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TENSILE TESTING MACHINE

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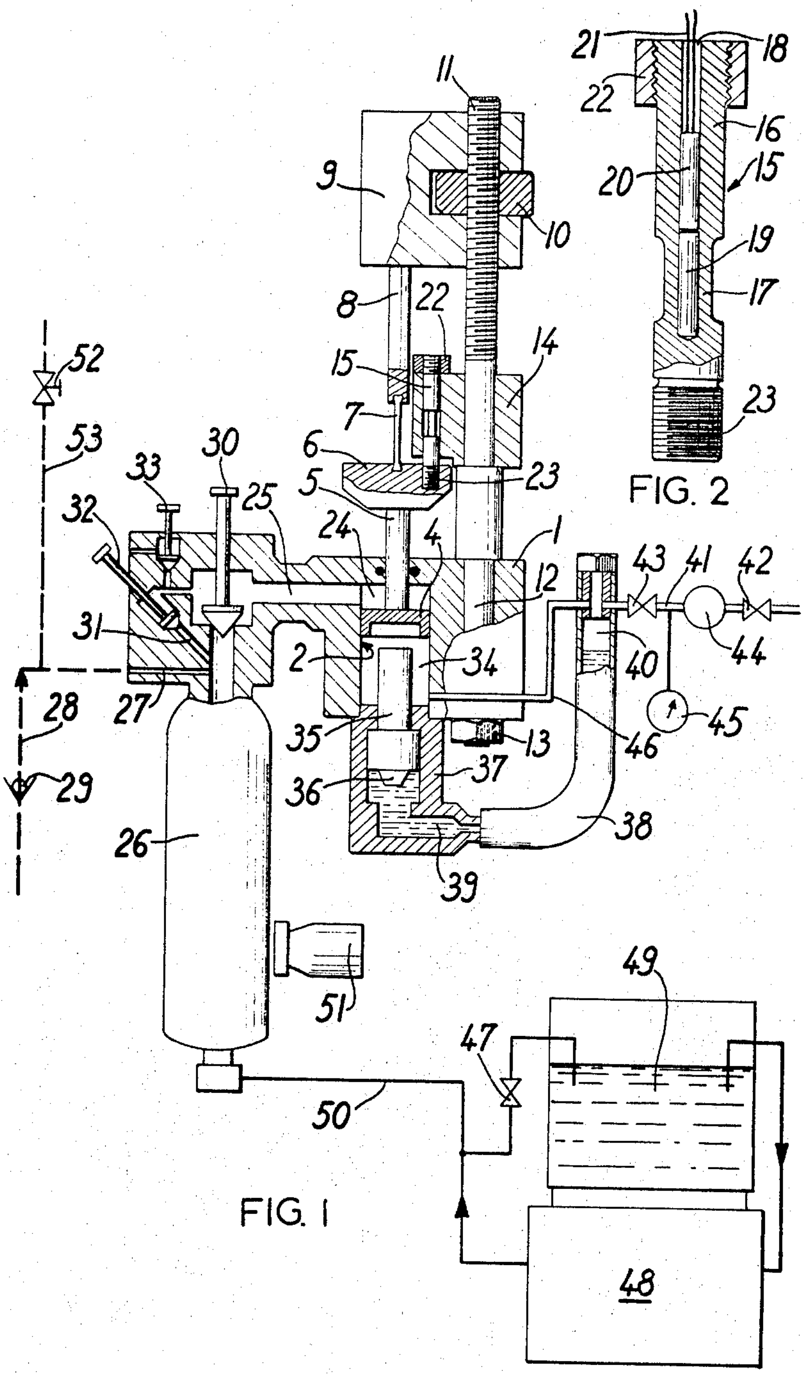

FIG. 2

FIG. 1

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TENSILE TESTING MACHINE

Yvon Sophy, Saint-Maurice, France, assignor to Commissariat à l'Energie Atomique, Paris, France

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ABSTRACT OF THE DISCLOSURE

High speed tensile testing of a test piece is obtained by subjecting the test piece to a high tensile force exerted thereon by a piston with motion of the piston under pressure initially prevented by a frangible member which is subjected to fast fracture by the detonation of an explosive charge within the frangible member.

The present invention is concerned with a tensile testing machine which makes it possible to apply a constant tractive force on a test-piece at a relatively very high rate of the order of 40 to 50 m./s. in particular.

It is known that conventional tensile testing machines which apply either hydraulic or electro-mechanical principles permit a working speed which is usually very low, namely either below or equal to 1 cm./s., higher speeds being permited only as a result of certain extrapolations but in any case not exceeding 1 m./s. In order to attain speeds of an even higher order, it is necessary to have recourse to other machines which operate on the principle of expansion of compressed gases, these gases being preferably produced by the combustion of an explosive powder. However, in the case just referred-to, a number of drawbacks must be taken into consideration. In the first place, the powder ignition time is substantial compared with the duration of the test, which makes it difficult to ensure good synchronization of measurements. In the second place, the profile of the pressure curve as a function of time is a bell-shaped curve, the shape of which is very variable from one test to another in respect of a same weight of powder. Finally, when the pressure chamber inside which the combustion of powder takes place is connected to the atmosphere, both flames and smoke are liable to hinder certain optical observations.

