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(54) **TURBINE ELEMENT REPAIR FIXTURE**

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(57) **ABSTRACT**

A blade processing fixture has first and second jaws. The second jaw is movable relative to the first jaw from a disengaged position for accepting a root of the blade. The blade is accepted in a receiving area between the first and second jaws. The second jaw is movable to an engaged position clamping the blade between the first and second jaws. A gas flow path extends from an inlet port to an outlet port. The outlet port is positioned to introduce gas to a blade inlet port when the blade is installed.

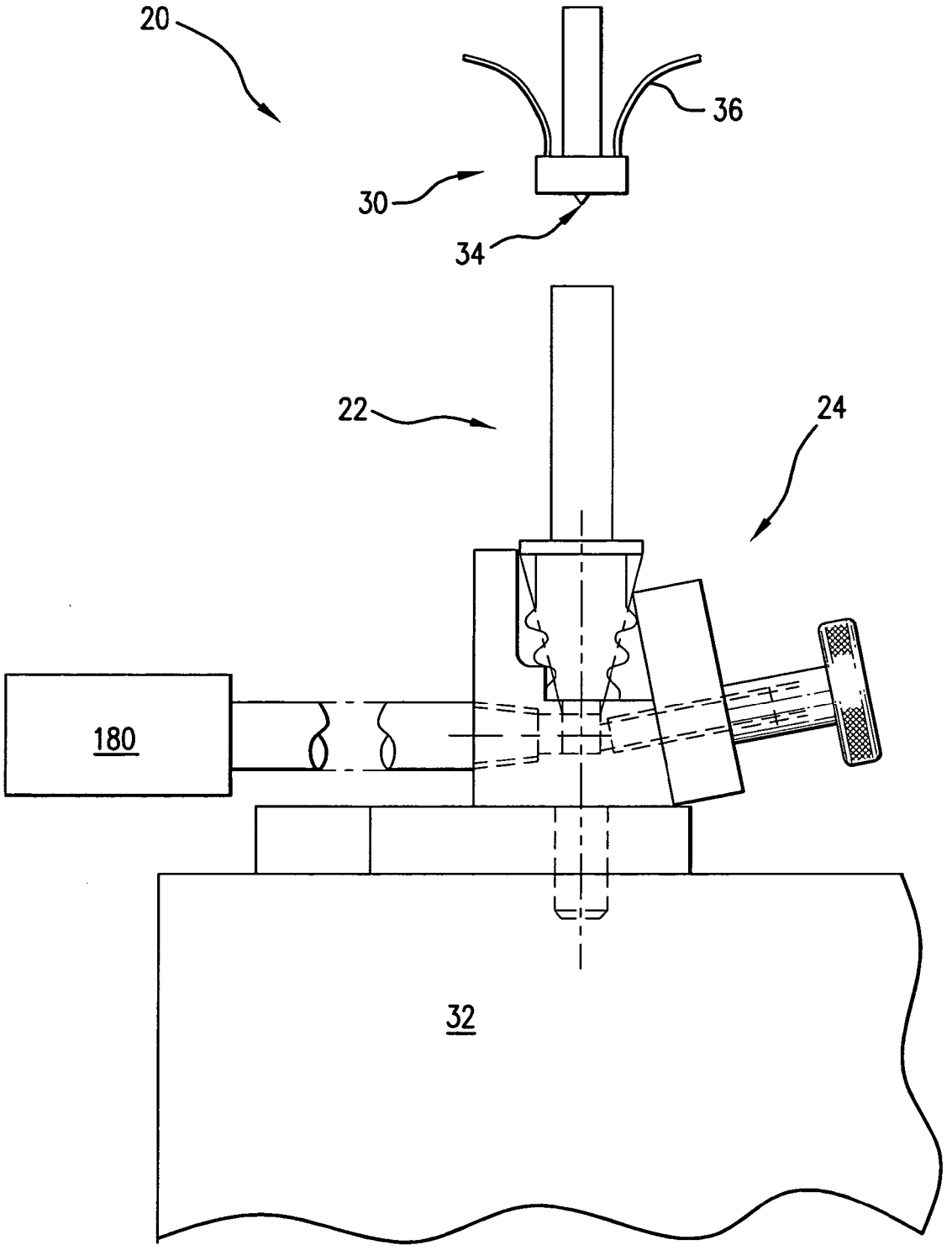


FIG. 1

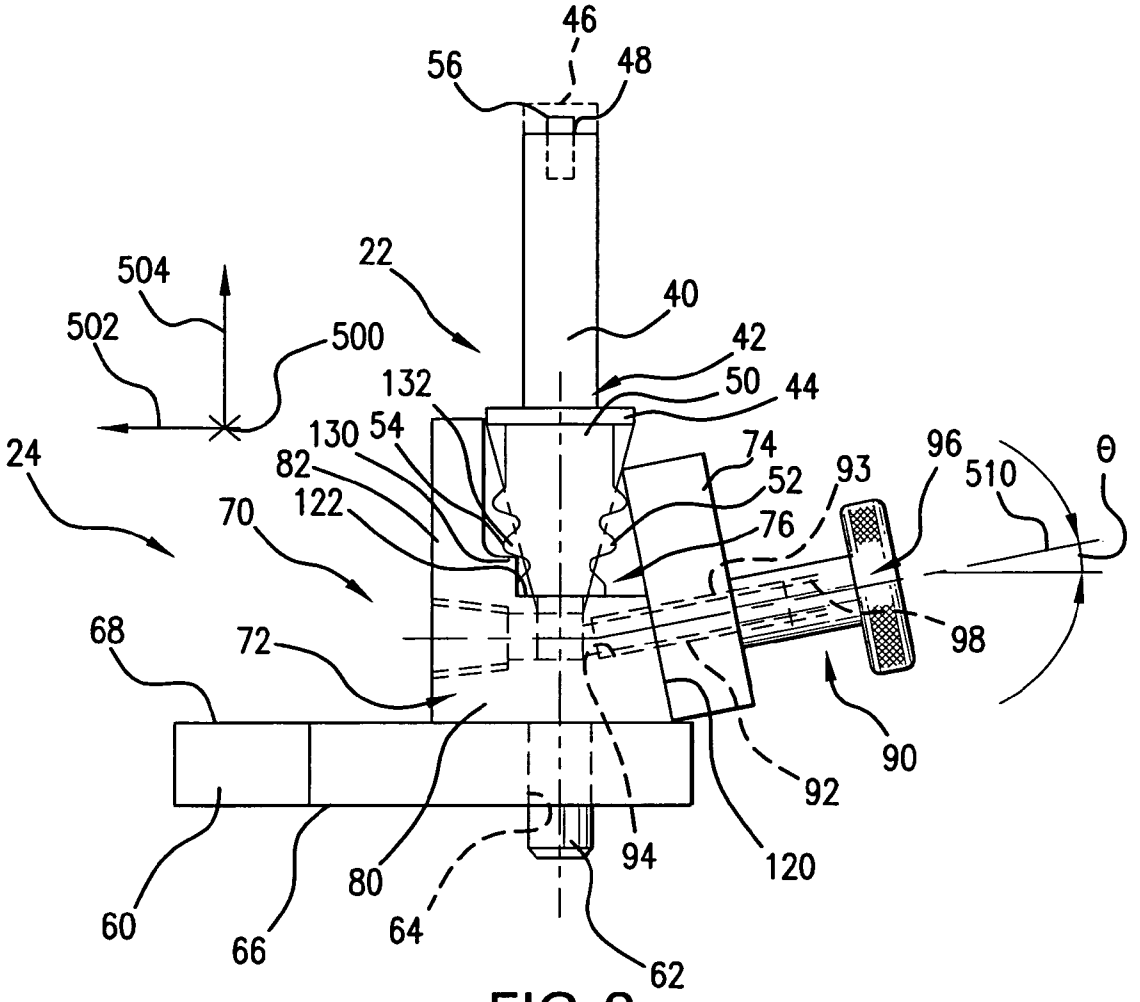

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62

FIG. 2

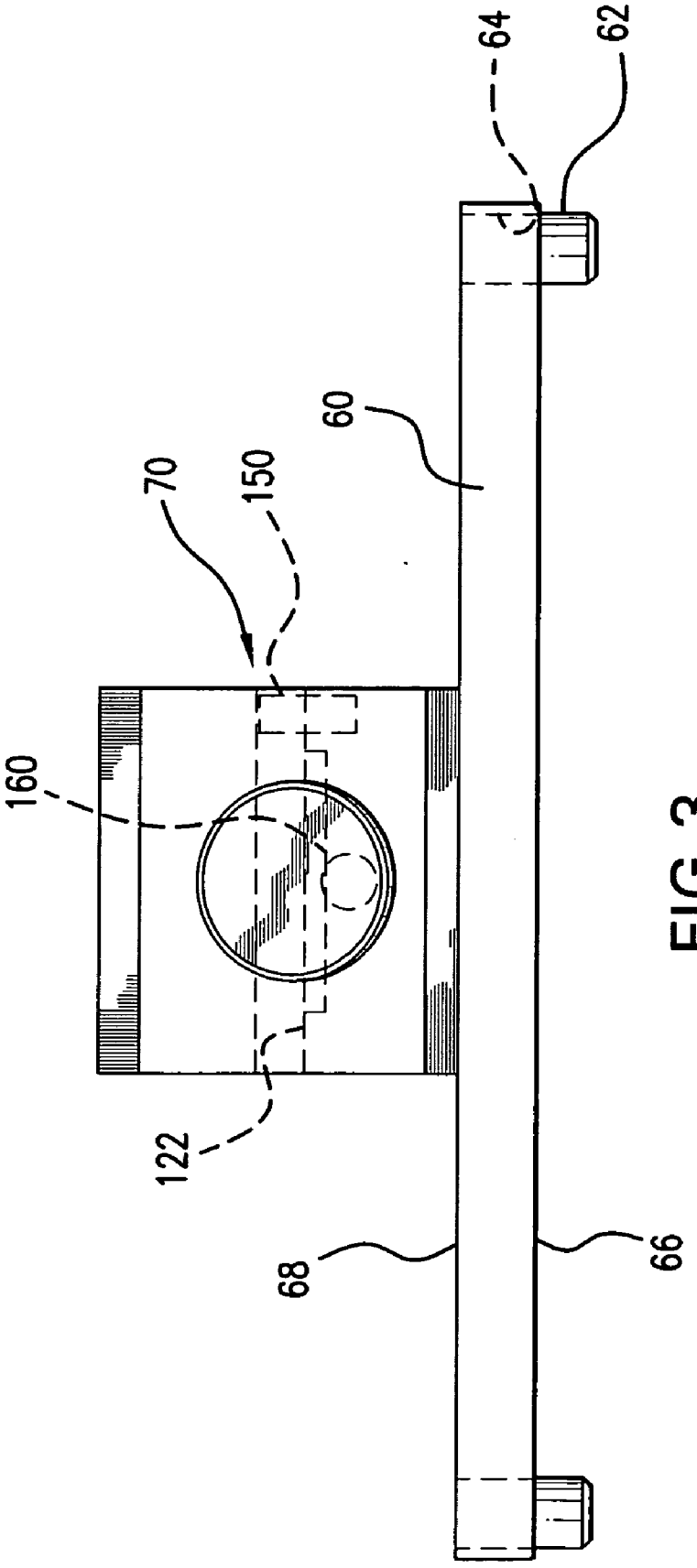


FIG. 3

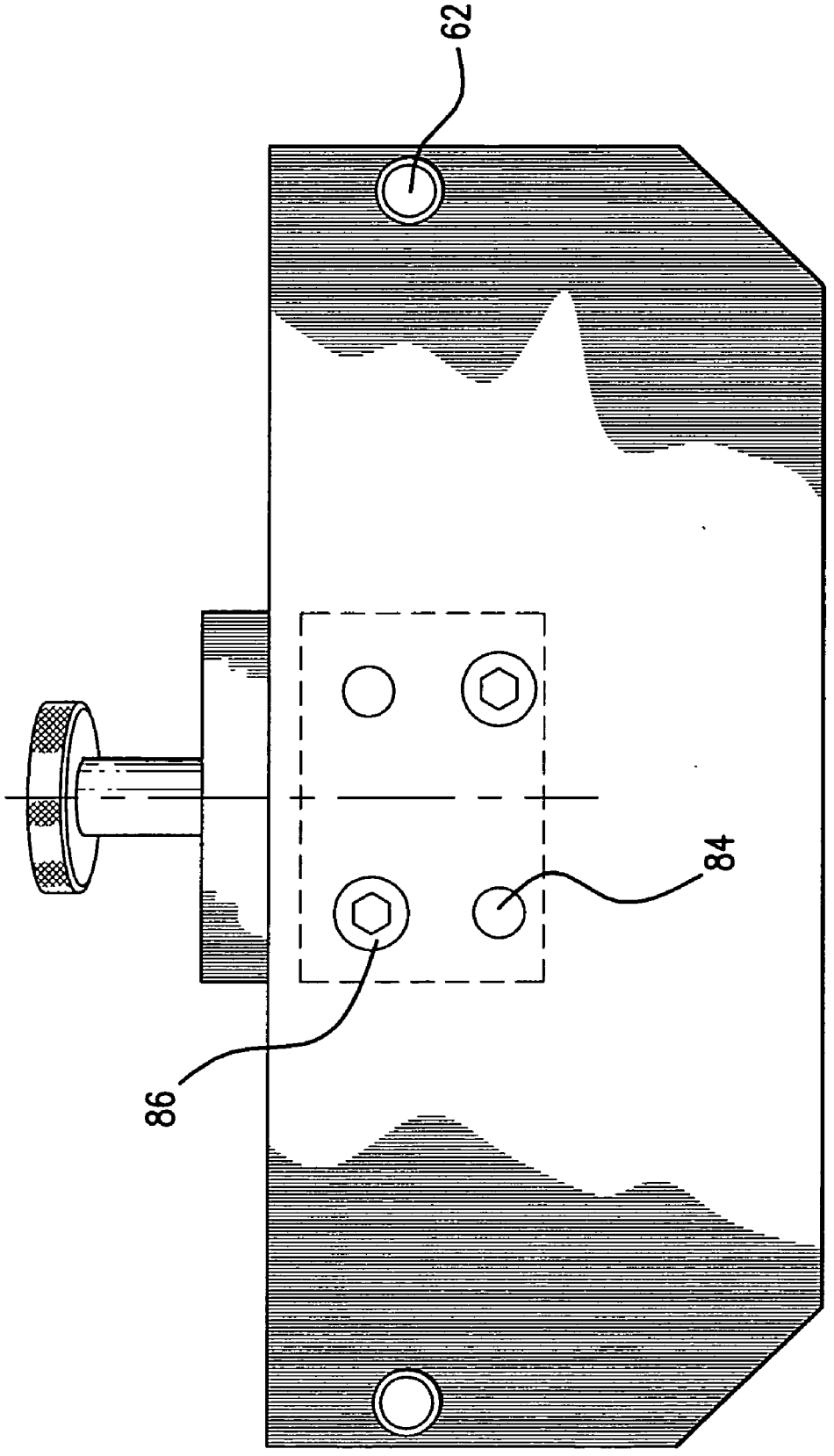


FIG.4

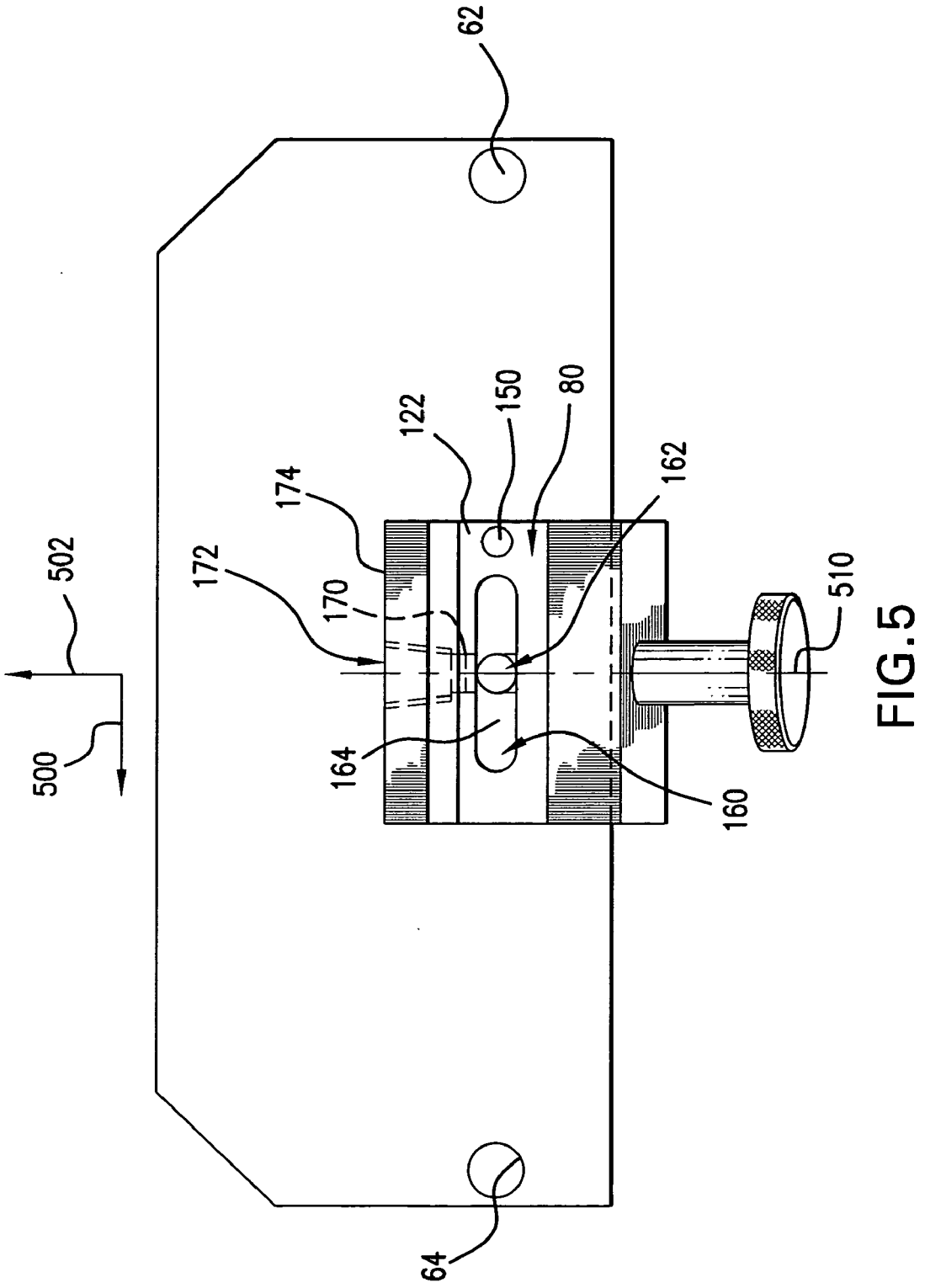


FIG.5

TURBINE ELEMENT REPAIR FIXTURE

BACKGROUND OF THE INVENTION

[0001] The invention relates to repair of turbine engine components. More particularly, the invention relates to fixtures for repairing turbine engine blades.

[0002] Turbine engine blades (including fan, compressor, and turbine section blades) are subject to wear