March 9, 1971 G. STADE ET AL 3,568,373

ADJUSTING DEVICE FOR THREAD GRINDING MACHINE

Filed Dec. 17, 1968 2 Sheets-Sheet 1

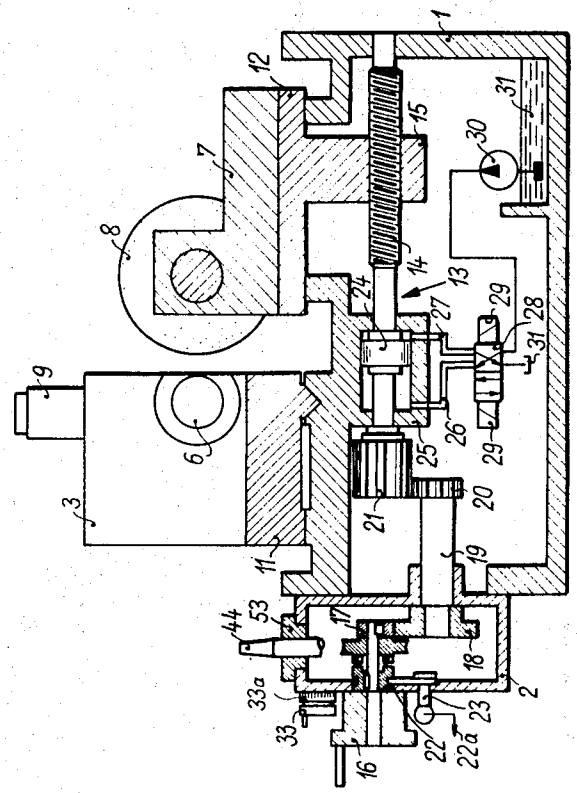


Fig. 2

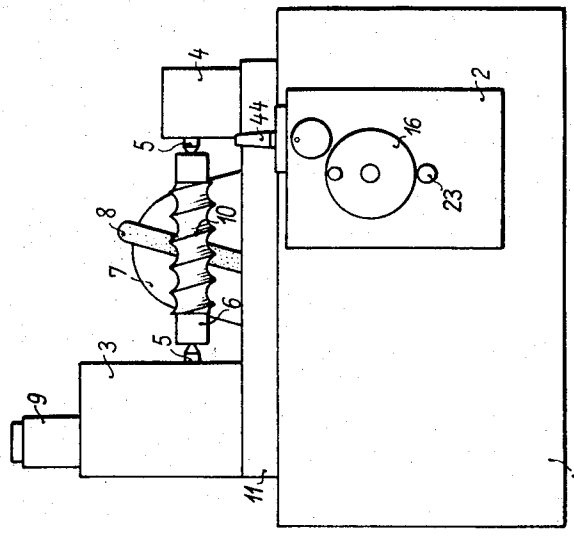


Fig. 1

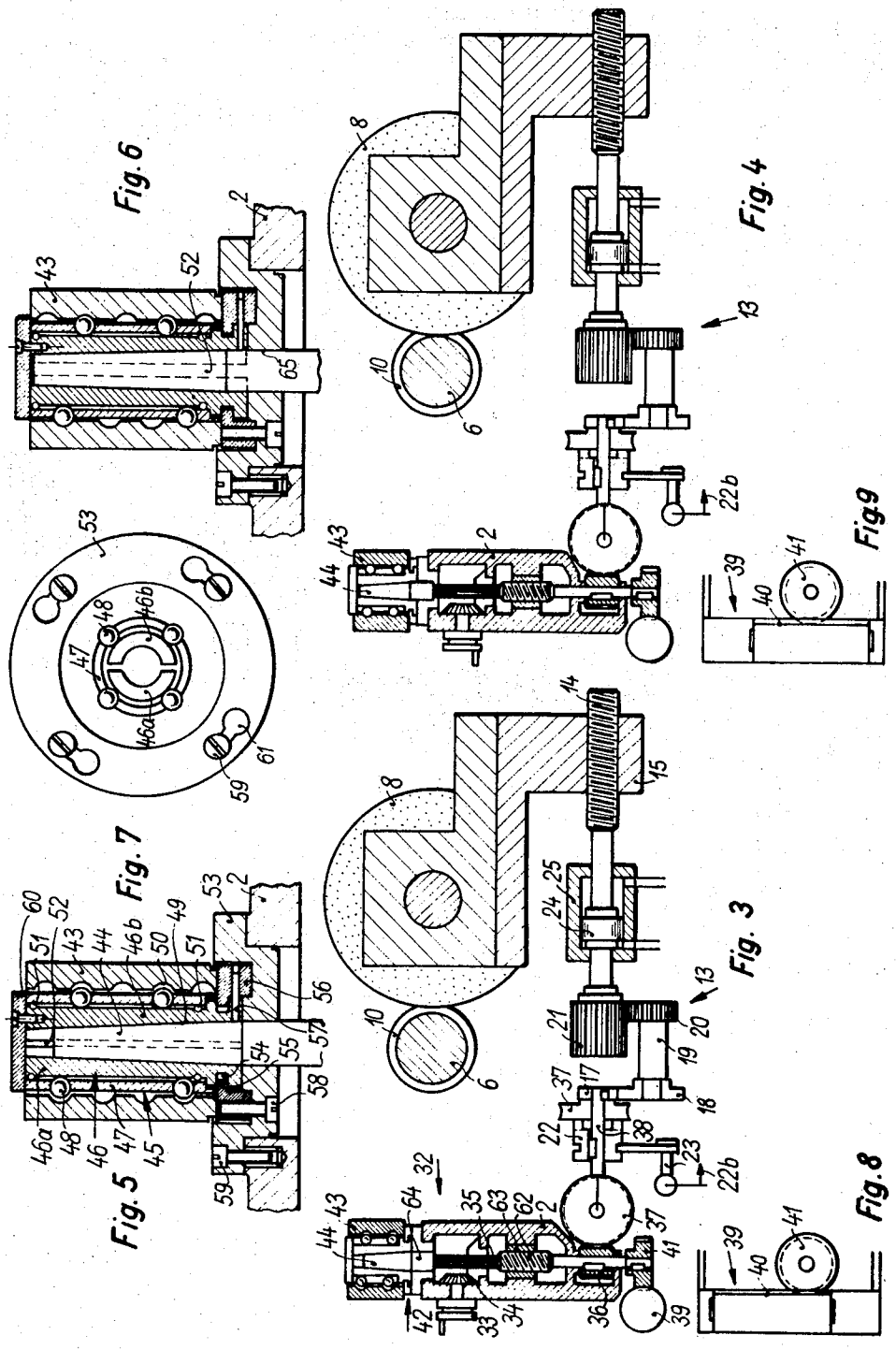
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ADJUSTING DEVICE FOR THREAD GRINDING MACHINE

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ADJUSTING DEVICE FOR THREAD GRINDING MACHINE

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Int. Cl. B24b 49/00
U.S. Cl. 51—165 7 Claims

ABSTRACT OF THE DISCLOSURE

An adjusting device on a thread grinding machine controls grinding of a male thread of high fitting accuracy on workpieces such as spindles, bolts and the like which are to be paired with female workpieces such as threaded ball bearing nuts and the like. The adjusting device includes a measuring cone for receiving a measuring head for the nut to be measured, and this measuring head is in geared connection with the usual fine adjusting shaft of the grinding machine and is so arranged as to be displaced axially within the measuring head when the fine adjusting device is operated. The measuring head is secured on the adjusting housing coaxially with the measuring cone which protrudes from the adjusting housing. The measuring head includes an expansion sleeve having an inner conical surface identical with the smooth-walled outer conical surface of the measuring cone, and this expansion sleeve is expanded by the aforementioned axial movement.

BACKGROUND OF THE INVENTION

The grinding of female threads and male threads of paired workpieces, such as threaded nuts and spindles or bolts, has been effected heretofore independently of each other. This resulted necessarily in different fit tolerances of the threads. The respective workpieces were therefore selected and grouped according to fits, and then each group was sorted in pairs. This had the disadvantage that the workpieces selected as matching with each other did not always have the desired high fit accuracy of the threads. This is particularly true in the case of threaded ball bearing nuts arranged to be paired with threaded spindles, bolts and the like. A further disadvantage is that, if high fit accuracies are required, it is difficult to find fitting workpieces. The division of the workpieces into groups having various tolerances is rarely sufficiently accurate, and it is necessary to look for a long time in associated groups, among the workpieces contained therein, before paired pieces of high fit accuracy can be found.

SUMMARY OF THE INVENTION

This invention relates to thread grinding and, more particularly, to a novel adjusting device for a thread grinding machine, for grinding a male thread of high fit accuracy on workpieces, such as spindles, bolts, and the like, which are to be paired with a threaded ball bearing nut.

In accordance with the invention, an adjusting device is provided in addition to the usual coarse adjustment gearing and fine adjustment gearing, in such a way that the measuring head is cooperable with the fine adjustment gearing. The fine adjustment gearing is in geared relation with a measuring cone for receiving a measuring head for the nut to be measured, with the measuring cone being connected with the adjusting shaft of the fine adjustment gearing in such a manner that the measuring cone is displaced axially inside the measuring head when the fine adjustment gearing is actuated. This measuring head is

secured on the adjusting housing coaxially with the measuring cone, which protrudes from the adjusting housing.

The adjusting device of the invention has the advantage that it permits grinding of an exactly matching bolt or the like for each threaded ball bearing nut or the like, with automatic adaptation of the male thread diameter to the varying female thread diameter of the nut. The threaded male and female workpieces, produced in pairs, have a high fitting accuracy which is impossible to attain by picking out workpieces fitting to each other. The threaded workpieces, produced in pairs in accordance with the invention, and which preferably constitute ball bearing nuts and bolts or spindles, remain together as pairs, so that it is no longer necessary to pick out workpieces which have a reasonably close fit with each other. This simplifies the keeping of an inventory, since threaded workpieces which are already paired can be withdrawn from the inventory.

The transfer of the differential measurement setting within the fine adjustment gearing of the thread grinding machine is thus effected, with respect to each individual threaded nut, without the necessity of measuring numerical values. The basic setting of the thread grinding machine with respect to the adjusting gearing is effected on the basis of two master pieces, namely the nut and the bolt. Starting from this basic setting, only the differential setting, which results from the measured setting of the nut, is transferred to the grinding disk for grinding the bolt which is to have its thread reground. Since the roughly ground male thread has only to be reground or finely ground to match the workpieces, the male thread must naturally be initially incompletely ground with respect to its specified final measurements.

The adjusting device of the invention can be applied to the female thread grinding machine, in which the male thread on a bolt, spindle or the like is used as the starting point of the measurement, while the rough-ground female thread is finish-ground with accurate fit and matched, by transferring the setting differences to the grinding disk. This possibility of reversal of the procedure or apparatus is within the purview of the invention.

In accordance with an advantageous embodiment of the invention, the shaft of the fine adjustment gearing is guided for axial displacement in the adjusting housing and fixedly connected with a threaded feed spindle which is threadedly engaged in a stationary threaded nut arranged in the adjusting housing and which, in turn, is connected with the measuring cone. The measuring cone preferably has a cylindrical guide face adjoining the cone per se, and by means of which the measuring cone is guided in a bore provided in the housing. The displacement of the measuring cone by the fine adjustment gearing can also be effected in a manner such that the shaft of the fine adjusting gearing is coupled through an interposed axially elongated pinion and toothed gearing with the threaded feed spindle, so that the latter, with its gear wheel, can move relative to the axially elongated pinion.

In accordance with another feature of the invention, the measuring head has an expansion sleeve with an inner conical surface which is equal to the smooth wall outer conical surface of the measuring cone. This expansion sleeve is connected, for expansion, with a bottom plate with which it can be secured on the adjusting housing. As the outer conical surface of the measuring cone is smooth walled and as the expansion sleeve has the same smooth-walled inner conical surface, the measuring head is very simple. This permits a very uniform spreading movement of the expansion sleeve, for which purpose an expansion displaceable connection is provided with the bottom plate serving to secure the measuring head on the adjusting housing.

The outer cylindrical surface of the expansion sleeve carries preferably a cylindrical ball cage of substantially equal axial length, and which receives measuring balls at two measuring points, remote from each other, arranged in the thread pitch. This ball cage is arranged between the bottom plate and a cover plate of the expansion sleeve. The bottom plate per se can be detachably mounted on the adjustment housing by bayonet joints or slots and cooperating clamping screws.

The thread spreading insert, consisting of the expansion sleeve, the ball cage and the balls, is exchangeable. Only the measuring cone remains on the adjustment housing of the thread grinding machine.

A manual operator can be provided for the fine adjustment gearing, but the latter can also be connected with a preferably hydraulic piston driven rack and associated gear, in order to effect mechanically a fine adjustment and to transfer the setting difference, in the sense of the invention.

An object of the invention is to provide an improved adjustment device for thread grinding machines for grinding threads on at least one workpiece of a mating pair of male and female workpieces so that the two workpieces will have a high thread fit accuracy.

Another object of the invention is to provide such an adjusting device operable to produce exactly matched pairs of threaded female and male elements.

A further object of the invention is to provide such an adjusting device which is cooperable with the fine adjustment gearing provided on the usual thread grinding machine.

Another object of the invention is to provide such an adjustment device effective to obtain a differential measurement setting for the fine adjustment gearing of a thread grinding machine and to obtain this setting with respect to each individual threaded workpiece without having to measure numerical values.

A further object of the invention is to provide such an adjusting device in which only the differential setting, resulting from the differential measurement, is transferred to the grinding disk for the mating workpiece to be reground.

Another object of the invention is to provide such an adjusting device which is capable of ready interchange in accordance with the workpieces to be accurately matched during grinding.

For an understanding of the principles of the invention, reference is made to the following description of a typical embodiment thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a somewhat schematic side elevation view of a thread grinding machine embodying the invention;

FIG. 2 is a cross section view of the thread grinding machine shown in FIG. 1, illustrating the adjustment gearing;

FIG. 3 is a cross sectional view of the adjustment gearing of FIG. 2 with a fine adjustment gearing associated with it, in a position in which the grinding disk is inoperative;

FIG. 4 is a view, similar to 3, illustrating the adjustment gearing in the measuring position;

FIG. 5 is an enlarged axial sectional view of the measuring head in the position corresponding to FIG. 3;

FIG. 6 is a view similar to FIG. 5 with the measuring head in the position corresponding to FIG. 4;

FIG. 7 is a top plan view of the bottom plate of the measuring head;

FIG. 8 is a top plan view of a piston operated rack and pinion driving gear in a position corresponding to FIG. 3; and

FIG. 9 is a view similar to FIG. 8, with the parts in a position corresponding to FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, the illustrated thread grinding machine has a machine frame **1** on which is mounted the adjustment gearing housing **2**, the thread grinding machine being represented somewhat schematically. The workpiece spindle housing is shown at **3**, the tailstock at **4**, and the centers, between which workpiece **6** is received, at **5**. The grinding spindle carriage **7** carries the driven grinding disk **8**. The rough-ground workpiece **6** receives its rotational drive, in the usual manner, from a motor **9**.

Grinding disk **8** is inclined at the pitch angle of thread **10**, and workpiece spindle carriage **11** performs a longitudinal movement relative to grinding disk **8**. The customary gear with the lead spindle is not represented, since it is well known to those skilled in the art.

In order to set grinding disk **8** to the depth of the thread, the adjusting carriage disk **12** is actuated by the adjustment means generally indicated at **13**. In a known manner, this adjustment means comprises an adjusting spindle **14** which is rotatably supported in the machine housing and is threadedly engaged through a nut **15** connected with adjusting carriage **12**. For coarse adjustment, driving of adjusting spindle **14** is effected by hand wheel **16** through pinion **17**, gear **18**, shaft **19**, gear **20**, and axially elongated gear **21**. In FIG. 2, the clutch **22** for fine adjustment is disengaged, as indicated by arrow **22*a***. Clutch **22** is operated by the handle **23**.

Adjusting spindle **14** is connected with the rapid stroke piston **24** which is arranged in the cylinder **25** for hydraulic adjustment. The hydraulic supply and return lines are indicated at **26** and **27** as connected to a control valve **28** which is operable by control electromagnets **29**. The pressure pump is indicated at **30** and the oil reservoir at **31**.

The fine adjustment gearing, with the measuring mechanism, is generally designated at **32**, as illustrated in FIGS. 3 and 4 with respect to FIG. 2. Clutch **22** is engaged, as indicated by the arrow **22*b***. Hand wheel **33** is thus operatively connected, for fine adjustment, with adjusting shaft **14** through the pair of bevel gears **34**, the fine adjusting shaft **35**, the worm **36** and the worm gear **37**. Worm gear **37** is connected with shaft **38** by the engaged clutch **22**, and shaft **38** has the aforementioned pinion **17** thereon. From pinion **17**, the gear train includes gears **18**, **20** and **21**, driving adjusting shaft **14** as described above for the coarse adjustment. Instead of the manual operation of the fine adjusting shaft **35**, the latter can also be operated mechanically by a hydraulically actuated rack and pinion arrangement **39**, including a rack **40** engaged with a gear or pinion **41** on fine adjustment shaft **35**.

The above-described coarse and fine adjustment gearing is provided on thread grinding machines, and is known per se.

The invention is directed to a further development of the fine adjustment gearing **32** whose fine adjustment shaft **35** is connected with the measuring mechanism generally designated at **42**, and which will be described hereinafter. Measuring mechanism **42**, in connection with fine adjustment gearing **32**, serves to transfer the setting difference to grinding disk **8** during the paired grinding of the male thread **10** on the workpiece **6**. Workpiece **6** is represented in FIG. 1 as a ball bearing roller spindle, and is to be ground with accurate relation with respect to the finish-ground female thread of a nut, which is shown in FIGS. 3 through 6 as a threaded ball bearing nut **43**.

The essential parts of measuring mechanism **42** are a measuring cone **44** and a measuring head **45**, received by cone **44**, for measuring the nut **43** to be measured. The measuring head **45** comprises an expansion sleeve **46** and a ball bearing cage **47**, with measuring ball bearings **48**

arranged in the thread pitch of nut **43** to be measured. Expansion sleeve **46** has an inner conical surface **49** which is identical with the smooth-walled outer conical surface of measuring cone **44**. The external surface of expansion sleeve **46** is cylindrical, and it engages measuring ball bearings **48** which are arranged at remote measuring points in agreement with the thread **50** of ball nut **43**. Several of these measuring balls or ball bearings are used in each of the two respective thread courses which are used for the measurement.

The ball bearings bear on the cylindrical outer surface of the expansion sleeve, and are pressed outwardly during expansion of this sleeve inside ball cage **47** and come finally to bear on the thread courses **50** of the threaded ball nut **43** to be measured. In FIG. 5, the measuring balls or ball bearings **48** are shown in released position and in FIG. 6 they are shown in the bearing position, which is the measuring position.

Expansion sleeve **46** consists of two halves, a left half **46***a* and a right half **46***b*, as best seen in FIGS. 5, 6 and 7. The two halves are held together by annular springs **51**. The oblong slot separating the two parts is indicated at **52**.

Expansion sleeve **46** is connected, for expansion, with a bottom plate **53**. For this purpose, the two sleeve halves **46***a* and **46***b* have, at their bottom ends, semi-annular recesses **54** in which are engaged noses **55** of ring segments **56** connected non-rotatably with the respective sleeve halves **46***a* and **46***b* by pins **57**, which allow the sleeve halves to expand. Ring segments **56** are connected by screws **58** which bottom retaining plate **53**, and this plate, in turn, is secured by screws **59** on the top surface of adjustment housing **2**. The head of one half of expansion sleeve **46** is connected with a cover plate **60** by one or more screws. Cylindrical ball bearing cage **47** is terminated at the bottom by ring segments **56**, and at the top, by cover plate **60**, and the length of this ball bearing cage corresponds to the effective height of expansion sleeve **46**.

The above-described measuring head is assembled for a certain threaded ball nut. In order to adapt it to a thread with a different pitch, all that is necessary is to exchange the ball bearing cage **47**. It is also possible to have, in stock, measuring heads for different thread pitches. In this case, it is necessary only to loosen the screws **59** of bottom plate **53**, and to exchange the measuring head **42** as a whole. To this end, bottom plate **53** is provided with bayonet joints or apertures **61** for clamping screws **59**, so that it is only necessary to loosen screws **59** slightly so that bottom plate **53** can be turned slightly and can then be removed. This arrangement is advantageous for a rapid exchange of measuring head **42**.

Axial displacement of measuring cone **44** is effected automatically when the fine adjustment gearing is actuated. In the illustrated embodiment of the invention, measuring cone **44** is fixedly connected with adjusting shaft **35** of the fine adjustment gearing, and this shaft is mounted for axial displacement in adjustment housing **2**. In addition, the adjustment shaft **35** includes a threaded feed spindle **62** threaded through a stationary threaded nut **63** arranged in the adjustment housing. Measuring cone **44** has a cylindrical guide surface **64** directly adjoining the cone proper and guided in a cylindrical bore **65** of bottom plate **53**. Naturally, axial displacement of measuring cone **44** can be effected by other arrangements.

The adjusting device, including the measuring head **42**, works in a manner which will now be described. Initially the grinding machine is set with respect to the adjustment of the grinding disk **8** to the workpiece. For this purpose, there are used masterpieces comprising a nut and a bolt. The master nut is screwed onto the measuring head **45**. The matching master bolt or master spindle is received between the two centers **5**, **5**. Clutch **22** is switched in the direction of arrow **22***b* of FIGS. 3 and 4. Hand wheel **16** for adjusting shaft **14** is disconnected, and the fine adjustment gearing is connected. At this time, fine adjustment hand wheel **33** is turned until it stops. This stop is effected by the measuring ball bearings **48** when the latter bear on the ball thread **50** of the master nut. The stop position of hand wheel **33** is the zero position, and scale **33***a* of the hand wheel is turned to the zero position. Measuring cone **44** can now be moved back and the master nut can be removed. The next step is the setting according to the threaded master bolt. For this setting, clutch **22** is switched in the direction of arrow **22***a*, to connect hand wheel **16**. Using hand wheel **16**, grinding disk **8** is set on the bottom of the thread of the master bolt until disk **8** sparks slightly. This setting corresponds to FIG. 4 of the drawing. After grinding disk **8** has been retracted at high speed by the rapid stroke piston **24**, the master bolt can be removed. The thread grinding machine is now in a starting position, which is indicated by the remaining zero position on scale **33***a* of hand wheel **33**. The paired grinding of ball bearing nuts and bolts or spindles, which correspond to the master spindles, can now be effected.

On the measuring head **45** is now screwed the threaded nut **43** which is paired with the threaded bolt to be ground. The rough-ground threaded workpiece **6** is positioned between the centers **5**, and this workpiece must have an incomplete rough grinding or "overmeasure" for matched grinding. Then, quick adjustment of grinding disk **8** is effected by the quick stroke piston **24**. The regrinding of the threaded workpiece **6** is effected usually in several passes, using the fine adjustment gearing, for which purpose clutch **22** is switched again in the direction of **22***b*.

Grinding is continued up to the arresting of the fine adjustment, which occurs when measuring ball bearings **48** engage firmly in the thread **50** of the nut **43**. At the time the measuring balls **48** thus engage the thread **50**, the proper depth of thread on workpiece **6** has been attained. After grinding out the last chip, the grinding disk **8** is returned at high speed. By reversely turning hand wheel **33**, measuring cone **44** is retracted. The workpiece **6**, match-ground with nut **43**, as well as the nut **43**, can now be removed. The process is then repeated for another pair of workpieces.

What is claimed is:

1. For use with a thread grinding machine having a grinding wheel adjustment housing containing a fine adjustment gearing including a fine adjustment rotatable shaft, an adjusting device, for grinding a male thread of a high thread fit accuracy on male workpieces, said adjusting device comprising, in combination, a measuring cone projecting from said adjustment housing to receive a measuring head for the nut to be measured; a measuring head secured on said adjustment housing coaxially with said measuring cone and received by said measuring cone; and gearing connecting said measuring cone with said fine adjustment shaft and operable to displace said measuring cone axially within said measuring head responsive to rotation of said fine adjustment shaft.

2. For use with a thread grinding machine, an adjusting device, as claimed in claim **1**, in which said fine adjustment shaft is mounted for axial displacement in said adjustment housing; a threaded feed spindle connected to said fine adjustment shaft for rotation therewith; and a stationary threaded nut in said housing and threadedly engaged with said feed spindle; said feed spindle being connected to said measuring cone.

3. For use with a thread grinding machine, an adjusting device, as claimed in claim **1**, in which said measuring cone is provided with means forming a cylindrical guiding surface adjacent one end thereof; said housing being formed with a cylindrical bore receiving said guiding surface.

4. For use with a thread grinding machine, an adjusting device, as claimed in claim **1**, in which said measuring head includes an expansion sleeve having an inner conical surface identical with a smooth-walled

outer conical surface of said measuring cone; and a bottom plate connected to said expansion sleeve and providing for expansion thereof; said expansion sleeve being secured on said adjusting housing through the medium of said bottom plate.

5. For use with a thread grinding machine, an adjusting device, as claimed in claim 4, including a cylindrical ball bearing cage carried by said expansion sleeve and having an axial length substantially equal to that of said expansion sleeve; measuring balls carried by said cage at measuring points, remote from each other, and the thread pitch of the nut to be measured; said cage being arranged between said bottom plate and a cover plate secured to said expansion sleeve.

6. For use with a thread grinding machine, an adjusting device, as claimed in claim 5, in which said bottom plate is disengageably secured on said adjustment housing and

is formed with bayonet slots receiving clamping screws threaded into said adjustment housing.

7. For use with a thread grinding machine, an adjusting device, as claimed in claim 1, including a fluid pressure actuated rack and pinion grearing connected to said fine adjustment shaft for rotation of the latter.

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