May 1, 1945. M. M. SEMCHYSHEN 2,375,034

APPARATUS FOR HIGH TEMPERATURE TENSILE TESTING OF MATERIALS

Filed Aug. 27, 1943

Fig. 2

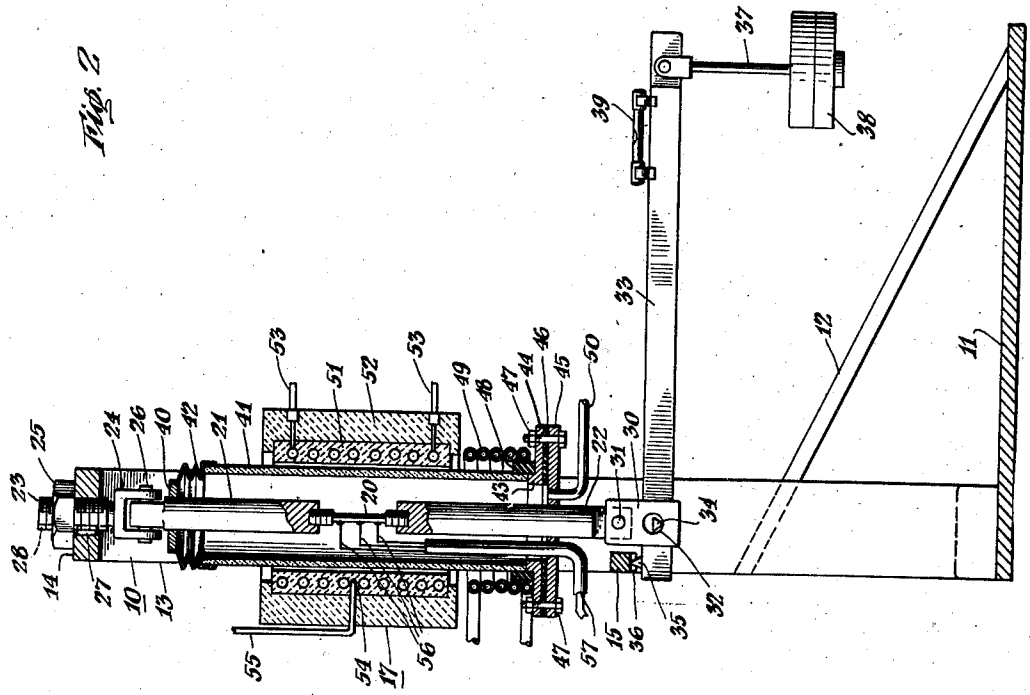
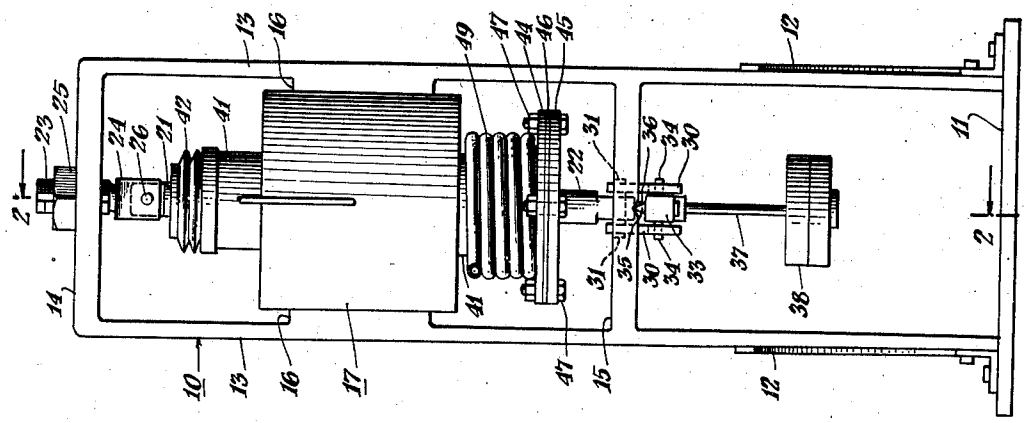


Fig. 1



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Patented May 1, 1945

2,375,034

UNITED STATES PATENT OFFICE

2,375,034

APPARATUS FOR HIGH TEMPERATURE TENSILE TESTING OF MATERIALS

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Application August 27, 1943, Serial No. 500,223

10 Claims. (Cl. 73—95)

This invention relates to testing of materials and relates more particularly to stress-rupture testing of materials at elevated temperature.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the instrumentalities and combinations pointed out in the appended claims.