and damage (e.g., foreign object damage (FOD)). Repair of such damage may include coating removal, machining of a wear/damage site, and/or the attachment of a scaffold material. The scaffold material may be externally attached, inserted, or in situ formed. The scaffold surface may define an external or internal surface of repair material built-up atop the scaffold. Exemplary build-up may be by welding (including laser cladding), brazing, or deposition. During repair, the blade may be held in a fixture. An exemplary fixture is a vice-like structure having drawers configured to grasp pressure and suction side surfaces of the blade airfoil.

SUMMARY OF THE INVENTION

[0003] One aspect of the invention involves a fixture for processing a blade. The fixture has first and second jaws. The second jaw is movable relative to the first jaw from a disengaged position for accepting a root of the blade. The blade is accepted in a receiving area between the first and second jaws. The second jaw is movable to an engaged position clamping the blade between the first and second jaws. A gas flow path extends from an inlet port to an outlet port. The outlet port is positioned to introduce gas to a blade inlet port when the blade is installed. In various implementations, at least one of the jaws may be removable and replaceable with a structurally different jaw to permit the fixture to accommodate a structurally different blade. The fixture may be used in a build-up repair on the blade. During the repair, a suitably non-reactive gas may be introduced through the fixture to limit or avoid adverse reaction (e.g., oxidation) of a scaffold element, the blade parent material, and/or the deposition material.

[0004] The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. **1** is a view of a blade processing station.

[0006] FIG. **2** is a side view of a fixture from the station of FIG. **1**.

[0007] FIG. **3** is a front view of the fixture of FIG. **2**.