The aim of this invention is to overcome the disadvantages referred-to above and is accordingly concerned with a tensile testing machine which utilizes the expansion of a previously compressed gas, the initial instant of commencement of said expansion being controlled with high precision by the sudden rupture of a component by means of an explosive charge after the test-piece has been loaded.

Said tensile testing machine is characterized in that it comprises a stationary cylinder which is fitted internally with a movable piston, a piston-rod coupled to the extremity of a test-piece, a rigid head positionally adjustable relatively to said stationary cylinder and coupled to the other extremity of said test-piece, means whereby a compressed gas at variable pressure is admitted into said stationary cylinder on one face of said piston, frangible member which provides a temporary coupling between said movable piston and said stationary cylinder and which is adapted to fail by fast fracture initiated by explosive means.

Preferably, the frangible member which is adapted to fail by fast fracture is constituted by at least one coupling tube having a zone of lesser resistance which can be caused to fracture at a precise predetermined instant by firing an explosive charge. Advantageously, each coupling tube is enclosed within a demountable support bracket constructed in two sections respectively coupled to the

movable piston and the stationary cylinder, vents being provided through said support bracket so as to permit the discharge of burnt gases after explosion of the charge.

In a preferred embodiment, the stationary cylinder comprises a hydraulic brake which absorbs the residual energy of the compressed gas at the end of travel of the movable piston, said brake being constituted by a second piston having a conical profile and adapted to deliver progressively a viscous fluid and especially oil into a low-pressure storage tank which is connected to said stationary cylinder. In addition, and in accordance with a further characteristic feature, the rigid head is provided for the positional adjustment thereof with a hand-wheel designed to cooperate with a screw which is rigidly fixed to said cylinder, said head being fitted with a detachable rod, the extremity of said rod being adapted ot receive the test-piece. As a further adantageous feature, said rod can serve as a dynamometer by measuring its deformation. Finally, the means employed for admitting a compressed-gas pressure into the cylinder are preferably constituted by a compressor which may be associated with a motor pump and oil supply tank so as to increase the gas pressure within a chamber which communicates with said stationary cylinder.

All of the features outlined in the foregoing are preferably employed at the same time but could if necessary be employed independently and will in any case be more clearly brought out by the following description of one example of construction which is given solely by way of indication and not in any limiting sense, reference being had to the accompanying drawings, in which:

FIG. 1 is a diagrammatic sectional view of a tensile testing machine which is constructed in accordance with the invention;

FIG. 2 is a sectional view on a larger scale showing a detail of FIG. 1.

The machine which is shown in FIG. 1 essentially comprises a cylinder block **1** inside which is provided a chamber **2**, a piston **4** mounted within said chamber, a piston-rod **5** provided with an extension in the form of a cross-head **6** on which is fixed one of the extremities of a metal test-piece **7** with a view to subjecting this latter to a high-speed tensile test. The other extremity of said test-piece **7** is secured by any suitable means to a detachable rod **8** which is in turn secured to a rigid head **9** placed above the cylinder block **1**. The position of said head relatively to the cylinder block can be adjusted by means of a hand-wheel **10** forming a nut which is adapted to cooperate with a screw **11**, the lower end **12** of which is rigidly secured to the cylinder block **1** by means of a fixing member **13**.

In accordance with the invention, the crosshead **6** is coupled with the stationary cylinder **1** by means of a support bracket **14** which is secured to said cylinder by means of the screw **11**, the coupling between said crosshead and said bracket being provided by two detonation tubes **15**, one particular design of which is illustrated on a larger scale in FIG. 2. Each coupling or detonation tube comprises a body **16** of cylindrical shape having a necked central portion **17**. As a preferable feature, the body **16** is formed of high-tensile steel in such a manner that the lower resistance of the portion **17** makes it possible to produce a clean fracture of the coupling tube at this point. The coupling tube is accordingly provided with a blind-end bore **18** within which is introduced an explosive charge **19**, then a detonator **20** which is connected by lead-wires such as the wire **21** to an electrical apparatus (not shown in the drawings) for the purpose of firing the detonator and instantaneously fracturing the coupling tube in its necked portion **17**. The support bracket **14** is provided with vents for the discharge of burnt gases. The coupling tube **15** is secured at one end to the support bracket **14** by means of a nut **22** and at the other end to the crosshead **6** by virtue of the threaded portion **23** of said tube.

