

[54] SEMICONDUCTOR WAFER TRANSFER
FIXTURE

- [75] Inventor: **Robert William Hurlbrink, III**,
Sinking Spring, Pa.
[73] Assignee: **Bell Telephone Laboratories,**
Incorporated, Murray Hill, Berkeley
Heights, N.J.
[22] Filed: **June 29, 1973**
[21] Appl. No.: **375,020**

- [52] U.S. Cl. **294/87 R**, 294/106, 294/116
[51] Int. Cl. **B65b 5/08**, B66c 1/48
[58] Field of Search 294/1 R, 15, 16, 86 R,
294/87 R, 99 R, 100, 106, 115, 116; 29/278
R; 81/3 R; 214/309; 53/247, 254

[56] **References Cited**
UNITED STATES PATENTS

- | | | | |
|-----------|---------|----------------------|-----------|
| 1,938,485 | 12/1933 | Cossor | 294/106 |
| 3,126,222 | 3/1964 | Stuart | 294/116 X |
| 3,163,401 | 12/1964 | Johnston et al. | 294/116 X |
| 3,179,137 | 4/1965 | Kilner | 294/106 X |
| 3,581,653 | 6/1971 | Boyer et al. | 294/116 X |

Primary Examiner—Richard A. Schacher
Assistant Examiner—Johnny D. Cherry
Attorney, Agent, or Firm—H. W. Lockhart

[57] **ABSTRACT**

A wafer transfer fixture for transferring a batch of circular semiconductor wafers from deep-walled containers used for storage and washing operations to slotted platforms used as furnace boats. The wafer transfer fixture comprises a wafer carrier having transversely-disposed grooves for holding individual wafers, which is split longitudinally into two halves like a clam shell and is mounted within a support frame. Each half of the split carrier is hinged about an upper, central axis to enable the halves to separate in clam-shell fashion when cammed apart by thumb depressed plungers on the support frame. The top face of the fixture is arranged to register with the top face of the deep-walled container to enable convenient transfer from container to fixture, and the reverse, of the entire batch of wafers by gravity action. The bottom of the split carrier is partially open so that the lower segment of each wafer protrudes. The transfer fixture is placed atop a furnace boat using registration elements whereupon each protruding wafer rests in a corresponding slot in the platform of the furnace boat. The split halves of the carrier are then cammed apart so that the fixture can be lifted away leaving the batch of wafers resting on the furnace boat. The process is reversible.

