

The present invention concerns a measurement apparatus for ascertaining the measurements of an object in three dimensions in accordance with the introductory part of patent claim 1 or 2.

In such known measurement apparatuses, the dimensions of the object to be measured are ascertained in that the measurement carriage is displaced to a suitable height and then the measurement rail that is, for example horizontally displaceable, is run out until a feeler surface provided thereon touches the object. From the measure of the displacement of the measurement rail it is possible to derive one dimension of the object in the horizontal direction. For ascertaining a vertical dimension, the measurement rail is run out until it overlaps the object to be measured, and the measurement carriage is lowered until another feeler surface on the measurement rail touches the object. From the height position of the carriage, it is possible to derive a further dimension, that is to say, in the vertical direction.

Since the moment when the feeler surface touches the object cannot be readily determined, or since a displacement based on touch of, for example the measurement rail towards the object until it just touches the latter, would be far too inaccurate, measurement feeler means, for example, in the form of dial gauges are used which register the touching of the object with the required accuracy.

Generally known measurement feeler means operate unidirectionally and linearly, that is to say, a linear change in dimension in a specified direction (and only in this direction) is proportionally converted into a display of the measurement apparatus. Thus to measure the dimensions, dimension deviations or a change in the dimension of a workpiece in two, let alone more directions, it was therefore necessary either to convert and readjust the measurement apparatus used, including the measurement feeler means, or two or more measurement apparatuses working independently of each other, were required. This was reflected in a surplus input of operating time and/or of financial investment.

Such a complicated measurement apparatus for ascertaining the measurements of a workpiece in three dimensions is known from the US-A-4 251 922. In this apparatus, three measurement devices operating independently of each other are provided for the measurement of all three dimensions, which leads to a considerable increase in the cost of the whole apparatus. From the DE-A-2 330 197, it is admittedly known that the workpieces are rotatably mounted for being measured, but from that document, no indication may be gathered that it is possible to measure the workpiece in all three dimensions without a changeover of the measurement apparatus. Finally, in the DE-A-3 234 470, a multicoordinate feeler head is described. But this has a very complicated structure and in view of its com-

plicated structure, it also appears to be sensitive to rough handling and wear and tear, which may considerably impair its measurement accuracy.

5 It is the object of the present invention to avoid these drawbacks and to improve a measurement apparatus of the kind mentioned at the outset in such a way that it can be used more rapidly and on a more universal basis, that is to say that by
10 means of this measurement apparatus, an object can be measured in several different directions without any need for modifying or readjusting the arrangement of the measurement apparatus. Finally, the apparatus should be compact and inexpensive, and at the same time, very accurate and be suitable for determining deviations in dimensions in relation to a specified standard dimension, for ascertaining the rotational accuracy of
15 rotatable workpieces, or for determining the position of a workpiece relative to a reference position.

20 In accordance with the invention, this problem is solved in a measurement apparatus of the kind mentioned at the outset by the apparatuses according to the patent claim 1 or 2.

25 Thereby, one ensures firstly that rotationally symmetrical objects can be conveniently measured from all sides, secondly, that with a blocked measurement rail or a blocked carriage, precise measurements are made possible of, for example, the rotational accuracy of rotationally symmetrical objects, or of changes in the dimensions of objects and thirdly, that all
30 measurements comprising arbitrary measurement directions within a sector of 90° can be effected without modification or readjustment of the apparatus.

35 Further developments of the object of the invention and preferred modes of embodiment thereof are described in the dependent patent claims 3 to 15.