The invention consists in the novel parts, constructions, arrangements, combinations and improvements herein shown and described.

The accompanying drawing, referred to herein and constituting a part hereof, illustrates one embodiment of the invention, and together with the description, serves to explain the principles of the invention.

Objects of the invention are: to provide a new and improved testing apparatus; and, to provide apparatus for making stress-rupture tests of materials under a pure tensile load and at elevated temperatures through the use of which the corrosion variable in tensile testing of materials at such temperatures is eliminated, or at least reduced to a very small, negligible value.

Of the drawing:

Figure 1 is a view in front elevation of a typical and illustrative embodiment of this invention; and

Figure 2 is a view taken along the line 2—2 of Figure 1.

In accordance with the illustrative embodiment of the invention, provision is made for mounting a tensile test specimen between holders in a space which may be evacuated and in which the specimen may be heated to the desired testing temperature, suitable means being provided for externally applying a load of desired magnitude to the specimen in its holders so as to produce and maintain pure tensile stress in the specimen from the applied load.

It will be understood that the foregoing general description and the following detailed description as well are exemplary and explanatory but are not restrictive of the invention.

Referring now more particularly to the accompanying drawing, a framework 10 preferably of steel is anchored firmly in an upright position to a suitable base such, for example, as the platform 11 to which it is braced preferably by means of a pair of rigid brace members 12.

The framework 10 as embodied is of sturdy construction with a column factor of sufficient magnitude to prevent buckling under compressive loads of considerable magnitude and as here preferably embodied comprises vertical side rails 13 connected at their upper extremities by a horizontal top rail 14 and connected between their upper and lower extremities by a horizontal bottom rail 15, the top, bottom and side rails preferably forming an integral structure. The side rails 13 are provided between the top and bottom rails 14 and 15 with a pair of bracket members 16 each extending inwardly from its side rail in opposition to the other for supporting between the side rails a heater 17, to be described more fully hereinafter.

Means are provided for supporting a standard tensile test specimen 20 in the framework 10 and for applying a load to the test specimen which will produce in it pure tensile stress. The embodied means is readily demountable to permit ready installation and removal of the test specimen and preferably of a nature to permit at least approximate determination of the extent of elongation of the specimen under load. As here preferably embodied, upper and lower specimen holders 21 and 22, respectively, preferably of cylindrical contour throughout the major portion of their length threadedly engage either end of the test specimen 20 and support it therebetween. A bolt 23 having a bifurcated head portion 24 passes from beneath and through the top rail 14 in sliding engagement therewith and is threadedly engaged above the rail by an adjustment nut 25 which seats on the rail. The upper end of the specimen holder 21 is lodged between the arms of the bifurcated head portion 24 to which it is releasably pin-connected by a pin 26. In order to prevent rotation of the bolt 23 upon rotation of the nut 25, the top or supporting rail 14 is provided with a key 27 slidably lodged in a keyway 28 in the bolt shank.

A saddle formed by pair of plate members 30 is pin-connected removably to the lower extremity of the specimen holder 22 by a pin 31, the members 30 being located at either side of the specimen holder and being provided below the pin 31 with an opening 32 in each. The openings 32 are suitably located so as to be coaxial when the members 30 hang vertically and to have their common axis intersect the common longitudinal axis of the holders 21 and 22 in this condition.

A lever 33 positioned between the plate members 30 is provided intermediate its ends with a pair of knife edges 34 extending in aligned relation from opposite sides of the lever in the respective openings 32. One end of the lever extends under the bottom rail 15 and is provided

with a knife edge 35 by which the lever is fulcrumed in a suitably shaped notch 36 in the rail. The other end of the lever is provided with a pivotally mounted weight holder 37 to which weights 38 may be added as required for tensioning the test specimen. Obviously, by varying the weights, or if necessary, the length of the lever, any desired tensile stress can be set up in the test specimen.

A bubble gauge 39 is mounted on the lever 33 and enables the operator to tell when the lever 33 is in a horizontal position which position may be maintained as the load is applied by tightening the adjustment nut 25 as required and is the position in which a pure tensile load will be applied to the specimen. The bubble gauge may be suitably calibrated so as to provide means for measuring the approximate elongation of the specimen when the test is in progress.