3 Claims, 11 Drawing Figures

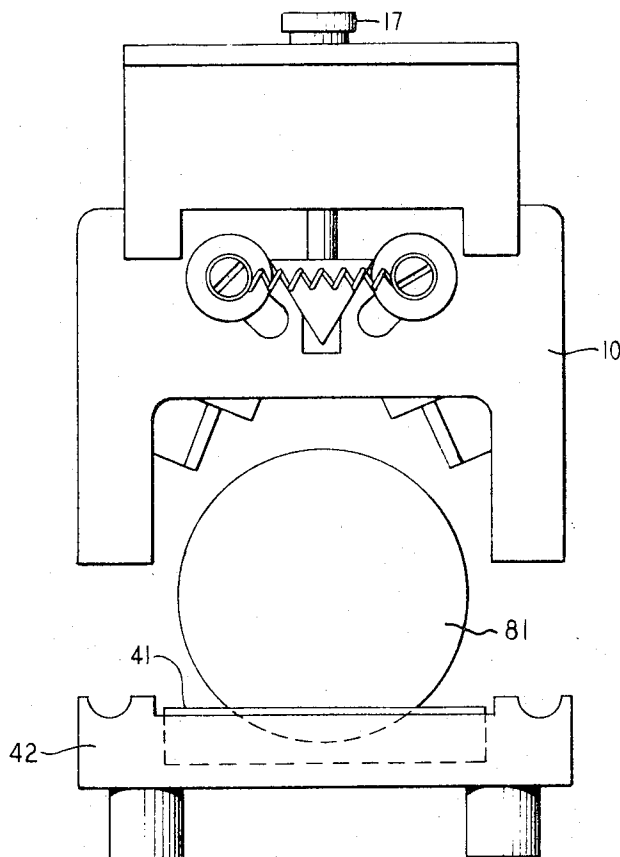
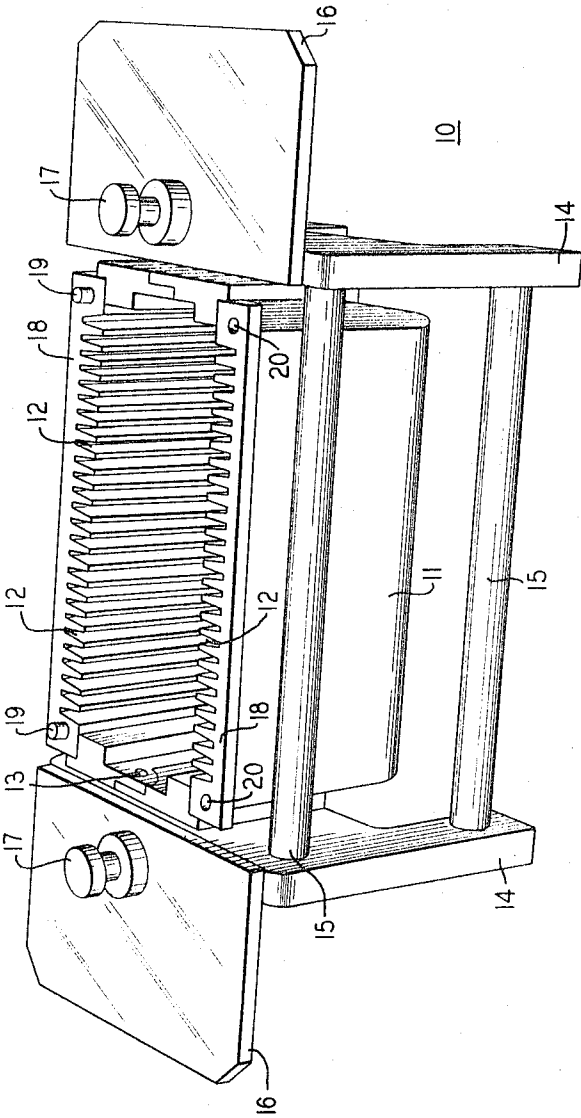


FIG. 1



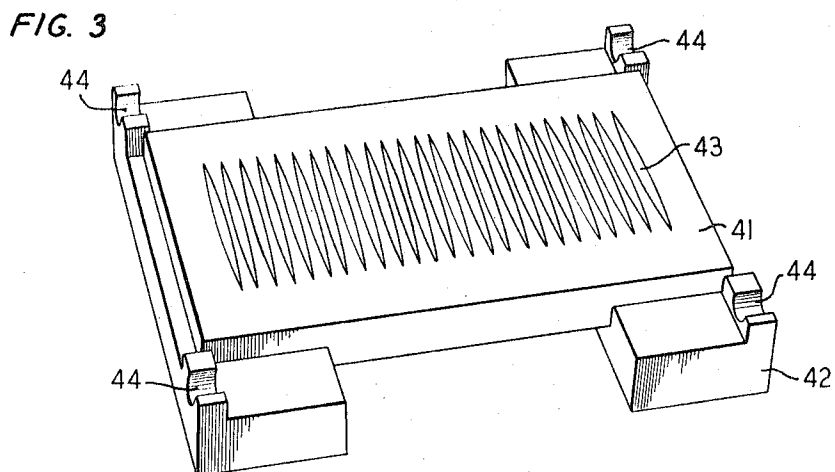
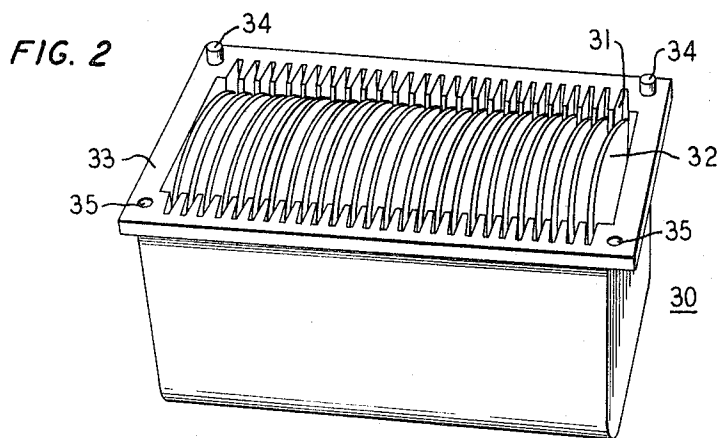