40 An example of the object of the invention is described below in greater detail with reference to the attached drawings. In the drawings there are shown in:

- 40 Figure 1 a schematic front view of the measurement apparatus in accordance with the invention with a cut away base plate;
- 45 Fig.1a - 1c three different examples of inserts in the holding means for the object;
- 50 Figure 2 a schematic front view of the measurement apparatus in accordance with the invention without the inserted object and without an attached measurement feeler means;
- Figure 3 a view similar to Figure 2 but with an inserted workpiece during a first measurement;

- Figure 4 a view similar to Figure 3 during a second measurement;
- 5 Figure 5 an enlarged side view of the measurement feeler means in its rest position;
- Figure 6 an enlarged side view of the measurement feeler means subjected to a measuring force;
- 10 Figure 7 a schematic detailed view, partly cut away, of the arresting means;
- Figure 8 a top view of the arresting means according to Figure 7;
- 15 Figure 9 detail A of Figure 7; and
- Figure 10 detail B of Figure 8.

20 The measurement apparatus represented in Figures 1 to 4 has a base plate body 1 preferably designed as a rigid cast component and which has two exactly planar surface zones 2 and 3. On the surface zone 2, there is secured, for example, screwed on, a measurement carriage arrangement designated by 4 as a whole, the detailed design of which will be discussed further below. An object-holding means designated by 5 as a whole is recessed into the surface zone 3. This object-holding means comprises a sleeve 6 serving as a clamping device for the object to be measured, which sleeve has a centrally arranged conical receiving bore 7 that is open towards the top. Expediently, the shape and dimensions of this bore may correspond to a standard tool shaft, so that such a tool may be directly inserted into the object-holding means 5 for the purpose of the measurement. The sleeve 6 is rotatably mounted without play by means of two ball bearings 8 and 9 arranged at a distance from each other in a recess 12 of the base plate body 1, the upper ball bearing 8 being covered by a cover ring 10 having a central bore 11 for the passing of the sleeve 6; if required, a seal (not shown) of a known design may be inserted between the edge of the bore 11 and the sleeve 6.

If the object to be measured does not have a conical shaft that fits directly and conjugately into the receiving bore 7 of the sleeve 6, provision may be made for additional adapting clamping elements 14 in accordance with Figures 1a to 1c.

Figure 1a shows in cross section a reducing sleeve 15 having a surface zone 16 exactly corresponding in shape and dimensions to the receiving bore 7 of the sleeve 6. With this surface zone, it can be directly and conjugately inserted into the receiving bore 7 of the sleeve 6. The reducing sleeve has a conical receiving bore 17 with smaller dimensions, for instance, for receiving a tool having a slimmer conical shaft.

Figure 1b shows a schematic side view of a, for example hydraulic chuck 25 having a surface zone 26 corresponding in shape and dimensions to the receiving bore 7 of the rotatable sleeve 6, so that the chuck 25 can be inserted directly and conjugately into the sleeve 6. The chuck is provided with a, for example cylindrical receiving bore 27, wherein there may be inserted tools or other objects with a cylindrical shaft.

Figure 1c shows a schematic side view of a chucking and centring element 35 whose head part 37 cooperates with a mating element (not represented) carrying the object to be measured. Such chucking and centring elements are used for example, as highly accurate rapid action chucking couplings for electrodes on electro-erosive processing machines. The chucking and centring element 35 has a shaft 38 with a surface zone 36 again corresponding exactly in shape and dimensions to the receiving bore 7 in the rotatable sleeve 6 so that the element 35 can also be directly and conjugately inserted into the sleeve 6.

It will be understood that the adapting elements 14 represented in Figures 1a to 1c merely form some examples. Depending on the conditions and the object to be measured, provision can be made for other adapting elements, or the rotatable sleeve 6 can be fitted with other suitable clamping means instead of a conical bore 7. It is only important that the sleeve 6 should be rotatably mounted without play in the axial and radial direction and be capable of immovably accommodating an object to be measured.

The measurement carriage arrangement 4 generally comprises a mounting plate 40 whereon there is arranged a guide column 41 in such a way that it extends exactly perpendicular to the planar surface zone 3. The guide column 41 is provided with a guide rail 42 whereon there is mounted an upwardly and downwardly displaceable measurement carriage 43. The carriage 43 is expediently mounted on the rail 42 in known linear ball bearing guideways (not shown), in such a way that the guide rail 42 has guide grooves, V-shaped in cross section and arranged on both sides, wherein there roll ball bearings movably accommodated in the carriage. As is known, such linear guides ensure a very precise mounting of a component which has to be displaced along a straight line, virtually without play and requiring little maintenance.

