Embodiment

As shown in FIG. **10** and FIG. **12**, a first arm **102** extends from a first handle end **106** through a first handle **108** and a first middle portion **112** to a first jaw end **114**. Directly attached to the first jaw end **114** is a first jaw **116**. Protruding at approximately a right angle from the underside of the first middle portion **112** is a first linkage extension **111**.

As depicted in FIG. **10**, the first jaw **116** extends parallel to the longitudinal axis of the first handle **108** from the first jaw end **114** in a direction opposite from the direction of the first arm **102** and laterally to either side of the first jaw end **114** so that the first jaw **116** forms a flat plate of uniform thickness. In this context the phrase “longitudinal axis of the first handle **108**” refers to a straight line drawn from substantially the lateral center of the first handle end **106** to substantially the lateral center of the first middle portion **112**, this line running parallel to the centerline of the first arm **102**, and “uniform” means a thickness variation across the plate surface of no more than approximately 10%. The edge of the first jaw **116** farthest from the first jaw end **114** is the first jaw leading edge **121**. The first jaw insertion limit line **119** is the endpoint for insertion of the first jaw **116** into the receptacle **604**. For the first further embodiment the first

jaw insertion limit line **119** is the forward attachment point of the first jaw **116** to the first jaw end **114**, “forward” meaning in a direction opposite to the first handle **108**. The insertion distance into the receptacle **604** of the first jaw **116** is the distance from the first jaw leading edge **121** to the first jaw insertion limit line **119**, this insertion distance being represented in FIG. **10** by the letter **L**.

As illustrated in FIG. **11** and FIG. **12**, a second arm **104** extends from a second handle end **107** through a second handle **110** and a second middle portion **113** to a second jaw end **115**. Directly attached to the second jaw end **115** is a second jaw **118**. Protruding at approximately a right angle from the underside of the second middle portion **113** is a second linkage extension **117**.

As depicted in FIG. **11**, the second jaw **118** extends parallel to the longitudinal axis of the second handle **110** from the second jaw end **115** in a direction opposite from the direction of the second arm **104** and laterally to either side of the second jaw end **115** so that the second jaw **118** forms a flat plate of uniform thickness. In this context the phrase “longitudinal axis of the second handle **110**” refers to a straight line drawn from substantially the lateral center of the second handle end **107** to substantially the lateral center of the second middle portion **113**, this line running parallel to the centerline of the second arm **104**, and “uniform” means a thickness variation across the plate surface of no more than approximately 10%. The edge of the second jaw **118** farthest from the second jaw end **115** is the second jaw leading edge **136**. For the first further embodiment the second jaw insertion limit line **204** is the forward attachment point of the second jaw **118** to the second jaw end **115**, “forward” meaning in a direction opposite to the second handle **110**. The insertion distance into the receptacle **604** of the second jaw **118** is the distance from the second jaw leading edge **136** to the second jaw insertion limit line **204**, this insertion distance being represented in FIG. **11** by the letter **L**.

First and second arms **102**, **104** may be formed of metal such as aluminum or steel, molded plastic, carbon fiber, or other materials. First and second arms **102**, **104** length is sufficient to operate comfortably with one hand, for example in this embodiment approximately six inches. First and second handles **108**, **110**, as shown in FIGS. **10** through **12**, may be ergonomically shaped. Other embodiments may use different materials of manufacture and/or different size and/or different shape configurations.

As depicted in FIGS. **10** through **12**, and FIG. **14**, the first linkage extension **111** and the second linkage extension **117** overlap and are attached in the overlap area by a pivot pin **124**. Connecting the first arm **102** and the second arm **104** in this manner permits an operator of this

embodiment to alter the gap between the first jaw **116** and the second jaw **118** by actuating the first handle **108** and the second handle **110** and thereby operate in a tong-like fashion this apparatus. Though the first arm **102** and the second arm **104** are shown as unitary structures of a particular shape in the referenced figures, they may be shaped differently in other embodiments and their representation herein should not be considered a limitation. Similarly, overlap and connection by the pivot pin **124** of the first linkage extension **111** and the second linkage extension **117** may be arranged differently in other embodiments and their presentation herein should not be considered a limitation.

As shown in FIG. **10** and FIG. **11**, a spring **122** is mounted on the pivot pin **124**. Integral to the spring **122** are two spring arms **120**, which apply pressure to the first arm **102** and the second arm **104**, thereby biasing the first jaw **116** and the second jaw **118** toward the closed position.