FIG. 11

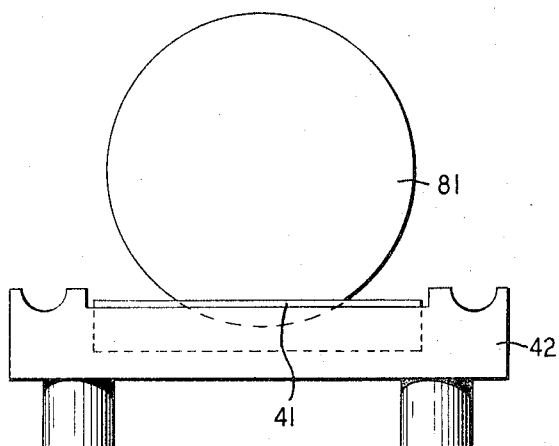
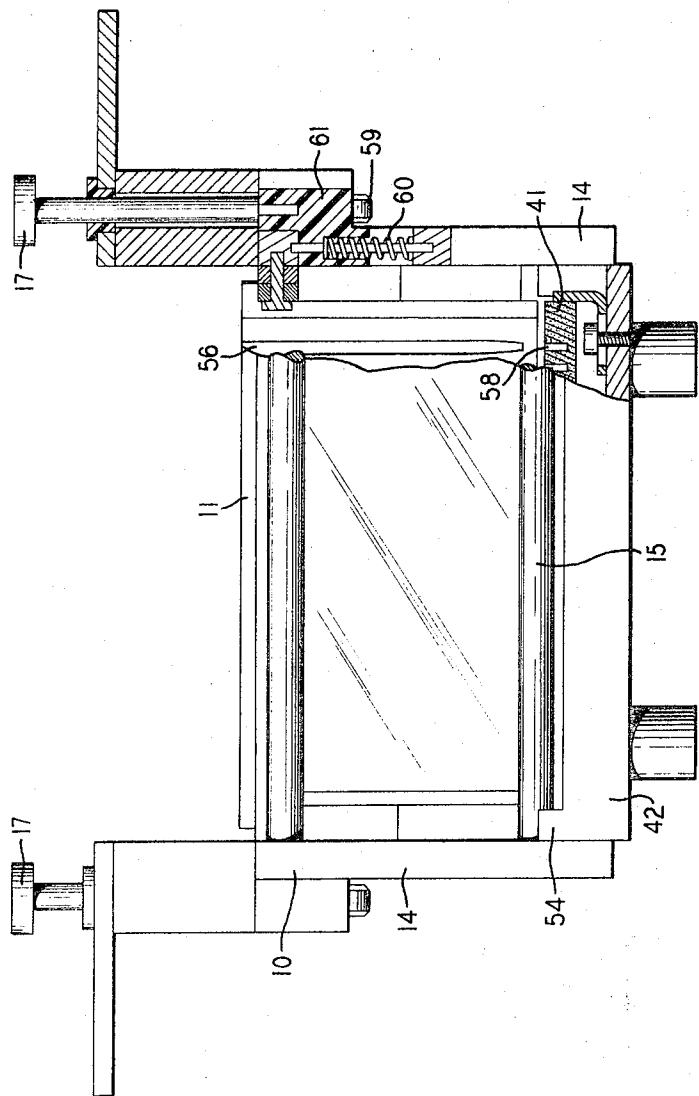