For driving the measurement carriage 43, provision is made for a drive 45 on a head part 44 of the guide column 41, which drive comprises a drive wheel 46 with an actuating handle 47. By means of a switch-over button 48, the drive can be changed from rapid travel for a major displacement of the carriage 43 to a slow travel for a fine displacement of the carriage 43. For driving the carriage, any known solution may qualify which proves to be expedient, for example, a cable line drive, a toothed gear drive or similar; in the present context, further

discussion of this point is not necessary. The carriage 43 is provided with an arresting means 50 which is secured on the carriage casing 49 and cooperates with the guide rail 42. The arresting means 50 can be started by an actuating button 51 and serves to fix the carriage 43 rigidly at its height position. Details of the arresting means 50 will be discussed in greater detail below with reference to Figures 7, 8, 9 and 10.

The carriage 43 moreover comprises a measurement bar 60 which in the case of the example is mounted for displacement in the horizontal direction. The direction of displacement of the measurement bar does, in any case, extend at right angles to the direction of movement of the carriage 43. The guide for the bar 60 can expediently be designed in a similar way as described above, that is to say, as a linear ball bearing guideway. For the displacement of the measurement bar 60 there again serves a drive 61 with an actuating wheel 62, a handle 63 and a change-over button 64 wherewith it is possible to change over from rapid travel to slow travel. One end 65 of the measurement bar 60 facing the object-holding means 5 is adapted for receiving a feeler member; this point will be discussed in greater detail below. Finally, the carriage 43 may be provided with a further arresting means (not shown) corresponding to the arresting means 50 and serving to block the measurement bar 60 firmly as far as its horizontal movement is concerned.

In accordance with Figure 2, the end 65 of the measurement bar 60 is provided with a feeler member generally designated by 70. The latter comprises a measurement feeler means 80 which will be discussed in greater detail below with reference to Figures 5 and 6, and a support 71 accommodating a measurement instrument 72 of a known design. The measurement feeler means 80 has a rigid sector 84 rigidly connected to the end 65 of the measurement bar 60 and a movable sector 83 carrying a feeler head 86. The feeler 73 of the measurement instrument 72 bears on the movable sector 83, so that the measurement instrument 72 indicates the magnitude of every displacement of the movable sector 83 relative to the rigid sector 84.

Figure 5 shows the basic structure of the measurement feeler means 80. In the example in question, it has a feeler member 82 which, as has already been mentioned, is subdivided into a first sector 83 and a second sector 84. These two sectors 83 and 84 are movable or displaceable relative to each other as will be explained below.

The second sector 84 is provided with two fixing bores 85, by means of which the measurement feeler sector 84 is anchored at the end 65 of the measurement bar 60. The first sector 83 is movably connected to the second sector 84 and carries a feeler head 86 that is rigidly fixed by means of a screw 87 on an extension 89 of the first sector 83 of the feeler member 82. In the example in question, the feeler head 86 is formed by a

cube having at least two measurement surfaces 90a and 90b. These measurement surfaces are processed to be planar and are disposed with respect to each other at an angle of 90° . Depending on the application, the feeler member 86 may have a different shape, for example, a prismatic shape or it may also have measurement points or measurement edges instead of the planar measurement surfaces.

The movable coupling of the first sector 83 with the second sector 84 of the feeler member 82 is effected via elastically deformable connecting members disposed at an angle of 45° relative to the measurement directions and hence also relative to the measurement surfaces 90a and 90b. In the example in question, provision is made for two connecting members 91 and 92 forming part of the feeler member 82 which is designed to be integral, that is to say, the sectors 83 and 84 of the feeler member 82 are constituted by one and the same body. The subdivision into the two sectors 83 and 84 is effected in that provision is made for several slits 93a - 93c and 94 that separate the two sectors 83 and 84 from each other.

