

1 **Patent Application of**

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3 **for**

4 **GRIPPER FOR MANIPULATING PLANAR WORKPIECE IN TIGHT-FITTING RECEPTACLE**

5
6 **CROSS REFERENCES TO RELATED APPLICATIONS**

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

8 **STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT:**

9 Not applicable to this application.

10 **FIELD OF THE INVENTION**

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

15 **BACKGROUND OF THE INVENTION**

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

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

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

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

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

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

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

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

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

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

10 SUMMARY OF THE INVENTION

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

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

24 BRIEF DESCRIPTION OF THE DRAWINGS

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

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

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

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

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

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

- 1 FIG 7. is a top perspective view of another embodiment of the present invention.
- 2 FIG 8. is a bottom perspective view of another embodiment of the present invention.
- 3 FIG 9. is a side sectional view of another embodiment of the present invention in use.
- 4 FIG 10. is a top perspective view of a further embodiment of the present invention.
- 5 FIG 11. is a bottom perspective view of a further embodiment of the present invention.
- 6 FIG 12. is a side view of a further embodiment of the present invention.
- 7 FIG 13. is a top view of a further embodiment of the present invention.
- 8 FIG 14. is a side sectional view of a further embodiment of the present invention in use.
- 9 FIG 15. is a top perspective view of a further embodiment of the present invention.
- 10 FIG 16. is a bottom perspective view of a further embodiment of the present invention.
- 11 FIG 17. is a side sectional view of a further embodiment of the present invention in use.

12 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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1 DETAILED DESCRIPTION OF THE FIRST EMBODIMENT

2 A. Overview of the First Embodiment

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

15 B. Detailed Description of the First Embodiment

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

20 As depicted in FIG. 1, the first jaw 116 extends parallel to the longitudinal axis of the first
21 handle 108 from the first jaw end 114 in a direction opposite from the direction of the first arm
22 102 and laterally to either side of the first jaw end 114 so that the first jaw 116 forms a flat plate
23 of uniform thickness. In this context the phrase “longitudinal axis of the first handle 108” refers to
24 a straight line drawn from substantially the lateral center of the first handle end 106 to
25 substantially the lateral center of the first middle portion 112, this line running parallel to the
26 centerline of the first arm 102, and “uniform” means a thickness variation across the plate
27 surface of no more than approximately 10%. The edge of the first jaw 116 farthest from the first
28 jaw end 114 is the first jaw leading edge 121. The first jaw insertion limit line 119 is the endpoint
29 for insertion of the first jaw 116 into the receptacle 604. For the first embodiment the first jaw
30 insertion limit line 119 is the forward attachment point of the first jaw 116 to the first jaw end
31 114, “forward” meaning in a direction opposite to the first handle 108. The insertion distance into
32 the receptacle 604 of the first jaw 116 is the distance from the first jaw leading edge 121 to the

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

3 As illustrated in FIG. **2** and FIG. **3**, a second arm **104** extends from a second handle end
4 **107** through a second handle **110** and a second middle portion **113** to a second jaw end **115**.
5 Directly attached to the second jaw end **115** is a second jaw **118**. Protruding at approximately a
6 right angle from the underside of the second middle portion **113** is a second linkage extension
7 **117**.

8 As depicted in FIG. **2**, the second jaw **118** extends parallel to the longitudinal axis of the
9 second handle **110** from the second jaw end **115** in a direction opposite from the direction of the
10 second arm **104** and laterally to either side of the second jaw end **115** so that the second jaw
11 **118** forms a flat plate of uniform thickness. In this context the phrase “longitudinal axis of the
12 second handle **110**” refers to a straight line drawn from substantially the lateral center of the
13 second handle end **107** to substantially the lateral center of the second middle portion **113**, this
14 line running parallel to the centerline of the second arm **104**, and “uniform” means a thickness
15 variation across the plate surface of no more than approximately 10%. The edge of the second
16 jaw **118** farthest from the second jaw end **115** is the second jaw leading edge **136**. For the first
17 embodiment the second jaw insertion limit line **204** is the forward attachment point of the
18 second jaw **118** to the second jaw end **115**, “forward” meaning in a direction opposite to the
19 second handle **110**. The insertion distance into the receptacle **604** of the second jaw **118** is the
20 distance from the second jaw leading edge **136** to the second jaw insertion limit line **204**, this
21 insertion distance being represented in FIG. **2** by the letter **L**.

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

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

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

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

9 As depicted in FIG. **3**, the first jaw **116** has an outer surface **134** and a first gripping surface
10 **206**, and the second jaw **118** has an outer surface **134** and a second gripping surface **132**. The
11 first jaw **116** and the second jaw **118** overlap one another and, in this embodiment, have
12 coincident edges when viewed from a point six inches along an axis perpendicular to the plane
13 of the first jaw **116** that extends outward from the first jaw **116** center point. The first jaw **116**
14 and the second jaw **118** are substantially parallel to one another and, for the HVAC filter
15 manipulation application discussed earlier, have an adjustable gap of approximately one inch
16 between the first gripping surface **206** and the second gripping surface **132**. Other embodiments
17 for different applications may have different jaw dimensions, jaw overlap, and gripping surface
18 gap.

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

1 The dimensions and material of manufacture for the first jaw **116** and the second jaw **118**
2 can vary based on gripper application. For the application involving manipulation of HVAC filters
3 discussed earlier, the width **W** of the first jaw **116**, as shown in FIG. **1**, may be two inches and
4 the insertion distance **L** may be two inches or more. For the same HVAC filter manipulation
5 application the width **W** of the second jaw **118**, as shown in FIG. **2**, may be two inches and the
6 insertion distance **L** may be two inches or more. These first jaw **116** and second jaw **118**
7 insertion distance and width dimensions will need to be substantially at least 1.25 inches to
8 ensure sufficient gripping surface and depth of insertion into the receptacle **604**, the term
9 “substantially at least 1.25 inches” meaning no less than 1.125 inches. One possible first jaw
10 **116** and second jaw **118** material of manufacture in this HVAC filter manipulation application is
11 16 gauge cold-rolled steel (0.0598 inches thick). For applications using cold-rolled steel jaws as
12 a material of manufacture, an anti-corrosion coating such as, but not limited to, zinc or paint
13 may be applied. Other embodiments for this HVAC filter or different applications may use
14 stainless steel, plastic, carbon fiber or other materials for jaws.

