



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) **EP 1 197 294 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:

17.04.2002 Bulletin 2002/16

(51) Int Cl.7: **B24B 49/04, B24B 5/18**

(21) Application number: **01308679.8**

(22) Date of filing: **11.10.2001**

(84) Designated Contracting States:

**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**

Designated Extension States:

AL LT LV MK RO SI

(30) Priority: **11.10.2000 GB 0024933**

(71) Applicant: **Douglas Curtis Limited
Colchester, Essex CO7 7RR (GB)**

(72) Inventor: **Wallis, John Philip
Daventry, NN11 3ET (GB)**

(74) Representative: **Chettle, Adrian John
Withers & Rogers,
Goldings House,
2 Hays Lane
London SE1 2HW (GB)**

(54) **Centerless grinder with measuring device**

(57) A rotary machine tool having a carriage (20) movable in X,Y directions has a drop down micrometer (30) for measuring diameter of a workpart (11). The fixed jaw (33) of the micrometer (30) is driven against the workpart (11) by movement of the carriage (20). Carriage movement is suspended on relative movement of

the micrometer (30) following which the movable jaw (34) is driven against the workpart to gauge diameter thereof. The invention provides a compact means of diameter measurement on the grinding axis, and which can also be used to measure taper of a workpart.

EP 1 197 294 A1

Description

[0001] This invention relates to improvements in cylindrical grinding, and particularly in centreless grinding.

[0002] Precision punches for sheet steel are produced from cylindrical blanks to very precise dimensions, by centreless concentric grinding. Generally speaking the punching end of the blank is ground to the desired diameter and for the desired length, the other end of the blank providing a standard shape for gripping in a punch holder.

[0003] A CNC punching machine typically has a magazine with numerous punches of different size. The breakage of a punch can seriously interrupt production, but the wide variety of punch sizes means that stockholding of replacements is limited for economic reasons. As a result it has become usual for punch suppliers to grind a replacement punch on demand, and deliver the punch to the end user within twenty four hours. Each punch is ground under manual control, and the production process is thus labour intensive and somewhat expensive. Automated grinding of punches would be desirable.

[0004] Another difficulty in the production of such punches is that measurement of the diameter of the workpart during grinding is essential in order to compensate for wear in the grinding and control wheels. Typically the grinding wheel plunges generally horizontally against the workpart whereas the measuring device acts vertically.

[0005] Existing measuring devices are however unsatisfactory. One such device uses scissor like arms on the grinding wheel side to grip the workpart and therefore gauge diameter. However since the arms do not contact the workpart on a diameter, the distance between the scissor pivot and the centreline of the workpart is critical to accurate gauging. In centreless grinding, where the control wheel provides a fixed reference, the workpart centreline will move relative to the scissor pivot as the diameter of the workpart reduces.

[0006] Another device uses vertically movable probes having anvils to ensure contact with the workpart on a diameter. This arrangement reduces available space in the vicinity of the workpart and may restrict movement. Also the anvils may not contact the workpart exactly on a diameter, and this may introduce inaccuracy.

[0007] Both prior measuring proposals have components of significant length and are subject to thermal expansion and contraction. Furthermore both prior proposals typically gauge diameter at a fixed location, and cannot therefore measure taper of the workpart. Accurate measuring of the workpart is essential in order to determine the extent of a final grinding step to the desired finished diameter.

[0008] According to a first aspect of the invention there is provided a centreless concentric grinder comprising a grinding wheel, a control wheel, a rolling clamp and workrest, the clamp and workrest being adapted to

hold a workpart against the control wheel at a predetermined height, and the grinding wheel being arranged to plunge at one side of the workrest to grind a workpart to a desired diameter, wherein the workrest presents a flat face to the workpart, said face being at an acute angle to vertical, and the workrest being mounted on a powered slide for movement towards and away from the control wheel.

[0009] Such an arrangement permits the height of the workpart to be set as a function of the lateral displacement of the workrest, and moreover for the workrest to be automatically driven to the desired position in response to an input of the selected punch dimensions.

[0010] In practice the workrest is driven to the position which permits initial grinding of the workpart to an oversize, at which point the precise diameter of the workpart is measured. Following this the finish grinding step is performed to bring the component to the desired diameter.

[0011] Owing to the fact that a finish grind is always required after measurement, the lateral position of the workrest does not need to be absolutely true, a small variation in workpart diameter being possible for a given workrest position. It is thus envisaged that conventional motorized drives are suitable for positioning the workrest according to the diameter of the punch to be ground.