FIG. 4



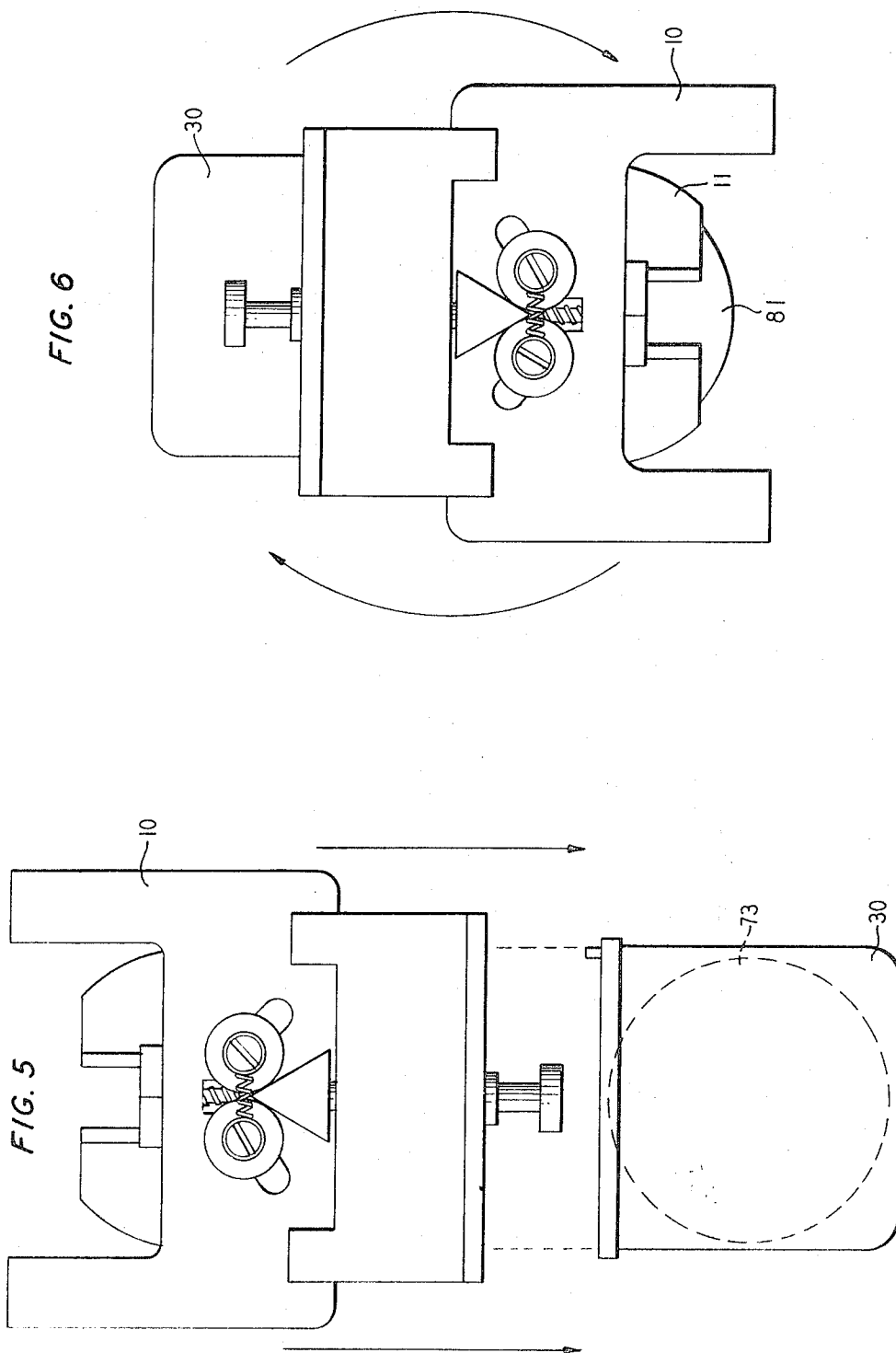


FIG. 7

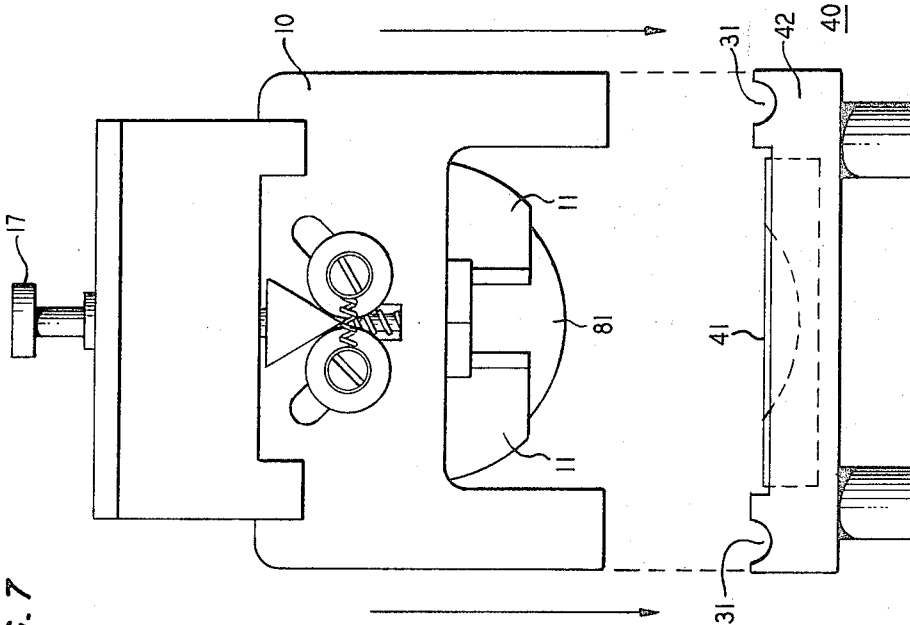


FIG. 8