The space **24** which is formed within the chamber **2** of the cylinder block **1** above the piston **4** communicates by way of a duct **25** with a vessel or bottle **26** and by way of a small duct **27** with a line **28** which is connected with interposition of a non-return valve **29** to a conventional compressor (not shown in the drawings). A neeedle valve **30** provides a connection between the bottle **26** and the duct **25** whilst a second small duct **31** or by-pass duct is fitted with a valve **32**. The intended function of said second small duct is to permit the opening of the needle valve **30** without undue effort and generally to duplicate the connection just mentioned. A third valve **33** serves to connect the space **24** to the atmosphere whilst a gate-valve **52** serves to connect the vessel **26** to the atmosphere via the line **53**.

The piston **4** also defines within the chamber **2** a space **34** within which is mounted a second piston **35**, the end **36** of which has a slightly conical profile which enables said piston to perform the function of a hydraulic brake. With this object in view, the lower end of the chamber **2** is connected to a casing **37** which forms an extension of the cylinder block **1** and terminates in a tubular chamber **38** containing a given quantity **39** of a viscous damping fluid and especially oil. Provision is made above the oil level within the tubular chamber **38** for a gas cushion **40** which preferably consists of slightly compressed air, said gas being admitted through a line **41** fitted with gate-valves **42** and **43** and a relief-valve **44**, the gas pressure being adjusted to a fairly low value which is controlled by means of a manometer **45**. Finally, provision is made for a connecting-pipe **46** between the tubular chamber **38** and the space **34** of the cylinder **2** for the purpose of establishing pressure equilibrium and returning the damping piston **35** and the piston **4** to their initial positions as will become apparent hereinafter.

The equipment of the machine is completed by a motor pump set **48** of conventional design for delivering oil from a supply tank **49** through a pipe **50** to the lower end of the bottle **26**, the level within this latter being measured and controlled by means of an apparatus **51**.

The operation of the tensile testing machine as hereinabove described is as follows: the detonation tubes **15** having been placed in position in such a manner as to couple the crosshead **6** to the support bracket **14**, the test-piece **7** is secured at one end to the crosshead **6** and at the other end to the rod **8**, the position of which is adjusted together with the position of the head **9** by means of the hand-wheel **10**. Once this operation has been completed, a compressed-gas or compressed-air pressure is admitted into the tubular chamber **38** via the pipe **41**, said pressure being equal to approximately 1 bar. The gate-valve **43** is then closed, the pistons **4** and **35** being in the positions shown in FIG. 1. The pressure within the bottle **26** is regulated to a predetermined value which is equal to **200** bars at a maximum value. Once this pressure has been reached, the by-pass valve **32** and then the main valve **30** are opened, the pressure is exerted on that face of the piston **4** which is in contact with the space **24**. At this moment, the firing of the detonation tubes **15** is triggered and the instantaneous rupture of said tubes is accordingly initiated. The pressurized gas contained in the cylinder block **1** expands and the piston **4** exerts a tensile stress on the test-piece with sufficient acceleration to ob-

tain the desired speed (by way of example, in the case of a working stroke of the piston of approximately 50 millimeters, the speed obtained is of the order of 48 m./s.) At the end of travel, the piston **4** comes into contact with the second piston **35** which, by means of its conical portion **36**, progressively drives the oil **39** back into the tubular chamber **38** through an orifice which becomes increasingly narrow until the speed is reduced to zero.

In order to carry out a test under an even higher pressure, the mode of operation is initially similar to the process which has been described above, the pressure of the gas within the bottle **26** being set at the maximum value delivered by the compressor. The motor pump set **48** is then started up so as to deliver the oil contained in the supply tank **49** through the pipe **50** into the bottle **26** and thus to establish the new pressure which is desired. The machine then operates as in the condition previously described, the oil being returned to the supply tank **49** by means of a valve **47**.

As is readily apparent, the invention is not limited to the mode of construction which has been described in the foregoing in reference to the accompanying drawings and which has been given solely by way of example.

What I claim is:

1. A high speed tensile testing machine for a test piece comprising a stationary cylinder block, a movable piston in said block, a piston rod coupled to said piston and to an extremity of the test piece, a rigid head carried by and positionally adjustable relative to said cylinder block and coupled to the other extremity of the test piece, means for admitting a compressed gas at variable pressure into said cylinder block on the face of said piston adjacent the test piece, a frangible member providing a temporary coupling between said piston and said cylinder block preventing movement of said piston by the compressed gas, said frangible member failing by fast fracture and comprising at least one coupling tube, said tube including a zone of lesser resistance, an explosive charge in said tube whereby said tube may be fractured at a predetermined instant by firing said explosive charge, a demountable support bracket on said cylinder block enclosing said tube, said tube being constructed in two sections respectively coupled to said piston and to said cylinder block and vents through said support bracket for discharge of burnt gases after explosion of the charge.

2. A tensile testing machine as described in claim **1**, said cylinder block including a hydraulic brake absorbing the residual energy of the decompressed gas at the end of travel of said piston, said brake comprising a second piston with a conical profile and delivering progressively a viscous fluid into a low pressure storage tank connected to said cylinder block.

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RICHARD C. QUEISSER, *Primary Examiner.*

J. H. WILLIAMSON, *Assistant Examiner.*