[0012] In order to set the ground length of the workpart, it is also envisaged that the usual end stop is motorized. This also permits the workpart to be positioned correctly relative to the workrest and control wheel. The end stop may act on the underside of an enlarged head of the workpart, or against the head, depending on which direction the usual end forces are generated. The position of the end stop is fixed in relation to workparts of a given length, and accordingly the position of the end stop does not need to be changed for similar workparts which vary in diameter.

[0013] According to a second aspect of the invention a measuring device is provided for a rotary machine tool having a powered carrier for plunge movement relative to a workpart, the measuring device comprising an arm adapted for pivoting mounting on a said carrier, and a calliper slidably mounted on the arm for inward and outward movement thereof, the calliper being biased to an end stop of said arm, and having a fixed jaw and a movable jaw, and the calliper further including means to determine the relative position of the fixed and movable jaws, a first actuator being provided to pivot said arm from an inactive condition to an active condition in which said jaws lie on either side of a workpart, and said carrier being movable to draw the fixed jaw against a workpart, and a second actuator being provided to move the jaws of the calliper together, so as to grip a workpart on a diameter in order to determine the size thereof.

[0014] Plunge movement is generally perpendicular to the axis of rotation of the rotary machine tool, and generally perpendicular to the rotational axis of a work-

part in the machine tool. The powered carrier is typically a motorized member drivable relative to the machine tool frame under servo control, and may for example be drivable on two mutually perpendicular axes so as to bring a machining member such as a grinding wheel into contact with a workpart.

[0015] This measuring device can be pivoted from an inactive (vertical) position to an active (horizontal position) for gauging workpart diameter. The calliper is slidable on the arm for the purpose of indicating when the fixed jaw is in contact with the workpart, the movable jaw being afterwards moved towards the fixed jaw to enable the precise diameter to be determined. In the preferred embodiment a limit switch is provided to permit contact between the fixed jaw and the workpart to be sensed, and to suspend movement of the powered slide. Other means of suspending slide movement are however possible, for example by making an electrical circuit between the fixed jaw and the workpart.

[0016] The arrangement permits precise measurement of workpart diameter on the (horizontal) grinding axis rather than at right angles thereto, and the measuring device is not as susceptible to thermal effects since it is usually in the inactive condition away from the heat generated by the grinding apparatus.

[0017] Other features of the invention are shown in the accompanying drawing of a preferred embodiment shown by way of example only in the accompanying drawings in which:-

- Fig. 1 is a schematic plan view of a centreless grinder;
- Fig. 2 is a schematic plan view of the grinder of Fig. 1 in an alternative position;
- Fig. 3 shows in section a workrest in two alternative positions;
- Fig. 4 shows in side elevation a schematic measuring device;
- Fig. 5 shows a measuring device in the inactive condition; and
- Fig. 6 shows the measuring device of Fig. 5 in the active condition.

[0018] A conventional concentric centreless grinding arrangement is illustrated in Figs. 1-3. A workpart 11 is held against a control wheel 13 by a workrest 14 and a concentric roller 15. A grinding wheel 12 is mounted on a carriage 20 and is driven towards the workpart on axis X in order to reduce the diameter thereof. The workrest 14 and roller 15 act at one side of the portion of the workpart which is to be ground.

[0019] The carriage 20 is also movable on axis Y to permit initial grinding with a roughing wheel 12a, followed by final grinding with a finishing wheel 12b. X-Y movement permits periodic dressing of both grinding wheels against a fixed dresser 16, and allows a carriage mounted measuring gauge 17 to be brought into contact with the workpart. An end stop 18 prevents axial move-

ment of the workpart due to the usual end forces present in centreless grinding.

[0020] In concentric grinding the height of the workpart centreline is not varied with changes in the diameter clamped. Thus up until now the workrest has been set to maintain the workpart on the centreline of the grinding wheel, this being a function of the finished diameter of the workpart. Setting and adjusting of the height and horizontal displacement of the workrest has required manual intervention, which is time consuming.

[0021] In the present invention however, the workrest is mounted on a servo driven slide for movement on the X axis, and by providing the workrest with an angled contact face various diameters of workpart can be accommodated at the same height.

[0022] Typically the workrest contact face 19 is flat and at an angle of 45°, permitting a variation of workpart diameter in the ratio 1:3 by moving the workrest on the X axis. Thus workparts in the size range of e.g. 4-12 mm or 6-18 mm may be accommodated by servo movement of the workrest to the desired position.

[0023] Fig. 3 is a somewhat schematic section through a device according to the invention to illustrate the effect of the workrest. The drawing is not to scale, and certain parts are exaggerated in order to clearly illustrate this aspect of the invention.

[0024] Fig. 3a illustrates a control wheel 13, the workrest 14 and concentric roller 15 in section. The workpart 11a is a relatively small diameter, and lies on the control wheel centreline 21. The workrest has a 45° flat support face 22 and is close to the control wheel 13, with the workpart supported close to the upper end of the support face 22.

[0025] Fig. 3b illustrates a somewhat larger workpart 11b supported by the same workrest at a greater distance from the control wheel 13. The workpart remains on the centreline 21 and is supported somewhat lower on the support face 22. The workrest 14 moves between Fig. 3a and Fig. 3b in a horizontal plane only, in the direction of the axis 21.

[0026] Fig. 4 illustrates schematically a measuring device according to the invention.

[0027] An electronic micrometer 30 is provided on a frame 31 mounted for pivoting in a vertical plane on the grinding wheel carriage, typically on the grinding wheel guard. The pivot axis 32 is shown diagrammatically. An actuator of any suitable kind is provided to swing the frame about axis 32 between end stops defining an advanced (horizontal) condition, as illustrated, and a retracted (upright) condition. The fixed jaw 33 of the micrometer is of sufficient length to lie on a diameter of the workpart when the workpart is in the micrometer jaw. The micrometer body 35 is mounted on the frame 31 for limited sliding movement in the radial direction, and is biased inwardly to an end stop by a light tension spring 36.

[0028] Figs. 5 and 6 illustrate a typically measuring device according to the invention. Reference numerals

in common with Fig. 4 are used where appropriate.

[0029] The micrometer 30 is mounted on a frame 31 by a cylindrical shaft 40 supported in a linear ball bearing 41. An anti-rotation pin 42 extends from the micrometer to the frame 31 to maintain the micrometer in the desired plane. The shaft 40 has a head 43 against which acts as a coil compression spring 36 grounded on the frame 31. The spring 36 biases the micrometer inwardly of the frame 31.

[0030] The frame 31 is pivotable about axis 32 by a double acting ram 44 of any suitable kind. The micrometer has a fixed jaw 33, and movable jaw 34 as illustrated. Two limit switches 37 are provided to ensure continued operability should one switch fail.

[0031] Fig. 6 illustrates a damper and adjustable stop 45 to ensure that the micrometer comes smoothly to rest on a diameter of a workpart 11 in use. Electrical leads 46, shown schematically, connect the micrometer to a suitable display/recording device. Circle 47 represents a typical grinding wheel.

[0032] In use measurement is performed by driving the grinding wheel carriage on the Y axis until the micrometer is aligned with the diameter to be measured. The carriage is driven in the X direction such that when the frame 31 is pivoted to the horizontal position, the fixed jaw 33 of the micrometer is lowered to the opposite side of the workpart. Necessarily the micrometer protrudes slightly more than the maximum diameter of the grinding wheel(s) and the carriage is driven on the X axis to ensure clearance between the workpart 11 and the fixed micrometer jaw 33.

[0033] From the position illustrated in Fig. 6, the frame 31 is driven away from the workpart on the X axis (to the left) by movement of the grinding wheel carriage, until the fixed jaw meets the workpart. At this point the micrometer body moves relative to the frame against the effect of the spring 36, and a limit switch 37 is provided to suspend movement of the carriage at a predetermined light load. The movable jaw 34 of the micrometer is then driven against the workpart so as to measure the diameter thereof in a conventional manner.

[0034] After measurement, the procedure is reversed to bring the micrometer to the retracted position.

[0035] The spring load at which carriage movement is suspended is not important provided that the fixed jaw lies against the workpart and the load is not sufficient to introduce distortion. It is envisaged that gross movement of the micrometer body 35 will be of the order of 1 mm. Furthermore, the load at which the carriage ceases movement due to operation of the limit switch is constant regardless of the diameter being measured-it being merely necessary to ensure that the fixed jaw 33 clears the workpart on dropping to the measuring position.

[0036] Typically a master component of known diameter would be loaded into the grinding machine from time to time in order to permit the micrometer to be calibrated.

[0037] Although this measuring device has been de-

scribed in relation to centreless grinders, it is equally suitable for use on any machine tool having a traversable carriage. For example the device could be mounted on the wheel guard of a between-centres grinder or on the saddle of a lathe.

[0038] Measurement of the diameter of the workpart may be repeated at several axial positions, in order to check for taper, by simply traversing the carriage on the Y axis to the desired location and repeating the measuring procedure.

[0039] It will be understood that the location of the pivot and the extent of movement of the carriage on the X axis are not critical to the dimension measured by the micrometer; these merely bring the micrometer into a position from which an accurate measurement can be made in order to determine the amount of material to be removed in a final grinding pass.