Figure 5 shows that the feeler member 82 has a side face 95 disposed at an angle of 45° to the measurement surfaces 90a and 90b; by means of this design, free access is obtained to a further measurement surface 90d. The slit 93c extends parallel to, and at a short distance from this side face 95, that is to say, also at an angle of 45° and thus in such a way that a first connecting member 92 is formed; this is the remaining material web in the feeler member 82, which web connects the first sector 83 to the second sector 84.

The slit 93c continues, via a slit 93b disposed at right angles thereto (which, for its part, is disposed at an angle of 45° to the measurement surfaces 90a and 90b), in a slit 93a that forms a right angle with the last mentioned slit 93b and hence extends parallel to the slit 93c, but at a certain distance therefrom. Finally, parallel to that slit 93a, provision is made at a short distance therefrom for a slit 94 extending as far as the edge of the feeler member 82, so that a material web remains between the slit 94 and the slit 93a, which web forms the other connecting member 91.

It is essential, as will be explained below, that the webs 91 and 92 serving as the connecting members extend exactly at an angle of 45° to the measurement surfaces 90a and 90d. On the other hand, it is not essential for the connecting members 91 and 92 to be integral parts of the feeler member 82; it is just as possible for the sectors 83 and 84 of the feeler member 82 to be designed as independent individual parts and to be interconnected by two leaf springs (not shown). These then assume the function of the webs 91 and 92, but in this context, care must be taken that in an unloaded state, the leaf springs extend longitudinally at an angle of 45° to the measurement surfaces 90a and 90b.

Now, if (in accordance with Figure 6) a force is acting on the measurement surface 90a in the direction of arrow P₁, the latter basically tends to displace itself too in the direction of arrow P₁. Since the first sector 83 of the feeler member 82 and hence the feeler head 86 is tiltably mounted on the second rigid sector 84 of the feeler member, the feeler head 86 is caused to move in the direction of arrow P₁ and simultaneously in the direction of arrow P₂. This is so, because the first movable sector 83 is connected to the second rigid sector 84 via the two webs 91 and 92 extending at an angle of 45° to the measurement directions. At their transition to the feeler member sector 84, that is to say, at points X and Y (Figure 6), there are formed thereby some kinds of swivel axes, round which there moves the displaceable sector 83.

Figure 6 shows the maximum possible displaced position of the feeler head 86 under the effect of a force P₁. It will be seen that the left hand end of the slits 94 and 93c has closed, whilst the left hand end of the slit 93a has increased in width. By the bearing of the left hand ends of the two webs 91 and 92 on the adjoining feeler member walls, a stop is formed that opposes any further movement of the sector 83.

In practice, the maximum displacement path of the feeler head 86 relative to the rigid sector of the feeler member 82 amounts to some fractions of a millimetre; this is entirely adequate, since the measurement feeler is, in the present case, used for precision measurements related to a reference position of an object and not for an absolute determination of dimensions. Because of this, the theoretical inaccuracy occurring with the deformation is entirely insignificant, since the displacement path is very small.

Exactly the same happens when a measuring force is caused to operate in the direction of arrow P₂ on the measurement surface 90b. Although theoretically, the feeler head 86 tends to give way in the direction of the measuring force, it is constrained, as explained above, into a diagonal movement between the arrows P₁ and P₂. But because of this, it is made possible to ascertain the displacement of the feeler head 86 in two directions disposed perpendicular to each other (for example, in the direction of the arrow P₁ and in the direction of arrow P₂) with a single measurement apparatus, that is to say, with the measurement instrument 72 according to Figure 2. Surprisingly, this does not only apply to any action on the feeler head 86 in the two measurement directions disposed perpendicular to each other, but also to every measuring force acting on the feeler head 86 in any arbitrary direction between the two above mentioned measurement directions. In other words, any force acting within the sector P₁ - P₂ on the feeler head 86 results in the same direction of displacement of the feeler head 86 relative to the rigid sector 84.