In order that stress-duration data of the test specimen may be obtained at high temperature with substantial freedom from the corrosion variable, means are provided for heating the test specimen in vacuo. The heating means as embodied permits maintenance of an extremely rarified atmosphere around the test specimen in a heated condition and elongation of the specimen at the same time. As here preferably embodied, the upper specimen holder 21 is provided with an annular sealing plate member 40, preferably of steel, concentric therewith and permanently attached thereto as by welding.

A refractory tube 41, preferably of quartz, coaxial with the seal plate 40 encloses the test specimen 20 and is sealingly connected at its upper end by an airtight bellows 42, preferably of metal, e. g. brass or copper, to the seal plate 40. The lower end of the tube 41 rests upon an annular upstanding flange 43 of an annular member 44 of metal surrounding the holder 22 in spaced relation thereto.

The annular member 44 is in turn supported by an annular member 45, of metal, permanently attached to and concentric with the lower specimen holder 22. An annular sealing gasket 46 of rubber or other suitable sealing material between the members 44 and 45 together with a series of bolts 47 in a circle concentric therewith provide for sealing the joint between the members 44 and 45. Likewise, an annular gasket 48 of rubber or other suitable sealing material snugly encompasses and seals the joint between the tube 41 and flange 43. In order to avoid destruction of the gasket 48 by high temperatures, a water cooling coil 49 is wound around this joint so that the gasket may be kept below a temperature of preferably not more than 400°–500° F.

Thus, there is provided an airtight expansible chamber for containing the test specimen 20 and from which air is adapted to be evacuated by means of a pump (not shown) connectable to the chamber by the eduction conduit 50 leading sealingly through the annular member 45.

The heater 17 as embodied is electrically powered and is suitably constructed to heat the test specimen 20 so that its temperature over its entire length will be practically uniform. As here preferably embodied, an annular resistance heating element 51 snugly surrounds the refractory tube 41 and is jacketed with insulation 52 of required thickness through which pass the power leads 53 to a suitable power source (not shown). The resistance element 51 should preferably be provided with one or more shunts for temperature control and if desired an external resistance (not shown) may be placed in series therewith, so that the current may be adjusted to a value slightly above that required to maintain the furnace at the desired temperature.

A thermocouple bead 54 is placed in the resistance element 51 close to its winding and may be connected by lead wires 55 to a temperature controller (not shown). Likewise, thermocouple beads 56 for determining the actual temperature of the test piece are wired to the outside thereof in firm contact with its surface, the lead wires 57 being led sealingly through the sealing flange 45 to suitable temperature indicators (not shown).

The instant embodiment is primarily suited to conducting stress-rupture tests up to 1600° F. At higher temperatures, it may be found desirable to place the heater in the space which is evacuated and seal the whole system with a metallic box.

In order to install the test specimen, the pin 31 may be removed to free the loading apparatus and the bolts 47 removed to free the lower holder 22. The test piece is then screwed firmly into the upper holder 21, the lower holder screwed onto the test piece and the bolts and loading apparatus replaced.

The test piece is brought up to temperature in vacuo and the load applied as desired by addition of the weights 38. By maintaining the lever 33 horizontal by means of the adjusting screw 25 the applied load will be purely tensile. The amount of elongation may be determined approximately by the bubble gauge 39.

The invention in its broader aspects is not limited to the specific mechanisms shown and described but departures may be made therefrom within the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages.

What is claimed is:

1. Apparatus for high temperature tensile testing of materials in vacuo comprising in combination a pair of specimen holders for holding a test specimen therebetween; means forming an airtight evacuable, expensible chamber inclosing the test specimen; means for applying a pure tensile load through said holders to the test specimen; and, means for heating the test specimen in vacuo in said chamber.

2. Apparatus for high temperature tensile testing of materials in vacuo comprising in combination a pair of specimen holders for holding a test specimen therebetween; means for supporting one of said holders; means for applying a tensile load through the other of said holders to the test specimen; means forming an airtight evacuable, expansible chamber enclosing the test specimen; and, a heater surrounding the chamber.