[0008] FIG. **4** is a bottom view of the fixture of FIG. **2**.

[0009] FIG. **5** is a top view of the fixture of FIG. **2**.

[0010] Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0011] FIG. **1** shows a station **20** for processing (e.g., repair) of a turbine element **22** (e.g., a gas turbine engine compressor or turbine section blade). The blade **22** is held by a fixture **24**.

[0012] An exemplary processing of the blade involves adding material (e.g., a build-up of material in a repair or restoration process). The processing may also or alternatively include removing material (e.g., preparatory or finish machining). An exemplary build-up of material may be by a welding process such as laser cladding. Accordingly, to apply the material, the station **20** may include a welding head **30**. To position the head **30** relative to the blade **22**, one or both of the head **30** and fixture **24** may be movable. For example, the fixture **24** may be mounted to an automatically controlled reference such as a five-axis rotary table **32**. An exemplary head is a laser cladding head having a nozzle **34** and metal powder feed lines **36**.

[0013] FIG. **2** shows further details of an exemplary blade **22** and fixture **24**. The blade has an airfoil **40**. The airfoil **40** extends from an inboard end **42** at a platform **44** to an outboard tip **46**. In an exemplary repair situation, the tip may have been damaged and the blade is shown having been machined along a surface **48**. A convoluted fir-tree attachment root **50** depends from an underside of the platform **44**. The root **50** has first and second longitudinal ends and first and second circumferential sides **52** and **54**. For reference, "longitudinal", "circumferential", and "radial" directions **500**, **502**, and **504** defined relative to the orientation that the blade assumes when the root **50** is installed in a complementary slot in a disk of a turbine engine. A scaffold element **56** has a first portion extending into a passageway or compartment in the airfoil below the surface **48**. The scaffold **56** has a second portion protruding from the surface **48** for re-forming an end portion of the passageway or compartment when a deposition material is applied atop the surface **48** and scaffold **56**. An exemplary scaffold is a refractory metal-based (e.g., molybdenum) core element.

[0014] The exemplary fixture **24** includes a base **60** for mounting the fixture to the table **32**. An exemplary base **60** is formed as a metal plate (e.g., of an aluminum alloy or steel). In the exemplary base **60**, a pair of metal (e.g., steel) dowel pins **62** (FIG. **3**) have upper portions press fit into associated apertures **64** in the base and have lower portions protruding below an underside **66** of the base. The pins **62** may be received by complementary holes or slots in the table to register the fixture relative to the table. The fixture may be secured to the table by means such as clamps (not shown).

[0015] The upper surface **68** of the exemplary base **60** carries a root-engaging clamp structure **70**. The exemplary clamp structure **70** (FIG. **2**) includes a fixed jaw **72** and a movable jaw **74**. The fixed and movable jaws **72** and **74** cooperate to define a channel-like receiving area **76** for receiving the blade root **50**.

[0016] The exemplary fixed jaw **72** includes the unitary combination of a bottom portion **80** along the base **60** and a wall portion **82** opposite the moving jaw **74** and extending away from the base **60**. The exemplary fixed jaw is mounted to the base by means of registering pins **84** and screws **86** (FIG. **4**).

[0017] A screw or other means are provided for tightening the moving jaw **74**. An exemplary screw assembly **90**

includes a threaded shaft **92** passing through a bore **93** in the jaw **74** and into threaded engagement with a bore **94** of the fixed jaw **72**. The exemplary screw **90** further includes an actuator **96** (e.g., a knob). The exemplary knob **96** has a bore **98** receiving an outboard portion of the screw. Tightening/loosening of the knob **96** may do one or both of tightening/loosening of the shaft relative to the knob or the shaft relative to the screw fixed jaw to shift the moving jaw **74** toward/away from an engaged condition.

[**0018**] The exemplary screw assembly **90** has a central axis of rotation **510** at an angle θ off-parallel to the base underside **66**. Exemplary θ is 5-30°. With the radial direction **504** essentially normal to the underside **66**, the axis **510** is off-normal to the radial direction by θ. The exemplary bottom portion **80** has a front face **120** oriented normal to the axis **510**. The fixed jaw bottom portion **80** has a generally horizontal upper surface **122**. With the blade installed and the jaws in the engaged condition, an underside **124** of the root contacts the bottom portion upper surface **122**. A shoulder **130** of the fixed jaw wall portion **82** engages an associated neck region **132** of the adjacent side of the root. An upper rear edge portion **140** of the moving jaw **74** engages a neck portion **142** of its adjacent side of the root. The off horizontal angle of the axis **510** helps cause the moving jaw **74** to exert a downward force to the blade root, clamping the blade root both against the fixed jaw wall portion **82** and bottom portion **80**.