The position of the point of bearing of the measurement

apparatus on the measurement feeler means 80, that is to say, the bearing of the measurement feeler 73 of the measurement instrument 72 is in itself non-critical, as long as one is concerned with an exactly planar surface disposed in a defined angular position with respect to the measurement directions. It is possible to give the head 88 of the screw 87 holding the feeler head 86 a planar design and to apply the measurement feeler 73 thereto.

Figures 7 to 10 show the structure and mode of operation of the arresting means 50. In accordance with Figures 7 and 8, the latter has a locking yoke 53 consisting of a bottom part 53a and an upper part 53b which both have a plate-type design and are arranged at a short distance parallel to each other. The two plate-type parts 53a and 53b are interconnected by means of a lamellar connecting member. In the present example, the lamellar connecting member consists of a material web 54 that is integrally formed on the two parts 53a and 53b. The bottom part 53a is rigidly connected to the casing 49 of the carriage 43 and extends at right angles to the orientation of the guide rail 42. The upper part 53b extending at a short distance parallel above the bottom part 53a, and therefore also at right angles to the guide rail 42, is provided with two lateral extensions 55 that laterally overlap the guide rail 42, or the V-shaped guide grooves formed therein.

Both extensions 55 are provided with locking pins 56 designed as set screws and which are screwed into corresponding tapped holes in the extensions 55. The free end, remote from the grooves 42a of each locking pin 56, carries one lock nut 57 respectively, to secure the pins against any unintentional displacement. The other end of the locking pins 56 has a conical shape and extends into the V-shaped grooves 42a. The upper part 53b of the locking yoke 53 is provided with a locking screw 58 whose front end may be brought to bear on the facing surface of the guide rail 42 as the locking screw is screwed in.

Because of the arrangement chosen, the upper part 53b can be moved relative to the bottom part 53a within the plate plane in a direction perpendicular to the guide rail 42, but not in the direction of the guide rail 42. This is so, because the web 54 is flexurally elastic but rigid in the extension direction. The latter condition is promoted still further in that the axis of the locking pins 56 extends exactly in the extended median plane through the web 55 (Figure 9).

The mode of operation of the arresting means 50 is as follows: in the unlocked state, the screw 58 is released and the two locking pins 56 are set in such a way that their conical end zones extend with small clearance into the V-shaped groove 42a but without touching their walls. Thus the carriage can be moved unimpeded up and down. To block the carriage movement, the screw 58 is tightened, its front face bears on the guide

5 rail 42 and the upper part 53b of the locking yoke 53 moves away from the guide rail 42 with an elastic deformation of the web 54. Admittedly the amount of movement is very small, approximately of the order of fractions of a millimetre. There-
10 with the conical ends of the locking pins 56 come to bear on the walls of the V-shaped groove 42a and prevent any further displacement of the carriage 43. The locking force is there- with transmitted from the upper part 53b via the web 55 on to the bottom part 53a of the locking yoke; since, however, as
15 mentioned above, the web 55 rigidly resists any extension, a rigid blocking is ensured.

15 To prevent damage of the V-shaped grooves 42a wherein there move the balls of the linear ball bearing guideway, the conical ends of the locking pins 56 have such a slender shape that they bear on the walls of the grooves 42a in a zone that is not touched by the ball bearings. Figure 10 clearly
20 shows that the locking pins 56 touch the wall 59 of the groove in a zone I which lies at a considerably lower level inside the groove than the zone II wherein the ball bearings are rolling.

25 The measurement of a tool will be explained with reference to Figures 3 and 4 by way of an example representing numerous other possibilities of application of the measurement apparatus in accordance with the invention. A cutter 100 has a shaft 101 carrying a cutter head 102, wherein there are in-
30 serted a multiplicity of cutter tips 103. The shaft 101 is rotatably accommodated in the object-holding means 5, for example, directly in the sleeve 6 (Figure 1). In order to determine the effective diameter of the cutter head 102, the carriage 43 is moved to such a height that the feeler head 86 is at a suitable level to be brought to bear against the edge
35 of a cutter tip 103. The carriage 43 is then locked by actuating the arresting means 50; an unintentional height adjustment of the carriage 43 is thereby excluded. Now the measurement bar 60 is moved out towards the cutter 100 until the feeler head 86 bears against the side edge of the cutter tip 103.
40 By means of fine adjustment of the measurement bar 60, a position of the latter may then be sought wherein the measurement instrument 72 displays the value of "0", corresponding to an exactly defined position of the feeler head 86.

45 In this connection, it remains to be pointed out that it is of course necessary for the whole measurement apparatus to be first calibrated before any objects can be measured. This calibration is effected once, when the apparatus is first com-
50 missioned, and whenever the feeler member has been modified or changed. One may, for example, use a calibration pin with known dimensions as regards its diameter and height, which is inserted into the object-holding means 5. As the feeler head 86 bears on the peripheral surface of the calibration pin and as the reading of the measurement instrument 72 is set to "0", a reference value is established for the measure of the dis-

placement of the measurement bar, which serves as the calculation basis for all subsequent measurements. Corresponding considerations apply to the height position: The feeler head 86 is moved with its bottom measurement face against the front face of the calibration pin and the measurement instrument is set to "0". Thereby a reference value is established for the height position of the carriage 43.

Returning to the example in accordance with Figure 3, the ascertained value of the extraction of the measurement bar 60 at a "0" display of the measurement instrument 72 is related to the known reference value and the actual effective cutter head diameter is derived therefrom. Similarly, it is also possible to check the true rotational accuracy of the cutter 100 by rotating the cutter 100 in the holding means 5, so that the diameter can be ascertained at various points of the periphery.

In the example in accordance with Figure 4, the same cutter 100 is to be measured as regards its effective height. For this purpose, starting from the situation in Figure 3, the measurement bar 60 is run back a little, the arresting means 50 is released, the carriage 43 is moved up to such an extent that the feeler head 86 is located above the cutter tip 103 to be measured, a suitable means, if provided, is activated for arresting the movement of the measurement bar and finally, the carriage 43 is moved down until the feeler head 86 comes to bear on the surface of the cutter tip 103. It remains to subject the carriage to a fine adjustment until the measurement instrument 72 displays the "0" value, and to relate the ascertained height position of the carriage 43 to the known height position reference value in order to derive therefrom the effective height of the cutter 100. As mentioned above, here too, the cutter may be rotated to effect several measurements for example, on several cutter tips 103.

It will be noted that the whole feeler member arrangement 70 is the same in Figures 3 and 4, although it was possible to determine two different dimensions disposed perpendicular to each other. This is due to the fact that the displacement of the feeler head 86 relative to the rigid sector 84 of the feeler member is always the same as regards amount and direction, irrespective as to whether the measurement is effected by the abutment of the front measurement surface 90b or by the abutment of the bottom measurement surface 90a. It is even possible to measure slanting faces of an object in this way, since no deviation occurs in the result of the measurement when the measuring force is acting in any arbitrary angle between the two above mentioned measuring force directions (horizontal and vertical). Thus, with the measurement apparatus in accordance with the invention, an instrument is created that makes it possible to monitor two measurement directions extending perpendicular to each other as well as any measurement directions between them and to register any

changes in them without any constructional modification of the measurement arrangement. In particular, it is also readily possible to ascertain a change in shape of a workpiece with the same measurement apparatus, or its exact position without modifying the apparatus, for example, the transition of an end conical part of a twist drill into the cylindrical drill part, or the angle or uniformity of a conical countersunk portion in a workpiece.