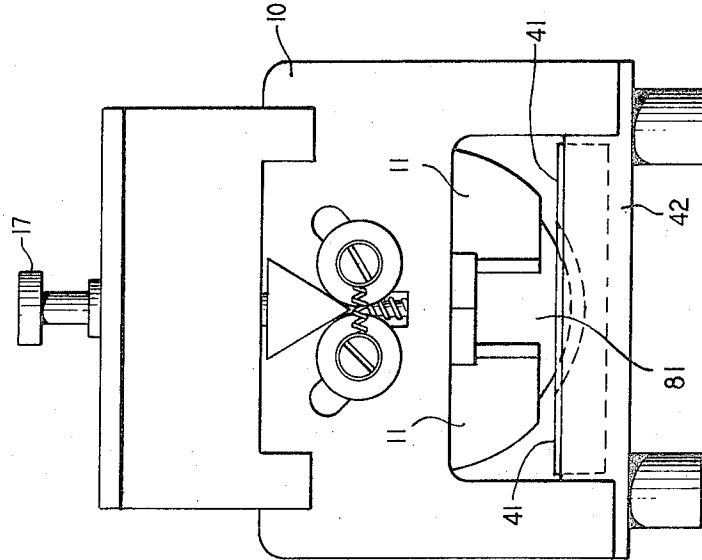


FIG. 10

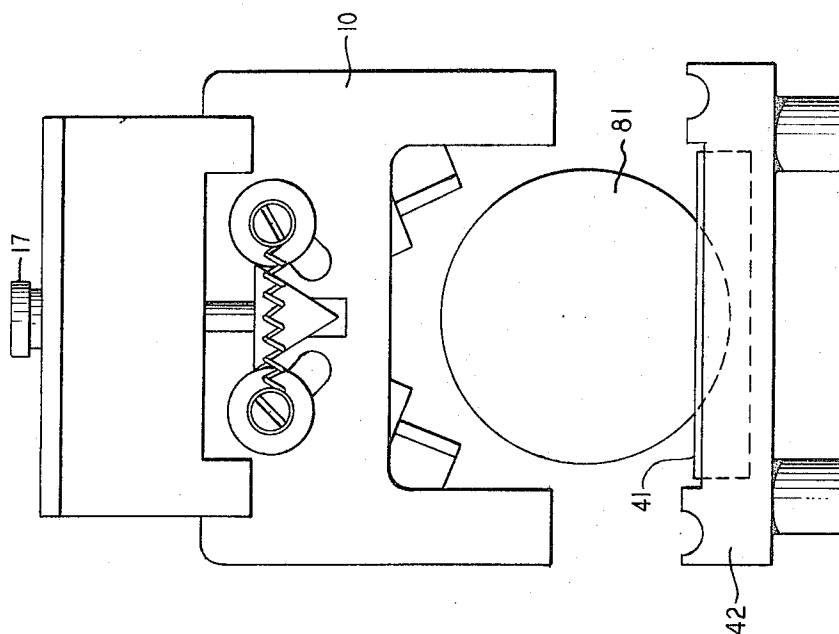
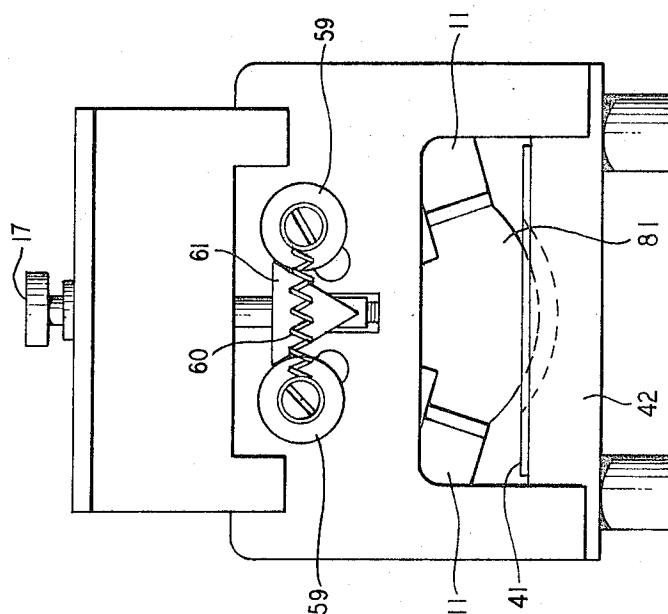


