

CLAIMS

What is claimed:

1. A device for removing solids, such as adsorbents or catalyst, from a vessel, the device comprising:
 - a frame structure comprising:
 - a first end member and a second end member;
 - one or more frame members connecting the first end member to the second end member;
 - a first motor and a second motor, each connected to one of the first end member and the second end member;
 - a first rotatable screw connected at a first end to the frame structure via an end bearing and operably connected at a second end to the first motor;
 - a second rotatable screw connected at a first end to the frame structure via an end bearing and operably connected at a second end to the second motor;
 - a vacuum head connected to the frame structure on or proximate the first end member, the vacuum head having a suction end and a discharge end connectable to a vacuum hose.
2. The device of claim 1, wherein the first end member and second end member are plates.
3. The device of claim 1, wherein at least one of the one or more frame members is expandable and contractible to selectively vary a distance between the first end plate and the second end plate.
4. The device of claim 1, wherein the first rotatable screw and the second rotatable screw are configured to rotate in opposite directions when both are providing forward propulsion.
5. The device of claim 1, wherein each of the first and second motors are independently operable, such that, independently, the first motor may rotate the first rotatable screw clockwise or counterclockwise, and the second motor may rotate the second rotatable screw clockwise or counterclockwise, thereby providing propulsion and turning capability.
6. The device of claim 1, wherein the first and second end plates comprise multiple connection points or adjustable connection points such that the frame structure is connectable to first and second rotatable screws of different diameter.

7. The device of claim 1, further comprising a counterweight disposed on the frame structure on or proximate the second end member, wherein the counterweight counterbalances the weight disposed on or proximate the first end member.
8. The device of claim 7, wherein a position of the counterweight is adjustable.
9. The device of claim 8, wherein a position of the counterweight is remotely adjustable.
10. The device of claim 1, further comprising a camera mounted directly or indirectly to the frame structure.
11. The device of claim 1, further comprising a light connected directly or indirectly to the frame structure.
12. The device of claim 1, further comprising a sensor or detector mounted directly or indirectly to the frame structure.
13. The device of claim 1, further comprising one or more bumpers directly or indirectly coupled to the frame structure.
14. The device of claim 1, wherein a position of the vacuum head is adjustable via a mechanical linkage connecting the vacuum head to the frame structure.
15. The device of claim 14, wherein a position of the vacuum head is remotely adjustable.
16. The device of claim 1, wherein the discharge end and the suction end of the vacuum head are detachable.
17. The device of claim 1, further comprising a breaking device directly or indirectly coupled to the frame structure.
18. The device of claim 17, further comprising a third motor for rotating or driving the breaking device.
19. The device of claim 17, wherein the breaking device includes one or more of:
 - a breaking device coupled to the second end member;
 - a breaking device coupled to the first end member; or
 - a breaking device coupled to or integral with the vacuum head.
20. The device of claim 17, wherein the breaking device comprises ripper teeth, sheep foot rollers, paddles, crushers, or a nitrogen jet.
21. The device of claim 1, wherein the first and second motors are pneumatic motors, the motors further comprising an exhaust system configured to discharge gas proximate the suction end of the vacuum head.
22. The device of claim 1, further comprising means for adjusting a suction through the vacuum head.

23. The device of claim 1, wherein a position of the vacuum head is adjustable via a hydraulic cylinder connecting the vacuum head to the frame structure.
24. The device of claim 23, wherein a position of the vacuum head is remotely adjustable.
25. The device of claim 17, wherein the breaking device comprises a disc harrow, a worm drive, a chipping gun, or a hydraulic/pneumatic splitter and drill.
26. The device of claim 20, wherein the breaking device is raised and lowered by a hydraulic cylinder.
27. The device of claim 25, wherein the breaking device is raised and lowered by a hydraulic cylinder.
28. A system for removing solids, such as adsorbents or catalyst, from a vessel, the system comprising:
 - a device according to any one of claims 1-27;
 - a vacuum unit connected to the discharge end of the vacuum head via a vacuum hose;
 - and
 - a power unit coupled to the device.
29. The system of claim 28, further comprising a jib configured to attach to the vessel, raise and lower the device into and out of the vessel, and to support a weight of the vacuum hose.
30. The system of claim 28, further comprising a jib configured to attach to the vessel access platform, with an arm that extends into a side manway to enter and retract the device into and out of the vessel via a horizontal opening and still also raise and lower the device inside the vessel, and potentially to also support a weight of the vacuum hose.
31. The system of claim 29, further comprising an adjustable base plate to connect the jib to different manway configurations.
32. The system of claim 29, further comprising a control unit configured to control operation of the device.
33. The system of claim 28, further comprising a control station for remotely operating the device.
34. A method of removing solids, such as adsorbents or catalyst, from a vessel, the method comprising:
 - locating a system according to any one of claims 28-33 proximate the vessel;
 - disposing the device within the vessel; and

removing solids from the vessel by operating the device, the vacuum unit, and the power unit.