United States Patent

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[54] **PICKUP DEVICE**
8 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **294/64**
[51] **Int. Cl.** **B66c 1/02**
[50] **Field of Search** 294/64

[56] **References Cited**

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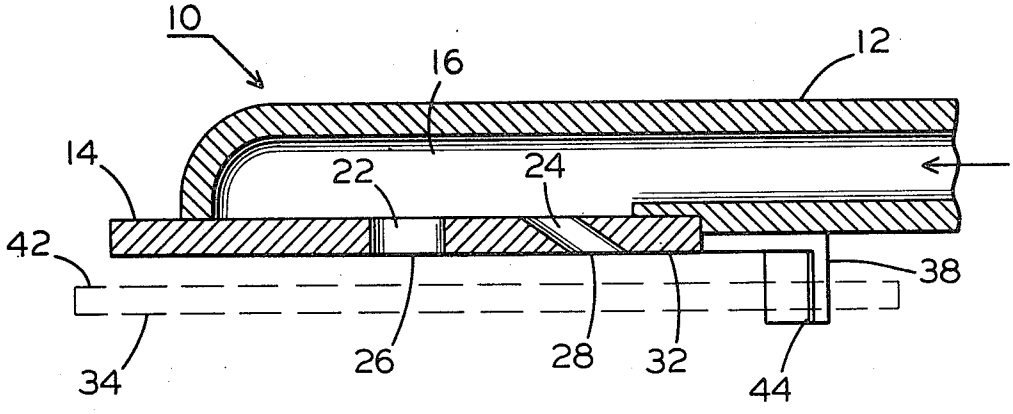
ABSTRACT: A fluid flow is provided in radially opposite directions over the surface of a work piece to provide lift and a fluid flow is directed over the surface towards depending members of the device to urge the work piece against the members and restrict its lateral movement.