FIG. 9



SEMICONDUCTOR WAFER TRANSFER FIXTURE

This invention relates to semiconductor device fabrication and particularly to the handling of semiconductor wafers.

BACKGROUND OF THE INVENTION

Semiconductor wafers are large, substantially circular, slices of monocrystalline semiconductor material, formed by transverse cutting of the single crystal ingots which are the product of the crystal formation process. Typically, such wafers are the basic medium from which large numbers, hundreds of thousands, of individual semiconductor devices are made using the well-known dielectric coating, photolithographic masking and impurity introduction techniques. These semiconductor wafers are highly polished on both faces and when prepared for introduction into the device fabrication process, range in thickness, typically from about 30 to as thin as 10 mils and may be 2 or 3 inches or more in diameter. The latter dimension is rapidly becoming a standard in the industry for silicon semiconductor wafers.

Even at this point, before any device fabrication processing has been done on them, these wafers have considerable value as a product requiring rather unique and precise processing techniques. They are relatively fragile and their highly polished surfaces are readily damaged by mishandling with the result that they may be unusable for device fabrication.

These wafers are handled in batches of typically twenty to forty in bucket-like plastic containers having transversely-disposed grooves to retain each individual wafer. These deep-walled containers are useful for storage and for the myriad of washing and wet chemical treatments which are a part of the processing. However, for the numerous precessing steps carried out at high temperatures, such as oxidation and impurity diffusion, the wafers are mounted on a slotted platform or boat so that a minimum of the wafer surface is masked from the ambient, the boat being capable of withstanding temperatures of the order of 1000° C. or more.

It has been the practice heretofore to perform the transfer of polished semiconductor wafers individually and manually, using suitable tweezers to protect the fragile wafers. This is a slow and tedious process, dependent to considerable extent upon the performance of a skilled operator. Moreover, even with specially coated tweezers, damage still occurs to parts of the polished surfaces of the wafers.

Accordingly, an object of this invention is the transfer of semiconductor wafers in batches from the deep-walled type of container to the unwallled furnace boat and vice versa without the individual, manual handling which has been the previous practice.

SUMMARY OF THE INVENTION

In accordance with this invention, a batch of semiconductor wafers, which are substantially circular and of a uniform diameter, are transferred simultaneously from a deep-walled container to an unwallled furnace boat and vice versa by means of a wafer transfer fixture. This fixture comprises a wafer carrier somewhat similar to the deep-walled plastic container in that it likewise has a series of transversely-disposed internal grooves for retaining individual wafers. This carrier, however, is split into two halves longitudinally and is

mounted within a support frame. Each half of the split carrier is hinged about an upper, central axis so that the two halves may be rotated apart like a clam shell. Such rotation is produced by a camming action generated by depressing plungers affixed to the support frame. The top face of the carrier portion of the transfer fixture is arranged to register with the top face of the deep-walled container to enable the transfer from one grooved carrier to the other of the entire batch of wafers simply by gravity action.

