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[72] Inventors James E. Shriver
Plano;
Gerald M. Streater, Richardson, Tex.

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[73] Assignee Texas Instruments Incorporated
Dallas, Tex.
a corporation of Delaware

[54] APPARATUS FOR LOADING AND UNLOADING FURNACE

5 Claims, 2 Drawing Figs.

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[50] Field of Search 214/18, 23, 26; 226/186, 187

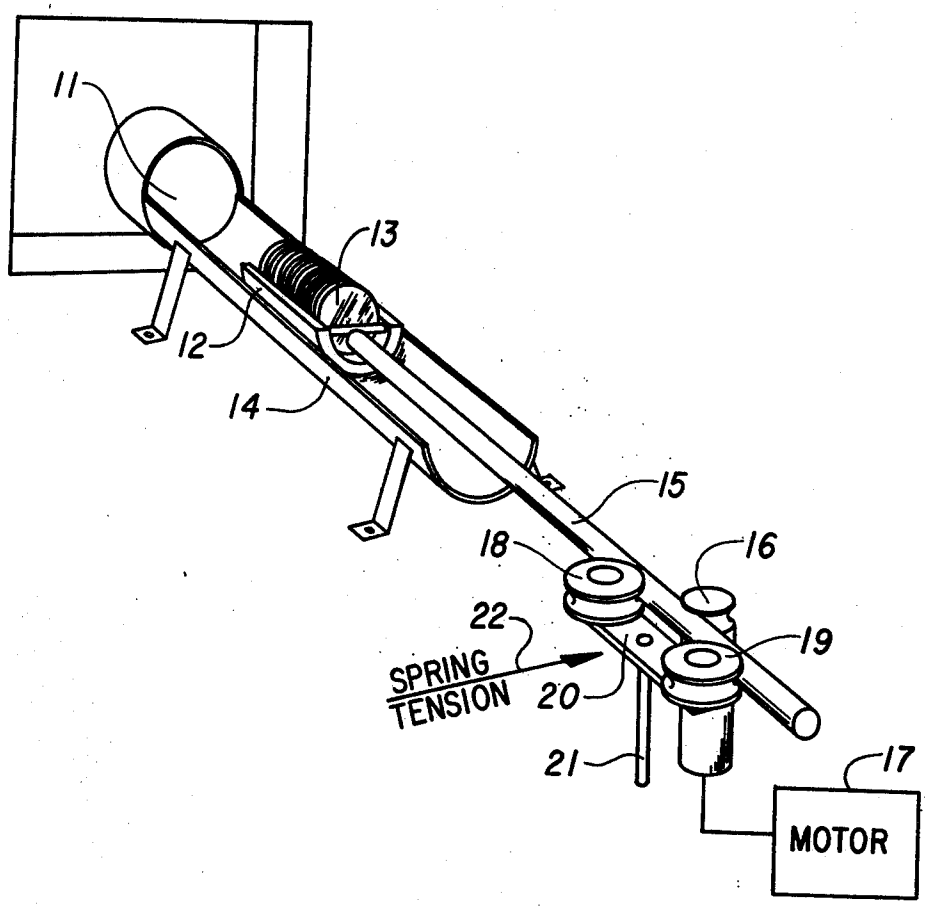
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Primary Examiner—Robert G. Sheridan
Attorneys—James O. Dixon, Andrew M. Hassell, Harold Levine, Melvin Sharp, John E. Vandigriff, Henry T. Olsen, Michael A. Sileo, Jr. and Gary C. Honeycutt

ABSTRACT: In order to minimize slip dislocations, the rates of introduction and withdrawal of semiconductor wafers into and from a high temperature furnace are carefully controlled by means of apparatus comprising a conveyor, a pushrod for moving a furnace boat along the conveyor path, and a novel mechanism for driving the pushrod. The mechanism includes a roller drive and two idler wheels pivotally supported about an axis lying in a common plane with the roller drive axis.