As depicted in FIG. **12**, the first jaw **116** has an outer surface **134** and a first gripping surface **206**, and the second jaw **118** has an outer surface **134** and a second gripping surface **132**. The first jaw **116** and the second jaw **118** overlap one another and, in this embodiment, have coincident edges when viewed from a point six inches along an axis perpendicular to the plane of the first jaw **116** that extends outward from the first jaw **116** center point. The first jaw **116** and the second jaw **118** are substantially parallel to one another and, for the HVAC filter manipulation application discussed earlier, have an adjustable gap of approximately one inch between the first gripping surface **206** and the second gripping surface **132**. Other embodiments for different applications may have different jaw dimensions, jaw overlap, and gripping surface gap.

The dimensions and material of manufacture for the first jaw **116** and the second jaw **118** can vary based on gripper application. For the application involving manipulation of HVAC filters discussed earlier, the width **W** of the first jaw **116**, as shown in FIG. **10**, may be two inches and the insertion distance **L** may be two inches or more. For the same HVAC filter manipulation application the width **W** of the second jaw **118**, as shown in FIG. **11**, may be two inches and the insertion distance **L** may be two inches or more. These first jaw **116** and second jaw **118** insertion distance and width dimensions will need to be substantially at least 1.25 inches to ensure sufficient gripping surface and depth of insertion into the receptacle **604**, the term “substantially at least 1.25 inches” meaning no less than 1.125 inches. One possible first jaw **116** and second jaw **118** material of manufacture in this HVAC filter manipulation application is 16 gauge cold-rolled steel (0.0598 inches thick). For applications using cold-rolled steel jaws as

a material of manufacture, an anti-corrosion coating such as, but not limited to, zinc or paint may be applied. Other embodiments for this HVAC filter or different applications may use stainless steel, plastic, carbon fiber or other materials for jaws.

The thickness of the first jaw **116** and the second jaw **118** material must be less than approximately 0.075 inches, meaning that the thickness cannot exceed 0.080 inches. This minimal jaw thickness permits use of the gripper when a planar workpiece **602** fits tightly or is stuck in in its receptacle **604**, “fits tightly”, “stuck in”, and “fit tightly” being defined as one or more of the following conditions: a) less than approximately 0.25 inches of space between an outer edge of the planar workpiece **602** and an outer edge of the receptacle **604** on one or both sides of the planar workpiece **602**; b) a necessity to shake, oscillate, rock side-to-side or otherwise manipulate with force the planar workpiece **602** in order to free it from the receptacle **604** on removal or seat it fully into the receptacle **604** on insertion; c) insertion or removal requires damage or deformation of the planar workpiece **602**, “damage or deformation” being defined as an increase or decrease of one or more dimensions of the planar workpiece **602** – dimensions being length, width and thickness – of more than 5% of that dimension and/or the tearing, detachment or disassociation of planar workpiece **602** components such as, for example, planar workpiece **602** frame or border from other planar workpiece **602** material. Planar workpiece **602** as used herein refers to a mechanical object shaped as a rectangular cuboid.

A rigid material is required for the first jaw **116** and the second jaw **118**, “rigid material” being defined as one that can maintain planarity across its surface to within a deflection from flatness of no more than one-eighth inch along the unsupported edge when a weight of ten pounds is applied to the unsupported edge of a 4 inch by 4 inch piece of this rigid material secured in a horizontal position such that a 2 by 4 inch dimension of this piece is cantilevered and thus unsupported. This measurement can be done by clamping to a flat-topped table one half of a 4 inch by 4 inch piece of the rigid material being tested so that the other half of the test material (a 2 inch by 4 inch section) is off the table top and thus unsupported. Then a ten pound weight is applied to the unsupported edge of the test material (farthest from the table edge) and the deflection of the weighted edge is measured with respect to the table edge.

C. Operation of the First Further Embodiment

FIG. **14** shows the gripper in operation. In the case of planar workpiece **602** removal, the operator squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **116** and the second jaw **118** until it equals the width of the receptacle **604**.

The operator then inserts the first jaw **116** and the second jaw **118** into the receptacle **604** so that first gripping surface **206** and the second gripping surface **132** overlap the planar workpiece **602**, then the operator releases the first handle **108** and the second handle **110**. The resulting tension applied by the spring **122** and the spring arms **120** presses together the first jaw **116** and the second jaw **118**. This pressing together of the first jaw **116** and the second jaw **118** causes gripping of the planar workpiece **602** by the first gripping surface **206** and the second gripping surface **132**. Once gripped, the planar workpiece **602** can be manipulated as necessary to free its edges from a receptacle frame **606** present on either side of the planar workpiece **602** and then removed.

Planar workpiece **602** insertion is the opposite of removal. The operator squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **116** and the second jaw **118** until it exceeds the width of the planar workpiece **602**. The operator then slides the outer edge of the planar workpiece **602** between the first gripping surface **206** and the second gripping surface **132** and releases the first handle **108** and the second handle **110** so that the tension applied by the spring **122** and the spring arms **120** presses together the first jaw **116** and the second jaw **118**. The gripper now firmly holds the planar workpiece **602**. The operator then inserts the planar workpiece **602** into the receptacle **604**. Once partially inserted in the receptacle **604**, the planar workpiece **602** can be manipulated as necessary to slide it fully into the receptacle **604**. After full insertion of the planar workpiece **602** into the receptacle **604**, the operator squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **116** and the second jaw **118** until it exceeds the width of the planar workpiece **602**, then the operator withdraws the gripper from the receptacle **604**.

In FIG. **14** the planar workpiece **602** is shown as recessed below a receptacle frame edge **608**, which is a common occurrence either because the receptacle **604** is deeper than the planar workpiece **602** or because the planar workpiece **602** has become deformed during use. The planar workpiece **602** can be removed from the receptacle **604** in only one direction because the receptacle frame **606** is closed at the other end of the receptacle **604** (bottom of receptacle **604** is not shown in FIG. **14**). This placement of the planar workpiece **602** recessed below (or level with) the receptacle frame edge **608** represents the proper operational location for such a planar workpiece **602**.

The components depicted in FIG. **14** including but not limited to the receptacle **604**, the receptacle frame **606**, and the receptacle frame edge **608** are an example of a mechanical system whose operation requires insertion and removal of a planar workpiece **602** that resides

in a receptacle **604** during normal operation. The representation of FIG. **14** is for reference only; other arrangements are possible that utilize a planar workpiece **602** whose insertion and removal may require a specialized tool such as the currently described gripper.

D. Overview of the Second Further Embodiment

A modification of the gripper first further embodiment depicted in FIGS. **10** through **13** is presented in FIGS. **15** and **16**, wherein the gripper has a first offset jaw **702** and a second offset jaw **704** that are step-shaped rather than flat. In this second further embodiment, the first offset jaw **702** adds a first offset jaw top step **706**, and a first offset jaw riser **708**, while the second offset jaw **704** of this second further embodiment adds a second offset jaw top step **714**, and a second offset jaw riser **716**. In addition, for this second further embodiment the numbering for certain elements changes as follows:

Element Name	First Further Embodiment Numeral	Second Further Embodiment Numeral
first jaw	116	710
second jaw	118	718
first gripping surface	206	802
second gripping surface	132	720
first jaw insertion limit line	119	712
first jaw leading edge	121	804
second jaw insertion limit line	204	806
second jaw leading edge	136	722

With the exception of these aforesaid jaw and gripping surface elements, the gripper first further embodiment of FIGS. **10** through **13** and the gripper second further embodiment of FIGS. **15** and **16** are identical. As such this section will describe only the step-shaped offset jaws of this second further embodiment, their orientation, their attachment, and their operation, and the earlier description of all gripper components other than the jaws and gripping surfaces applies equally to this second further embodiment.

E. Detailed Description of a Second Further Embodiment

As depicted in FIGS. **15** and **16**, the first offset jaw **702** comprises three planar surfaces connected to form the equivalent of two horizontal and parallel but non-overlapping steps that are attached to one another by a connecting vertical riser. A first offset jaw top step **706** forms the first such planar surface. The longitudinal axis of the first offset jaw top step **706** is oriented parallel to the longitudinal axis of the gripper and is attached to the underside of the first jaw end **114**. A first offset jaw riser **708** forms the second such planar surface. The first offset jaw riser **708** is attached to the edge of the first offset jaw top step **706** opposite the first jaw end **114** and is oriented at a right angle to the first offset jaw top step **706** so as to form a downward-oriented riser component in relation to the first offset jaw top step **706**. A first jaw **710** forms the third

such planar surface. The first jaw **710** is attached to the bottom edge of the first offset jaw riser **708** and extends parallel to the longitudinal axis of the first handle **108** from the first offset jaw riser **708** in a direction opposite from the direction of the first arm **102** and laterally to either side so that the first jaw **710** forms a flat plate of uniform thickness. In this context the phrase "longitudinal axis of the first handle **108**" refers to a straight line drawn from substantially the lateral center of the first handle end **106** to substantially the lateral center of the first middle portion **112**, this line running parallel to the centerline of the first arm **102**, and "uniform" means a thickness variation across the plate surface of no more than approximately 10%. The edge of the first jaw **710** farthest from the first offset jaw riser **708** is the first jaw leading edge **804**. The first jaw insertion limit line **712** is the endpoint for insertion of the first jaw **710** into the receptacle **604**. For the second further embodiment the first jaw insertion limit line **712** is the attachment point of the first jaw **710** to the first offset jaw riser **708**. The insertion distance into the receptacle **604** of the first jaw **710** is the distance from the first jaw leading edge **804** (visible in FIG. **16** but not in FIG. **15)** to the first jaw insertion limit line **712**, this insertion distance being represented in FIG. **15** by the designation **L1**. A first gripping surface **802** (visible in FIG. **16** but not in FIG. **15**) is located on the underside of the first jaw **710**. The two steps and riser of the first offset jaw **702** may be a unitary structure.