15 The thickness of the first jaw **116** and the second jaw **118** material must be less than
16 approximately 0.075 inches, meaning that the thickness cannot exceed 0.080 inches. This
17 minimal jaw thickness permits use of the gripper when a planar workpiece **602** fits tightly or is
18 stuck in in its receptacle **604**, “fits tightly”, “stuck in”, and “fit tightly” being defined as one or
19 more of the following conditions: a) less than approximately 0.25 inches of space between an
20 outer edge of the planar workpiece **602** and an outer edge of the receptacle **604** on one or both
21 sides of the planar workpiece **602**; b) a necessity to shake, oscillate, rock side-to-side or
22 otherwise manipulate with force the planar workpiece **602** in order to free it from the receptacle
23 **604** on removal or seat it fully into the receptacle **604** on insertion; c) insertion or removal
24 requires damage or deformation of the planar workpiece **602**, “damage or deformation” being
25 defined as an increase or decrease of one or more dimensions of the planar workpiece **602** –
26 dimensions being length, width and thickness – of more than 5% of that dimension and/or the
27 tearing, detachment or disassociation of planar workpiece **602** components such as, for
28 example, planar workpiece **602** frame or border from other planar workpiece **602** material.
29 Planar workpiece **602** as used herein refers to a mechanical object shaped as a rectangular
30 cuboid.

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

1 applied to the unsupported edge of a 4 inch by 4 inch piece of this rigid material secured in a
2 horizontal position such that a 2 by 4 inch dimension of this piece is cantilevered and thus
3 unsupported. This measurement can be done by clamping to a flat-topped table one half of a 4
4 inch by 4 inch piece of the rigid material being tested so that the other half of the test material (a
5 2 inch by 4 inch section) is off the table top and thus unsupported. Then a ten pound weight is
6 applied to the unsupported edge of the test material (farthest from the table edge) and the
7 deflection of the weighted edge is measured with respect to the table edge.

8 C. Operation of the First Embodiment

9 FIG. 6 shows the gripper in operation. The operator first turns the jaw gap adjuster **126** until
10 the gap between the first jaw **116** and the second jaw **118** is slightly less than the thickness of
11 the planar workpiece **602** to be manipulated. In the case of planar workpiece **602** removal, the
12 operator then squeezes the first handle **108** and the second handle **110** together to expand the
13 gap between the first jaw **116** and the second jaw **118** until it equals the width of the receptacle
14 **604**. The operator then inserts the first jaw **116** and the second jaw **118** into the receptacle **604**
15 so that first gripping surface **206** and the second gripping surface **132** overlap the planar
16 workpiece **602**, then the operator releases the first handle **108** and the second handle **110**. The
17 resulting tension applied by the spring **122** and the spring arms **120** presses together the first
18 jaw **116** and the second jaw **118** until the stopping point set with the jaw gap adjuster **126**. This
19 pressing together of the first jaw **116** and the second jaw **118** causes gripping of the planar
20 workpiece **602** by the first gripping surface **206** and the second gripping surface **132**. Once
21 gripped, the planar workpiece **602** can be manipulated as necessary to free its edges from a
22 receptacle frame **606** present on either side of the planar workpiece **602** and then removed.

23 Planar workpiece **602** insertion is the opposite of removal. The operator first turns the jaw
24 gap adjuster **126** until the gap between the first jaw **116** and the second jaw **118** is set to be
25 slightly less than the thickness of the planar workpiece **602** to be manipulated. The operator
26 then squeezes the first handle **108** and the second handle **110** together to expand the gap
27 between the first jaw **116** and the second jaw **118** until it exceeds the width of the planar
28 workpiece **602**. The operator then slides the outer edge of the planar workpiece **602** between
29 the first gripping surface **206** and the second gripping surface **132** and releases the first handle
30 **108** and the second handle **110** so that the tension applied by the spring **122** and the spring
31 arms **120** presses together the first jaw **116** and the second jaw **118** until the stopping point set
32 with the jaw gap adjuster **126**. The gripper now firmly holds the planar workpiece **602**. The
33 operator then inserts the planar workpiece **602** into the receptacle **604**. Once partially inserted

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

6 In FIG. **6** the planar workpiece **602** is shown as recessed below a receptacle frame edge
7 **608**, which is a common occurrence either because the receptacle **604** is deeper than the
8 planar workpiece **602** or because the planar workpiece **602** has become deformed during use.
9 The planar workpiece **602** can be removed from the receptacle **604** in only one direction
10 because the receptacle frame **606** is closed at the other end of the receptacle **604** (bottom of
11 receptacle **604** is not shown in FIG. **6**). This placement of the planar workpiece **602** recessed
12 below (or level with) the receptacle frame edge **608** represents the proper operational location
13 for such a planar workpiece **602**.

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

20

1 DETAILED DESCRIPTION OF AN ALTERNATIVE EMBODIMENT

2 A. Overview of an Alternative Embodiment

3 A modification of the gripper embodiment depicted in FIGS. 1 through 5 is presented in
4 FIGS. 7 and 8, wherein the gripper has a first offset jaw 702 and a second offset jaw 704 that
5 are step-shaped rather than flat. In this alternative embodiment, the first offset jaw 702 adds a
6 first offset jaw top step 706, and a first offset jaw riser 708, while the second offset jaw 704 of
7 this alternative embodiment adds a second offset jaw top step 714, and a second offset jaw
8 riser 716. In addition, for this alternative embodiment the numbering for certain elements
9 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

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

16 B. Detailed Description of an Alternative Embodiment

17 As depicted in FIGS. 7 and 8, the first offset jaw 702 comprises three planar surfaces
18 connected to form the equivalent of two horizontal and parallel but non-overlapping steps that
19 are attached to one another by a connecting vertical riser. A first offset jaw top step 706 forms
20 the first such planar surface. The longitudinal axis of the first offset jaw top step 706 is oriented
21 parallel to the longitudinal axis of the gripper and is attached to the underside of the first jaw end
22 114. A first offset jaw riser 708 forms the second such planar surface. The first offset jaw riser
23 708 is attached to the edge of the first offset jaw top step 706 opposite the first jaw end 114 and
24 is oriented at a right angle to the first offset jaw top step 706 so as to form a downward-oriented
25 riser component in relation to the first offset jaw top step 706. A first jaw 710 forms the third
26 such planar surface. The first jaw 710 is attached to the bottom edge of the first offset jaw riser
27 708 and extends parallel to the longitudinal axis of the first handle 108 from the first offset jaw

1 riser **708** in a direction opposite from the direction of the first arm **102** and laterally to either side
2 so that the first jaw **710** forms a flat plate of uniform thickness. In this context the phrase
3 “longitudinal axis of the first handle **108**” refers to a straight line drawn from substantially the
4 lateral center of the first handle end **106** to substantially the lateral center of the first middle
5 portion **112**, this line running parallel to the centerline of the first arm **102**, and “uniform” means
6 a thickness variation across the plate surface of no more than approximately 10%. The edge of
7 the first jaw **710** farthest from the first offset jaw riser **708** is the first jaw leading edge **804**. The
8 first jaw insertion limit line **712** is the endpoint for insertion of the first jaw **710** into the receptacle
9 **604**. For the alternative embodiment the first jaw insertion limit line **712** is the attachment point
10 of the first jaw **710** to the first offset jaw riser **708**. The insertion distance into the receptacle **604**
11 of the first jaw **710** is the distance from the first jaw leading edge **804** (visible in FIG. **8** but not in
12 FIG. **7**) to the first jaw insertion limit line **712**, this insertion distance being represented in FIG. **7**
13 by the designation **L1**. A first gripping surface **802** (visible in FIG. **8** but not in FIG. **7**) is located
14 on the underside of the first jaw **710**. The two steps and riser of the first offset jaw **702** may be a
15 unitary structure.

16 Continuing with FIGS. **7** and **8**, the second offset jaw **704** comprises three planar surfaces
17 connected to form two horizontal and parallel but non-overlapping steps that are attached to one
18 another by a connecting vertical riser to form a unitary structure. A second offset jaw top step
19 **714** forms the first such planar surface. The longitudinal axis of the second offset jaw top step
20 **714** is oriented parallel to the longitudinal axis of the gripper and is attached to the underside of
21 the second jaw end **115**. A second offset jaw riser **716** forms the second such planar surface.
22 The second offset jaw riser **716** is attached to the edge of the second offset jaw top step **714**
23 opposite the second jaw end **115** and is oriented at a right angle to the second offset jaw top
24 step **714** so as to form a downward-oriented riser component in relation to the second offset jaw
25 top step **714**. A second jaw **718** forms the third such planar surface. The second jaw **718** is
26 attached to the bottom edge of the second offset jaw riser **716** and extends parallel to the
27 longitudinal axis of the second handle **110** from the second offset jaw riser **716** in a direction
28 opposite from the direction of the second arm **104** and laterally to either side so that the second
29 jaw **718** forms a flat plate of uniform thickness. In this context the phrase “longitudinal axis of the
30 second handle **110**” refers to a straight line drawn from substantially the lateral center of the
31 second handle end **107** to substantially the lateral center of the second middle portion **113**, this
32 line running parallel to the centerline of the second arm **104**, and “uniform” means a thickness
33 variation across the plate surface of no more than approximately 10%. The edge of the second
34 jaw **718** farthest from the second offset jaw riser **716** is the second jaw leading edge **722**. The

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

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

20 As illustrated in FIGS. **7** and **9**, a first threaded sleeve **202** (not visible in FIG. **7**) is attached
21 to the underside of the first arm **102** between the first middle portion **112** and the first jaw end
22 **114**. A second threaded sleeve **130** is attached to the underside of the second arm **104**
23 between the second middle portion **113** and the second jaw end **115**. A jaw gap adjuster **126**
24 passes through an adjuster hole **128** (visible only in FIG. **7**) and the first threaded sleeve **202**
25 then enters second threaded sleeve **130**. Turning the jaw gap adjuster **126** clockwise or
26 counterclockwise provides a means for setting or varying the gap or space between the first
27 gripping surface **802** and the second gripping surface **720**, this adjustment mechanism being
28 such that the gap or space remains constant when the gripper is at rest without pressure on the
29 first handle **108** or second handle **110**. The description presented here of a means for setting or
30 varying the gap or space between the first gripping surface **802** and the second gripping surface
31 **720** represents only one way to set this gap and this description should not to be considered a
32 limitation; any mechanism known to one skilled in the art will suffice so long as the gap or space
33 is maintained while the gripper is at rest.

1 The dimensions and material of manufacture for the first offset jaw **702** and the second
2 offset jaw **704** can vary based on gripper application. For the application involving manipulation
3 of HVAC filters discussed earlier, the width **W1** of the first jaw **710**, shown in FIGS. **7** and **8**, may
4 be two inches and the insertion distance **L1** may be two inches or more. For the same HVAC
5 filter manipulation application the width **W1** of the second jaw **718**, as illustrated in FIGS. **7** and
6 **8**, may be two inches and the insertion distance **L1** may be two inches or more. These first jaw
7 **710** and second jaw **718** insertion distance and width dimensions will need to be substantially at
8 least 1.25 inches to ensure sufficient gripping surface and depth of insertion into the receptacle
9 **604**, the term “substantially at least 1.25 inches” meaning no less than 1.125 inches. One
10 possible first offset jaw **702** and second offset jaw **704** material of manufacture in this HVAC
11 filter manipulation application is 16 gauge cold-rolled steel (0.0598 inches thick). For
12 applications using cold-rolled steel jaws as a material of manufacture, an anti-corrosion coating
13 such as, but not limited to, zinc or paint may be applied. Other embodiments for this HVAC filter
14 or different applications may use stainless steel, plastic, carbon fiber or other materials for jaws.