The bottom of the split carrier of the transfer fixture is arranged so that the lower portion of each wafer protrudes therefrom. The transfer fixture is placed on top of a furnace boat or platform which rests in a supporting alignment frame having registration elements so that each protruding wafer portion rests in a corresponding slot in the furnace boat. The halves of the carrier member then are cammed apart so that the fixture can be lifted away, leaving the batch of wafers resting in the slotted furnace boat. The transfer of the wafers from the boat back to the deep-walled container is done by a reversal of the above-described procedure.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention and its other objects and features will be more readily understood from the following detailed description taken in conjunction with the drawing in which

FIG. 1 is a perspective view of the wafer transfer fixture in accordance with this invention;

FIG. 2 is a perspective view of a standard deep-walled container having a batch of semiconductor wafers therein;

FIG. 3 is a perspective view of a furnace boat resting in an alignment frame;

FIG. 4 is a side view of the wafer transfer fixture of FIG. 1 resting on top of the furnace boat and alignment frame of FIG. 3 with both shown partially in section;

FIG. 5 is a schematic view taken from the end of the wafer transfer fixture aligned with the deep-walled container preparatory to transfer of the batch of wafers from the container to the fixture;

FIG. 6 depicts a progression in the transfer operation showing the batch of wafers in the wafer transfer fixture;

FIG. 7 is a schematic end view showing the wafer transfer fixture aligned with the furnace boat and alignment frame;

FIG. 8 shows an ensuing step in the transfer process with the fixture resting directly on the furnace boat and associated alignment frame; and

FIGS. 9, 10 and 11 depict the following successive steps in transferring the batch of wafers to the furnace boat.

DETAILED DESCRIPTION

FIG. 1 shows a wafer transfer fixture 10 having a carrier 11 with 25 internal grooves 12 for handling up to 25 semiconductor wafers. The carrier 11 is split into two halves by a longitudinal division and is arranged so that each half is supported about a common hinge point 13 on the central axis of the carrier 11 near its top surface. The split carrier 11 is supported from these hinge points 13 at each end by a support member which is comprised of a pair of end plates 14 and support rods 15. A pair of platform members 16 secured to the top

of the end plates 14 provide handles and support for operating plungers 17 which actuate camming means for rotating the halves of the split carrier 11 apart in clam-shell fashion, as will be further explained hereinafter. The upper face 18 of the carrier 11 includes two registration pins 19 on one side and two recesses 20 on the other which match similar pins and recesses in the deep-walled container described hereinafter.

FIG. 2 shows a deep-walled container 30 representative of a standard type for holding a batch of semiconductor wafers. The container typically is made of a plastic material such as nylon or polyethylene and has a series of internal grooves 31, each of which is adapted to receive a semiconductor wafer 32. The groove spacing and other dimensions of the container are standard and match the dimensions of the carrier portion of the wafer transfer fixture. The pins 34 and recesses 35 in the top face 33 match the pins 19 and recesses 20 of the transfer fixture carrier 11 as well as those of other containers of the same type. This container is used typically to store semiconductor wafers between operations as well as to provide a suitable receptacle during which certain etching and washing operations may be performed on a batch of wafers.

FIG. 3 shows an assembly 40 comprising a furnace boat 41 resting in a supporting alignment frame 42. The furnace boat 41 has a series of slots 43 corresponding in number and spacing to the grooves in the carrier members described hereinbefore, the slots 43 being of a width and depth to support semiconductor wafers in substantially parallel, upright position. The furnace boat is made of a material capable of withstanding the high temperatures encountered in diffusion and oxidation furnaces and one which is inert or neutral with respect to the other materials involved in such processing. Typically, the furnace boat is made of silicon of high purity, either polycrystalline or single crystal.

The alignment frame 42 within which the boat 41 rests is of metal, such as aluminum or stainless steel, inasmuch as it is not a part of furnace operations but simply provides the alignment and support means for the wafer transfer process. In particular, the alignment frame includes a set of grooves 44 within which the support rods 15 of the transfer fixture rest, as will be explained more fully hereinafter.

Although the furnace boat 41 shown in FIG. 3 contains slots 43 for 25 wafers, it will be understood that boats of considerably greater length may be used accommodating a plurality of 25 wafer batches, for example four, each loaded from a standard transfer fixture. In such instance, the alignment frame 42 is of a configuration to provide the necessary alignment longitudinally and transversely between the transfer fixture and a set of slots 43 in the furnace boat 41. For example, the alignment frame may be as long as the multiple batch furnace boat with a plurality of sets of registration grooves 44, each set related to a set of grooves 43 in the boat 41.