[0040] As an alternative to the limit switch, movement of the carriage in the X direction may be suspended by making an electrical circuit between the fixed jaw 33 and the workpart. A low voltage circuit would be suitable, and connected to any conventional means for causing the traversing motor to cease.

[0041] A third actuator, or releasable catch may be provided to maintain the micrometer jaws in a fixed position during movement to and from the measuring position, and whilst in the retracted condition. Such a device will prevent chattering due to machine vibration and during movement about the pivot 32.

[0042] In use it is envisaged that a typical automatic machining sequence will be as follows.

1. Unload previous component.
2. Adjust position of workrest and end stop to suit required dimensions of next component, by reference to a look-up table.
3. Load unfinished blank.
4. Drive head of workpart against end stop.
5. Rough grind workpart in one or more plunges to the finished size +0.2 mm on diameter, using roughing wheel.
6. Semi-finish grind workpart with finishing wheel to finished size +0.05 mm on diameter.
7. Traverse grinding wheel away from workpart and advance micrometer to measure ground diameter.
8. Calculate remaining depth of material to be removed by reference to actual and required diameter.
9. Finish grind to desired diameter.
10. Optionally, re-measure diameter as confirmation.

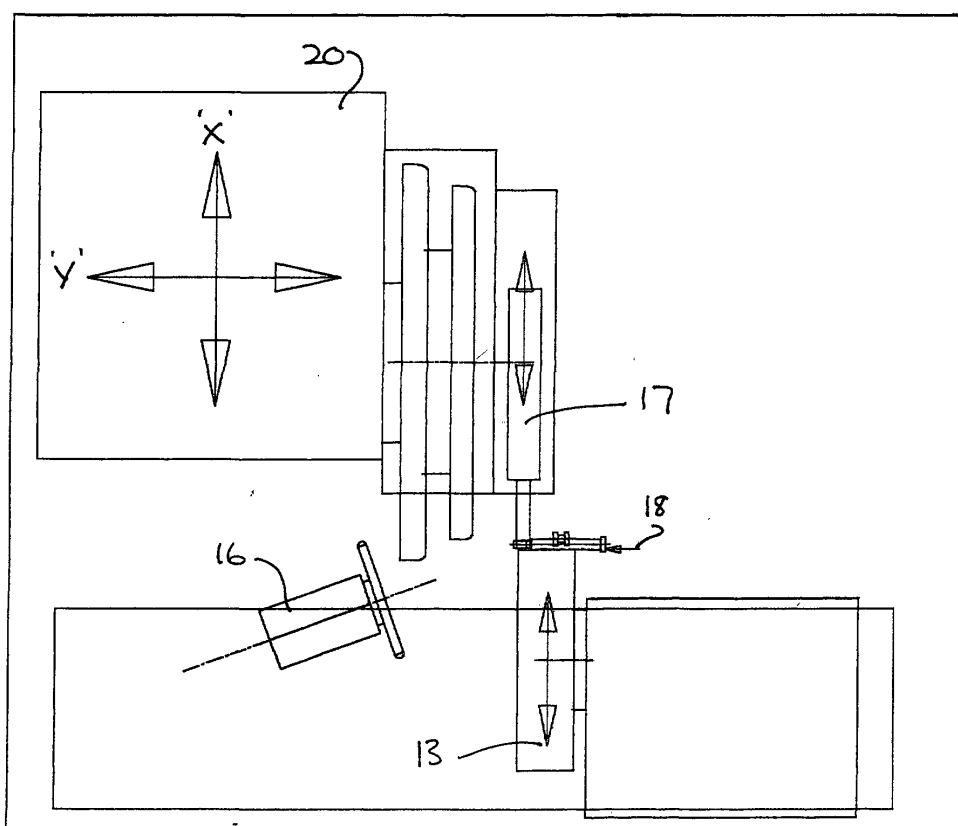
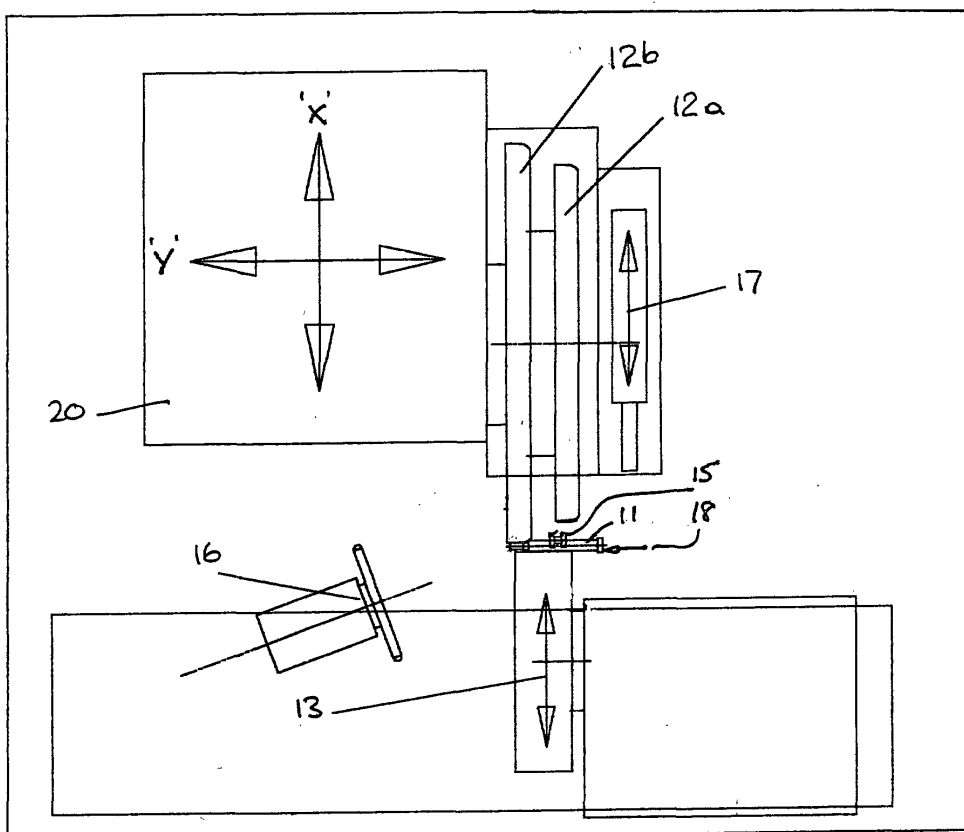
[0043] This sequence provides unmanned grinding of punches, and can record measurements at several grinding stages in order to provide inspection and quality control data.

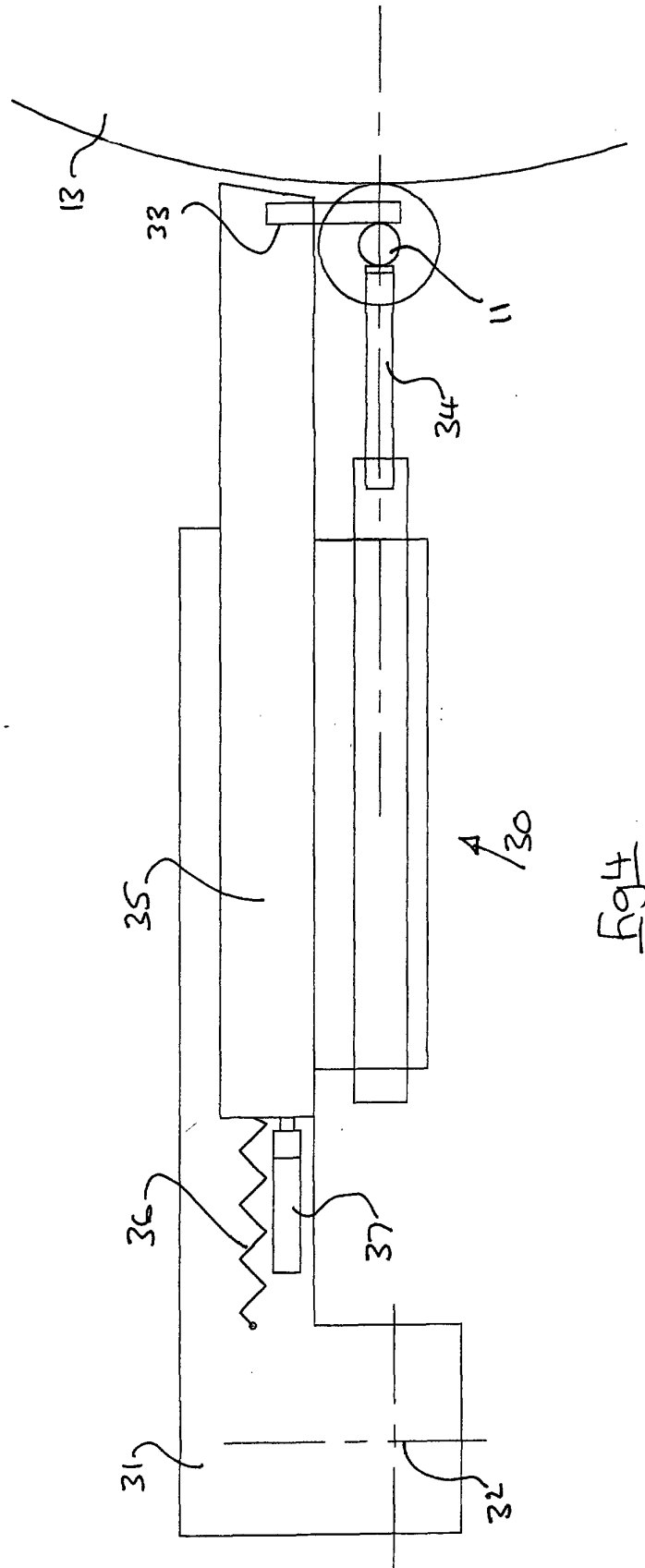
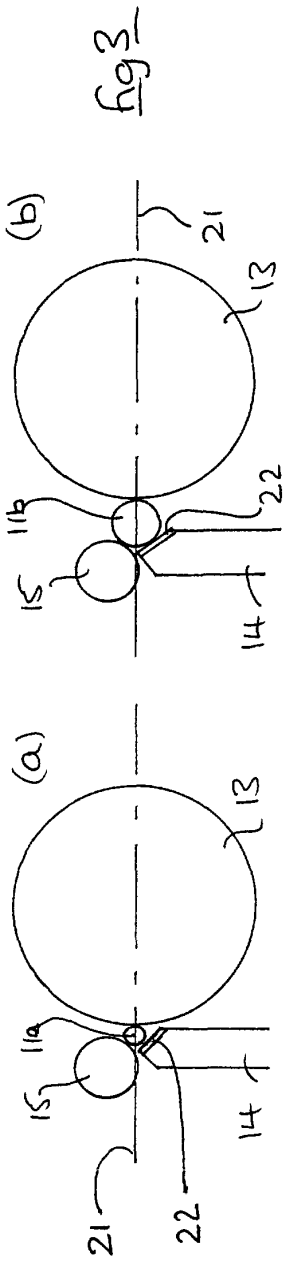
[0044] Automatic loading and unloading by gripping the punch head is envisaged. Such loading is typically