A very convenient, rapid and exact operating mode is ensured, in particular with electrical position logging of the position of the measurement bar on the one hand, and the height position of the carriage on the other hand. A control unit can then be expediently used that stores the above mentioned reference values, automatically relates them to the actual position value of the measurement bar and carriage and displays the derived measurement value. With such a unit, it is also possible to preprogram various reference values, for example, individual machine values; if a certain tool is then to be used on various processing machines, the tool is measured with the measurement apparatus herein described before being inserted into the machine, in which process one calls up the stored reference values appertaining to the machine concerned. The ascertained measurement data can then be entered directly into the machine as correction values.

PATENT CLAIMS

1. A measurement apparatus for ascertaining the measurements of an object in three dimensions, with a base plate (1) with holding means (5) provided on the base plate for receiving the object to be measured, and with a measurement carriage arrangement (4) secured to the base plate (1) at a distance from the holding means (5) with a measurement carriage (43) mounted on a guide rail (42) for displacement along a first axis and provided with arresting means (50) for blocking at least its displacement movement along the guide rail (42), and which carriage has a measurement bar (60) extending along a second axis perpendicular to the said first axis and being displaceably and arrestably mounted, at the end of which measurement bar, there is arranged a measurement feeler means (80) with a feeler head (90), characterized in that the holding means (5) have a clamping device (6) rotatably mounted in the base plate (1) for receiving the object, and in that the measurement feeler means (80) is formed by an integral feeler member (82) subdivided into two sectors (83, 84) displaceable with respect to each other, a feeler head (86) being mounted on a first sector (83) that can be brought to bear on the workpiece to be measured and connected to the measurement apparatus for action, which feeler head is formed by a cube rigidly connected to the first sector (83), that has at least two free measurement surfaces (90a-90d) forming together an angle of 90°, wherein the second sector (84) is connected to the said first sector (83) by means of elastically deformable connecting members (91, 92) extending at an angle of 45° to the measurement surfaces (90a-90d) of the feeler head (86), wherein the integral feeler member is subdivided into the said two first and second sectors (83, 84) by means of slits (93a, 93b, 93c, 94) formed in the feeler member (82) and extending at 45° to the measurement surfaces (90a-90d) in order to form the connecting members (91, 92), and wherein the measurement feeler means (80) is provided with a measurement instrument (72) for indicating the relative position of the feeler head (86) relative to the feeler member (82).

2. A measurement apparatus for ascertaining the measurements of an object in three dimensions, with a base plate (1) with holding means (5) provided on the base plate for receiving the object to be measured, and with a measurement carriage arrangement (4) secured to the base plate (1) at a distance from the holding means (5) with a measurement carriage (43) mounted on a guide rail (42) for displacement along a first axis and provided with arresting means (50) for blocking at least its displacement movement along the guide rail (42), and which carriage has a measurement bar (60) extending along a second axis perpendicular to the said first axis and being displaceably and arrestably mounted, at the end of which measurement bar, there is arranged a measurement feeler means (80) with a feeler head (90), characterized in that the holding means (5)



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have a clamping device (6) rotatably mounted in the base plate (1) for receiving the object, and in that the measurement feeler means (80) is formed by a feeler member (82) subdivided into two sectors (83, 84) displaceable with respect to each other, wherein a feeler head (86) is mounted on a first sector (83) that can be brought to bear on the workpiece to be measured and connected to the measurement apparatus for action, which feeler head is formed by a cube rigidly connected to the first sector (83), that has at least two free measurement surfaces (90a-90d) forming together an angle of 90°, wherein the two sectors (83, 84) of the feeler member (82) are formed by separate elements, wherein the second sector (84) is connected to the said first sector (83) by means of two leaf spring elements extending at an angle of 45° to the measurement surfaces (90a-90d) of the feeler head (86), and wherein the measurement feeler means (80) is provided with a measurement instrument (72) for indicating the relative position of the feeler head (86) relative to the feeler member (82).