[**0019**] The exemplary fixture includes additional means for precisely registering the blade relative to the fixture. Exemplary registering means include a projection at least partially captured in an aperture of the blade. In the illustrated embodiment, the projection is formed by the upper end of a pin **150** (FIGS. **3** and **5**). The exemplary pin **150** (e.g., steel) has a pin upper portion protruding from the fixed jaw bottom portion **80** upper surface **122** and a pin lower portion received in press-fit relation in an associated bore in the fixed jaw bottom portion **80**.

[**0020**] A channel **160** (FIG. **5**) is formed in the fixed jaw bottom portion upper surface **122**. The exemplary channel **160** extends elongate in the blade longitudinal direction **500** (i.e., transverse also to the axis **510**). The exemplary channel **160** is obround and may be formed by milling. A bored port **162** extends downward from a base **164** of the channel. The port meets a transverse bore **170** (e.g., extending approximately in the blade circumferential direction **502**) from an inlet port **172** on the backside **174** of the fixed jaw. The bore **170** may include pipe threads for engaging a fitting (not shown) to couple the fixture to a source **180** (FIG. **1**) of inert gas (e.g., argon or other noble gas or a gas essentially non-reactive in the welding process). For example, otherwise desirable materials for scaffold elements may be subject to oxidation or other chemical degradation. These may include refractory metal-based cores for forming/reforming internal passageways. The gas may be effective to limit such degradation to a tolerable amount or essentially eliminate it.

[**0021**] One or more embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, details of the particular turbine elements to be worked upon and details of the work station may influence details of any particular implementation. Accordingly, other embodiments are within the scope of the following claims.

What is claimed is:

1. A fixture for processing a blade comprising:

a first jaw;

a second jaw, movable relative to the first jaw from a disengaged position for accepting a root of the blade in a receiving area between the first and second jaws to an engaged position clamping the blade between the first and second jaws; and

a gas flow path from an inlet port to an outlet port, the outlet port positioned to introduce gas to a blade inlet port when the blade is installed.

2. The fixture of claim 1 wherein:

the first jaw is unitarily formed with or secured relative to a bottom portion for said receiving area.

3. The fixture of claim 1 wherein:

the outlet port is formed in a foot portion of the first jaw.

4. The fixture of claim 1 further comprising:

a base having a mounting surface defining a mounting plane; and

a screw for securing the second jaw against the root, the screw having a screw axis 5-30° off parallel to the mounting plane.

5. The fixture of claim 1 in combination with the blade and wherein:

the first and second jaws respectively engage first and second lateral sides of the root.

6. The fixture of claim 1 in combination with a welding station and wherein:

the fixture is mounted to a rotary table of the welding station.

7. The fixture of claim 1 in combination with a welding station and wherein:

the fixture is mounted to a rotary table of the welding station.

8. The combination of claim 1 in combination with a welding station and wherein:

the inlet port is coupled to a source of an essentially inert gas.

9. A method for processing a turbine engine blade comprising:

placing a root of the blade in a receiving area of a fixture;

tightening a clamping portion of the fixture against the root;

delivering a gas through the fixture and the blade through a port in the root; and

adding material to a site on the blade.

10. The method of claim 9 wherein:

during at least a portion of the adding, the gas exits through at least a first outlet at the site.

11. The method of claim 10 wherein:

the adding closes the first outlet.

12. The method of claim 9 wherein:

the tightening comprises rotating an actuation member about an axis off normal to a central radial plane of the root by 5-30°.

13. The method of claim 9 further comprising:

mounting the fixture to an automated table.

14. The method of claim 9 wherein:

the adding comprises welding.

15. An apparatus for processing a blade comprising:

means for receiving and gripping a blade root; and

means for introducing introduce gas to a blade inlet port.

16. The apparatus of claim 15 further comprising:

means for welding to the blade.

17. The apparatus of claim 15 further comprising:

means for moving the blade while gripped by the means for receiving.

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