by robot arm from a pallet of punch blanks, the finished punch being stored in a separate pallet with known identity and location. For an average punch having a blank diameter of 12 mm, a punching diameter of 5 mm and a punching length of 20 mm, a cycle time of less than 150 seconds is envisaged.

Claims

1. A measuring device for a rotary machine tool having a carrier (20) adapted for plunge movement relative to a workpart (11), the measuring device comprising an arm (31) adapted for pivoting mounting on a said carrier (20), and a calliper (30) slidably mounted on the arm (31) for inward and outward movement thereof, the calliper (30) being biased to an end stop of said arm (31), and having a fixed jaw (33) and a movable jaw (34), and the calliper further including means to determine the relative position of the fixed and movable jaws (33,34), a first actuator (44) being provided to move said arm from an inactive condition to an active condition in which said jaws lie on either side of a workpart (11), and said carrier (20) being movable to draw the fixed jaw against a workpart (11), and a second actuator being provided to move the jaws of the calliper together, so as to grip a workpart (11) on a diameter in order to determine the size thereof.
2. A measuring device according to claim 1 and including an actuator to urge said calliper in one of said inward and outward directions.
3. A measuring device according to claim 1 or claim 2 and including a spring (36) to urge said calliper in one of said inward and outward directions.
4. A measuring device according to claim 3 wherein said spring (36) is a coiled compression spring.
5. A measuring device according to claim 3 or claim 4 wherein said spring is adapted to urge said calliper inwardly of said arm.
6. A measuring device according to any preceding claim wherein said arm is adapted to pivot from the inactive condition to the active condition.
7. A rotary machine tool having a carrier adapted for plunge movement relative to the rotary axis of the machine tool, and the measuring device of any preceding claim mounted thereon.
8. A centreless grinder having a grinding wheel adapted for plunge movement relative to a workpart, and a measuring device according to any of claims 1-6 mounted thereon.
9. A centreless grinder according to claim 8 wherein said measuring device is substantially horizontal in the active condition and upright in the inactive condition.
10. A centreless grinder according to claim 8 or claim 9 wherein said measuring device is mounted on a wheel guard of said grinding wheel.





