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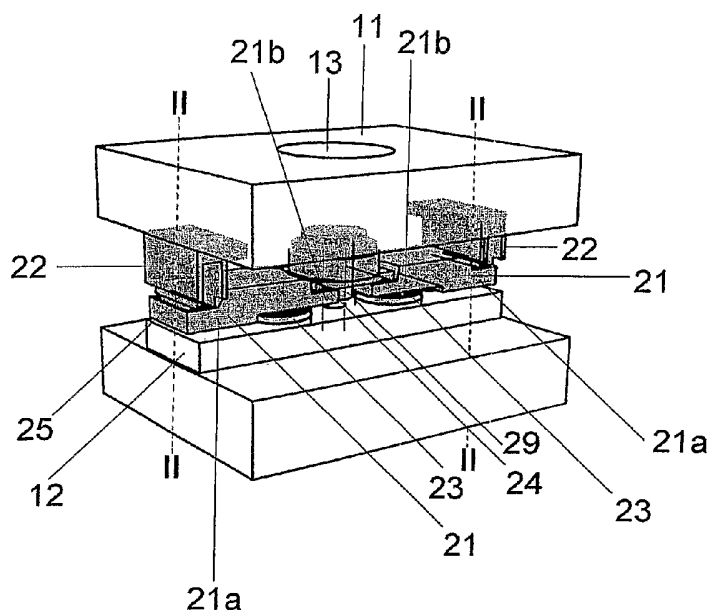
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(54) Title: FIXTURE



(57) Abstract: A fixture for holding a test specimen in a compression test machine, said test specimen comprising two ends and sides and the fixture comprising: a bot- torn part (12), a clamping part for engaging said sides, first force transferring means (21b) and second force transferring means (21a). The bottom part (12) supporting said first and said second force transferring means and being for connecting to a press. The fixture comprise at least one lever (21) having two arms, the first arm (21b) defining said first force transferring means adapted for transferring of force to an end of said test specimen, and said second arm (21a) defining said second force transferring means adapted for transferring of force to the clamping part of the fixture.

Fixture

This invention relates to a fixture for holding a test specimen to be tested in a testing machine, said test specimen comprising two ends and sides and the fixture comprising; a bottom part, a clamping part for engaging said sides,
5 first force transferring means and second force transferring means.

Compression tests are typically performed on a test specimen of test material of uniform width and the compressive force can be applied directly on the end of the specimen, or generated by longitudinal shear forces at the side of
10 the specimen or a combination of the two. Therefore compression test methods are normally categorized as either "shear loading methods", "end loading methods" or "combined end and shear loading methods" depending on how the compressive force is introduced into a test specimen. To prevent surface damage or damage at the ends of the test material, the test specimen is
15 normally covered with a layer of protective material adhesively bounded to the sides and each end of the test specimen. These coverings, called tabs or tabbing, thus minimize premature failures induced by fixation of the test specimen in a fixture.

20 Because different test methods performed rarely produce the same results engineers have to structurally overcompensate when designing constructions like e.g. windmills, which causes many engineered constructions to be much bigger, heavier and more expensive than necessary.

25 A newly developed hydraulic fixture, having means for applying both end and shear force with a controlled ratio between the two, has proved to give much more reliable results than fixtures solely applying end or shear forces.

The hydraulic fixture was initially developed to conduct static testing but a
30 growing need for a fixture capable of conducting cyclic testing initiated the use of said fixture in cyclic testing.

The hydraulic fixture however has disadvantages due to damping caused by the fluids in the hydraulic system. Damping between the center hydraulic cylinder applying a force to the end of the test specimen and the two side cylinders applying a force to the top plate leads to insufficient clamping of the test specimen in cyclic loading. Another problem associated with the hydraulic fixture is leaking of hydraulic fluids during the highly demanding cyclic tests, which often are performed for up to 3 millions cycles at 7 Hz. During each of the cycles, the hydraulic fluid is highly compressed and the highly pressurized hydraulic fluid has a negative impact on e.g. the seals in the hydraulic cylinders inevitably leading to leaking of hydraulic fluids.

It is a general object of the invention to provide a novel fixture for holding a test specimen in a testing machine, particularly a fixture capable of applying both end forces and shear forces with a controlled ratio between the two to a test specimen.

It is a further object of the invention to provide a fixture by means of which the force applied to a test specimen can be measured more precisely, whereby a test result of improved quality is obtained.

It is a still further object of the invention to provide a fixture for holding a test specimen in a testing machine which does not have the disadvantages associated with the hydraulic fixture.

The object of the invention is achieved by a fixture where said bottom part supporting said first and said second force transferring means and being for connecting to a press, said at least one lever having two arms, the first arm defining said first force transferring means adapted for transferring of force to an end of said test specimen, and said second arm defining said second

force transferring means adapted for transferring of force to the clamping part of the fixture.

Preferable the lever comprise a spherical bearing and the spherical bearing
5 may further define a fulcrum having a center of rotation essentially at the same distance from the bottom plate as said lever's first and second force transferring means. The provision of fulcrum having a point of rotation essentially aligned with the force transferring means on first and second arms will minimize mutual movements between the lever's force transferring means
10 and the fixture's means for receiving of said force thus minimizing the energy loss. The result is a lever system having a very high mechanical efficiency.

The spherical bearing may comprise a spherical ring and a bowl-shaped part. By construction the spherical bearing with an upper part being bowl-shaped and a lower part being ring shaped, a bearing with reduced contact
15 surfaces is obtained thus minimizing friction.

The lever may further comprise two additional bearing surfaces preferably extending essentially perpendicular to the plane of rotation and along the
20 edges of the lever. This will minimize the energy loss between the lever's force transferring means and the fixture's force receiving means. The two extending additional bearing surfaces may preferably be vaulted. According to a preferred embodiment, the two additional vaulted bearing surfaces comprise two axles, which are essentially cut in halves lengthwise, the axles being supported in a second bearing comprising a track in said lever. This allows a necessary movement between the bearings and the lever during use thus preventing mutual locking of the fixtures parts and improving overall maintenance as well as easy renewal or replacement of the additional bearings.