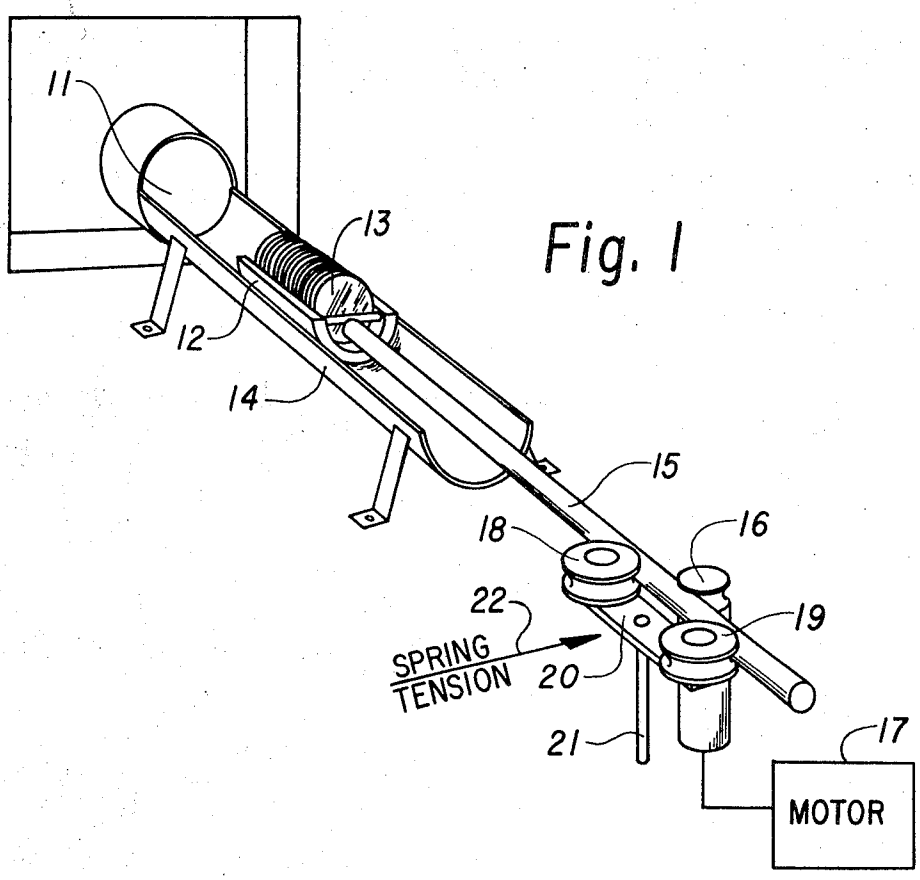


Fig. 1

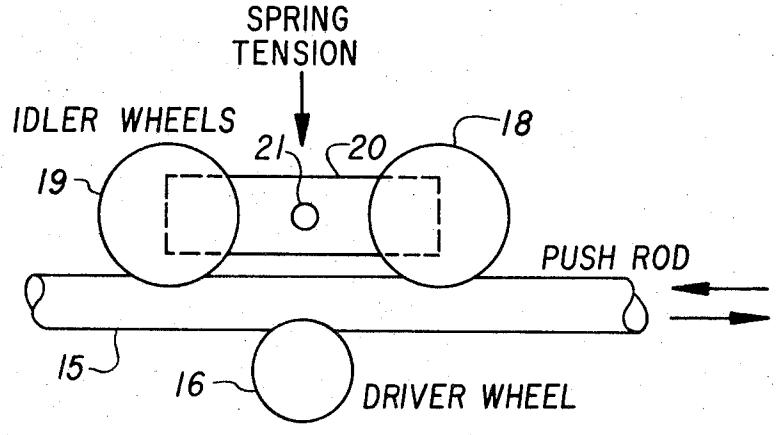


Fig. 2

INVENTOR
JAMES E. SHRIVER
GERALD M. STREATER

BY Gary C. Honeycutt
ATTORNEY

APPARATUS FOR LOADING AND UNLOADING FURNACE

This invention relates to the introduction and withdrawal of semiconductor material into and from a high temperature furnace, and more particularly, to apparatus for achieving such introduction and withdrawal at carefully controlled rates. In a specific aspect, the invention relates to a push-pull mechanism, including a roller driven pushrod assembly which enables a furnace boat being inserted into or removed from a furnace to follow the irregular contour of the furnace liner without tilting.

In the process of impurity diffusion, silicon slices are typically heated to temperatures in excess of 1000° C. The manner in which the slices are subjected to such high temperatures determines the amount of slip dislocation formed in the slice. Slip dislocations are irreversible defects in the crystal lattice, created by excessive thermal gradients across the slice. It is essential, therefore, that each diffusion step in the manufacture of a particular device be slip-free in order to produce a slip-free final product. Any diffusion ambient above 1000° C. can produce slip dislocations if proper care is not exercised in the loading and unloading of semiconductor slices into and from the diffusion furnace.

In the manufacture of semiconductor devices, the "common carrier" boat is the most widely used furnace boat. The silicon slices stand vertically and parallel to each other in the boat with their faces perpendicular to the longitudinal axis of the furnace tube. Although a number of variables influence the probability of slip dislocations, the rate of introduction and withdrawal of the slices to and from the high temperature ambient is of particular concern for the purposes of the present invention. In general, the loading and unloading of furnace boats has been a random variable and has been carried out manually, with no significant degree of rate control.

Accordingly, it is a primary object of the present invention to reduce the probability of slip dislocation formation in semiconductor slices when loading or unloading the slices into or from a high temperature furnace. It is a more specific object of the invention to control the push and/or pull rate of the semiconductor slice carrier during such furnace loading and unloading.

It is a further object of the invention to provide suitable apparatus for controlling push and/or pull rates. More specifically, it is an object of the invention to provide a novel mechanism for driving a pushrod in such a manner as to permit minor lateral oscillations therein, caused, for example, by irregularities in the contour of a surface to be followed by a semiconductor slice carrier, or other object, being pushed or pulled by the rod.