3. Apparatus for high temperature tensile testing of materials in vacuo comprising a pair of specimen holders for holding a tensile test specimen therebetween; a framework adjustably supporting one of said holders for axial movement; a lever for applying a tensile load through the other of said holders to said test specimen; means forming an airtight evacuable, expansible chamber for enclosing the test specimen; and, an electrical resistance heater surrounding the chamber.

4. Apparatus for high temperature tensile testing of materials comprising in combination upper and lower specimen holders for holding a test specimen therebetween; a framework; adjustable means pin-connected to said upper specimen

holder and supporting the same from said framework for axial movement; a lever fulcrumed on said framework and pin-connected to said lower holder for applying a pure tensile load through said lower holder to said test specimen; a bubble gauge on said lever for indicating the horizontal position of said lever; means including a tube of refractory material and sealing means between the same and the holders forming an airtight evacuable expansion chamber enclosing the test specimen; and, an electrical resistance heater surrounding said tube for heating the test specimen.

5. Apparatus for tensile testing of materials comprising in combination upper and lower specimen holders for holding a test specimen therebetween; a framework; adjustable means pin-connected to said upper specimen holder and supporting the same for axial movement; means for applying a pure tensile load through said lower holder to the test specimen including means forming a thrust bearing pin-connected to said lower specimen holder and a second class lever having knife-edge bearing engagement with said thrust-bearing means; means for forming an airtight evacuable, expansible chamber for inclosing the test specimen; means for heating said chamber; and, means responsive to movement of said lever means for indicating the horizontal position of said lever.

6. Apparatus for tensile testing of materials at elevated temperatures in vacuo comprising in combination upper and lower specimen holders for holding a test specimen therebetween; means for applying a tensile load through said holders to the test specimen; a quartz tube surrounding said holders; a sealing flange carried by the upper holder, an expansion member connecting said flange with said tube; a sealing flange carried by the lower holder for supporting said tube; means for sealing the joint between said lower holder sealing flange and said tube; means for cooling said sealing means; and, an electrical resistance heater in annularly spaced relation to said holders.

7. Apparatus for high temperature tensile testing of materials in vacuo comprising a pair of specimen holders for holding a tensile test specimen therebetween; means for applying a pure tensile load to the specimen through said holders; and, means for heating the specimen in vacuo comprising generally tubular axially extensible chamber-forming means and means flexibly connecting said holders and the chamber forming means and providing an evacuable chamber for containing the test specimen and an electrical resistance heater surrounding said chamber forming means.

8. Apparatus for tensile testing of materials comprising axially aligned specimen holders in relatively axially movable relation; a framework; means for effecting non-rotational axial movement of one of said holders, said means comprising a threaded bolt having its head portion pin-connected to said holder and its shank portion slidably socketed in and keyed against rotation in said framework and a nut on said bolt seating on said framework; a tube for inclosing the test specimen and forming a chamber, expansible sealing means between one end of the tube and the first-named holder; sealing means between the other end of the tube and the other of said holders; means for heating the chamber and, means including a lever coacting with said framework for applying a pure tensile load through the other of said holders to a test specimen carried by said holders.

9. Apparatus for tensile testing of materials comprising a pair of specimen holders for holding a tensile test specimen therebetween; means for anchoring one of said holders against axial movement; a tube for inclosing the test specimen and forming a chamber; expansible sealing means between one end of the tube and the first-named holder; sealing means between the other end of the tube and the other of said holders; means for heating the chamber; and, means for applying a tensile load to the other of said holders, said applying means comprising apertured thrust bearing means flexibly-connected to said other holder, a second class lever having oppositely extending knife-edge members seated in said apertures of said bearing means; and a gauge on said lever for indicating the horizontal position of said lever.

10. Apparatus for high temperature tensile testing of materials in vacuo comprising in combination upper and lower specimen holders for holding a test specimen therebetween; an electrical resistance heater in annularly spaced relation to said holders for radiantly heating the test specimen; a quartz tube situated between said holders and heater and surrounding said holders; a gas-tight bellows connection between said tube and the upper holder; sealing means between the tube and lower holder comprising a sealing flange carried by the lower holder, a tube sealing flange bolted to said holder sealing flange and having an upstanding annular rim upon which said tube is seated, a gasket sealing the joint between said flanges, and a gasket for sealing the joint between said tube and said rim; a cooling coil surrounding said last-mentioned gasket; and, means for applying a purely tensile load to a test specimen between said holders.

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