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

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

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

1 otherwise manipulate with force the planar workpiece **602** in order to free it from the receptacle
2 **604** on removal or seat it fully into the receptacle **604** on insertion; c) insertion or removal
3 requires damage or deformation of the planar workpiece **602**, “damage or deformation” being
4 defined as an increase or decrease of one or more dimensions of the planar workpiece **602** –
5 dimensions being length, width and depth – of more than 5% of that dimension and/or the
6 tearing, detachment or disassociation of planar workpiece **602** components such as, for
7 example, planar workpiece **602** frame or border from other planar workpiece **602** material.
8 Planar workpiece **602** as used herein refers to a mechanical object shaped as a rectangular
9 cuboid.

10 A rigid material is required for the first jaw **710** and the second jaw **718**, “rigid material” being
11 defined as one that can maintain planarity across its surface to within a deflection from flatness
12 of no more than one-eighth inch along the unsupported edge when a weight of ten pounds is
13 applied to the unsupported edge of a 4 inch by 4 inch piece of this rigid material secured in a
14 horizontal position such that a 2 by 4 inch dimension of this piece is cantilevered and thus
15 unsupported. This measurement can be done by clamping to a flat-topped table one half of a 4
16 inch by 4 inch piece of the rigid material being tested so that the other half of the test material (a
17 2 inch by 4 inch section) is off the table top and thus unsupported. Then a ten pound weight is
18 applied to the unsupported edge of the test material (farthest from the table edge) and the
19 deflection of the weighted edge is measured with respect to the table edge.

20 C. Operation of an Alternative Embodiment

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

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

4 Planar workpiece **602** insertion using the offset jaw embodiment of the gripper as depicted
5 in FIG. **9** is the opposite of removal. The operator first turns the jaw gap adjuster **126** until the
6 gap between the first jaw **710** and the second jaw **718** is set to be slightly less than the
7 thickness of the planar workpiece **602** to be manipulated. The operator then squeezes the first
8 handle **108** and the second handle **110** together to expand the gap between the first jaw **710**
9 and the second jaw **718** until it exceeds the width of the planar workpiece **602**. The operator
10 then slides the outer edge of the planar workpiece **602** between the first gripping surface **802**
11 and the second gripping surface **720** and releases the first handle **108** and the second handle
12 **110** so that the tension applied by the spring **122** and the spring arms **120** presses together the
13 first jaw **710** and the second jaw **718** until the stopping point set with the jaw gap adjuster **126**.
14 The gripper now firmly holds the planar workpiece **602**. The operator then inserts the planar
15 workpiece **602** into the receptacle **604**. Once partially inserted in the receptacle **604**, the planar
16 workpiece **602** can be manipulated as necessary to slide it fully into the receptacle **604**. After full
17 insertion of the planar workpiece **602** into the receptacle **604**, the operator squeezes the first
18 handle **108** and the second handle **110** together to expand the gap between the first jaw **710**
19 and the second jaw **718** until it exceeds the width of the planar workpiece **602**, then the operator
20 withdraws the gripper from the receptacle **604** leaving the planar workpiece **602** in place.

21 In FIG. **9** the planar workpiece **602** is shown as recessed below a receptacle frame edge
22 **608**, which is a common occurrence either because the receptacle **604** is deeper than the
23 planar workpiece **602** or because the planar workpiece **602** has become deformed during use.
24 The planar workpiece **602** can be removed from the receptacle **604** in only one direction
25 because the receptacle frame **606** is closed at the other end of the receptacle **604** (bottom of
26 receptacle **604** is not shown in FIG. **9**). This placement of the planar workpiece recessed below
27 (or level with) the receptacle frame edge represents the proper operational location for such a
28 planar workpiece.

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

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

3

4

1 DETAILED DESCRIPTION OF FURTHER EMBODIMENTS

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

6 A. Overview of the First Further Embodiment

7 As depicted in FIGS. **10** through **14**, a first further embodiment of a gripper comprises a first
8 arm **102** that extends from a first handle end **106** through a first handle **108** and a first middle
9 portion **112** to a first jaw end **114**. Attached to the first jaw end **114** is a first jaw **116**. A second
10 arm **104** extends from a second handle end **107** through a second handle **110** and a second
11 middle portion **113** to a second jaw end **115**. Attached to the second jaw end **115** is a second
12 jaw **118**. Protruding at approximately a right angle from the underside of the first middle portion
13 **112** is a first linkage extension **111**. Protruding at approximately a right angle from the underside
14 of the second middle portion **113** is a second linkage extension **117**. The first linkage extension
15 **111** and the second linkage extension **117** partially overlap and are attached in this overlap area
16 using a pivot pin **124** so that the first handle **108** and the second handle **110** can be actuated to
17 vary the gap between the first jaw **116** and the second jaw **118**, permitting the operator to grasp
18 and manipulate a planar workpiece **602**.

19 B. Detailed Description of the First Further Embodiment

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

24 As depicted in FIG. **10**, the first jaw **116** extends parallel to the longitudinal axis of the first
25 handle **108** from the first jaw end **114** in a direction opposite from the direction of the first arm
26 **102** and laterally to either side of the first jaw end **114** so that the first jaw **116** forms a flat plate
27 of uniform thickness. In this context the phrase “longitudinal axis of the first handle **108**” refers to
28 a straight line drawn from substantially the lateral center of the first handle end **106** to
29 substantially the lateral center of the first middle portion **112**, this line running parallel to the
30 centerline of the first arm **102**, and “uniform” means a thickness variation across the plate
31 surface of no more than approximately 10%. The edge of the first jaw **116** farthest from the first
32 jaw end **114** is the first jaw leading edge **121**. The first jaw insertion limit line **119** is the endpoint
33 for insertion of the first jaw **116** into the receptacle **604**. For the first further embodiment the first

1 jaw insertion limit line **119** is the forward attachment point of the first jaw **116** to the first jaw end
2 **114**, “forward” meaning in a direction opposite to the first handle **108**. The insertion distance into
3 the receptacle **604** of the first jaw **116** is the distance from the first jaw leading edge **121** to the
4 first jaw insertion limit line **119**, this insertion distance being represented in FIG. **10** by the letter
5 **L**.

6 As illustrated in FIG. **11** and FIG. **12**, a second arm **104** extends from a second handle end
7 **107** through a second handle **110** and a second middle portion **113** to a second jaw end **115**.
8 Directly attached to the second jaw end **115** is a second jaw **118**. Protruding at approximately a
9 right angle from the underside of the second middle portion **113** is a second linkage extension
10 **117**.

11 As depicted in FIG. **11**, the second jaw **118** extends parallel to the longitudinal axis of the
12 second handle **110** from the second jaw end **115** in a direction opposite from the direction of the
13 second arm **104** and laterally to either side of the second jaw end **115** so that the second jaw
14 **118** forms a flat plate of uniform thickness. In this context the phrase “longitudinal axis of the
15 second handle **110**” refers to a straight line drawn from substantially the lateral center of the
16 second handle end **107** to substantially the lateral center of the second middle portion **113**, this
17 line running parallel to the centerline of the second arm **104**, and “uniform” means a thickness
18 variation across the plate surface of no more than approximately 10%. The edge of the second
19 jaw **118** farthest from the second jaw end **115** is the second jaw leading edge **136**. For the first
20 further embodiment the second jaw insertion limit line **204** is the forward attachment point of the
21 second jaw **118** to the second jaw end **115**, “forward” meaning in a direction opposite to the
22 second handle **110**. The insertion distance into the receptacle **604** of the second jaw **118** is the
23 distance from the second jaw leading edge **136** to the second jaw insertion limit line **204**, this
24 insertion distance being represented in FIG. **11** by the letter **L**.

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

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

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

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

13 As depicted in FIG. **12**, the first jaw **116** has an outer surface **134** and a first gripping surface
14 **206**, and the second jaw **118** has an outer surface **134** and a second gripping surface **132**. The
15 first jaw **116** and the second jaw **118** overlap one another and, in this embodiment, have
16 coincident edges when viewed from a point six inches along an axis perpendicular to the plane
17 of the first jaw **116** that extends outward from the first jaw **116** center point. The first jaw **116**
18 and the second jaw **118** are substantially parallel to one another and, for the HVAC filter
19 manipulation application discussed earlier, have an adjustable gap of approximately one inch
20 between the first gripping surface **206** and the second gripping surface **132**. Other embodiments
21 for different applications may have different jaw dimensions, jaw overlap, and gripping surface
22 gap.

23 The dimensions and material of manufacture for the first jaw **116** and the second jaw **118**
24 can vary based on gripper application. For the application involving manipulation of HVAC filters
25 discussed earlier, the width **W** of the first jaw **116**, as shown in FIG. **10**, may be two inches and
26 the insertion distance **L** may be two inches or more. For the same HVAC filter manipulation
27 application the width **W** of the second jaw **118**, as shown in FIG. **11**, may be two inches and the
28 insertion distance **L** may be two inches or more. These first jaw **116** and second jaw **118**
29 insertion distance and width dimensions will need to be substantially at least 1.25 inches to
30 ensure sufficient gripping surface and depth of insertion into the receptacle **604**, the term
31 “substantially at least 1.25 inches” meaning no less than 1.125 inches. One possible first jaw
32 **116** and second jaw **118** material of manufacture in this HVAC filter manipulation application is
33 16 gauge cold-rolled steel (0.0598 inches thick). For applications using cold-rolled steel jaws as

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

4 The thickness of the first jaw **116** and the second jaw **118** material must be less than
5 approximately 0.075 inches, meaning that the thickness cannot exceed 0.080 inches. This
6 minimal jaw thickness permits use of the gripper when a planar workpiece **602** fits tightly or is
7 stuck in in its receptacle **604**, “fits tightly”, “stuck in”, and “fit tightly” being defined as one or
8 more of the following conditions: a) less than approximately 0.25 inches of space between an
9 outer edge of the planar workpiece **602** and an outer edge of the receptacle **604** on one or both
10 sides of the planar workpiece **602**; b) a necessity to shake, oscillate, rock side-to-side or
11 otherwise manipulate with force the planar workpiece **602** in order to free it from the receptacle
12 **604** on removal or seat it fully into the receptacle **604** on insertion; c) insertion or removal
13 requires damage or deformation of the planar workpiece **602**, “damage or deformation” being
14 defined as an increase or decrease of one or more dimensions of the planar workpiece **602** –
15 dimensions being length, width and thickness – of more than 5% of that dimension and/or the
16 tearing, detachment or disassociation of planar workpiece **602** components such as, for
17 example, planar workpiece **602** frame or border from other planar workpiece **602** material.
18 Planar workpiece **602** as used herein refers to a mechanical object shaped as a rectangular
19 cuboid.

20 A rigid material is required for the first jaw **116** and the second jaw **118**, “rigid material” being
21 defined as one that can maintain planarity across its surface to within a deflection from flatness
22 of no more than one-eighth inch along the unsupported edge when a weight of ten pounds is
23 applied to the unsupported edge of a 4 inch by 4 inch piece of this rigid material secured in a
24 horizontal position such that a 2 by 4 inch dimension of this piece is cantilevered and thus
25 unsupported. This measurement can be done by clamping to a flat-topped table one half of a 4
26 inch by 4 inch piece of the rigid material being tested so that the other half of the test material (a
27 2 inch by 4 inch section) is off the table top and thus unsupported. Then a ten pound weight is
28 applied to the unsupported edge of the test material (farthest from the table edge) and the
29 deflection of the weighted edge is measured with respect to the table edge.

30 C. Operation of the First Further Embodiment

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

1 The operator then inserts the first jaw **116** and the second jaw **118** into the receptacle **604** so
2 that first gripping surface **206** and the second gripping surface **132** overlap the planar workpiece
3 **602**, then the operator releases the first handle **108** and the second handle **110**. The resulting
4 tension applied by the spring **122** and the spring arms **120** presses together the first jaw **116**
5 and the second jaw **118**. This pressing together of the first jaw **116** and the second jaw **118**
6 causes gripping of the planar workpiece **602** by the first gripping surface **206** and the second
7 gripping surface **132**. Once gripped, the planar workpiece **602** can be manipulated as necessary
8 to free its edges from a receptacle frame **606** present on either side of the planar workpiece **602**
9 and then removed.