The invention is embodied in apparatus for loading a furnace which includes a chute or conveyor for supporting and guiding a furnace boat or other carrier into the furnace, a pushrod for moving the boat along the conveyor path, and a mechanism for driving the pushrod that enables the boat to follow any irregularities in the contour of the furnace lining without tilting.

The mechanism for driving the pushrod includes a roller drive in combination with an assembly for urging the pushrod against the roller drive in such a manner that minor lateral oscillations of the pushrod can readily be tolerated without difficulty. The assembly includes a pair of contact members fur urging the pushrod against the roller drive, said members being pivotally supported about an axis lying in a common plane with the roller drive axis, the plane being preferably substantially perpendicular to the pushrod.

In a preferred embodiment, the said assembly includes two idler wheels positioned to engage and urge the pushrod against the roller drive, in combination with first and second supporting members arranged to provide a freedom of motion in the idler wheels which permits the pushrod to undergo minor oscillations without causing an interruption in the controlled rate of motion, and without damaging the apparatus. The first support member, on which the idler wheels are mounted, is

pivotally supported by the second support member, at a point intermediate the centers of the idler wheels. The idler wheels and supporting assembly are resiliently urged against the pushrod. It will be apparent that a balanced system requires the roller drive to contact the pushrod at a point halfway between the locations at which the idler wheels engage the pushrod; however, some degree of imbalance may be desired for some purposes, and is therefore considered to be within the scope of the invention.

FIG. 1 is an isometric view of some one embodiment of the apparatus of the invention.

FIG. 2 is a diagrammatic plan view of the mechanism for driving the pushrod.

In FIG. 1, apparatus is shown for loading a high temperature furnace 11, such as employed in the fabrication of semiconductor silicon devices for the selective diffusion of impurities, epitaxial deposition, and any other process wherein a temperature in excess of about 1000° C. is required. Such a furnace is typically loaded by means of a boat 12, carrying semiconductor slices 13 stacked vertically and parallel to each other with faces oriented perpendicular to the longitudinal axis of the furnace tube. Chute or conveyor 14 is aligned with the furnace tube, as a means for supporting and guiding furnace boat 12. The boat is pushed and/or pulled along the conveyor path by means of pushrod 15 driven by roller 16.

The rate of pushrod motion is controlled by DC servomotor system 17, equipped with a tachometer and microammeter having an adjusted scale to give a direct inches per minute reading in either direction. Typical rates are from 0.1 in./min. up to about 12 in./min.

Idler wheels 18 and 19 urge rod 15 against roller 16 to maintain sufficient frictional engagement to ensure a reliable and reproducible rate of movement. Both the idler wheels and the roller drive are circumferentially grooved to fit the contour of rod 15, thereby providing support for the pushrod and improved frictional contact. The idler wheels are mounted on support member 20 which is pivotally supported by member 21. The point of pivotal support is halfway between wheels 18 and 19, and is directly opposite rod 15 from the center of roller drive 16. Accordingly, in the illustrated embodiment, it will be apparent that the pivot axis and the roller drive axis lie in a common plane perpendicular to rod 15. The idler wheel assembly is resiliently urged against the rod by means of spring 22 or its equivalent. In this manner, it can be seen that minor lateral oscillations of rod 15 are accommodated, such as may result from possible motion of boat 12 caused by irregularities in the contour of either conveyor 14 of furnace tube 11.

The arrangement of roller drive 16 and idler wheels 18 and 19 with relation to pushrod 15 is more clearly illustrated in FIG. 2, which is a diagrammatic plan view of the assembly.

We claim:

1. A mechanism for driving a pushrod comprising a combination:
   a. roller drive means;
   means for urging the pushrod against the roller drive means, including a pair of idler wheels pivotally supported about an axis lying in a common plane with the roller drive axis;
   c. first support means centrally supporting each of said idler wheels; and
   d. second support means pivotally supporting said first support means at a point halfway between the centers of said idler wheels, and directly across the pushrod from the roller drive axis.

2. A mechanism for driving a pushrod as defined in claim 1 wherein said means for urging the pushrod against the roller drive means further includes spring tension means.

3. A mechanism for driving a pushrod as defined in claim 1 wherein said roller drive means includes a DC servosystem for controlling the rate motion of the pushrod.

4. A mechanism as defined by claim 1 wherein both said idler wheels and said roller drive are circumferentially grooved to fit the contour of said pushrod.

5. A mechanism for driving a pushrod comprising in combination:

a. two idler wheels to engage one side of the rod at first and second locations;

b. a driver wheel to engage the opposite side of the rod at a third location, intermediate said first and second locations;

c. first support means centrally supporting each of said idler wheels;

d. second support means pivotally supporting said first support means at a point intermediate the centers of said idler wheels; and

e. means for urging said first and second support means in a direction to cause said idler wheels to urge said rod against said driver wheel.