30

The fixture may comprise an intermediate piece adapted for the transferring of force between the lever and the clamping part of the fixture.

According to another embodiment, the clamping part of the fixture may comprise two essentially identical wedges cooperating with each other for holding the test specimen and the fixture may also comprise two essentially identical levers, said levers further comprising two arms, the first arm being adapted for transferring forces to a test specimen end tab, and the second arm being adapted for transferring forces to the cooperating wedges. Preferable the fixture further comprise a spherical bearing disposed essentially between the two levers, the bearing comprising means for transferring force from both of said two levers to the end of a test specimen. This will entail a lever system comprising two levers being capable of transferring pure axial force to the end or end tab of a test specimen.

Preferably said spherical bearing comprise a bushing disposed essentially centrally within the bearing, said bushing being guided by an elongated member anchored essentially centrally in the bottom plate.

According to a preferred embodiment, the fixture comprise at least one lever having a second arm being essentially 3 times the length of the first arm. This will entail a preferred distribution of compressive forces introduced into a test specimen as essentially $2/8$ being applied as longitudinal shear forces to the sides of a test specimen and $6/8$ being applied as pure compression force to an end of a test specimen

The invention in other aspects provides a lever as recited in claim 15-21.

Embodiments of the invention will be described in detail in the following with reference to the drawings in which:

fig. 1 is a perspective drawing of a fixture;

fig. 2 a and 2b shows a typical test specimen;

fig. 3 is a front view of a fixture comprising a lever comprising a conventional bearing having its centre of rotation concentrically with the centre of the bearing;

fig. 4 shows a front view of a fixture comprising a lever comprising a two spherical bearings;

fig. 5 shows a schematic drawing of the force distribution in a fixture according to the invention;

fig. 6 is a front view of a fixture comprising a lever having its centre of rotation on top of the bottom plate;

fig. 7 is a front view of a fixture comprising a lever having its centre of rotation on top of the bottom plate, the lever further comprising roller plates;

fig. 8 is a detailed cross sectional view of a fixture comprising two different lever systems and,

fig. 9 is a front view of a lever system comprising two clamping systems arranged coaxially and mirror symmetrical to each others and the two systems being positioned with one clamping system directly above the other.

Figure 1 shows a schematic view of a fixture for holding a test specimen in a testing machine. The testing machine is not shown. However, such a machine would usually comprise two similar fixtures holding respective end of a test specimen. The fixtures would typically be arranged coaxially and symmetrical to each other and the two similar fixtures would normally be positioned with one fixture directly above the other. Since the two fixtures (usu-

ally) are of identical construction only one (the lower one) of these fixtures consequently is shown in the figures and described in detail.

5 Referring to the drawings numeral 11 designates the top part of the fixture and 12 designate the bottom part. The top part 11 has a central opening 13 for mounting of a part capable of holding a test specimen (not shown) by clamping. The bottom part 12 is connected to a press, such as a hydraulic press (not shown).

10 The fixture shown in figure 1 comprise two levers 21 each being supported by a bearing 23. Each of the levers 21 has two arms: arm 21b, which supports a spherical bearing 24 and arm 21a, which supports an intermediate piece 22.

15 The centrally situated bearing 24 preferably comprises two parts, a (upper) part for the support of the end of a test specimen and a (lower) part being supported by each of the centrally situated arms 21b. The purpose of the centrally situated bearing 24 is to equalize angular misalignment between the two centrally positioned arms 21b of the levers 21. The upper part 11 of the
20 fixture is supported by intermediate pieces 22 being supported by the outermost arms 21a of the levers 21.

When an upward force is applied to the lower part 12 of the fixture shown in figure 1 it will be distributed solely to the levers by each of the bearings 23
25 placed underneath the levers. The mechanical advantage of the levers 21 is the ratio of the length of the centrally located arms 21b to the length of the outer arms 21a. The force applied to the lower part 12 of the fixture is accordingly subdivided with a part acting on the side tabs 3 of a test specimen by the outer arms 21a and the rest acting on the end (reinforcement tab) of a
30 test specimen by the centrally positioned arms 21b.

The fixture shown in figure 1 comprises two levers 21 but it should be understood that the fixture may comprise one lever as well as two or more.

Figure 2a and 2b , show a test specimen 1, which is generally in the form of a strip of material, having a rectangular cross section. To prevent surface or end damage of the test material 6, the test specimen is covered with a layer of protective material 3 adhesively bonded to the sides and each end. These coverings called tabs or tabbing prevents failures induced by fixation of the test specimen in a fixture.

The side tabs 3 serves for transferring of shear force applied by the clamping means of the fixture while an end (reinforcement) tab 2 serves for transferring of forces applied directly to the end of a test specimen. The material to be tested 6 is covered with side tabs 3 such that a relatively small portion of the material is left unsupported between the side tabs 3. It is this unsupported region of material which is measured during testing, and the unsupported length is normally kept as short as possible to prevent buckling during compression. The unsupported portion must, however, preferably be long enough to allow strain gauge(s) 5 to be connected thereto.

Preferably the force applied to a test specimen is distributed at a ratio of 6/8 to the end (tab) of a test specimen tab and 2/8 to the side or side tabs.

Figure 3 shows a fixture having an upper part 11 with a clamping portion which comprises two wedges 10 for the holding of a test specimen 1. The test specimen 1 has an end reinforcement tab 2 and side tabs 3.

The reinforcement tab 2 of the test specimen 1 bears against a centrally placed block 7. The fixture comprises two levers 21 being supported by conventional bearings 20. The bearings 20 are positioned in elongated holders 8 attached to the lower part 12 of the fixture. The centrally situated arms 21b of the levers 21 support the block 7. The other arm 21a of the levers 21 sup-

port intermediate pieces 22. The intermediate pieces 22 are in the illustrated embodiment received in recesses formed in the levers.

When an upward force is applied to the lower part 12 of the fixture in a direction as indicated by the straight arrows at the right side of the figure, all force is distributed to the levers 21 through the bearings 20 positioned in each of the two elongated holders 8. The intermediate pieces 22 transfer the force coming from the arms 21a to the upper 11 part of the fixture causing the wedges 10 to clamp upon tabs 3 of test specimen 1 thereby also transferring the force coming from the arms 21a as shear force to the tabs 3.

The levers 21 distribute the force partly to the upper part 11 by the intermediate pieces 22 and partly to the end of the test specimen 1 by the block 7 when applied to the lower part 12 of the fixture. However, the construction shown in figure 3 may not be preferred in some embodiments due to the very limited movement of the bearing 20 during use of the fixture and calculations show that a proper dimensioned bearing 20 should have an outer diameter of about 100 mm, which would normally be impractical. A solution to this problem is shown in a schematic form in figure 6 and 7 showing fixtures comprising levers 21 bearing supported at singular points 51 also acting as fulcrum (centre of rotation) for the levers.

Figure 6 shows a fixture having two levers 21 each having a point of rotation (fulcrum) at the points 51 where the levers bear against the lower part 12 of the test fixture. The levers 21 shown in figure 6 transfer a force applied to the bottom part 12 partly to a centrally positioned block 7 by the contact points 20 b and partly to the upper part 11 by contact points 20 c. During operation of the fixture shown in figure 6, each lever 21 rotate about points 51, which disadvantageously causes the two contact points 20b and 20c to move along two different arches as illustrated by arrows on the right side of figure 6, both circular patterns having their centers of rotation coinciding with contact points

51. Even though the rotation of the levers 21 are very limited, the horizontal movement of the contact points 20b and 20c unavoidably leads to sliding movement between the levers and the central support 7 at contact points 20b as well as sliding movement between the levers 21 and the upper part 11 at contact points 20c. Therefore a drawback of this structure may be the horizontal movement of points 20b and 20c, which causes a sliding movement between the parts of the fixture inevitably leading to energy loss due to friction.

10 One way to reduce friction is to apply a lubricant to the surfaces, other ways are to use casters, rollers or ball bearings between the surfaces, or by use of rollers and plates as shown in figure 7.

15 However, the energy loss due to friction can also be minimized by reducing the movement between parts of the fixture which is preferable made by aligning the levers contact points 51, 20b and 20c in a direction essentially perpendicular to the direction in which force is applied to the levers.

20 Figure 4 shows a fixture comprising a lever having a bearing 23 with a center of rotation 27 ($\otimes$) displaced from the contact point (bearing surfaces) and horizontally aligned with the contact points 20b and 20c. The displacement of the center of rotation gives rise to a movement of the contact points 20b and 20a in a direction which is mainly vertical and thus facilitating an almost frictionless movement of the lever during operation of the fixture.

25

The displacement of the center of rotation is preferably obtained by the use of a spherical bearing, but the displacement may be obtained in many other ways known to the skilled person (e.g. by semi axles).

30 Reference is now being made to figure 5. When a force F is applied to the bottom part of a fixture according to the invention it should preferably be dis-

tributed through the levers, as schematically illustrated in figure 5 with a ratio of 2/8 transmitted to the side tabs and 6/8 of to the end tab. Though there has to be torque equilibrium around the levers fulcrum $\otimes$ the torque on the right side of each of the levers has to equalize the torque on the left side of each of the levers which lead to:

$$3/8 \times L_1 \times F = 1/8 \times L_2 \times F \Rightarrow L_2 = 3 \times L_1$$

Figure 8. For illustrative purposes, the figure illustrates two different embodiments of the invention.

The left side of figure 8, shows a lever 21' being supported by a spherical bearing 40. The bearing 40 comprises a bowl shaped upper part 41 having a central opening 43, and a correspondingly ring shaped under part 42. The upper part 41 is fastened to the lever 21' by a tap connection 44 through the central opening 43, however other type of fastening means may be employed. The spherical contact surfaces between the upper bowl shaped part 41 and the under part 42 of the spherical bearing 40 defines a center of rotation $\otimes$ for the bearing 40 - indicated by reference number 27' - thus also defining a fulcrum for the lever 21' at 27'.

Turning now to the right side of figure 8, the lever 21 is supported by a spherical bearing 23 having an upper part being an integrated part of the lever 21. The bearing 23 has an under part being an integrated part of the lower part 12 of the fixture. The lever 21 showed in the embodiment on the right side of the figure has a center of rotation (fulcrum) $\otimes$ indicated by reference 27.

A test specimen 1 having a rectangular cross-section, and adhesively bonded pieces 3 (tabs) on the sides is clamped between two clamping wedges 10 for applying of shear force through the adhesively bonded side

pieces 3. The end of the test specimen which comprises an end reinforcement tab 2 for applying of a compression force is supported by a bushing 17.

5 The levers 21,21' are able to rotate about their fulcrums 27, 27' defined by the spherical bearings 23, 40 and under operation of the fixture, the spherical bearings 23, 40 distributes all force coming from the bottom part 12 of the fixture to the test specimen as either shear force to the side tabs 3 or compressive force to the end tab 2. The fixture represented as a lower fixture has a clamping part (10,11) comprising two wedges 10 received in a groove 13 in a
10 top part 11 of the fixture.

The groove 13 may preferable be lined with a suitable material 31, preferably being hardened.

15 A fixture comprising two levers may due to small dimensionally inaccuracies between the constructional features in each of the levers, have an angular misaligned (not being parallel with the longitudinal axis of the test specimen) distribution of force to the end of a test specimen. A common known solution to equalize angular misalignment in a force distributing system is the use of
20 spherical bearings. Therefore fixtures comprising two levers preferably comprise a centrally positioned spherical bearing 24 adapted for transferring of force from the centrally positioned arms of the levers to the end or end tab of a test specimen. The spherical bearing 24 shown in figure 8 equalize small differences between two lever systems 21, 21' thus also facilitating applica-
25 tion of compression in a direction essentially axially to the test specimen 1.

The centrally positioned spherical bearing 24 may comprise a spherical ring and a bowl-shaped inner part, both with a central bore in which a bushing 16 is guided for axial movement by a guide 15. The bushing 16 insures that the
30 bearing 24 maintain a position which is essentially between the two levers. The top of the bushing 16 advantageously comprise a flange which is supported on the top of the bearing 24. The bushing 16 may further have a cen-

tral recess in which a plate 17 configured for the support of the end tab (not shown) of a test specimen is supported. The bushing 16 or the guide may be lined with e.g. bras for the preventing of seizing/galling (when two metals stick together and cannot be easily loosened) between the guide 15 and the bushing 16.

When distributing a force, the levers 21 rotate about their fulcrums and this rotational movement (however, optionally limited) has a horizontal component which, if prevented, causes interlocking of the levers 21. For preventing of interlocking of the parts due to the circular motion of the levers, the fixture preferable comprising bearing means adapted for a necessary movement between the parts of the fixture. In the shown embodiment in figure 8, the levers are equipped with additional bearings 25 being placed in grooves (not shown) extending in a direction essentially perpendicular to the levers plane of rotation and along the edges of each arm of the levers 21, 21'. The grooves provided along the edges of each lever are dimensioned such that a necessary movement of the bearings 25 may take place. For preventing of metal-to-metal seizing or galling, the bearings 25 may be made out of e.g. brass or other suitable material and preferable the bearings 25 may be semi axles (axles, which are essentially cut in halves lengthwise).

Under operation of a fixture as shown in figure 8, a specific force is applied to the lower part 12 and further distributed to the two levers 21, 21' through their support which would normally comprise two identical spherical bearings but in the shown embodiment in figure 8 comprises two different spherical bearings 23 and 40. The force transmitted to the two levers 21, 21' is further distributed through the arms of levers 21, 21' where the centrally positioned arms 21b of each of the two levers distribute a part of the force to the end (reinforcement tab) 2 of a test specimen. The two other arms 21 a of the levers 21, 21' distribute the rest of the force to the intermediate pieces 22 which further transfer the force to the top part 11 of the fixture causing the clamping

part 10,11 to transfer the force as shear forces to the side tabs 3 of the test specimen.

5 It should be understood that the bearings 25 not necessarily have to be identical as shown in figure 8 and may be constructed in many other ways known to skilled person.

10 A fixture according to another embodiment is shown in figure 9. The fixture shown in figure 9 comprises two clamping systems arranged coaxially and mirror symmetrical to each others and the two systems being positioned with one clamping 60, 70 system directly above the other 11,10.

The lower clamping system is provided with two wedges for the holding of a test specimen 1 and comprises:
15 a bottom plate, and a clamping part preferably comprising at least one wedge 10, first force transferring means, and second force transferring means wherein at least one lever 21 having two arms, the first arm defining said first force transferring means adapted for transferring of force to the end of said test specimen 1 and said second arm defining second force transfer-
20 ring means adapted for transferring of force to the clamping part of the fixture. The upper clamping system is preferably provided with two wedges 70 being received in a plate 60 for the holding of a test specimen 1.

25 The two clamping systems 10,11 and 60,70 are connected by a bolt 82 having a threaded end 80 and a nut 81. The threaded end 80 of the bolt 82 is attached to the bottom plate 12 and the other end of the bolt 82 is fastened to the upper clamping 60, 70 part of the fixture by a tightening nut 81. The (middle part) of bolt 82 is slideable engaged in both clamping systems.

30 When a force acts on the bottom plate 12 in a direction towards the test specimen 1, a compressive force is introduced into the test specimen 1 as either shear load (shear force) by the lower clamping part 11, 10 or end load

(compressive force) by the bearing 24 being supported on the central situated arm 21b of the lever 21.

- 5 When a force acts on the bottom plate 12 in a direction away from the test specimen 1, the force will be distributed by the bolt 82 and nut 81 to the upper clamping system 60, 70 causing this to introduce a stretching force (tension) applied as shear force by the clamping means 60 to the side (s) of a test specimen 1.
- 10 The spherical bearing 23 on the left side of figure 8 may preferably be a Teflon bearing or a Teflon coated bearing and tests have shown that the bearing GX 17 manufactured by SKF has excellent properties as support for a lever in a fixture according to this invention. Furthermore, the bearing GX 25 (also
- 15 bearing 24 transferring forces from both of the levers to the end of the test specimen.

Claims

1. A fixture for holding a test specimen in a compression test machine, said test specimen comprising two ends and sides and the fixture comprising;
- 5 - a bottom part (12)
 - a clamping part for engaging said sides
 - first force transferring means (21b)
 - second force transferring means (21a)
- 10 **characterized in** said bottom part (12) supporting said first and said second force transferring means and intended for connection to a press, said at least one lever (21) having two arms, the first arm (21b) defining said first force transferring means adapted for transferring of force to an end of said test specimen, and said second arm (21a) defining said second force transferring
- 15 means adapted for transferring of force to said clamping part of the fixture.
2. A fixture according to claim 1, **characterized by** said clamping part comprising at least one wedge.
- 20 3. A fixture according to claim 1 or 2 **characterized by** said lever having a fulcrum defined by a spherical bearing.
4. A fixture according to claim 3 **characterized by** said fulcrum being at essentially the same distance from the bottom part as said first and second
- 25 force transferring means of said lever.
5. A fixture according to claim 3 or 4 **characterized by** the spherical bearing comprising a spherical ring and a bowl-shaped part, said ring (11) preferable being on said bottom part (12).

6. A fixture according to any one of the claims 1-5 **characterized by** each of said first and second force transferring means of said lever each comprising bearing surface extending essentially perpendicular to both:
- the longitudinal axis of the lever
 - the lever's plane of rotation
- and extending along the edges of the lever.
7. A fixture according to claim 6 **characterized by** said bearing surfaces being vaulted.
8. A fixture according to claim 6 or 7 **characterized by** said bearing surfaces being moveably supported in a second bearing comprising a track formed in said lever.
9. A fixture according to any one of claims 1-8 **characterized by** said fixture further comprising an intermediate member (22) adapted for transferring of a force between the second force transferring means of the lever and the clamping part of the fixture.
10. A fixture according to any one of claims 2-9 **characterized by** said clamping part comprising two essentially identically wedges (10) cooperating with each other for holding said test specimen
11. A fixture according to any one of claims 1-10 **characterized by** said fixture comprising two essentially identical levers, each of said levers comprising two arms, the first arm being able to transfer force to the test specimen end, and the second arm being capable of transferring forces to the cooperating wedges.
12. A fixture according to claim 11 **characterized by** said fixture further comprising a spherical bearing (24) disposed essentially between said lev-

ers, said bearing (24) comprising means for transferring force from said second force transferring means of each lever (21) to said end (2) of the test specimen.

- 5 13. A fixture according to claim 12, **characterized by** said spherical bearing (24) comprising a bushing disposed essentially centrally within the bearing, said bushing being guided by an elongated member anchored essentially centrally in the bottom part.
- 10 14. A fixture according to any of the claims 1-13, **characterized by** the second arm of said lever (s) being three or about three times the length of the first arm.
- 15 15. A fixture according to any of the claims 1-14 **characterized in** an additional clamping system (70) capable of transferring tensile forces to a test specimen.
- 20 16. A lever for use in a fixture according to claims 1-15, said lever comprising means for transferring of a force from said bottom part to a test specimen, the lever having two arms, the first arm being first force transferring means adapted for transferring of force to the end of a test specimen, and the second arm being second force transferring means adapted for transferring of force to the clamping part of the fixture.
- 25 17. A lever according to claim 16, **characterized by** said lever having a fulcrum being essentially aligned with the first and second force transferring means of the lever.
- 30 18. A fixture according to claim 17 **characterized by** said lever having a centre of rotation defined by a spherical bearing.

19. A lever according to any of the claims 16-18 **characterized by** each of said first and second force transferring means of said lever further comprising two bearing surfaces extending essentially perpendicular to both:

- the longitudinal axis of the lever;
- 5 — the lever's plane of rotation and
along the edges of the lever.

20. A lever according to claim 19 **characterized by** said two bearing surfaces being convex.

10

21. A lever according to claim 20 **characterized by** said two bearing surfaces being moveable supported in a second bearing comprising a track in said lever.

- 15 22. A lever according to any one of claim 16-21 **characterized by** the second arm of the lever being three or about three times the length of the first arm.

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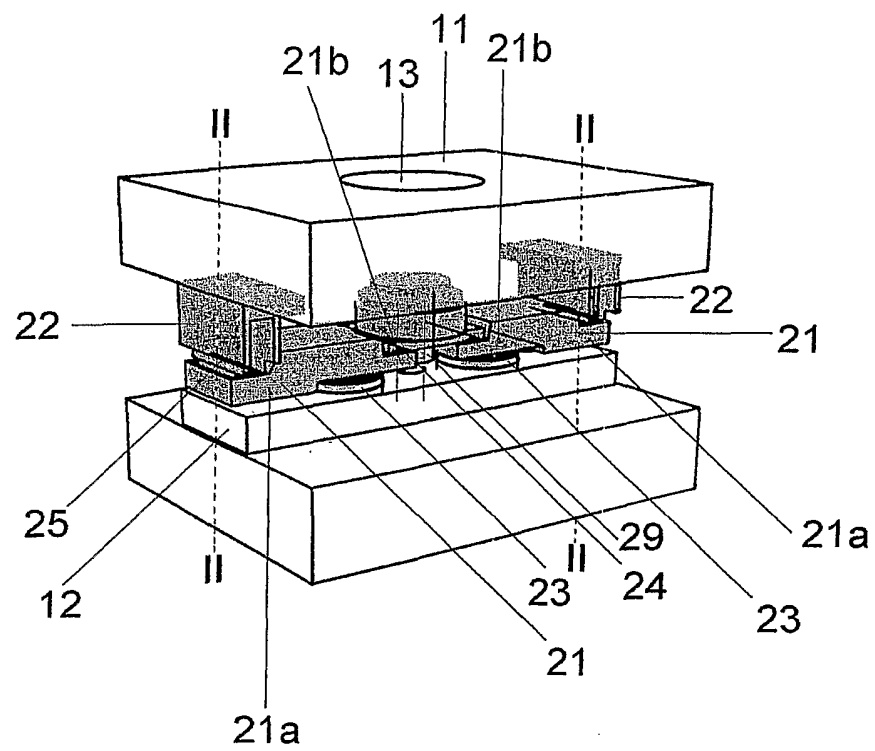


Fig. 1

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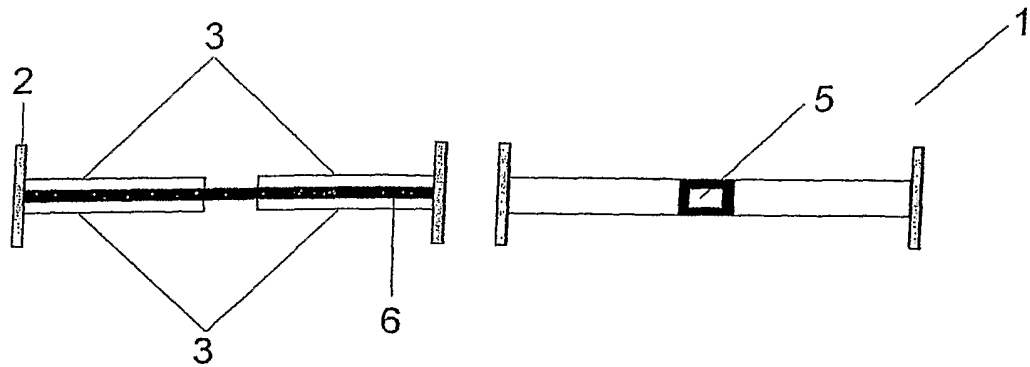


Fig. 2a

Fig. 2b

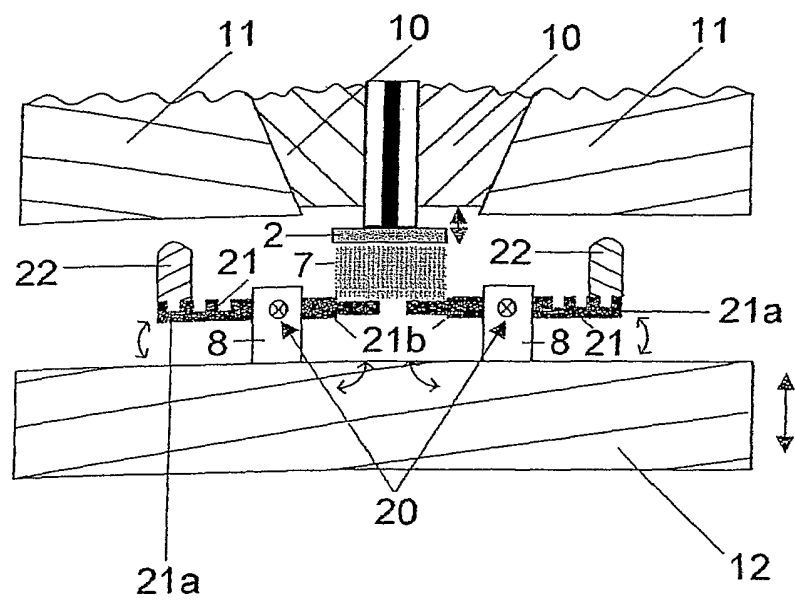


Fig. 3

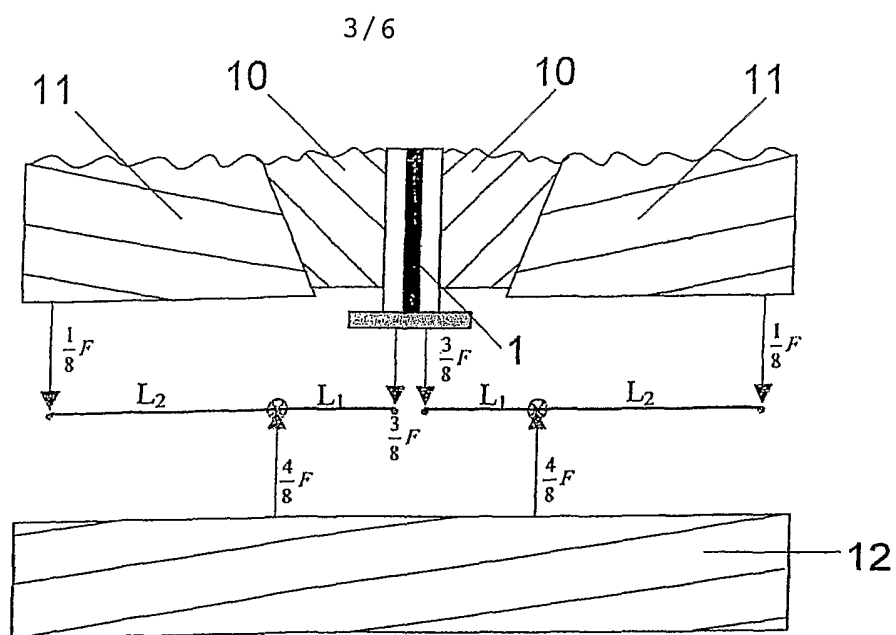


Fig. 5

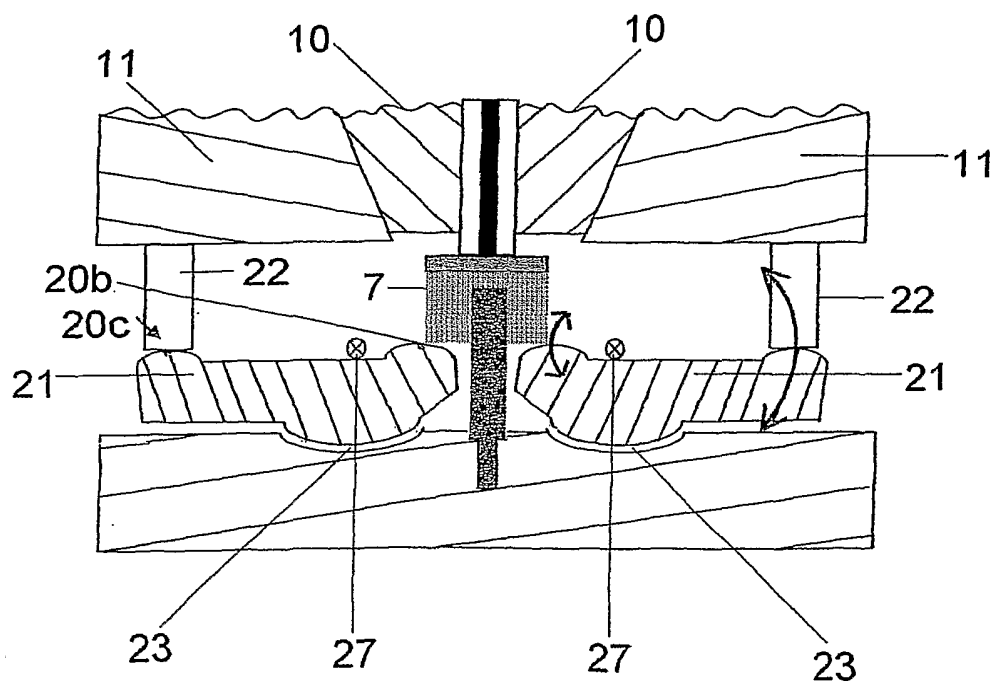
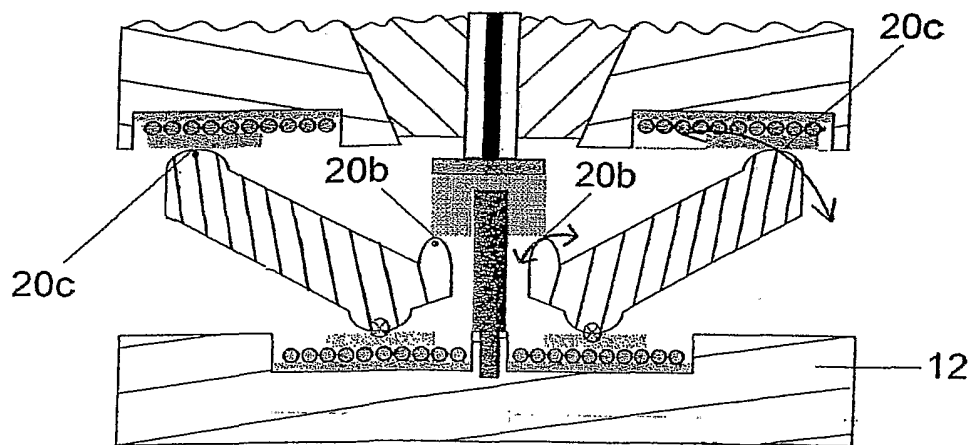
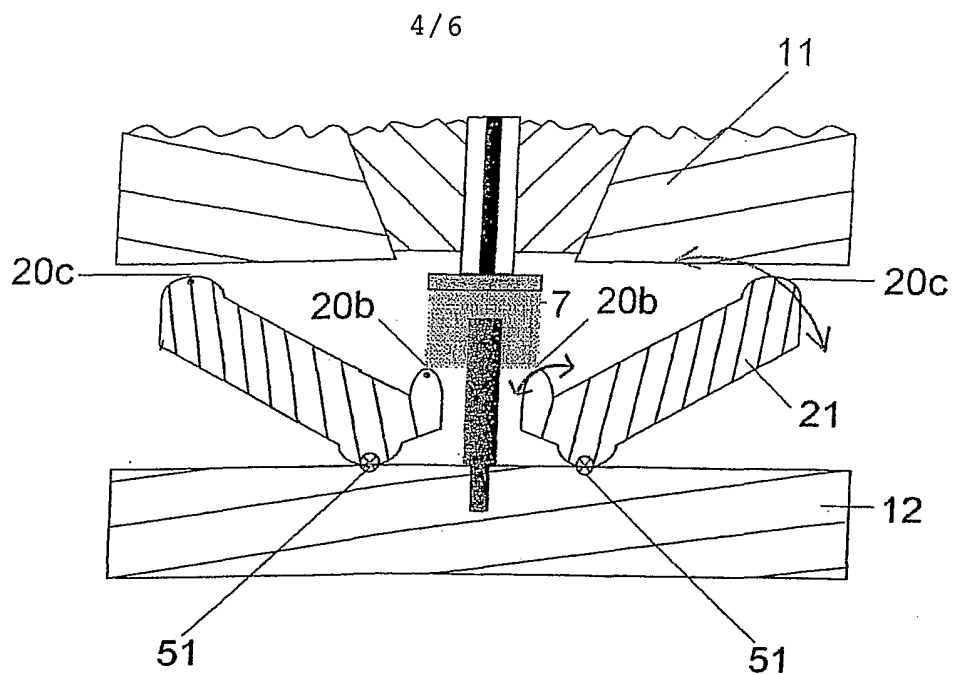


Fig. 4



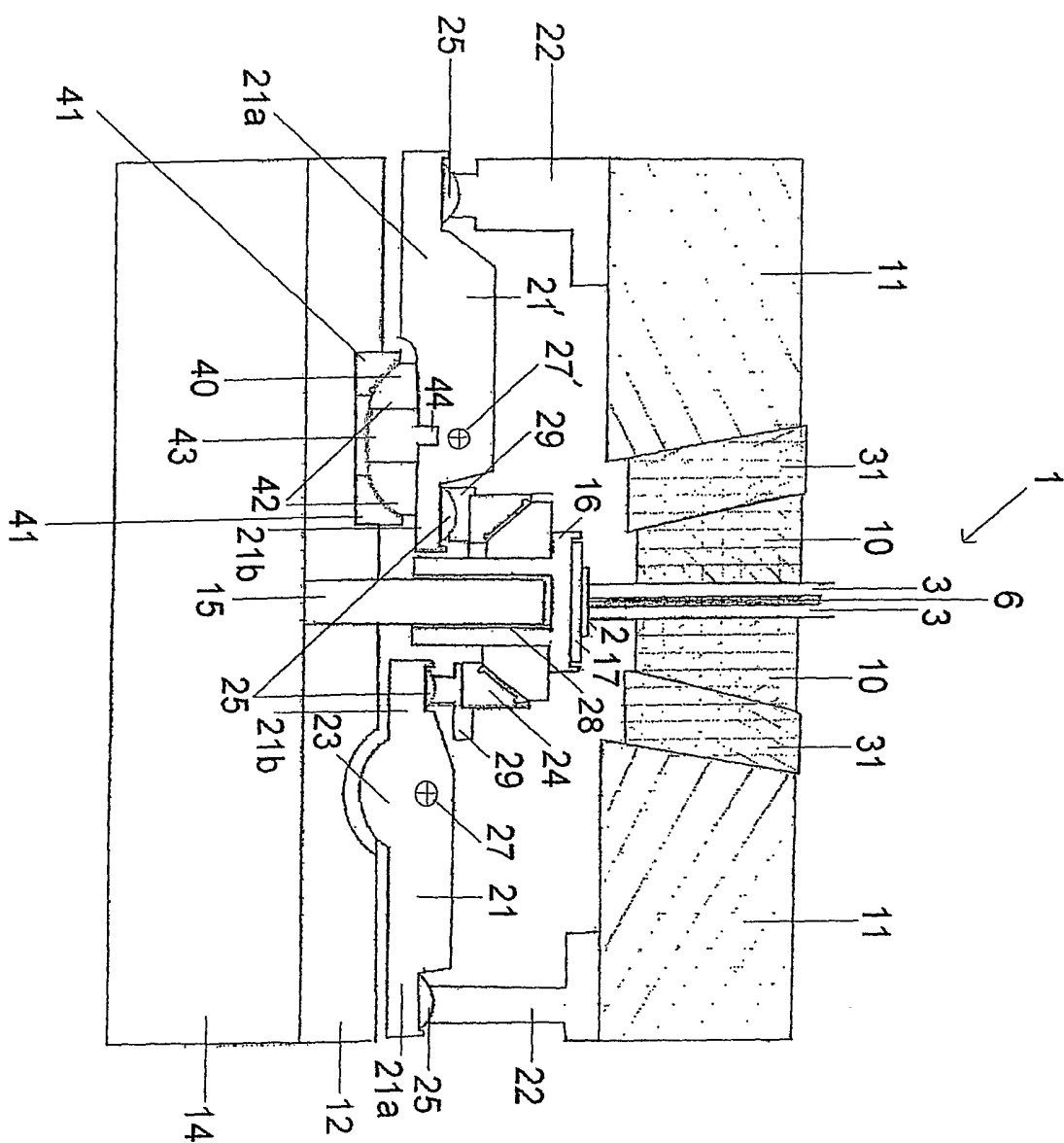


Fig. 8

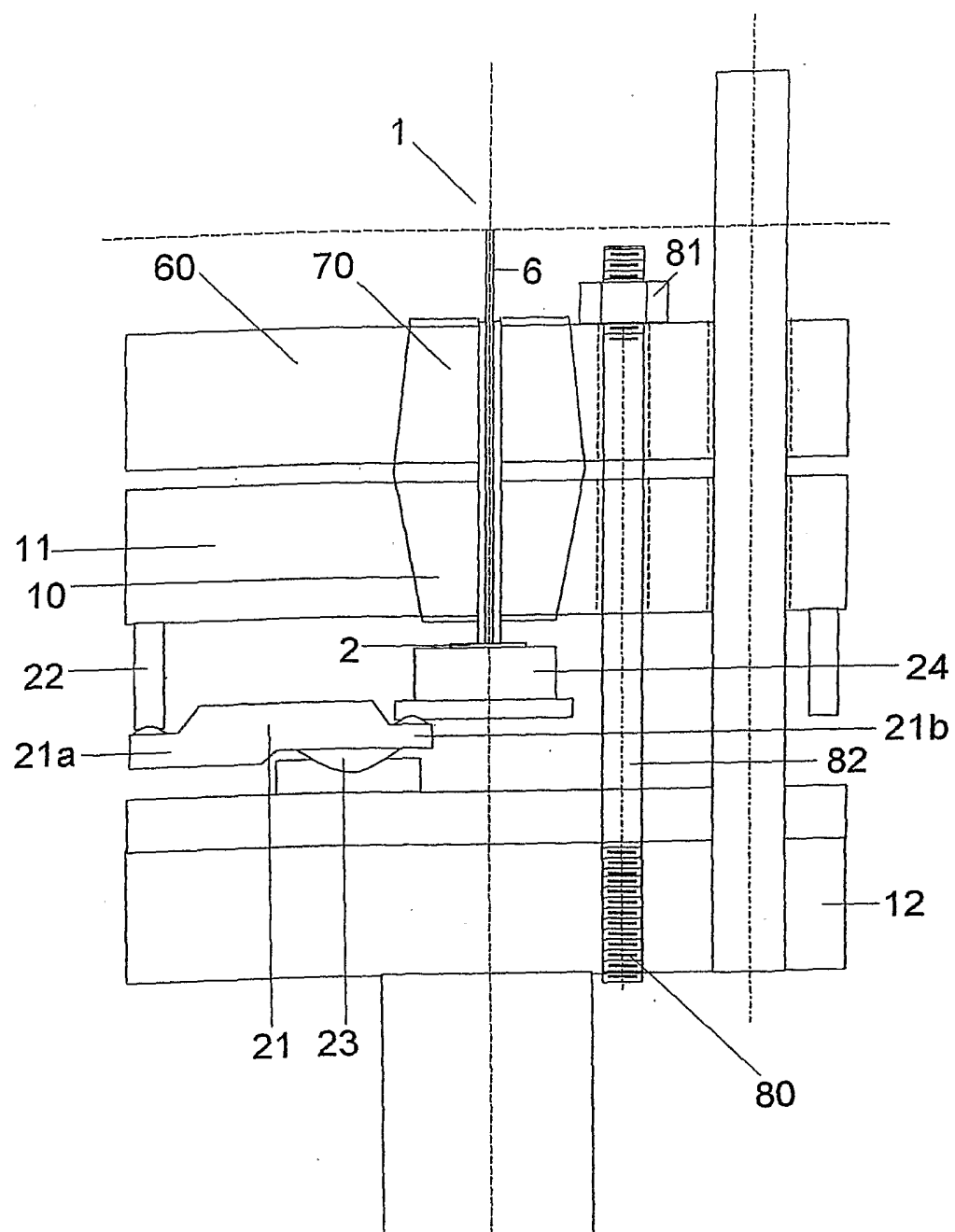


Fig. 9