10 Planar workpiece **602** insertion is the opposite of removal. The operator squeezes the first
11 handle **108** and the second handle **110** together to expand the gap between the first jaw **116**
12 and the second jaw **118** until it exceeds the width of the planar workpiece **602**. The operator
13 then slides the outer edge of the planar workpiece **602** between the first gripping surface **206**
14 and the second gripping surface **132** and releases the first handle **108** and the second handle
15 **110** so that the tension applied by the spring **122** and the spring arms **120** presses together the
16 first jaw **116** and the second jaw **118**. The gripper now firmly holds the planar workpiece **602**.
17 The operator then inserts the planar workpiece **602** into the receptacle **604**. Once partially
18 inserted in the receptacle **604**, the planar workpiece **602** can be manipulated as necessary to
19 slide it fully into the receptacle **604**. After full insertion of the planar workpiece **602** into the
20 receptacle **604**, the operator squeezes the first handle **108** and the second handle **110** together
21 to expand the gap between the first jaw **116** and the second jaw **118** until it exceeds the width of
22 the planar workpiece **602**, then the operator withdraws the gripper from the receptacle **604**.

23 In FIG. **14** the planar workpiece **602** is shown as recessed below a receptacle frame edge
24 **608**, which is a common occurrence either because the receptacle **604** is deeper than the
25 planar workpiece **602** or because the planar workpiece **602** has become deformed during use.
26 The planar workpiece **602** can be removed from the receptacle **604** in only one direction
27 because the receptacle frame **606** is closed at the other end of the receptacle **604** (bottom of
28 receptacle **604** is not shown in FIG. **14**). This placement of the planar workpiece **602** recessed
29 below (or level with) the receptacle frame edge **608** represents the proper operational location
30 for such a planar workpiece **602**.

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

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

4 D. Overview of the Second Further Embodiment

5 A modification of the gripper first further embodiment depicted in FIGS. **10** through **13** is
 6 presented in FIGS. **15** and **16**, wherein the gripper has a first offset jaw **702** and a second offset
 7 jaw **704** that are step-shaped rather than flat. In this second further embodiment, the first offset
 8 jaw **702** adds a first offset jaw top step **706**, and a first offset jaw riser **708**, while the second
 9 offset jaw **704** of this second further embodiment adds a second offset jaw top step **714**, and a
 10 second offset jaw riser **716**. In addition, for this second further embodiment the numbering for
 11 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

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

18 E. Detailed Description of a Second Further Embodiment

19 As depicted in FIGS. **15** and **16**, the first offset jaw **702** comprises three planar surfaces
 20 connected to form the equivalent of two horizontal and parallel but non-overlapping steps that
 21 are attached to one another by a connecting vertical riser. A first offset jaw top step **706** forms
 22 the first such planar surface. The longitudinal axis of the first offset jaw top step **706** is oriented
 23 parallel to the longitudinal axis of the gripper and is attached to the underside of the first jaw end
 24 **114**. A first offset jaw riser **708** forms the second such planar surface. The first offset jaw riser
 25 **708** is attached to the edge of the first offset jaw top step **706** opposite the first jaw end **114** and
 26 is oriented at a right angle to the first offset jaw top step **706** so as to form a downward-oriented
 27 riser component in relation to the first offset jaw top step **706**. A first jaw **710** forms the third

1 such planar surface. The first jaw **710** is attached to the bottom edge of the first offset jaw riser
2 **708** and extends parallel to the longitudinal axis of the first handle **108** from the first offset jaw
3 riser **708** in a direction opposite from the direction of the first arm **102** and laterally to either side
4 so that the first jaw **710** forms a flat plate of uniform thickness. In this context the phrase
5 “longitudinal axis of the first handle **108**” refers to a straight line drawn from substantially the
6 lateral center of the first handle end **106** to substantially the lateral center of the first middle
7 portion **112**, this line running parallel to the centerline of the first arm **102**, and “uniform” means
8 a thickness variation across the plate surface of no more than approximately 10%. The edge of
9 the first jaw **710** farthest from the first offset jaw riser **708** is the first jaw leading edge **804**. The
10 first jaw insertion limit line **712** is the endpoint for insertion of the first jaw **710** into the receptacle
11 **604**. For the second further embodiment the first jaw insertion limit line **712** is the attachment
12 point of the first jaw **710** to the first offset jaw riser **708**. The insertion distance into the
13 receptacle **604** of the first jaw **710** is the distance from the first jaw leading edge **804** (visible in
14 FIG. **16** but not in FIG. **15**) to the first jaw insertion limit line **712**, this insertion distance being
15 represented in FIG. **15** by the designation **L1**. A first gripping surface **802** (visible in FIG. **16** but
16 not in FIG. **15**) is located on the underside of the first jaw **710**. The two steps and riser of the
17 first offset jaw **702** may be a unitary structure.

18 Continuing with FIGS. **15** and **16**, the second offset jaw **704** comprises three planar surfaces
19 connected to form two horizontal and parallel but non-overlapping steps that are attached to one
20 another by a connecting vertical riser to form a unitary structure. A second offset jaw top step
21 **714** forms the first such planar surface. The longitudinal axis of the second offset jaw top step
22 **714** is oriented parallel to the longitudinal axis of the gripper and is attached to the underside of
23 the second jaw end **115**. A second offset jaw riser **716** forms the second such planar surface.
24 The second offset jaw riser **716** is attached to the edge of the second offset jaw top step **714**
25 opposite the second jaw end **115** and is oriented at a right angle to the second offset jaw top
26 step **714** so as to form a downward-oriented riser component in relation to the second offset jaw
27 top step **714**. A second jaw **718** forms the third such planar surface. The second jaw **718** is
28 attached to the bottom edge of the second offset jaw riser **716** and extends parallel to the
29 longitudinal axis of the second handle **110** from the second offset jaw riser **716** in a direction
30 opposite from the direction of the second arm **104** and laterally to either side so that the second
31 jaw **718** forms a flat plate of uniform thickness. In this context the phrase “longitudinal axis of the
32 second handle **110**” refers to a straight line drawn from substantially the lateral center of the
33 second handle end **107** to substantially the lateral center of the second middle portion **113**, this
34 line running parallel to the centerline of the second arm **104**, and “uniform” means a thickness