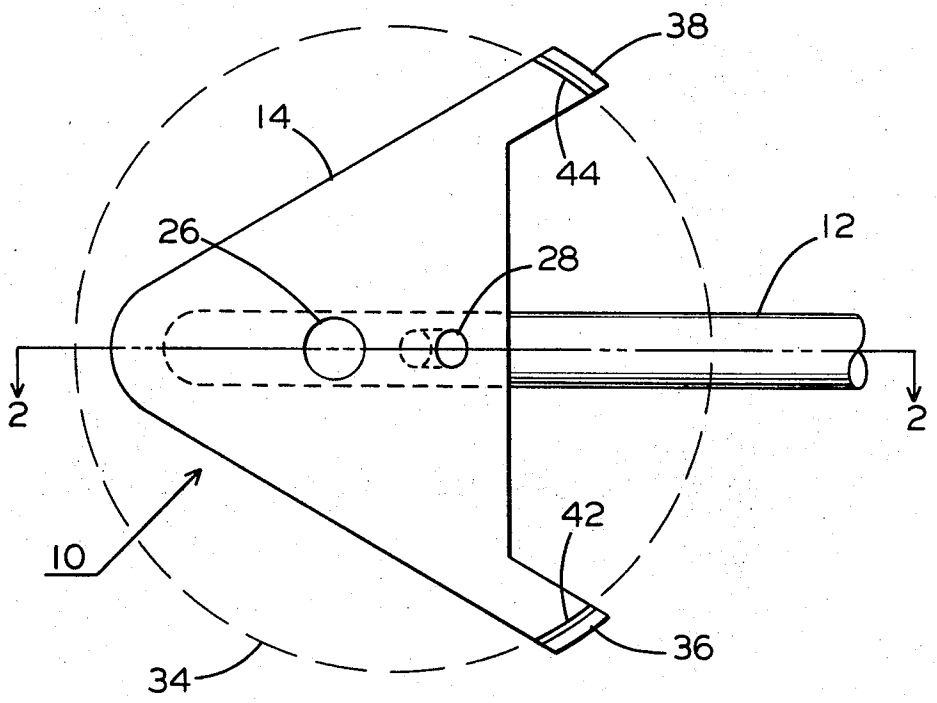


FIG. 1

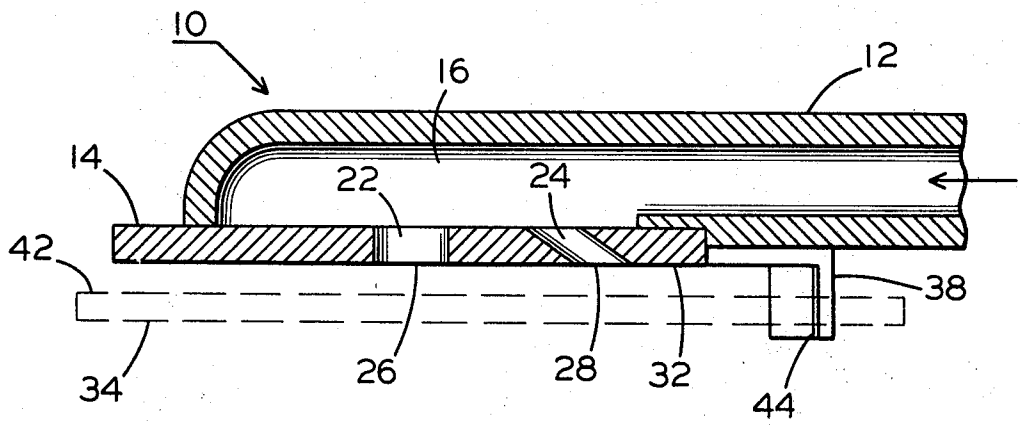


FIG. 2

PICKUP DEVICE

BACKGROUND OF THE INVENTION

This invention relates to pickup devices and more particularly to a pickup device which restricts vertical and lateral movement of a work piece without contact with the upper surface thereof.

In the prior art, pickup devices which utilize high velocity fluid flow to lift materials are well known. These generally operate by directing a flow of fluid such as a gas or the like in radially opposite directions over the upper surface of the work material so as to lift or attract a work piece towards the device. At the same time, the fluid provides an air or gas cushion so that the material surface does not come into contact with the unit.

While this type of device is suitable for automatic lifting of large sheet material which is to be maintained in a horizontal position, it is not well suited to the lifting and transporting by hand of small units as employed in the electronic arts; for example, semiconductor wafers or the like. This follows from the fact that the force exerted on the work material by the prior art devices is essentially normal to its surface and lateral movement of the work piece with respect to the apparatus is relatively unrestricted. Hence, the work tends to slide on the gas bearing and fall from the pickup device when it is tipped or moved quickly.

One object of the invention is to provide a device suitable for securely picking up material without deleterious contact with the upper surface thereof.

Another object of the invention is to provide a pickup device which firmly positions work material beneath the device.

A further object of the invention is to provide a pickup device which restricts lateral movement of the work material with respect to the device.

A still further object is to provide a pickup device having an unbalanced flow of fluid across a surface of the work to bias the work edge against depending members of the device.

SUMMARY OF THE INVENTION

A pickup device constructed in accordance with the invention comprises means for lifting a body, means limiting the lateral movement of said body in at least one direction, and means directing a flow of fluid across a surface of said body in said one direction so as to urge said body against said limiting means.

In a more limited sense, a pickup device constructed in accordance with the invention comprises a head adapted to provide a flow of fluid in radially opposite directions across a surface of a body for lifting thereof and an unbalanced flow of fluid across a surface of said body in the direction of depending members of said head for biasing said body thereagainst.

In a still more limited sense, the pickup device includes a hollow head adapted for coupling to a source of fluid under pressure, said head having a pair of ports and a depending member on the underside thereof, one of said ports being adapted to direct a flow of fluid in radially opposite directions over a surface of said body for lifting thereof, and the other of said ports being disposed between said one port and said member, and said other port being adapted to direct an unbalanced flow of fluid over said surface in the direction of said depending member for urging said body thereagainst and thereby positions said body beneath said head and restricts lateral movement of said body thereto.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a plan view of the underside of a pickup device provided in accordance with the invention; and

FIG. 2 is a cross section of pickup device taken along the line 2–2 of FIG. 1.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1 and 2 illustrate the pickup device of the preferred embodiment wherein a hollow head **10** is adapted for coupling to a source of fluid under pressure by means of transmission line **12**. Head **10** includes a triangular shaped plate **14** which is joined to line **12** to form a fluid chamber **16**.

