April 8, 1958 L. A. SAYCE 2,829,389

MACHINE FOR PRODUCING FINE PITCH SCREW THREADS FOR USE IN THE PRODUCTION OF DIFFRACTION GRATINGS

Filed Oct. 14, 1955 2 Sheets-Sheet 1

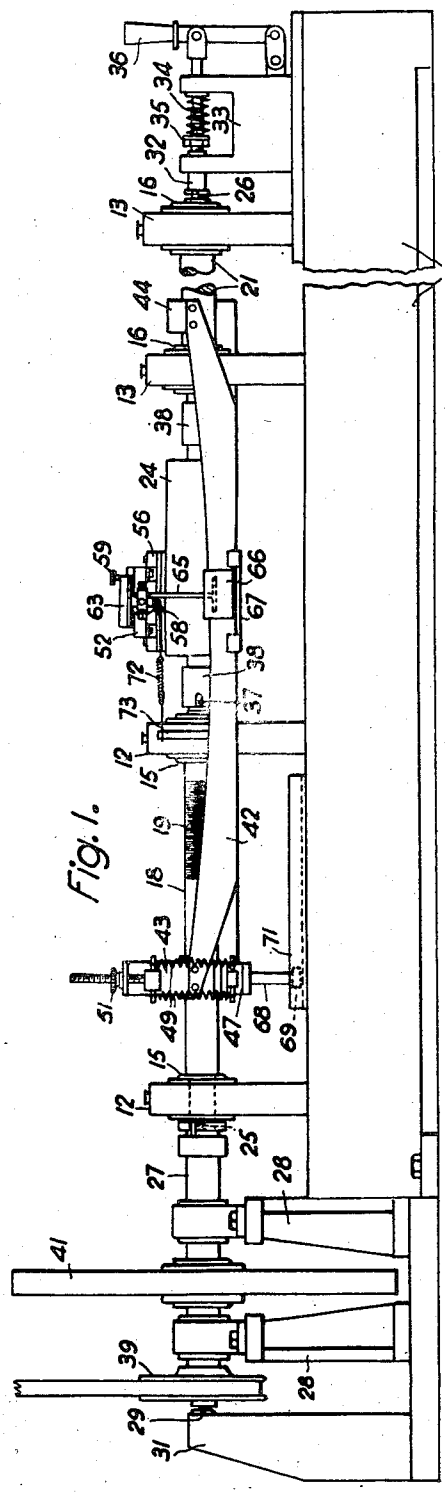

Fig. 1.

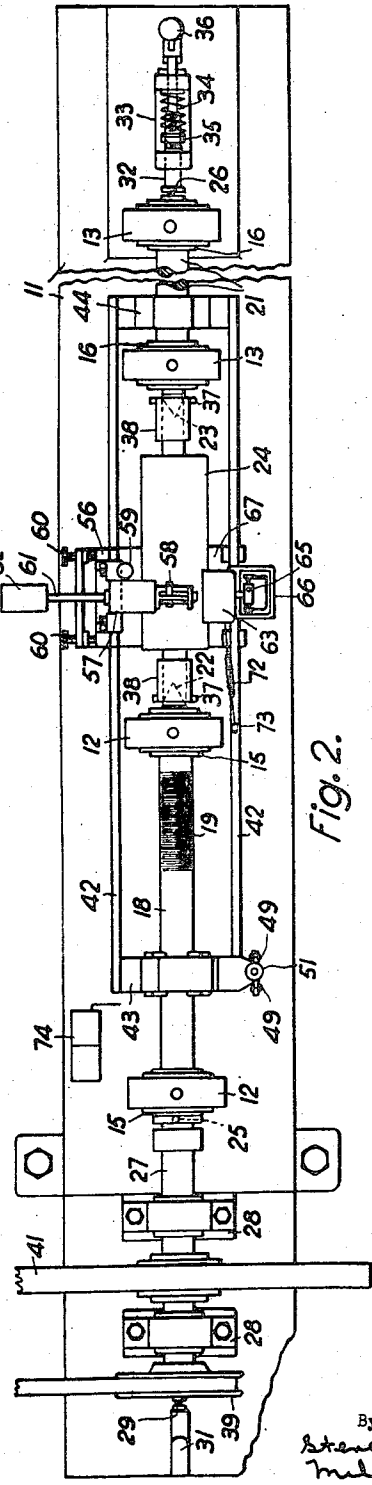

Fig. 2.

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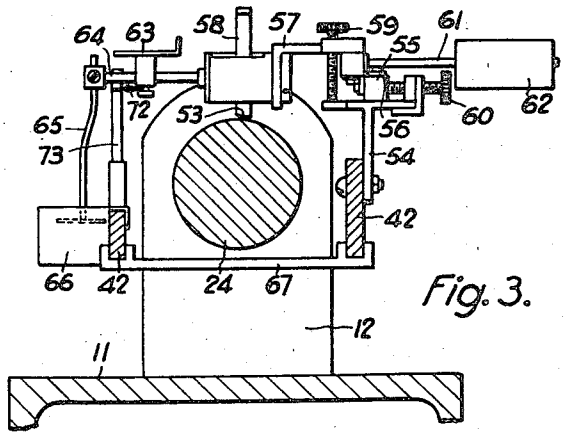

Fig. 3.

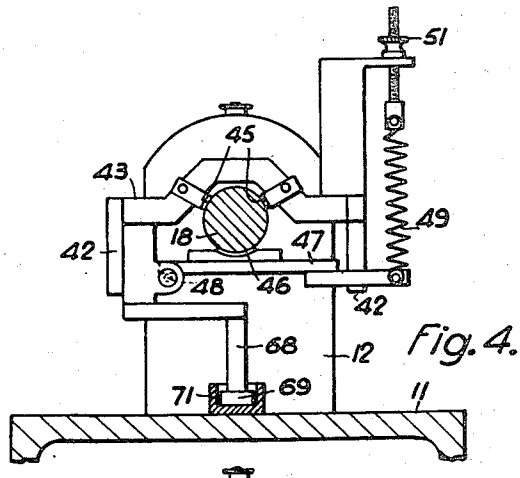

Fig. 4.

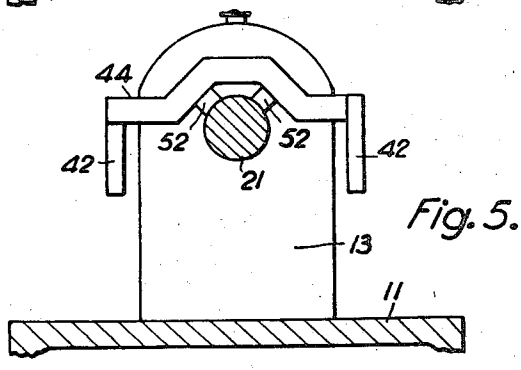

Fig. 5.

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MACHINE FOR PRODUCING FINE PITCH SCREW THREADS FOR USE IN THE PRODUCTION OF DIFFRACTION GRATINGS

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Application October 14, 1955, Serial No. 540,591

Claims priority, application Great Britain October 14, 1954

6 Claims. (Cl. 10—101)

This invention relates to the production of screw threads of high accuracy and generally of very fine pitch such as are useful in the production of helical diffraction gratings, and it is a development based on the methods disclosed in British patent specifications Nos. 684,846 and 708,539. The essential principle of that method consists in cutting a thread of the required pitch by means of a lathe or the like and eliminating the periodic and other errors by providing a nut which spans a sufficient plurality of threads and engages them by soft resilient or elastic material such as pith, cork, rubber, fibre, leather, balsa wood or the like, and transferring the motion thereby derived to a tool or a plurality of tools which produce another thread or threads on a plain part of the cylinder on which the original thread had been cut.

Excellent results are obtained in practice by this method, but the corrected thread involves a length of material two or three times as long as the original thread and the original thread can be used once only. It will be understood that for the production of fine threads of high quality the original material has to be a carefully prepared cylindrical bar with a highly polished surface, and that though the method eliminates errors it can only deal with errors of a small order, so that the original thread must be carefully cut in a lathe of high class.

An object of the present invention is to enable a corrected thread to be produced on a length of material of minimum length. A further object is to enable the original lathe-cut thread to be used repeatedly. Yet a further object is to enable a corrected thread to be produced on a prepared piece of material, the diameter of which differs from that of the original lathe-cut thread.