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

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

22 The dimensions and material of manufacture for the first offset jaw **702** and the second
23 offset jaw **704** can vary based on gripper application. For the application involving manipulation
24 of HVAC filters discussed earlier, the width **W1** of the first jaw **710**, shown in FIGS. **15** and **16**,
25 may be two inches and the insertion distance **L1** may be two inches or more. For the same
26 HVAC filter manipulation application the width **W1** of the second jaw **718**, as illustrated in FIGS.
27 **15** and **16**, may be two inches and the insertion distance **L1** may be two inches or more. These
28 first jaw **710** and second jaw **718** insertion distance and width dimensions will need to be
29 substantially at least 1.25 inches to ensure sufficient gripping surface and depth of insertion into
30 the receptacle **604**, the term “substantially at least 1.25 inches” meaning no less than 1.125
31 inches. One possible first offset jaw **702** and second offset jaw **704** material of manufacture in
32 this HVAC filter manipulation application is 16 gauge cold-rolled steel (0.0598 inches thick). For
33 applications using cold-rolled steel jaws as a material of manufacture, an anti-corrosion coating

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

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

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

15 The thickness of the first jaw 710 and the second jaw 718 material must be less than
16 approximately 0.075 inches, meaning that the thickness cannot exceed 0.080 inches. This
17 minimal jaw thickness permits use of the gripper when planar workpiece 602 fits tightly or is
18 stuck in in its receptacle 604, “fits tightly”, “stuck in”, and “fit tightly” being defined as one or
19 more of the following conditions: a) less than approximately 0.25 inches of space between an
20 outer edge of the planar workpiece 602 and an outer edge of the receptacle 604 on one or both
21 sides of the planar workpiece 602; b) a necessity to shake, oscillate, rock side-to-side or
22 otherwise manipulate with force the planar workpiece 602 in order to free it from the receptacle
23 604 on removal or seat it fully into the receptacle 604 on insertion; c) insertion or removal
24 requires damage or deformation of the planar workpiece 602, “damage or deformation” being
25 defined as an increase or decrease of one or more dimensions of the planar workpiece 602 –
26 dimensions being length, width and depth – of more than 5% of that dimension and/or the
27 tearing, detachment or disassociation of planar workpiece 602 components such as, for
28 example, planar workpiece 602 frame or border from other planar workpiece 602 material.
29 Planar workpiece 602 as used herein refers to a mechanical object shaped as a rectangular
30 cuboid.

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

1 applied to the unsupported edge of a 4 inch by 4 inch piece of this rigid material secured in a
2 horizontal position such that a 2 by 4 inch dimension of this piece is cantilevered and thus
3 unsupported. This measurement can be done by clamping to a flat-topped table one half of a 4
4 inch by 4 inch piece of the rigid material being tested so that the other half of the test material (a
5 2 inch by 4 inch section) is off the table top and thus unsupported. Then a ten pound weight is
6 applied to the unsupported edge of the test material (farthest from the table edge) and the
7 deflection of the weighted edge is measured with respect to the table edge.

8 F. Operation of a Second Further Embodiment

9 The second further embodiment of the gripper presented in FIG. 17 operates similarly to the
10 flat jaw gripper of FIGS. 10 through 13. In the case of planar workpiece 602 removal, the
11 operator squeezes the first handle 108 and the second handle 110 together to expand the gap
12 between the first jaw 710 and the second jaw 718 until it equals the width of the receptacle 604.
13 The operator then inserts the first jaw 710 and the second jaw 718 into the receptacle 604 so
14 that the first gripping surface 802 and the second gripping surface 720 overlap the planar
15 workpiece 602, then the operator releases the first handle 108 and the second handle 110. The
16 resulting tension applied by the spring 122 and the spring arms 120 presses together the first
17 jaw 710 and the second jaw 718. This pressing together of the first jaw 710 and the second jaw
18 718 causes gripping of the planar workpiece 602 by the first gripping surface 802 and the
19 second gripping surface 720. Once gripped, the planar workpiece 602 can be manipulated as
20 necessary to free its edges from a receptacle frame 606 present on either side of the planar
21 workpiece 602 and then removed.

22 Planar workpiece 602 insertion using the offset jaw embodiment of the gripper as depicted
23 in FIG. 17 is the opposite of removal. The operator squeezes the first handle 108 and the
24 second handle 110 together to expand the gap between the first jaw 710 and the second jaw
25 718 until it exceeds the width of the planar workpiece 602. The operator then slides the outer
26 edge of the planar workpiece 602 between the first gripping surface 802 and the second
27 gripping surface 720 and releases the first handle 108 and the second handle 110 so that the
28 tension applied by the spring 122 and the spring arms 120 presses together the first jaw 710
29 and the second jaw 718. The gripper now firmly holds the planar workpiece 602. The operator
30 then inserts the planar workpiece 602 into the receptacle 604. Once partially inserted in the
31 receptacle 604, the planar workpiece 602 can be manipulated as necessary to slide it fully into
32 the receptacle 604. After full insertion of the planar workpiece 602 into the receptacle 604, the
33 operator squeezes the first handle 108 and the second handle 110 together to expand the gap

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

4 In FIG. **17** the planar workpiece **602** is shown as recessed below a receptacle frame edge
5 **608**, which is a common occurrence either because the receptacle **604** is deeper than the
6 planar workpiece **602** or because the planar workpiece **602** has become deformed during use.
7 The planar workpiece **602** can be removed from the receptacle **604** in only one direction
8 because the receptacle frame **606** is closed at the other end of the receptacle **604** (bottom of
9 receptacle **604** is not shown in FIG. **17**). This placement of the planar workpiece recessed
10 below (or level with) the receptacle frame edge represents the proper operational location for
11 such a planar workpiece.

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

18
19

1 CLAIMS:

2 The invention claimed is:

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

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

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

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

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

27 (e) a first gripping surface (206, 802) comprising that surface of said first jaw (116)
28 located opposite said first jaw's (116) attachment point to said first jaw end (114),
29 and a second gripping surface (132, 720) comprising that surface of said second jaw
30 (118) located opposite said second jaw's (118) attachment point to said second jaw
31 end (115), said first gripping surface (206, 802) and said second gripping surface
32 (132, 720) together acting to grip said planar workpiece (602) when pressed against

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

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

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

12 2. The gripper of claim 1, wherein:

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

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

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

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

24 whereby said gripper enables insertion or removal of said planar workpiece (602) without
25 damage or deformation when the proper operational location for said planar workpiece
26 (602) is recessed below or level with a receptacle frame edge (608) of said receptacle
27 (604), and said planar workpiece (602) may fit tightly or be stuck in said receptacle
28 (604).