3. A measurement apparatus according to patent claim 1 or 2, characterized in that the clamping device has at least one sleeve (6) with a conical bore (7) for the conjugate accommodation of a conical tool shaft, which sleeve is rotatably mounted in a recess (12) of the base plate (1) by means of ball bearings (8,9).

4. A measurement apparatus according to patent claim 1 and 3 or according to patent claims 2 and 3, characterized in that the clamping device (6) comprises further clamping elements (14) having an outer surface corresponding in shape and dimensions to the sleeve (6) in such a way that they can be inserted with a form fit into the sleeve (6).

5. A measurement apparatus according to patent claim 4 characterized in that the further clamping elements (14) are formed by further sleeves (15) with a smaller conical receiving bore (17), by hydraulic chucks (25), by coupling elements (35) with a conical shaft (36) or similar.

6. A measurement apparatus according to one of the preceding claims. characterized in that the measurement carriage (43) has first arresting means (50) for blocking its displacement movement along the guide rail (42) and second arresting means for blocking the displacement movement of the measurement bar (60).

7. A measurement apparatus according to patent claims 1, 2 or 5, wherein provision is made respectively for a linear ball guideway with balls, for guiding the measurement carriage (43) along the guide rail (42) and for guiding the measurement bar (60) within the measurement carriage (43), which guideways run in V-shaped guide grooves (42a), characterized in that the arresting means (50) have a locking yoke (52) with a plate-



type bottom part (53a) extending substantially at right angles to the direction of movement of the measurement carriage (43) or of the measurement bar (60) and rigidly secured to the measurement carriage casing (49), and with a top part (53b) arranged parallel to, and at a distance from the bottom part, which top part has two lateral extensions (55) with locking pins (56) projecting into the V-shaped guideways (42a), which extensions overlap the opposed V-shaped guide grooves (42a), and which upper part is connected, movably relative to the bottom part (53a) in the plate plane perpendicular to the direction of movement of the measurement carriage (43) or of the measurement bar (60) but rigidly in the direction of movement of the measurement carriage (43) or of the measurement bar (60).

8. A measurement apparatus according to patent claim 7, characterized in that the upper part (53b) is provided with a locking screw (58), by means of which the upper part (53b) can be displaced relative to the bottom part (53a).

9. A measurement apparatus according to patent claim 7 or 8, characterized in that the connection between the upper part (53b) and the bottom part (53a) is effected by means of a blade-type connecting member (54) extending in the direction of movement of the measurement carriage (43) or of the measurement bar (60).

10. A measurement apparatus according to patent claim 9, characterized in that the blade-type connecting member (54) is integrally formed on the upper and lower part (53a, 53b).

11. A measurement apparatus according to one of claims 7 to 10, characterized in that the locking pins (56) passing through the extensions (55) are set screws with conical end zones directed towards the V-shaped guide grooves (42a), which set screws carry lock nuts (57) at their opposite ends.

12. A measurement apparatus according to patent claim 11, characterized in that the conical end zones of the locking pins (56) are designed to be so narrow that they can be inserted into the V-shaped guide grooves (42a) and can be brought to bear against the lateral faces of the grooves without touching the running surface of the guide balls on the side of the groove.

13. A measurement apparatus according to patent claims 7 to 12, characterized in that the median axes of the locking pins (56) lie at least approximately in the extended plane of the blade-type connecting member (54).

14. A measurement apparatus according to patent claim 1, characterized in that at least one connecting member (81) is formed between the said first and second sectors (83, 84) by a



narrow material web of the feeler member (82), which web lies between two parallel slits (93a, 94).

- 5 15. A measurement apparatus according to patent claim 1, characterized in that at least one connecting member (92) is formed between the said first and second sectors (83, 84) by a narrow material web of the feeler member (82), which web lies between an outer edge (95) of the feeler member (82) extending at an angle of 45° to the measurement surfaces (10a-10d) and a slit (93c) extending parallel thereto.
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