Continuing with FIGS. **15** and **16**, the second offset jaw **704** comprises three planar surfaces connected to form two horizontal and parallel but non-overlapping steps that are attached to one another by a connecting vertical riser to form a unitary structure. A second offset jaw top step **714** forms the first such planar surface. The longitudinal axis of the second offset jaw top step **714** is oriented parallel to the longitudinal axis of the gripper and is attached to the underside of the second jaw end **115**. A second offset jaw riser **716** forms the second such planar surface. The second offset jaw riser **716** is attached to the edge of the second offset jaw top step **714** opposite the second jaw end **115** and is oriented at a right angle to the second offset jaw top step **714** so as to form a downward-oriented riser component in relation to the second offset jaw top step **714**. A second jaw **718** forms the third such planar surface. The second jaw **718** is attached to the bottom edge of the second offset jaw riser **716** and extends parallel to the longitudinal axis of the second handle **110** from the second offset jaw riser **716** in a direction opposite from the direction of the second arm **104** and laterally to either side so that the second jaw **718** forms a flat plate of uniform thickness. In this context the phrase "longitudinal axis of the second handle **110**" refers to a straight line drawn from substantially the lateral center of the second handle end **107** to substantially the lateral center of the second middle portion **113**, this line running parallel to the centerline of the second arm **104**, and "uniform" means a thickness

variation across the plate surface of no more than approximately 10%. The edge of the second jaw **718** farthest from the second offset jaw riser **716** is the second jaw leading edge **722**. The second jaw insertion limit line **806** is the endpoint for insertion of the second jaw **718** into the receptacle **604**. For the second further embodiment the second jaw insertion limit line **806** is the attachment point of the second jaw **718** to the second offset jaw riser **716**. The insertion distance into the receptacle **604** of the second jaw **718** is the distance from the second jaw leading edge **722** (visible in FIG. **15** but not in FIG. **16)** to the second jaw insertion limit line **806**, this insertion distance being represented in FIG. **16** by the designation **L1**. A second gripping surface **720** (visible in FIG. **15** but not in FIG. **16**) is located on the top side of the second jaw **718**. The two steps and riser of the second offset jaw **704** may be a unitary structure.

As depicted in FIGS. **15** and **16**, the first jaw **710** and the second jaw **718** overlap one another. The first offset jaw **702** has an outer surface **134** and a first gripping surface **802**, and the second offset jaw **704** has an outer surface **134** and a second gripping surface **720**. The first gripping surface **802** and the second gripping surface **720** face one another and, in this embodiment, have coincident edges when viewed from a point six inches along an axis perpendicular to the plane of the first gripping surface **802** that extends outward from the first jaw **710** center point. The first gripping surface **802** and the second gripping surface **720** are substantially parallel to one another and, for the HVAC filter manipulation application discussed earlier, have an adjustable gap of approximately one inch between the first gripping surface **802** and the second gripping surface **720**. Other embodiments for different applications may have different jaw dimensions, jaw overlap, and gripping surface gap.

The dimensions and material of manufacture for the first offset jaw **702** and the second offset jaw **704** can vary based on gripper application. For the application involving manipulation of HVAC filters discussed earlier, the width **W1** of the first jaw **710**, shown in FIGS. **15** and **16**, may be two inches and the insertion distance **L1** may be two inches or more. For the same HVAC filter manipulation application the width **W1** of the second jaw **718**, as illustrated in FIGS. **15** and **16**, may be two inches and the insertion distance **L1** may be two inches or more. These first jaw **710** and second jaw **718** insertion distance and width dimensions will need to be substantially at least 1.25 inches to ensure sufficient gripping surface and depth of insertion into the receptacle **604**, the term “substantially at least 1.25 inches” meaning no less than 1.125 inches. One possible first offset jaw **702** and second offset jaw **704** material of manufacture in this HVAC filter manipulation application is 16 gauge cold-rolled steel (0.0598 inches thick). For applications using cold-rolled steel jaws as a material of manufacture, an anti-corrosion coating

such as, but not limited to, zinc or paint may be applied. Other embodiments for this HVAC filter or different applications may use stainless steel, plastic, carbon fiber or other materials for jaws.

As illustrated in FIG. **17**, this second further embodiment of the gripper is used when the receptacle frame **606** on one side of the receptacle **604** extends in the direction of insertion and removal of the planar workpiece **602** such that insertion of the gripper with flat jaws (FIGS. **10** through **13**) into the receptacle **604** is difficult or not possible.

Though the first offset jaw top step **706**, the first offset jaw riser **708**, and the first jaw **710** are shown as unitary structures in the referenced figures, they may be shaped or attached to one another and the first jaw end **114** differently in other embodiments and their representation herein should not be considered a limitation. Similarly, though second offset jaw top step **714**, the second offset jaw riser **716**, and the second jaw **718** are shown as unitary structures in the referenced figures, they may be shaped or attached to one another and the second jaw end **115** differently in other embodiments and their representation herein should not be considered a limitation.

The thickness of the first jaw **710** and the second jaw **718** material must be less than approximately 0.075 inches, meaning that the thickness cannot exceed 0.080 inches. This minimal jaw thickness permits use of the gripper when planar workpiece **602** fits tightly or is stuck in in its receptacle **604**, “fits tightly”, “stuck in”, and “fit tightly” being defined as one or more of the following conditions: a) less than approximately 0.25 inches of space between an outer edge of the planar workpiece **602** and an outer edge of the receptacle **604** on one or both sides of the planar workpiece **602**; b) a necessity to shake, oscillate, rock side-to-side or otherwise manipulate with force the planar workpiece **602** in order to free it from the receptacle **604** on removal or seat it fully into the receptacle **604** on insertion; c) insertion or removal requires damage or deformation of the planar workpiece **602**, “damage or deformation” being defined as an increase or decrease of one or more dimensions of the planar workpiece **602** – dimensions being length, width and depth – of more than 5% of that dimension and/or the tearing, detachment or disassociation of planar workpiece **602** components such as, for example, planar workpiece **602** frame or border from other planar workpiece **602** material. Planar workpiece **602** as used herein refers to a mechanical object shaped as a rectangular cuboid.

A rigid material is required for the first jaw **710** and the second jaw **718**, “rigid material” being defined as one that can maintain planarity across its surface to within a deflection from flatness of no more than one-eighth inch along the unsupported edge when a weight of ten pounds is

applied to the unsupported edge of a 4 inch by 4 inch piece of this rigid material secured in a horizontal position such that a 2 by 4 inch dimension of this piece is cantilevered and thus unsupported. This measurement can be done by clamping to a flat-topped table one half of a 4 inch by 4 inch piece of the rigid material being tested so that the other half of the test material (a 2 inch by 4 inch section) is off the table top and thus unsupported. Then a ten pound weight is applied to the unsupported edge of the test material (farthest from the table edge) and the deflection of the weighted edge is measured with respect to the table edge.

F. Operation of a Second Further Embodiment

The second further embodiment of the gripper presented in FIG. **17** operates similarly to the flat jaw gripper of FIGS. **10** through **13**. In the case of planar workpiece **602** removal, the operator squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **710** and the second jaw **718** until it equals the width of the receptacle **604**. The operator then inserts the first jaw **710** and the second jaw **718** into the receptacle **604** so that the first gripping surface **802** and the second gripping surface **720** overlap the planar workpiece **602**, then the operator releases the first handle **108** and the second handle **110**. The resulting tension applied by the spring **122** and the spring arms **120** presses together the first jaw **710** and the second jaw **718**. This pressing together of the first jaw **710** and the second jaw **718** causes gripping of the planar workpiece **602** by the first gripping surface **802** and the second gripping surface **720**. Once gripped, the planar workpiece **602** can be manipulated as necessary to free its edges from a receptacle frame **606** present on either side of the planar workpiece **602** and then removed.

Planar workpiece **602** insertion using the offset jaw embodiment of the gripper as depicted in FIG. **17** is the opposite of removal. The operator squeezes the first handle **108** and the second handle **110** together to expand the gap between the first jaw **710** and the second jaw **718** until it exceeds the width of the planar workpiece **602**. The operator then slides the outer edge of the planar workpiece **602** between the first gripping surface **802** and the second gripping surface **720** and releases the first handle **108** and the second handle **110** so that the tension applied by the spring **122** and the spring arms **120** presses together the first jaw **710** and the second jaw **718**. The gripper now firmly holds the planar workpiece **602**. The operator then inserts the planar workpiece **602** into the receptacle **604**. Once partially inserted in the receptacle **604**, the planar workpiece **602** can be manipulated as necessary to slide it fully into the receptacle **604**. After full insertion of the planar workpiece **602** into the receptacle **604**, the operator squeezes the first handle **108** and the second handle **110** together to expand the gap

between the first jaw **710** and the second jaw **718** until it exceeds the width of the planar workpiece **602**, then the operator withdraws the gripper from the receptacle **604** leaving the planar workpiece **602** in place.