29 3. The gripper of claim 1, wherein:

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

- 1 least 1.25 inches, and said first jaw (710) extends laterally to either side of said first
2 arm (102);
- 3 (b) said first offset jaw riser (708) attaches at a right angle to a first offset jaw top step
4 (706);
- 5 (c) said first offset jaw top step (706) attaches directly to said first jaw end (114) of said
6 first arm (102);
- 7 (d) said first jaw (710), said first offset jaw riser (708), and said first offset jaw top step
8 (706) together form a first offset jaw (702), said first offset jaw being a unitary
9 element having three flat surfaces with the plane of said first offset jaw top step (706)
10 being parallel to the plane of said first jaw (710);
- 11 (e) said first jaw (710) is less than approximately 0.075 inches thick;
- 12 (f) said second jaw (718) attaches at a right angle to a second offset jaw riser (716) at
13 said second jaw insertion limit line (806) and extends longitudinally from said second
14 jaw leading edge (722) to said second jaw insertion limit line (806) a distance that is
15 substantially at least 1.25 inches, and said second jaw (718) extends laterally to
16 either side of said second arm (104);
- 17 (g) said second offset jaw riser (716) attaches at a right angle to a second offset jaw top
18 step (714);
- 19 (h) said second offset jaw top step (714) attaches directly to said second jaw end (115)
20 of said second arm (104);
- 21 (i) said second jaw (718), said second offset jaw riser (716), and said second offset jaw
22 top step (714) together form a second offset jaw (704), said second offset jaw (702)
23 being a unitary element having three flat surfaces with the plane of said second
24 offset jaw top step (714) being parallel to the plane of said second jaw (718);
- 25 (j) said second jaw (718) is less than approximately 0.075 inches thick;
- 26 (k) said first jaw (710) and said second jaw (718) are arranged so that both jaws can be
27 inserted into a receptacle (604) a distance that is substantially at least 1.25 inches
28 with one jaw on each side of said planar workpiece (602);
- 29 (l) said planar workpiece (602) is substantially at least 0.50 inches thick;
- 30 whereby said gripper enables insertion or removal of said planar workpiece (602) without
31 damage or deformation when the proper operational location for said planar workpiece
32 (602) is recessed below or level with a receptacle frame edge (608) of said receptacle

1 (604), and said planar workpiece (602) may fit tightly or be stuck in said receptacle
2 (604).

3 4. A planar workpiece manipulation system comprising:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

- 1 6. The planar workpiece manipulation system of claim 4, wherein:
- 2 (a) said first jaw (710) attaches at a right angle to a first offset jaw riser (708) at said first
- 3 jaw insertion limit line (712) and extends longitudinally from said first jaw leading
- 4 edge (804) to said first jaw insertion limit line (712) a distance that is substantially at
- 5 least 1.25 inches, and said first jaw (710) extends laterally to either side of said first
- 6 arm (102);
- 7 (b) said first offset jaw riser (708) attaches at a right angle to a first offset jaw top step
- 8 (706);
- 9 (c) said first offset jaw top step (706) attaches directly to said first jaw end (114) of said
- 10 first arm (102);
- 11 (d) said first jaw (710), said first offset jaw riser (708), and said first offset jaw top step
- 12 (706) together form a first offset jaw (702), said first offset jaw being a unitary
- 13 element having three flat surfaces with the plane of said first offset jaw top step (706)
- 14 being parallel to the plane of said first jaw (710);
- 15 (e) said first jaw (710) is less than approximately 0.075 inches thick;
- 16 (f) said second jaw (718) attaches at a right angle to a second offset jaw riser (716) at
- 17 said second jaw insertion limit line (806) and extends longitudinally from said second
- 18 jaw leading edge (722) to said second jaw insertion limit line (806) a distance that is
- 19 substantially at least 1.25 inches, and said second jaw (718) extends laterally to
- 20 either side of said second arm (104);
- 21 (g) said second offset jaw riser (716) attaches at a right angle to a second offset jaw top
- 22 step (714);
- 23 (h) said second offset jaw top step (714) attaches directly to said second jaw end (115)
- 24 of said second arm (104);
- 25 (i) said second jaw (718), said second offset jaw riser (716), and said second offset jaw
- 26 top step (714) together form a second offset jaw (704), said second offset jaw (702)
- 27 being a unitary element having three flat surfaces with the plane of said second
- 28 offset jaw top step (714) being parallel to the plane of said second jaw (718);
- 29 (j) said second jaw (718) is less than approximately 0.075 inches thick;
- 30 (k) said first jaw (710) and said second jaw (718) are arranged so that both jaws can be
- 31 inserted into a receptacle (604) a distance that is substantially at least 1.25 inches
- 32 with one jaw on each side of said planar workpiece (602)

1 (l) said planar workpiece (602) is substantially at least 0.50 inches thick;
2 whereby said planar workpiece manipulation system enables insertion or removal of said
3 planar workpiece (602) without damage or deformation when the proper operational
4 location for said planar workpiece (602) is recessed below or level with a receptacle
5 frame edge (608) of said receptacle (604), and said planar workpiece (602) may fit
6 tightly or be stuck in said receptacle (604).

7

8

1 ABSTRACT:

2 This apparatus supports gripping, manipulation and/or insertion or removal of a planar
3 workpiece from a receptacle into which it fits tightly. The apparatus has two substantially
4 identical rigid arms attached to one another at a single pivot point near their longitudinal center.
5 One end of each arm forms a handle; pressing or releasing these two handles actuates the
6 gripper. The other end of each arm has attached on its inside surface a rigid plate. Together
7 these two substantially parallel plates form jaws to grip the planar workpiece. A spring attached
8 to the two handles biases the jaws toward the closed position. An optional adjustable stop
9 mechanism supports setting the gap between jaws when the apparatus is in the closed position.
10 An alternative embodiment utilizes step-shaped jaws for applications where flat jaws are difficult
11 to utilize.
12