A pair of passageways or ports **22** and **24** extend from chamber **16** through plate **14** and terminate in spaced apart orifices **26** and **28** of the underside or lower surface **32** of plate **14**. Ports **22**, **24** are arranged to direct fluid across a surface of a work piece **34** such as a wafer or the like which is to be picked up.

Plate **14** also includes a pair of spaced apart fixed members **36** and **38** which extend out of or beyond the outlet end of ports **22** and **24**. Members **36**, **38** extend out of the plane of outlet orifices **26**, **28** and at an angle to this plane. Preferably, the plane of the members is perpendicular to that of the orifices. Members **36**, **38** depend from the periphery of plate **14** and provide a positioning means for an edge of the work material **34** which limits lateral movement of the body in the direction of these members. Hence, the members provide a stop for the edge of the body.

In this embodiment, port **22** provides a passageway which is substantially perpendicular to the lower plate surface **32** such that fluid, for example, air or nitrogen or other gas delivered to chamber **16** will be directed in radially opposite directions across the upper surface **42** of the work piece when head **14** is positioned close to and over the latter. This radial flow provides a decrease in atmospheric pressure on upper surface **42** and a substantially perpendicular force on the work piece which biases or attracts it towards head **10**. Contact with the underside of plate **14** is prevented, however, by the gas flow which also creates a gas cushion or air bearing between head **10** and wafer **34**.

Port **24**, on the other hand, is inclined at an acute angle to the underside (surface **32**) of plate **14** and provides an unbalanced flow of fluid in the direction of the depending members **36** and **38**. This unbalanced flow provides a lateral force (primarily frictional) on the wafer **34** which biases or urges it against members **36** and **38** and hence, restricts lateral movement of the body with respect to head **10**. Small angles of inclination (0 to 30°) are preferable, however, small angles require a large separation between the outlet orifices since the ports, in this embodiment, lie in the same plane. Hence, an angle of inclination of 15° is preferred in this case.

The gas stream emitted from port **24** also provides slight lift (that is a force substantially perpendicular to the wafer) as well as a lateral force so that there is a resultant force from the unbalanced flow which tends to bias the wafer in a lateral and slightly upward direction against the edge stops. Since the unbalanced flow is emitted between the center of the work piece and stops **36** and **38**, its resultant force provides a rotational torque directed upward against the stops which securely holds the wafer against the latter and allows use of the novel device at any angle. Consequently, wafers can be safely lifted from the vertical position in which they are conventionally stored.

It should be noted that although many different arrangements or combinations of the balanced and unbalanced flow are possible, if the unbalanced flow is emitted from a point near the edge opposite the stops or if the position of the ports is reversed, that is, if lifting port **22** is placed between the inclined port **24** and the edge stops there will be a tendency for the wafer to rotate downward along the stops.

Since both the perpendicular and lateral forces on the wafer are functions of not only fluid volume but also the surface distance traversed by the flow, both ports should be positioned back from the edge of the work material. Preferably, main port **22** is centered over the material or slightly off center in a direction away from the depending members, and inclined port **24** is positioned close to the main port and between it and

the depending members. The minimum separation between orifices will depend upon the angle of inclination of port **24** as well as port diameter, etc. In this embodiment, orifices **26** and **28** are approximately .300 inch from center to center.

In the preferred embodiment, ports **22**, **24** lie on a plane which is perpendicular to the plane passing through depending members **36** and **38** and bisects the separation between them. This insures that the lateral force on the wafer will be directed substantially perpendicular to the plane of the stops and on a line bisecting them so as to stabilize the wafer against them.