In FIG. **17** the planar workpiece **602** is shown as recessed below a receptacle frame edge **608**, which is a common occurrence either because the receptacle **604** is deeper than the planar workpiece **602** or because the planar workpiece **602** has become deformed during use. The planar workpiece **602** can be removed from the receptacle **604** in only one direction because the receptacle frame **606** is closed at the other end of the receptacle **604** (bottom of receptacle **604** is not shown in FIG. **17**). This placement of the planar workpiece recessed below (or level with) the receptacle frame edge represents the proper operational location for such a planar workpiece.

The components depicted in FIG. **17** including but not limited to the receptacle **604**, the receptacle frame **606**, and the receptacle frame edge **608** are an example of a mechanical system whose operation requires insertion and removal of a planar workpiece **602** that resides in a receptacle **604** during normal operation. The representation of FIG. **17** is for reference only; other arrangements are possible that utilize a planar workpiece **602** whose insertion and removal may require a specialized tool such as the currently described gripper.

CLAIMS:

The invention claimed is:

1. A gripper for manipulating a planar workpiece (602) in a receptacle (604), the gripper comprising:

(a) a first arm (102) having a first handle (108), and a second arm (104) having a second handle (110), said arms (102), (104) being connected pivotally such that they operate in a tong-like fashion when the first handle (108) and the second handle (110) are actuated;

(b) a first jaw (116, 710) of rigid material and predetermined uniform thickness that attaches to a first jaw end (114) of said first arm (102) located opposite said first handle (108), said first jaw (116, 710) extending longitudinally as a flat surface from a first jaw leading edge (121) located opposite said first jaw end (114) in a direction toward said first jaw end (114) to a first jaw insertion limit line (119) at which said first jaw (116, 710) attaches to said first jaw end (114), and said first jaw (116, 710) extending as a flat surface laterally a width that is substantially at least 1.25 inches;

(c) a second jaw (118, 718) of rigid material and predetermined uniform thickness that attaches to a second jaw end (115) of said second arm (104) located opposite said second handle (110), said second jaw (118, 718) extending longitudinally as a flat surface from a second jaw leading edge (136) located opposite said second jaw end (115) in a direction toward said second jaw end (115) to a second jaw insertion limit line (204) at which said second jaw (118, 718) attaches to said second jaw end (115), and said second jaw (118, 718) extending as a flat surface laterally a width that is substantially at least 1.25 inches;

(d) a spring (122) and spring arms (120) that bias said gripper to the normally closed position as the result of said spring arms (120) exerting pressure on said first arm (102) and said second arm (104);

(e) a first gripping surface (206, 802) comprising that surface of said first jaw (116) located opposite said first jaw's (116) attachment point to said first jaw end (114), and a second gripping surface (132, 720) comprising that surface of said second jaw (118) located opposite said second jaw's (118) attachment point to said second jaw end (115), said first gripping surface (206, 802) and said second gripping surface (132, 720) together acting to grip said planar workpiece (602) when pressed against

said planar workpiece (602) by said spring (122) exerting pressure on said first arm (102) and said second arm (104);

(f) an arrangement of said first gripping surface (206, 802) and said second gripping surface (132, 720) such that these surfaces face one another directly and are substantially parallel to one another when separated by a gap approximately equal to the thickness of said planar workpiece (602);

whereby said first jaw (116, 710) and said second jaw (118, 718) can be inserted into said receptacle (604) with one jaw on each side of said planar workpiece (602), the insertion distance into said receptacle (604) being substantially parallel to the longitudinal axis of said first handle (108) and said second handle (110), and extending from each jaw's leading edge to each jaw's jaw insertion limit line.

2. The gripper of claim **1,** wherein:

(a) said first jaw (116) is less than approximately 0.075 inches thick and attaches directly to and extends longitudinally from said first jaw end (114) in a direction away from said first handle (108) a distance that is substantially at least 1.25 inches;

(b) said second jaw (118) is less than approximately 0.075 inches thick and attaches directly to and extends longitudinally from said second jaw end (115) in a direction away from said second handle (110) a distance that is substantially at least 1.25 inches;

(c) said first jaw (116) and said second jaw (118) are arranged so that both jaws can be inserted into a receptacle (604) a distance that is substantially at least 1.25 inches with one jaw on each side of said planar workpiece (602);

(d) said planar workpiece (602) is substantially at least 0.50 inches thick;

whereby said gripper enables insertion or removal of said planar workpiece (602) without damage or deformation when the proper operational location for said planar workpiece (602) is recessed below or level with a receptacle frame edge (608) of said receptacle (604), and said planar workpiece (602) may fit tightly or be stuck in said receptacle (604).

3. The gripper of claim **1**, wherein:

(a) said first jaw (710) attaches at a right angle to a first offset jaw riser (708) at said first jaw insertion limit line (712) and extends longitudinally from said first jaw leading edge (804) to said first jaw insertion limit line (712) a distance that is substantially at

least 1.25 inches, and said first jaw (710) extends laterally to either side of said first arm (102);

(b) said first offset jaw riser (708) attaches at a right angle to a first offset jaw top step (706);

(c) said first offset jaw top step (706) attaches directly to said first jaw end (114) of said first arm (102);

(d) said first jaw (710), said first offset jaw riser (708), and said first offset jaw top step (706) together form a first offset jaw (702), said first offset jaw being a unitary element having three flat surfaces with the plane of said first offset jaw top step (706) being parallel to the plane of said first jaw (710);

(e) said first jaw (710) is less than approximately 0.075 inches thick;

(f) said second jaw (718) attaches at a right angle to a second offset jaw riser (716) at said second jaw insertion limit line (806) and extends longitudinally from said second jaw leading edge (722) to said second jaw insertion limit line (806) a distance that is substantially at least 1.25 inches, and said second jaw (718) extends laterally to either side of said second arm (104);

(g) said second offset jaw riser (716) attaches at a right angle to a second offset jaw top step (714);

(h) said second offset jaw top step (714) attaches directly to said second jaw end (115) of said second arm (104);

(i) said second jaw (718), said second offset jaw riser (716), and said second offset jaw top step (714) together form a second offset jaw (704), said second offset jaw (702) being a unitary element having three flat surfaces with the plane of said second offset jaw top step (714) being parallel to the plane of said second jaw (718);

(j) said second jaw (718) is less than approximately 0.075 inches thick;

(k) said first jaw (710) and said second jaw (718) are arranged so that both jaws can be inserted into a receptacle (604) a distance that is substantially at least 1.25 inches with one jaw on each side of said planar workpiece (602);

(l) said planar workpiece (602) is substantially at least 0.50 inches thick;

whereby said gripper enables insertion or removal of said planar workpiece (602) without damage or deformation when the proper operational location for said planar workpiece (602) is recessed below or level with a receptacle frame edge (608) of said receptacle

(604), and said planar workpiece (602) may fit tightly or be stuck in said receptacle (604).

4. A planar workpiece manipulation system comprising:

(a) a planar workpiece (602) that resides in a receptacle (604) when in operation, and whose use requires installation and removal by a human;

(b) a mechanical system containing said receptacle (604) populated by said planar workpiece (602);

(c) a gripper comprising a first arm (102) having a first handle (108), a second arm (104) having a second handle (110), said arms (102), (104) being connected pivotally such that they operate in a tong-like fashion when the first handle (108) and the second handle (110) are actuated;

(d) said gripper having a first jaw (116, 710) of rigid material and predetermined uniform thickness that attaches to a first jaw end (114) of said first arm (102) located opposite said first handle (108), said first jaw (116, 710) extending longitudinally as a flat surface from a first jaw leading edge (121) located opposite said first jaw end (114) in a direction toward said first jaw end (114) to a first jaw insertion limit line (119) at which said first jaw (116) attaches to said first jaw end (114), and said first jaw (116, 710) extending as a flat surface laterally a width that is substantially at least 1.25 inches;

(e) said gripper having a second jaw (118, 718) of rigid material and predetermined uniform thickness that attaches to a second jaw end (115) of said second arm (104) located opposite said second handle (110), said second jaw (118, 718) extending longitudinally as a flat surface from a second jaw leading edge (136) located opposite said second jaw end (115) in a direction toward said second jaw end (115) to a second jaw insertion limit line (204) at which said second jaw (118, 718) attaches to said second jaw end (115), and said second jaw (118, 718) extending as a flat surface laterally a width that is substantially at least 1.25 inches;

(f) said gripper having a spring (122) and spring arms (120) that bias said gripper to the normally closed position as the result of said spring arms (120) exerting pressure on said first arm (102) and said second arm (104);

(g) said gripper having a first gripping surface (206, 802) comprising that surface of said first jaw (116) located opposite said first jaw's (116) attachment point to said first jaw end (114), and a second gripping surface (132, 720) comprising that surface of said

second jaw (118) located opposite said second jaw's (118) attachment point to said second jaw end (115), said first gripping surface (206, 802) and said second gripping surface (132, 720) together acting to grip a planar workpiece (602) when pressed against said planar workpiece (602) by said spring (122) exerting pressure on said first arm (102) and said second arm (104);

(h) said gripper having an arrangement of said first gripping surface (206, 802) and said second gripping surface (132, 720) such that these surfaces face one another directly and are substantially parallel to one another when separated by a gap approximately equal to the thickness of the planar workpiece (602);

whereby said gripper's first jaw (116) and second jaw (118) can be inserted into said receptacle (604) with one jaw on each side of said planar workpiece (602), the insertion distance into said receptacle (604) being substantially parallel to the longitudinal axis of said first handle (108) and said second handle (110), and extending from each jaw's leading edge to each jaw's jaw insertion limit line.

5. The planar workpiece manipulation system of claim **4**, wherein:

(a) said first jaw (116) is less than approximately 0.075 inches thick and attaches directly to and extends longitudinally from said first jaw end (114) in a direction away from said first handle (108) a distance that is substantially at least 1.25 inches;

(b) said second jaw (118) is less than approximately 0.075 inches thick and attaches directly to and extends longitudinally from said second jaw end (115) in a direction away from said second handle (110) a distance that is substantially at least 1.25 inches;

(c) said first jaw (116) and said second jaw (118) are arranged so that both jaws can be inserted into a receptacle (604) a distance that is substantially at least 1.25 inches with one jaw on each side of said planar workpiece (602);

(d) said planar workpiece (602) is substantially at least 0.50 inches thick;

whereby said planar workpiece manipulation system enables insertion or removal of said planar workpiece (602) without damage or deformation when the proper operational location for said planar workpiece (602) is recessed below or level with a receptacle frame edge (608) of said receptacle (604), and said planar workpiece (602) may fit tightly or be stuck in said receptacle (604).

6. The planar workpiece manipulation system of claim **4**, wherein:

(a) said first jaw (710) attaches at a right angle to a first offset jaw riser (708) at said first jaw insertion limit line (712) and extends longitudinally from said first jaw leading edge (804) to said first jaw insertion limit line (712) a distance that is substantially at least 1.25 inches, and said first jaw (710) extends laterally to either side of said first arm (102);

(b) said first offset jaw riser (708) attaches at a right angle to a first offset jaw top step (706);

(c) said first offset jaw top step (706) attaches directly to said first jaw end (114) of said first arm (102);

(d) said first jaw (710), said first offset jaw riser (708), and said first offset jaw top step (706) together form a first offset jaw (702), said first offset jaw being a unitary element having three flat surfaces with the plane of said first offset jaw top step (706) being parallel to the plane of said first jaw (710);

(e) said first jaw (710) is less than approximately 0.075 inches thick;

(f) said second jaw (718) attaches at a right angle to a second offset jaw riser (716) at said second jaw insertion limit line (806) and extends longitudinally from said second jaw leading edge (722) to said second jaw insertion limit line (806) a distance that is substantially at least 1.25 inches, and said second jaw (718) extends laterally to either side of said second arm (104);

(g) said second offset jaw riser (716) attaches at a right angle to a second offset jaw top step (714);

(h) said second offset jaw top step (714) attaches directly to said second jaw end (115) of said second arm (104);

(i) said second jaw (718), said second offset jaw riser (716), and said second offset jaw top step (714) together form a second offset jaw (704), said second offset jaw (702) being a unitary element having three flat surfaces with the plane of said second offset jaw top step (714) being parallel to the plane of said second jaw (718);

(j) said second jaw (718) is less than approximately 0.075 inches thick;

(k) said first jaw (710) and said second jaw (718) are arranged so that both jaws can be inserted into a receptacle (604) a distance that is substantially at least 1.25 inches with one jaw on each side of said planar workpiece (602)

(l) said planar workpiece (602) is substantially at least 0.50 inches thick;

whereby said planar workpiece manipulation system enables insertion or removal of said planar workpiece (602) without damage or deformation when the proper operational location for said planar workpiece (602) is recessed below or level with a receptacle frame edge (608) of said receptacle (604), and said planar workpiece (602) may fit tightly or be stuck in said receptacle (604).

ABSTRACT:

This apparatus supports gripping, manipulation and/or insertion or removal of a planar workpiece from a receptacle into which it fits tightly. The apparatus has two substantially identical rigid arms attached to one another at a single pivot point near their longitudinal center. One end of each arm forms a handle; pressing or releasing these two handles actuates the gripper. The other end of each arm has attached on its inside surface a rigid plate. Together these two substantially parallel plates form jaws to grip the planar workpiece. A spring attached to the two handles biases the jaws toward the closed position. An optional adjustable stop mechanism supports setting the gap between jaws when the apparatus is in the closed position. An alternative embodiment utilizes step-shaped jaws for applications where flat jaws are difficult to utilize.