The operation of the wafer transfer fixture may be more readily understood from the schematic representation of FIG. 4. In this view, the transfer fixture 10 is resting on top of the alignment frame 42 in registry or alignment with the furnace boat 41 as a consequence of the mating of the lower support rods 15 with the grooves in the end portions 54 of the alignment frame 42 and by the fact that the length of the frame 42 is just slightly less than the distance between the inside walls

of the end plates 14 of the transfer fixture 10. In the sectioned portion of the drawing the alignment between the groove 56 of the carrier 11 and the slot 58 in the furnace boat 41 is apparent. In addition, the schematic representation shows a portion of the cam follower wheel 59 and the biasing spring 60 for the cam member 61. Although not all of the parts are shown, the function of the fixture will be understood as involving the simultaneous depression of both plungers 17 resulting in depression of a triangular cam member 61 to spread apart the cam follower wheels 59 which are fixedly mounted one to each end of each carrier half. Typically the carrier member is made of a plastic of the same type as the deep-walled container of FIG. 2.

Referring to FIG. 5, the transfer fixture 10 is shown being placed against the deep-walled container 30 using the pin and hole registry arrangement shown in FIGS. 1 and 2. After the two members are nested together, the combination is carefully rotated to place the deep-walled container 30 over the wafer transfer fixture 10 during which the batch of wafers 73 indicated by dotted outline move by gravity into the wafer transfer fixture 10 to the location indicated by the wafer 81 a portion of which projects from the split carrier 11 as shown in FIG. 6.

Referring to FIG. 7, the wafer transfer fixture 10 containing the batch of wafers 81 then is placed on top of the assembly 40 comprising the furnace boat 41 and alignment frame 42 using the registration grooves 31 to properly align the fixture and assembly. At the conclusion of this operation, and as shown in FIG. 8, the portion of each wafer 81 protruding from the open bottom of the split carrier 11 of the transfer fixture 10 is resting in a corresponding slot in the furnace boat 41.

Next, as shown in FIG. 9, depression of the plunger 17 carrying the cam member 61 forces the cam follower wheels 59 apart and thereby cause the two halves of the split carrier 11 to rotate apart in clam-shell fashion. Spring 60 represents schematically means for biasing the split carrier halves toward the closed position. This movement of the carrier halves is sufficient to provide complete clearance of the carrier 11 around the circular semiconductor wafers 81 so that, as shown in FIG. 10, the wafer transfer fixture 10 may be lifted over and away from the furnace boat 41 upon which the batch of wafers 81 now is mounted. Thus, as shown in FIG. 11, the entire batch of wafers 81 is held in the furnace boat 41, ready for insertion in a high temperature apparatus such as a diffusion or oxidation furnace.

Thus, the transfer of an entire batch which typically may range from 20 to 40 semiconductor wafers, is accomplished without the usual manual handling of each individual wafer and without the wafers being subjected to the relatively rough handling associated therewith. The reverse procedure of moving a batch of wafers from the furnace boat to a deep-walled container is accomplished readily by a simple reversal of the operative steps illustrated in FIGS. 5 through 11.

What is claimed is:

1. A wafer transfer fixture for transferring a batch of substantially circular semiconductor wafers between a deep-walled, internally grooved container and a slotted, unwall platform-like carrier for holding a batch of wafers in substantially parallel upright array, said fixture comprising

a wafer carrier having a series of parallel, transverse-disposed, internal grooves for retaining said wa-

5

fers in a separated array, said carrier having an open top and being split into two half portions by a vertical, longitudinally disposed plane, said carrier having a bottom portion arranged to enable a portion of each wafer to protrude therefrom, a support member for hingedly supporting the half portions of the split carrier in clam-shell relation, and camming means attached to said support frame and said half portions for rotating each carrier half portion to separate the carrier halves a distance

6

greater than the diameter of the wafer.

2. A wafer transfer fixture in accordance with claim 1 in which said wafer carrier portion has registration means on the top face thereof for mating with the deep-walled container.

3. A wafer transfer fixture in accordance with claim 1 in which portions of said support member are arranged to register with alignment means for the slotted unwalled platform-like carrier.

* * * * *

15

20

25

30

35

40

45

50

55

60

65