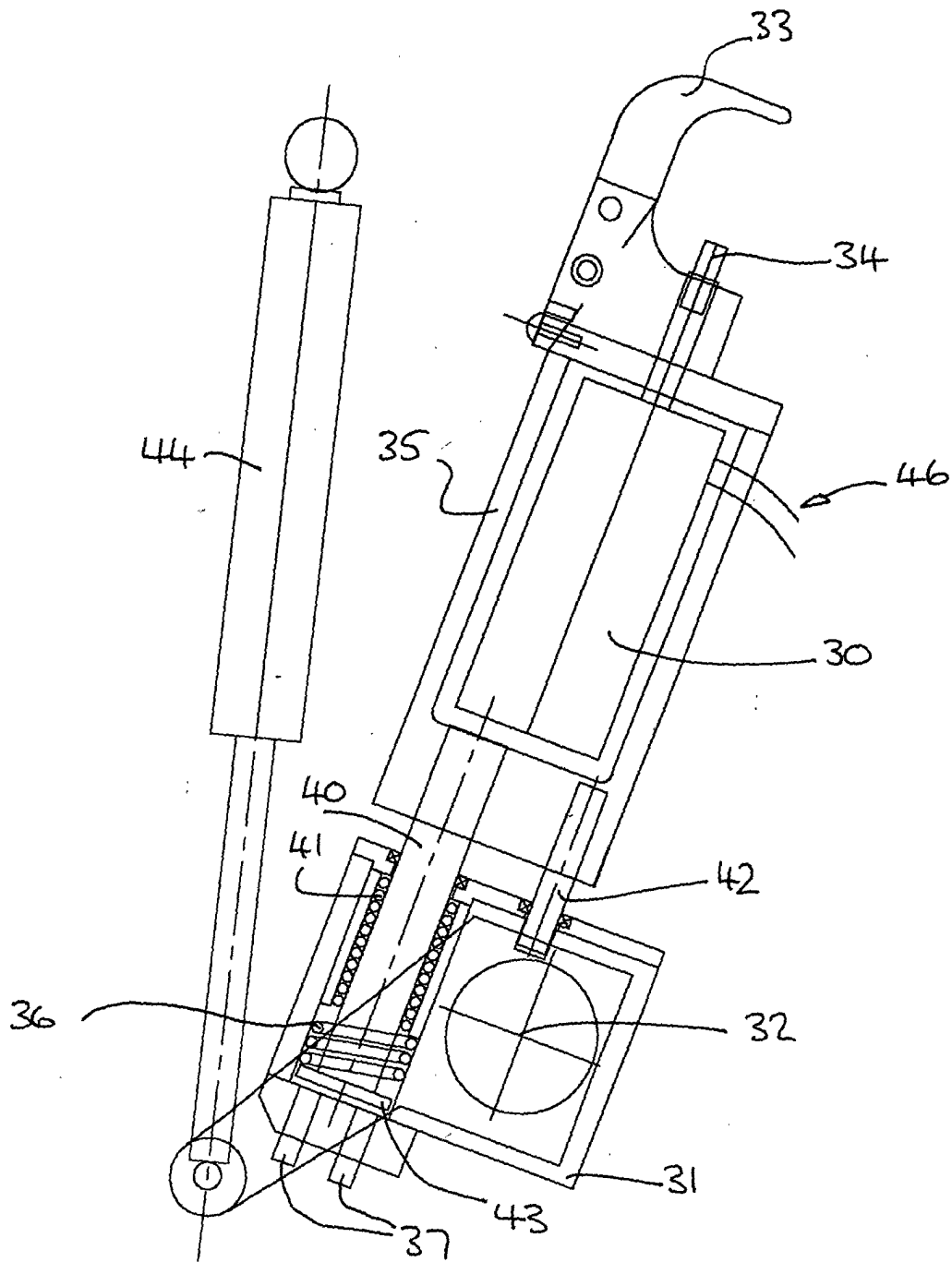
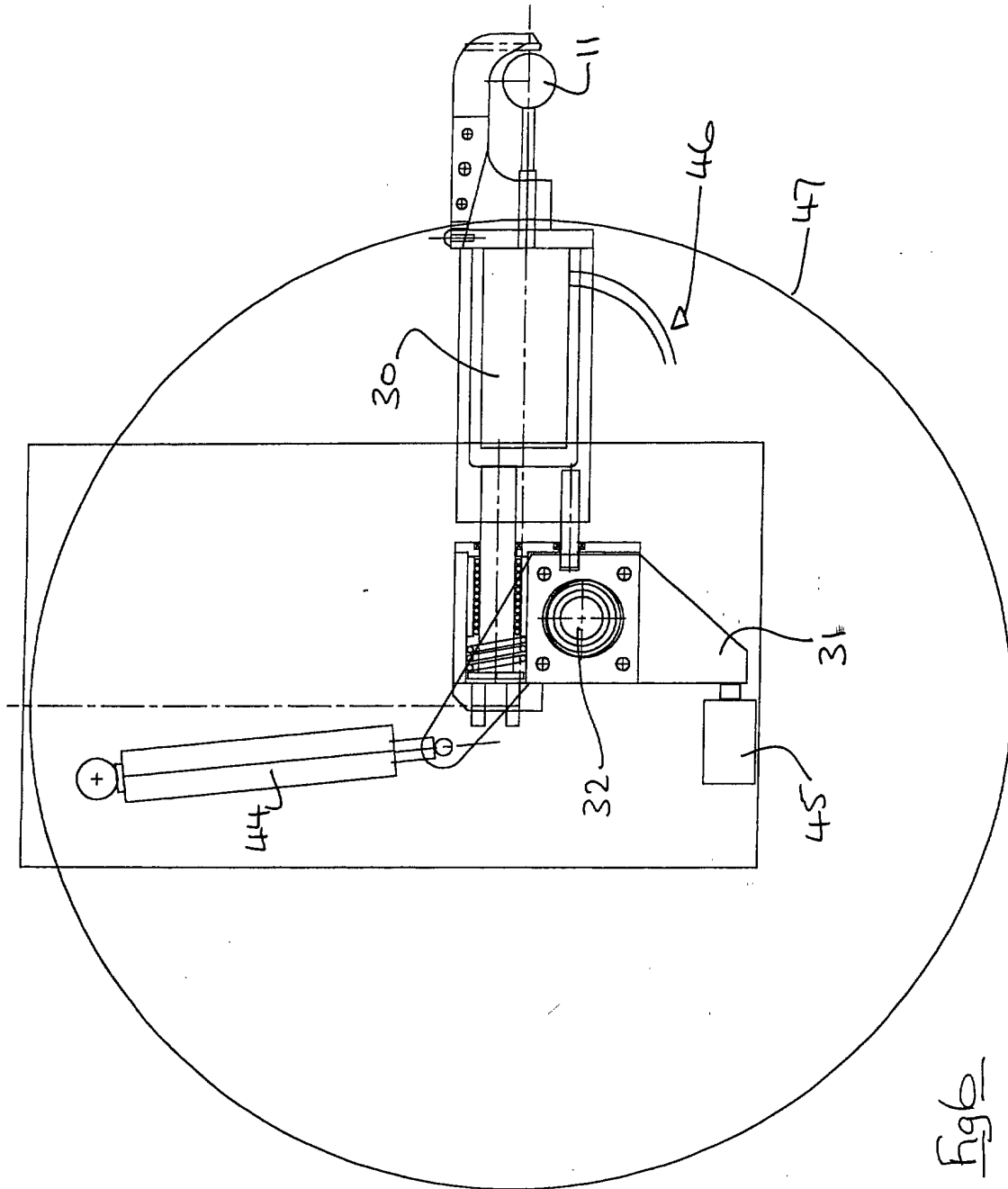


Fig 5





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 30 8679

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	GB 2 318 074 A (UNOVA UK LTD) 15 April 1998 (1998-04-15) * page 13, line 4 - line 18; figure 2 *	1	B24B49/04 B24B5/18
A	EP 0 903 199 A (UNOVA UK LTD) 24 March 1999 (1999-03-24) * abstract; figures *	1	
A	US 3 802 087 A (RAITERI A) 9 April 1974 (1974-04-09) * column 3, line 38 - column 4, line 62; figure 2 *	1	
A	US 5 542 188 A (BERTZ HANS-ULRICH ET AL) 6 August 1996 (1996-08-06) * abstract; figure 5 *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B24B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 January 2002	Examiner Garella, M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03 82 (P04G01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 01 30 8679

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-01-2002

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 2318074	A	15-04-1998	AU 2395897 A	12-11-1997
			BR 9706668 A	20-07-1999
			CA 2225962 A1	30-10-1997
			DE 69708858 D1	17-01-2002
			EP 0895614 A1	10-02-1999
			EP 0984343 A2	08-03-2000
			WO 9740432 A1	30-10-1997
			GB 2314285 A , B	24-12-1997
EP 0903199	A	24-03-1999	EP 0903199 A2	24-03-1999
			GB 2329472 A	24-03-1999
US 3802087	A	09-04-1974	NONE	
US 5542188	A	06-08-1996	DE 4420137 A1	14-12-1995
			EP 0686829 A2	13-12-1995