Two spaced apart stops are employed in this embodiment to allow handling of objects of different shapes. In this case, members **36** and **38** are substantially perpendicular to the outlet plane of the ports and are curved in this plane to conform to the generally circular perimeter of a conventional semiconductor wafer. However, this spaced apart arrangement will accommodate work pieces of many different shapes such as circular, rectangular, triangular or irregular shaped pieces.

It should be understood of course that since the device utilizes a lateral surface force to position the work piece against the edge stops, the work piece should preferably be substantially rigid. Moreover, in order to develop sufficient lift in comparison to the weight of the work material, a thin substantially planar work piece is most suitable.

Preferably, depending members **36** and **38** are made narrow so as to minimize contact of the wafer edge. In addition, their inner faces **42** and **44** are coated with a nonmarring and noncontaminating coating such as, for example, polytetrafluoroethylene or the like. Hence, since only the fluid and coated members **36**, **38** come in contact with the work piece, head **10** can be made of many different materials such as aluminum or nickel or the like.

The unit may also assume many different shapes. Plate **14** preferably provides a generally planar undersurface for suitable lifting and air cushioning, etc., however, the plate may be circular, rectangular or irregular in shape, rather than triangular as shown. Similarly, many different shapes and any number of dependent members are useful. Preferably, these edge stops will depend from the underside of the head as shown, and will be grouped together to limit lateral movement in one direction. Thus, a number of spaced-apart stops might be employed with the indicated bisecting fluid flow or, alternatively, a plurality of unbalanced fluid flows directed perpendicular to the plane of a single narrow stop may also be suitable. For example, two inclined ports equally spaced on each side of the plane of the lifting port and the single member can be suitably employed. In addition, a single wide stop may also be useful.

The fluid flow, which is a function of port size and source pressure, is determined in accordance with the size and mass of the object to be picked up. The relative flow from each port must also be controlled. In this embodiment, since both ports are in communication with the same fluid chamber their relative flow is a function of their respective diameters.

The inclined port is preferably made smaller in diameter than that of main port since the fluid flow from the former is more concentrated on the wafer. For example, the diameter of the smaller port may be made slightly less than one-half that of the main port.

In a specific example, a main port of 0.062 inch diameter and an inclined port of .025 inch was utilized with a source pressure of 15 to 100 pounds to lift conventional semiconductor wafers. The smaller port was inclined at an angle of 15° to the horizontal. In this case, less than 15 pounds did not produce sufficient lift whereas over 100 pounds resulted in vibration forces which tend to crack the fragile wafer.

I claim:

1. A pickup device comprising at least a pair of ports, one of said ports being disposed substantially perpendicular to the upper surface of a body for directing a flow of fluid in radially opposite directions over said surface so as to provide a lifting thereof, at least one member which extends beyond the outlet end of said ports for limiting lateral movement of said body in at least one direction, and the other of said ports being disposed at an acute angle to said surface for directing an unbalanced flow of fluid over said surface in said one direction for urging said body against said limiting member.

2. The device of claim **1** including a hollow head adapted for coupling to a source of fluid under pressure, said pair of ports being disposed on the underside of said head, and said member depending from said head and extending beyond the underside thereof.

3. The device of claim **2** wherein said depending member includes a nonmarring and noncontaminating surface for limiting the lateral movement of said body.

4. The device of claim **3** wherein said nonmarring and noncontaminating surface is polytetrafluoroethylene.

5. The device of claim **2** wherein the direction of unbalanced fluid flow is substantially along a plane passing through both ports.

6. The device of claim **5** including a plurality of said depending members in spaced relation, and said plane bisects said plurality.

7. The device of claim **6** wherein said head has a substantially planar underside, said plurality of members depend from the periphery of said underside, and said other port which emits an unbalanced flow of fluid over said surface is disposed between said one port and said members to provide positive engagement of an edge of said body with said members.

8. The device of claim **3** wherein said other port is smaller in diameter than said one port.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,539,216 Dated November 10, 1970

Inventor(s) Edward C. Forcier

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 49, "claim 3" should read -- claim 2 --

SIGNED AND SEALED

Febuary 2, 1971

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents