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Zuber

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[54] **CLAMPING DEVICE, ESPECIALLY FOR MATERIAL TESTING MACHINES**

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[51] **Int. Cl.²** **G01N 3/04**

[58] **Field of Search** 73/103; 269/25, 26

[56] **References Cited**

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2,660,440 11/1953 Kurtz 73/103

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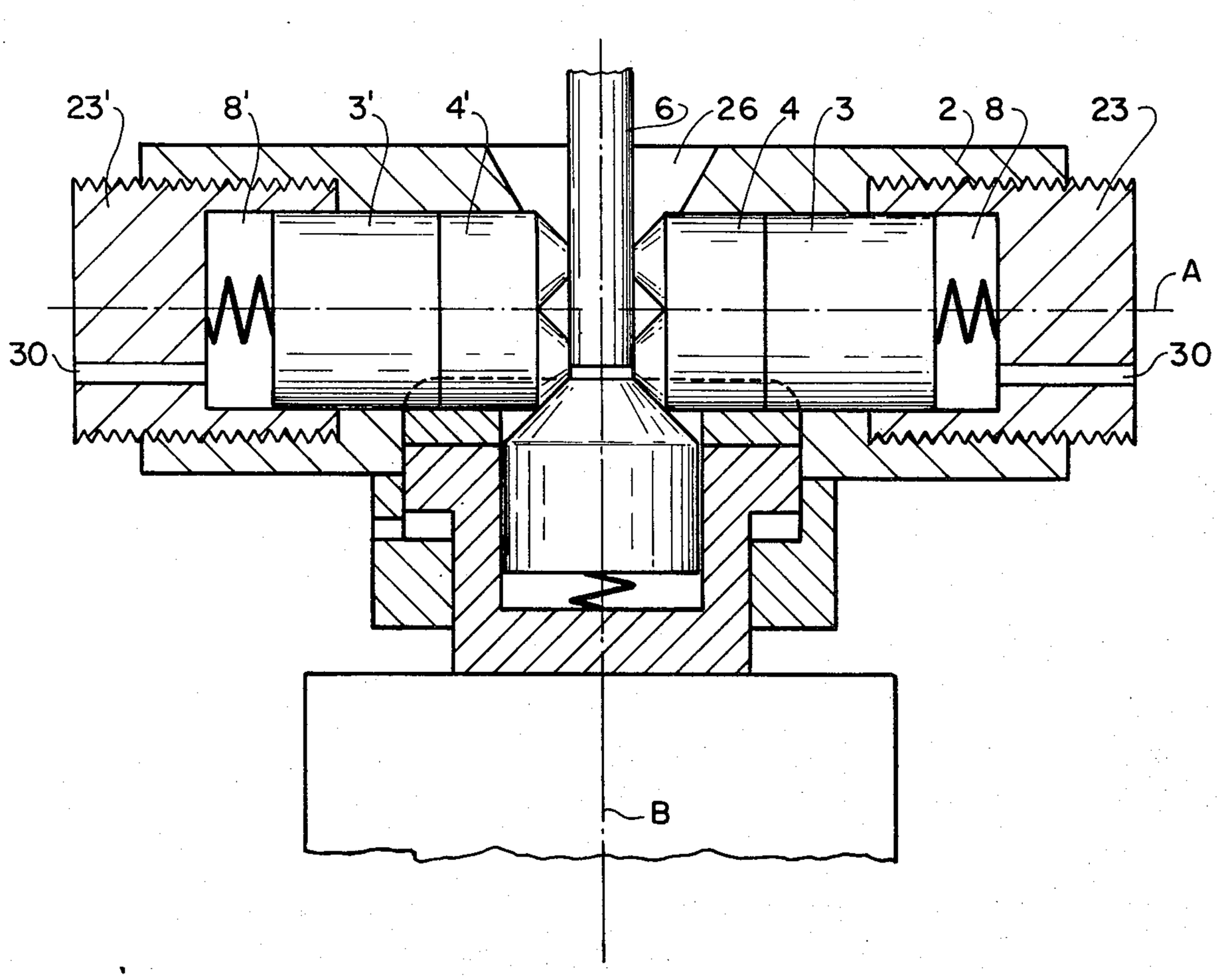
[57] **ABSTRACT**

The present clamping device is constructed to hold a workpiece substantially without play as is essential, for example, in material testing machines. To this end there are provided axially aligned clamping pistons movable back and forth relative to a workpiece, and guide piston means are arranged to press against the clamping pistons in a direction substantially perpendicular to the direction of movement of the clamping pistons. To further increase the guiding effect the guide piston means proper may be surrounded by a ring guide piston arranged to press against the clamping piston, for example, under the pressure of spring means or hydraulic pressure means.

18 Claims, 4 Drawing Figures



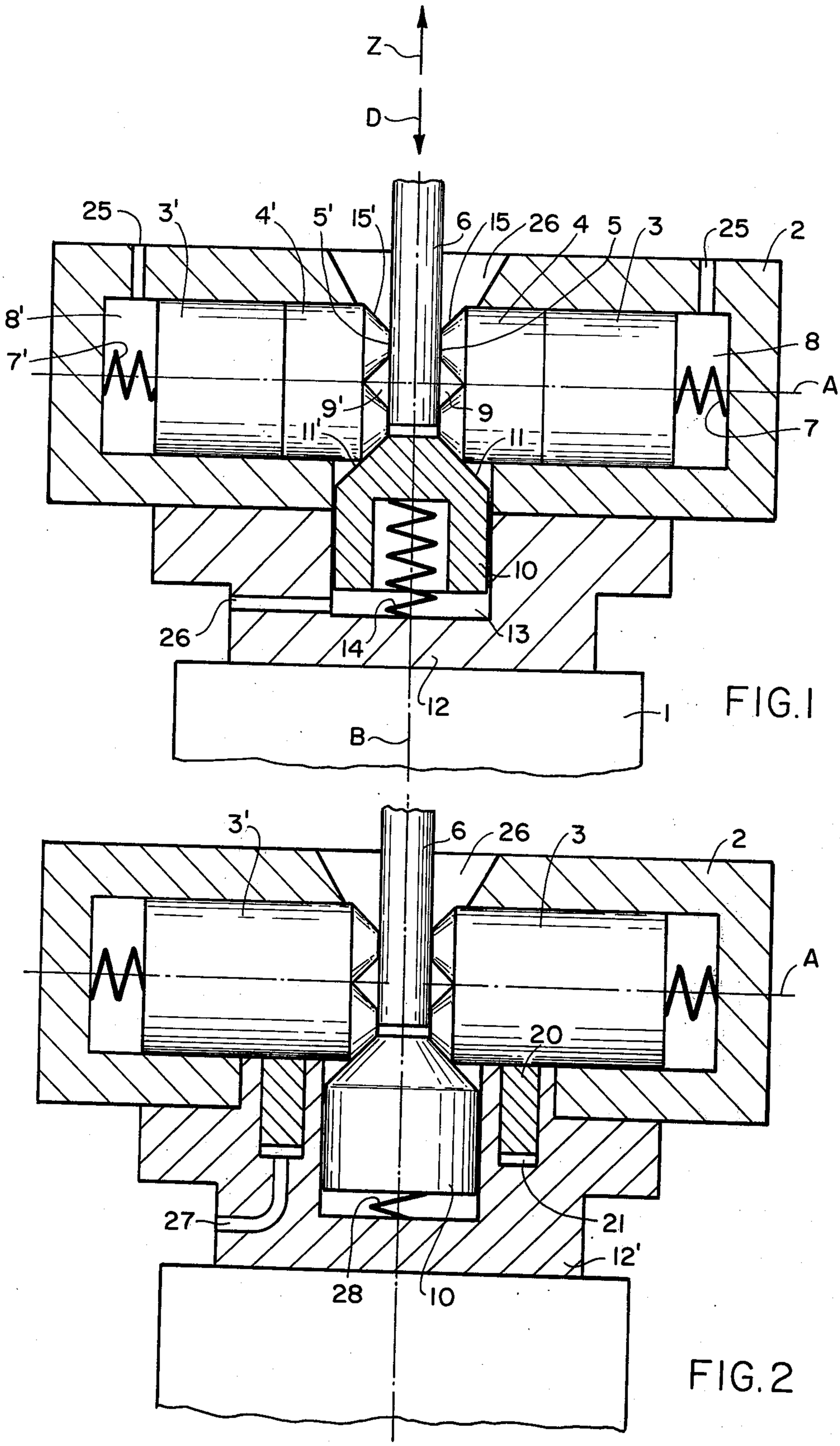

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FIG.1

FIG.2

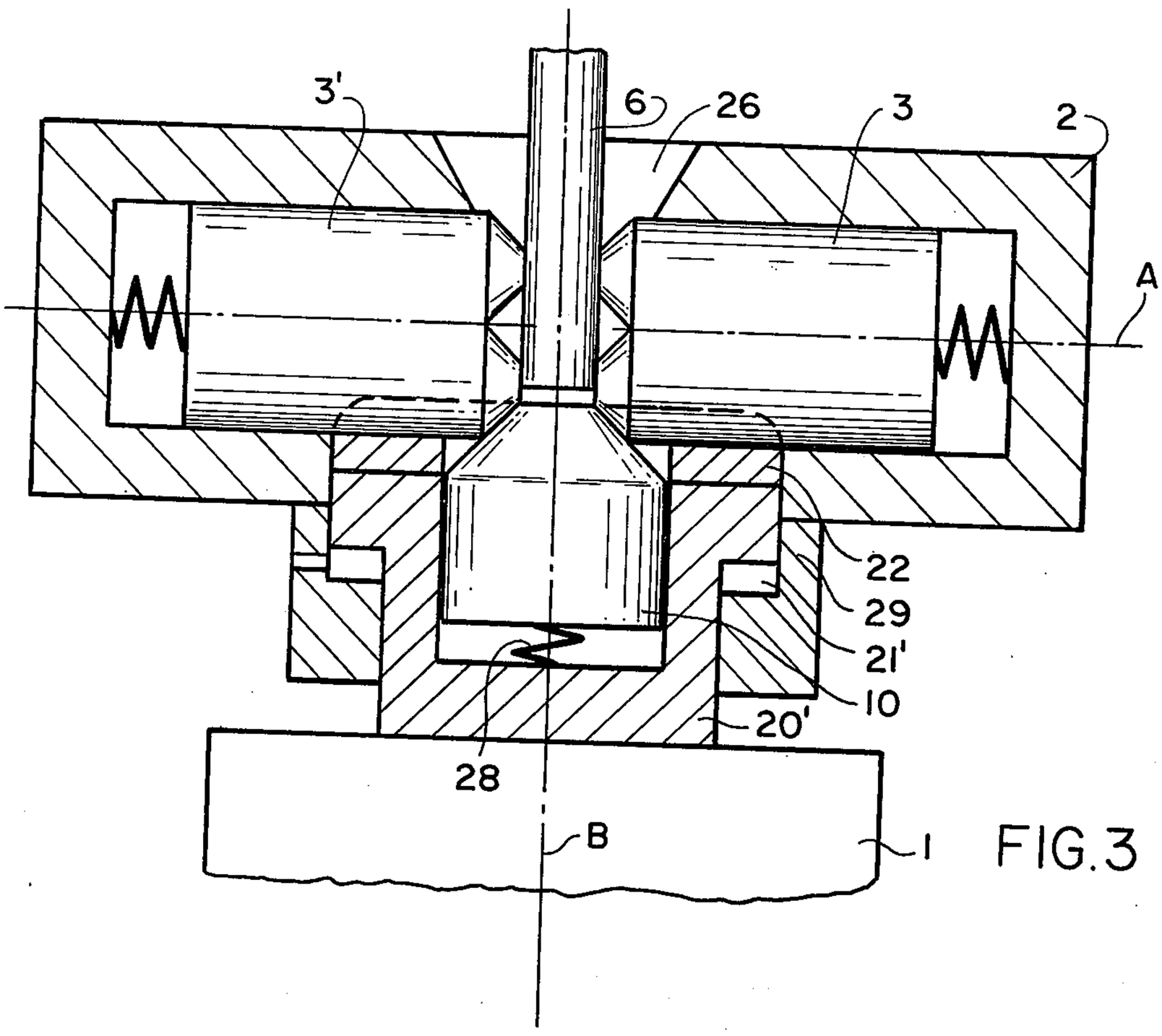

FIG.3

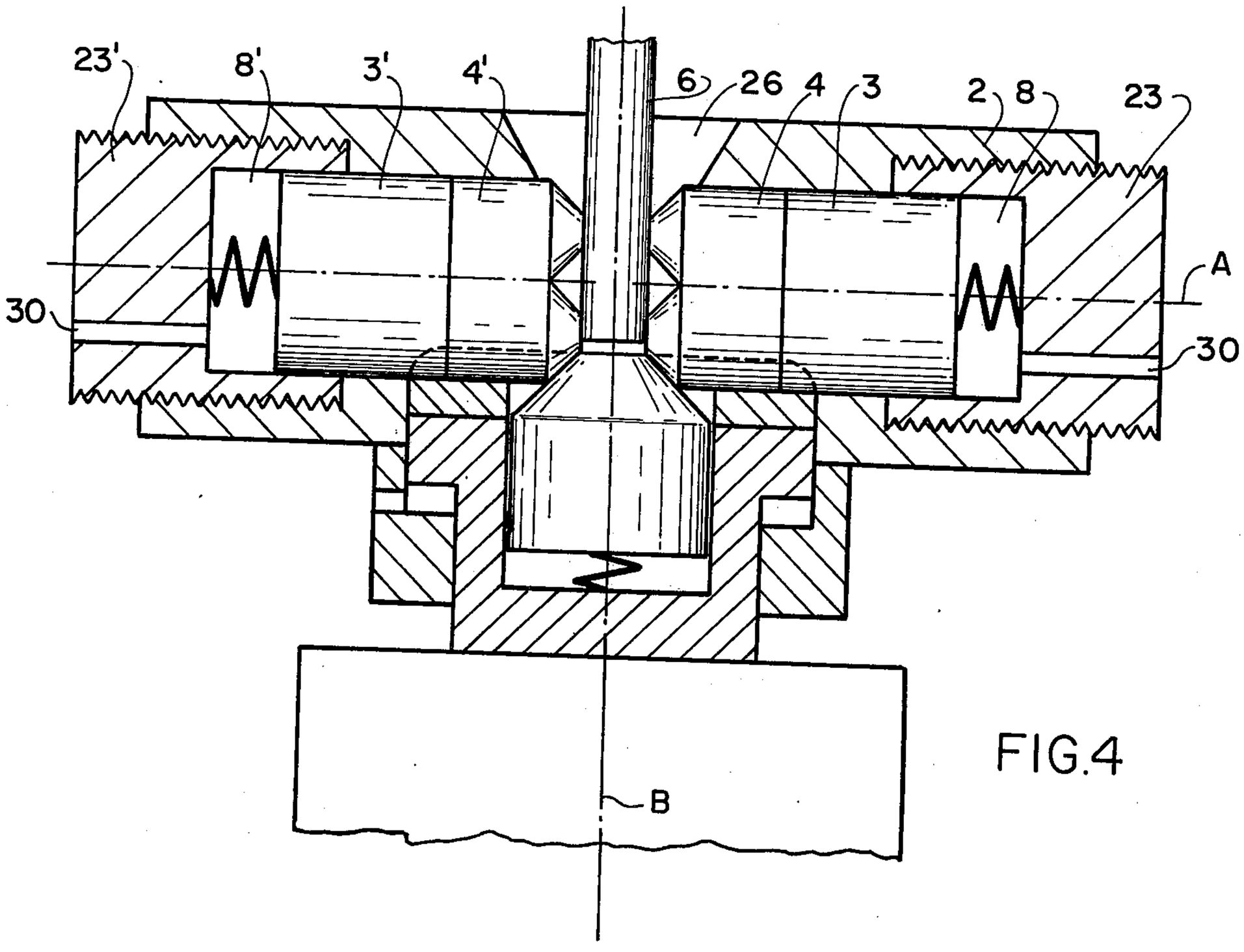

FIG.4

CLAMPING DEVICE, ESPECIALLY FOR MATERIAL TESTING MACHINES

BACKGROUND OF THE INVENTION

The invention relates to a clamping device, especially for testing machines, wherein at least two opposite clamping pistons cooperate for centrally clamping a workpiece.

One of the most important problems in the field of testing machines is seen in providing appropriate clamping devices for the workpiece to be tested. The clamping device should be suitable for all kinds of loads, such as tensile loads, compression loads, or alternating loads and especially for dynamic loads. Particularly for dynamic testing it is essential to provide a clamping device without any play in the direction of load application, combined with an exact centering of the workpieces in the clamping direction, because an eccentric clamping of the workpiece may subject the latter to unwanted loads, especially traverse loads, which would falsify the test result. The same effect may result in a clamping device in which play in the direction of load application has not been completely avoided. Furthermore, any play between the clamping surfaces will cause excessive wear of the clamping device, especially when applying dynamic loads.

A well known clamping device for testing machines with counteracting hydraulically actuated pistons for the central clamping of workpieces or specimens is described in German Pat. No. 1,648,616. In this clamping device the pistons act perpendicularly on two opposite sides of the workpiece to be clamped. The specimen or workpiece is centered hydraulically by applying equal amounts of pressure fluid to the opposite clamping pistons. To this end double stage cylinders are used comprising stepped pistons having equal effective piston areas in each stage. Thus, moving said stepped piston will supply approximately equal amounts of pressure fluid by both cylinder stages.

However, due to machining tolerances in the entire hydraulic system including cylinders, pistons and lines unavoidable differences will result in the amounts of pressure fluid required for an exact centering. These differences will defeat an exact centering and may even be still increased by different lengths of lines and by the compressibility of the pressure fluid. Thus, an exact central clamping cannot be guaranteed. The pistons of the clamping device will have necessarily a certain radial play which makes them less suited for dynamic loads including tension and compression forces.

OBJECTS OF THE INVENTION

In view of the above, it is the aim of the invention to achieve the following objects singly or in combination:

to avoid the drawbacks of the prior art, especially to provide a clamping device in which play may be avoided especially in the direction of loading;

to provide a clamping device, especially for testing machines by means of which any specimen, especially round and flat specimens with varying dimensions may be clamped and centered with high accuracy;

to provide a clamping device especially suitable for all types of dynamic specimen testing, particularly testing in which the direction of the applied force alternates continuously;

to provide means in a clamping device which will automatically compensate not only any difference in the clamping pressures exerted by the individual clamping elements, but also any manufacturing tolerances of the clamping pistons as well as any differences in the coefficients of friction between the clamping pistons and their respective cylinders;

to provide simple control means for the adjustment of the clamping motion of the clamping elements to move in unison or synchronism with each other over the entire stroke or range of movement of the clamping pistons;

to provide a plurality of guide piston means for assuring the necessary guide forces even where large guide forces are required;

to construct the guide means in such a manner that a precisely defined angular position between the guide means and the clamping pistons is not necessary; and

to arrange the clamping means so that they are easily exchangeable.

SUMMARY OF THE INVENTION

According to the invention there is provided a clamping device including at least one guiding piston between a number of clamping pistons, wherein said guiding piston is movable in a direction extending perpendicuarly to the direction of movement of the clamping pistons and in contact with respective surfaces of the clamping pistons. Preferably said guiding piston has wedge-shaped or slanted front faces, and the clamping pistons rest against the front faces of the guiding piston. The guiding piston guides the clamping pistons exactly in any position within the adjustable range of the device in the axial direction as well as in the radial direction, whereby the specimen will be exactly centered and simultaneously any play of the clamping device in the loading direction will be avoided.

A substantial advantage of the guiding piston is seen in that different pressures in the clamping cylinders, dimensional tolerances of the diameters of the clamping pistons, and different friction coefficients of the piston guideways are compensated automatically by the effect of the force applied to the contact surfaces between the guiding piston and the clamping pistons. The compensation is accomplished in that the guiding piston takes up the difference force present between the right and left clamping pistons so that an equal force will be exerted on the specimen by both pistons. Further, the synchronous motion of the clamping pistons will be positively assured in a mechanical manner by the guiding piston throughout the entire clamping range of the clamping pistons. Thus, a synchronous motion control is provided.

The operation of the present clamping device is very simple since the operator needs to adjust merely a certain pressure for the clamping pistons, and if desired, for the guiding piston according to predetermined pressure values. After the setting of the pressure or pressures the specimen will be automatically clamped and simultaneously it will be exactly centered as well as braced in the load direction without any play and without any additional work steps or particular attention on the part of the operator. Thus, any complicated hydraulic control device for the clamping device has been obviated. Simultaneously the central clamping makes sure that the specimen will not be subjected to unwanted forces which might otherwise influence the test result.

BRIEF FIGURE DESCRIPTION

In order that the invention may be more clearly understood, it will now be described, by way of example, with reference to the accompanying drawings, wherein:

FIG. 1 shows a clamping device according to the invention with a guiding piston;

FIG. 2 shows a modified clamping device with a guiding piston and a ring piston also serving as a guiding means;

FIG. 3 shows a clamping device with a first guiding piston mounted in an annular second guiding piston; and

FIG. 4 shows a clamping device with a guiding piston and an annular or ring guiding piston, as well as removably secured inserts for the clamping pistons.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

FIG. 1 shows a cross section through the clamping device according to the invention. The clamping device is mounted to the frame 1 of a testing machine. Clamping pistons 3 and 3′ are arranged in a housing 2 so as to oppose each other. The clamping pistons 3, 3′ are movable back and forth along a first axis A extending, for example, horizontally through the housing 2. These clamping pistons have workpiece holdings ends 4, 4′ facing toward a workpiece or specimen 6 extending along a further axis B defining the direction of force application and extending substantially perpendicularly to axis A. The clamping end pieces 4 and 4′ are preferably rotatable relative to the clamping piston proper whereby the clamping pieces are easily exchangeable for instance, if replacement due to wear is necessary. The relative rotation between the piston proper and the ends 4, 4′ has the advantage that the end pieces may be easily located into the proper position for clamping of flat and/or round specimens by simply turning the clamping end pieces 4, 4′. The clamping pieces 4 and 4′ are provided with clamping surfaces 5 and 5′ for clamping of a specimen 6. Between these surfaces 5, 5′ of the clamping end pieces there are spaces in which clamping prisms 9 and 9′ are located. These clamping prisms serve to hold round specimens. To this end the clamping prisms 9, 9′ will be rotated to take up a proper position relative to axis B which is the testing axis. In the housing 2 there are cylinder chambers 8 and 8′ which receive the clamping pistons 3, 3′ with their end pieces 4, 4′. The chambers or cylinder 8, 8′ are connected through ports 25 to a source of pressure, for example, a hydraulic pump not shown, whereby pressure fluid may be applied to effect the clamping operation. The compression loads are applied to the specimen 6 in the direction shown by the arrow D. The tension loads are applied in the opposite direction Z. Reset springs 7 and 7′ in the cylinders 8, 8′ retract the clamping pistons 3 and 3′ with the clamping pieces 4 and 4′ into their initial position when the clamping pressure is released.

A guiding piston 10 with front or control faces 11 and 11′ is movably supported in an intermediate housing member 12 connected with the frame 1 as well as with the housing, for example, by screws not shown. Pressure fluid may be applied to the cylinder chamber 13 in the intermediate housing member 12 through port 26. A housing spring 14 presses the guiding piston 10 against the clamping pieces 4 and 4′ independently of the pressure in the cylinder chamber 13. Where the clamping pistons 3, 3′ are not provided with clamping end pieces, as in FIG. 3, for example, the guiding piston bears directly against the clamping pistons under the force of the biasing spring 14.

The control faces 11 and 11′ of the guiding piston bear against the mating surfaces 15 and 15′ of the clamping pieces 4 and 4′ as shown in FIG. 1. The control faces of the guiding piston 10 may be, for instance, wedge-shaped or tapered, or they may have any other shape providing a wedging action. The mating surfaces 15 and 15′ of the clamping pieces are adapted to the shape of the guiding piston 10 for cooperation therewith. The mating surfaces may be, for instance, formed as a circular chamfer or as any surfaces with chamferred front faces. Between the guiding piston and the clamping pistons or clamping pieces respectively the control contact may be over a surface or along a line of contact, or at a point or points of contact. Where wedge-shaped or tapered front faces 11 and 11′ of the guiding piston 10 cooperate with mating surfaces 15 and 15′ of the clamping pistons the wedge or taper angles will be the same for the guiding piston and for the clamping pistons.

When clamping the specimen 6 the clamping pistons 3 and 3′ are initially in their outward, retracted position due to the force exerted by the reset springs 7 and 7′ connecting the respective piston to the housing whereby the largest possible opening 25 for the insertion of the specimen 6 is provided. The guiding piston 10 is also held in a starting or end position wherein faces 11 and 11′ of the guiding piston 10 contact the mating surfaces 15 and 15′ of the clamping pieces 4 and 4′. As soon as a pressure medium is admitted to the cylinder chambers 8 and 8′ the clamping pistons 3 and 3′ will move toward the specimen 6 to be centered and clamped. Due to this movement of the clamping piston 3, 3′ the guiding piston 10 is pushed back or downwardly by the force effective at the contact surfaces 11, 11′; 15, 15′ between the guiding piston and the clamping pieces, whereby first the force of the spring 14 must be overcome. Additional force may be exerted hydraulically on the guiding piston 10 by admitting pressure fluid to the cylinder chamber 13 through the port 26 from a pressure source not shown. The action of the spring 14 assures over the entire range of movement of the clamping pistons 3, 3′ that the guiding piston 10 will bear against the clamping pistons 3 and 3′ or the clamping pieces 4 and 4′ respectively. Instead of the spring 14, equivalent mechanical adjustment means may be employed for keeping the guiding piston 10 in bearing contact with the clamping piston means, for example, an adjustable spring may be used so that the bearing force exerted by the guiding piston 10 upon the clamping pistons 3 and 3′ may be varied in a wide range to adapt it to the requirements of any particular clamping arrangement. Moreover, the bearing force may be influenced by an appropriate selection of the taper angle of the contact surfaces between the guiding piston and the clamping pistons.

The taper at the contact surfaces between the guiding piston 10 and the clamping pieces 4 and 4′ will divide the bearing force into radial and axial components. The radial force components at the guiding piston 10 extend in the direction of the axis A. The axial force components extend in the direction of the axis B. The radial force components will compensate for any difference

between clamping forces exerted by the clamping pistons, which differences may result from different pressures in the cylinder chambers **8** and **8'**, or which may be due to dimensional tolerances of the piston diameters, or due to different friction coefficients of the pistons, and the like. The advantage of such compensation resides in the synchronization of the movement of the two clamping pistons since the guiding piston **10** takes up in its bearing surfaces the difference in the forces existing between the clamping pistons **3** and **3'** due to the spring **14** and due to the hydraulic pressure applied to chamber **13.** The axial force components on the guiding piston **10** press the clamping pistons **3, 3'** against their respective cylinder surfaces, whereby any play in the direction of the axis B is eliminated, whereby any play in the direction of loading is avoided right from the start, namely, when clamping the specimens **6.** To keep the play eliminated care must be taken that the sum of the force components acting upon the clamping pistons in the direction of loading are greater than the maximum counteracting load on the specimen **6.**

FIG. **2** shows the same basic construction as FIG. **1.** However, in FIG. **2** the intermediate housing member **12'** includes an annular cylinder **21** wherein a ring piston **20** is arranged concentrically about and in addition to the guiding piston **10.** Pressure may be applied to the ring piston **20** by supplying pressure fluid to the annular cylinder **21** through a port **27.** The ring piston **20** presses the two clamping pistons **3** and **3'** against their respective cylinder surfaces thus guiding the pistons **3,** 3' free of any play. In the embodiment of FIG. **2,** the clamping pistons may also be of the two piece construction to include clamping end pieces, whereby the ring piston **20** may rest against such clamping end pieces, see FIG. **4.** In this embodiment of the clamping device with a ring piston **20,** the guiding piston **10** substantially assures the guiding of the clamping pistons **3** and **3'** in the direction of the axis A, whereas the ring piston **20** substantially assures the guiding of the clamping pistons in the direction of the axis B. If desired, pressure fluid may be applied individually either to the guiding piston **10** or to the ring piston **20.** The clamping piston **3** and **3'** may be moved even after the application of pressure to the ring piston **20** since only approximately 20% of the clamping force of the ring piston will be required to overcome the friction of the clamping pistons while the clamping force of the clamping pistons is substantially larger. A spring **28** or equivalent mechanical or hydraulic or pneumatic adjustment means may be used to bias the guiding piston as described. Similarly, ring piston **20** may be pressed against the clamping pistons by any mechanical or equivalent means, for example, springs. The ring piston **20** has the advantage that it is possible to apply high forces for the free-of-play guiding of the clamping pistons in the direction of loading, and to relieve the contact surfaces of the guiding piston. Furthermore, the central clamping of the specimen may be performed by one component of the guiding means while the clamping free of play in the direction of loading may be perfomred by the other component of the guiding means thus facilitating achieving optimum structural features, such as compactness and simple shapes of the clamping device with due regard for any particular test purpose.

FIG. **3** shows an embodiment of the clamping device according to the invention wherein the guiding piston **10** is movably supported in a ring piston **20'**. The ring piston **20'** forms the cylinder for the guiding piston **10.** Pressure is applied to said piston **20'** by supplying pressure fluid to an annular cylinder chamber **21'**. The piston **20'** is directly connected to the frame **1.** When applying pressure fluid to the cylinder chamber **21'** the housing **2** and thus the clamping pistons **3** and **3'** will be pushed against the stationary ring piston **20'** due to the intermediate housing member **29,** whereby the clamping pistons **3** and **3'** bear against the ring piston **20'** either directly or through pressure blocks **22** which may be adapted to the shape of the clamping pistons to form a bearing shell for the clamping pistons. Incidentally, the ring piston **20'** may be constructed in any suitable manner. For example, the intermediate housing may be directly connected to the frame **1** so that the ring piston would be movable rather than stationary. In any event the embodiment of FIG. **3** is especially compact.

FIG. **4** shows an embodiment of the clamping device, wherein the clamping pistons **3** and **3'** are held in the housing **2** by inserts **23** and **23'**, which may be screwed into the housing **2.** However, these inserts may be fastened by any other means in the housing **2,** e.g. by bolts, bows, covers, and the like. Simultaneously, the inserts **23, 23'** form the ends of the cylinders for the clamping pistons **3** and **3'**. The hydraulic lines for the supply of pressure fluid to the cylinder chambers **8** and **8'** may be connected to ports **30** in these inserts. The lines may remain connected to the inserts even when removing said inserts.

The just described embodiment of FIG. **4** has the advantage that the clamping pistons and/or their workpiece engaging ends may easily be exchanged, for example, for replacement as a result of wear and tear, since the inserts **23, 23'** may easily be attached to or removed from the housing **2.**

Further advantages, which may be realized with all four embodiments of the invention are seen in that a compact clamping device may be constructed in accordance with the teachings disclosed herein. The clamping device has a small overall height and a relatively low weight. Further, since only simple structural elements are employed most of which are of rotational symmetry, the production costs are also reduced. Moreover, the control of the guiding forces by means of hydraulic or pneumatic pressure control is also rather simple.

Where, for certain clamping requirements the arrangement of one guiding piston if desired surrounded by a further guiding ring piston, is not sufficient, several such guiding piston units may be located between the clamping pistons. In this manner it is possible to establish any desired guiding forces and also to apply such guiding forces exactly where they are needed. Further, by providing several guiding piston means, the control pressure may be distributed so as to relieve the cooperating control surfaces between the guide piston means and the clamping piston means.

In the embodiment where the guide piston has a tapered or conical front face, the advantage is achieved that the guide piston may be rotated and does not require any precise angular position relative to the clamping pistons.

Although in the above described example embodiments, the central guide piston **10,** as well as the ring guide piston may be subjected to controlled hydraulic

pressure for the selection of the best suitable guide pressure, it will be appreciated that such pressures may be varied within a wide range and that in addition to, or instead of the hydraulic pressure, other pressure control or force control means may be employed such as springs or lever controlled pressure exerting means.

Another advantage of the invention is seen in that by making the workpiece engaging ends of the clamping pistons rotatable relative to the respective piston proper it is possible to locate these clamping ends with due regard to the type of workpiece to be clamped. For example, the end pieces may be suitable for engaging flat workpieces when rotated into one position, and to engage round workpieces when rotated into another position. To this end it is desirable to provide the workpiece engaging ends with clamping prisms as described above. By employing prisms of different sizes and by arranging these prisms at an angle relative to each other on the clamping surface it is possible to clamp round workpieces having different diameters.

Although the invention has been described with reference to specific example embodiments, it is to be understood, that it is intended to cover all modifications and equivalents within the scope of the appended claims.

What is claimed is:

1. A clamping device for securely holding a workpiece, especially for material testing machines, comprising housing means having a first axis, axially aligned first bores in said housing means extending in the direction of said first axis, a workpiece receiving opening in said housing means having a second axis extending substantially at a right angle to said first axis, clamping piston means movably located in said axially aligned bores and having workpiece clamping ends facing toward said second axis for centrally clamping a workpiece relative to said second axis in said housing means, a further bore in said housing axially aligned with said second axis, guide piston means axially movable in said further bore whereby the guide piston means is movable perpendicularly relative to the direction of movement of said clamping piston means, said guide piston means having guide surface means contacting said clamping piston means, first means for urging said clamping piston means toward said workpiece and second means operatively associated with said guide piston means for urging said guide piston means against said clamping piston means.

2. The device according to claim **1,** wherein said clamping piston means comprise at least two axially aligned clamping pistons each facing the other with its respective workpiece clamping end, said workpiece clamping ends having inclined control surfaces, said guide surface means of said guide piston means having a corresponding inclination for cooperation with said control surface means, whereby the guide piston means effect a wedging action on said clamping piston means.

3. The device according to claim **1,** comprising further guide means including a ring piston, said housing means including a ring cylinder opening into said first bores and receiving said ring piston in said ring cylinder for movement therein, said ring piston with its ring cylinder concentrically surrounding said guide piston means and pressing against said clamping piston means.

4. The device according to claim **3,** wherein said ring piston comprises a central axial bore to form a cylinder in which said guide piston means is movably received.

5. The device according to claim **1,** wherein said guide surface means of said guide piston means has a conical shape.

6. The device according to claim **5,** wherein said clamping piston means comprise control surface means adapted for cooperation with the conical guide surface means of the guide piston means.

7. The device according to claim **1,** wherein said second means operatively associated with said guide piston means are connected to a source of pressure for urging the guide piston means against said clamping piston means.

8. The device according to claim **1,** wherein said second means operatively associated with said guide piston means comprise mechanical adjustment means for urging the guide piston means against said clamping piston means.

9. The device according to claim **8,** wherein said mechanical adjustment means comprise spring means located in said further bore to urge the guide piston means against said clamping piston means.

10. The device according to claim **1,** comprising further guide means including a ring piston, said housing means including a ring cylinder opening into said first bores and receiving said ring piston in said ring cylinder for movement therein, and means operatively associated with said ring piston for urging the ring piston against said clamping piston means.

11. The device according to claim **10,** wherein said means operatively associated with said ring piston comprise mechanical adjustment means for urging the ring piston against said clamping piston means.

12. The device according to claim **11,** wherein said mechanical adjustment means comprise spring means located in said ring cylinder to urge the ring piston against said clamping piston means.

13. The device according to claim **1,** wherein said clamping piston means comprise clamping pieces forming said workpiece clamping ends of said clamping piston means, said clamping pieces being rotatable relative to the respective clamping piston.

14. The device according to claim **13,** wherein said clamping pieces comprise clamping prisms forming at least part of said workpiece clamping ends and facing toward said second axis.

15. The device according to claim **1,** wherein said workpiece clamping ends of said clamping piston means comprise clamping prisms facing toward said second axis.

16. The device according to claim **1,** further comprising insert elements, means for removably securing said insert elements in said first bores radially remote from said second axis, said insert elements holding said clamping piston means in said first bores.

17. The device according to claim **1,** further comprising retracting means operatively connected to said clamping piston means for holding the clamping piston means in a retracted position out of which position the clamping piston means are urged by said first means to press the workpiece clamping ends of said clamping piston means against a workpiece.

18. The device according to claim **17,** wherein said retracting means are springs.

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