According to the invention, the cylinder on which the thread is to be produced is mounted to share the rotation of a cylinder carrying the primary lathe-cut thread, the two cylinders being coaxial and restrained against relative axial movement, and the tool is carried by a bridge member one end of which is attached to a nut of the above described character engaging the lathe-cut thread, while the other end of the bridge member extends beyond the cylinder on which the thread is being cut and is supported by guide means which guide it in a path which is truly parallel with the axis of the two cylinders. It will be understood that some means is provided to prevent rotation of the bridge member so that as the two cylinders are rotated the tool will produce a corrected thread on the plain cylinder. There may, of course, be more than one tool, or the tool may take the form of an abrasive material as described in specification No. 708,539.

Desirably, the remote end of the bridge is guided on a third cylinder which is coaxial with the first two and rotates with them, the support being of a construction similar to the nut, i. e., being a bearing with a lining of resilient material. This form of support bearing combined with the rotation of the third cylinder imposes a

minimum of axial restraint on the movement of the bridge member.

A practical construction embodying the present invention is illustrated by way of example in the accompanying drawings in which:

Figure 1 is a side view of the complete apparatus.

Figure 2 is a plan view of Figure 1.

Figure 3 is an end view of the tool mounting.

Figure 4 is an end view of the nut and

Figure 5 is an end view of the support bearing.

The apparatus illustrated comprises a base or bed **11** on which there are two pairs of pillars **12, 12** and **13, 13** constituting two headstocks. These pillars could, for example, be cast in one with the base or bed but they may also be made separate and held to the base by screws not visible in the drawings. Each pillar carries a bearing marked **15** on the pillars **12** and **16** on the pillars **13**. These four bearings are very accurately in line. Each may comprise a bearing bush proper slidable within an outer bush. They may be conveniently aligned, for example, by the aid of a carefully prepared straight master bar upon which the bearing bushes proper are a very good running fit. The outer bushes fit with ample clearance in bores in the pillars and they are secured therein by the aid of a material such as an epoxy resin which can be introduced into the clearance in liquid or plastic form and then hardens or sets into a stable, solid form. It is found that by this means very accurate alignment can be obtained and maintained. In the bearings **15** runs a cylinder **18** on which a primary thread **19** has been cut in a lathe of suitable quality. In the bearings **16** runs the third, guide cylinder **21**. These two cylinders **18, 21** terminate on their facing ends in accurately formed male centres **22, 23** respectively which form a mounting for female centres accurately prepared in the ends of a polished cylinder **24** on which the corrected thread is to be produced.

To provide for axial location of the three cylinders in relation to one another and to the rest of the apparatus, the outer ends of the cylinders **18** and **21** carry in central seatings respective hardened steel balls **25, 26**. The ball **25** abuts against an accurate plane surface on the end of a drive shaft **27** mounted in a bearing bracket **28** secured to the base or bed and the outer end of this shaft similarly carries another hardened steel ball **29** which abuts against an accurate plane face on a fixed bracket **31** also secured to the base. Against the ball **26** abuts an accurate plane face formed on the end of a shaft **32** slidable in a bracket **33** secured to the base and pressed towards the cylinder assembly by a spring **34** adjustable by the aid of a screwed collar **35**. A hand lever **36** hinged to the bracket **33** enables the shaft **32** to be retracted against the pressure of the spring to enable the cylinders to be separated sufficiently to withdraw the centres **22, 23** and enable the cylinder **24** to be inserted or removed.

Rotational drive is provided by the aid of transverse pins **37** in the centres **22, 23**, which engage with slotted ferrules **38** attached to the ends of the prepared cylinder **24**. Drive is transmitted to the whole assembly from the shaft **27** by a similar arrangement of driving pin and ferrule. The shaft **27** is shown provided with a pulley **39** whereby it may be rotated by means of a V-belt and to ensure a steady drive this shaft also carries a heavy flywheel **41**.

As shown, the drive is transmitted to the cylinder **18** and thence through the cylinders **24, 21**, while the retractable shaft **32** engages the cylinder **21**. It will be understood that this is a mere matter of convenience and the parts might be arranged the reverse way.

A bridge member comprises a pair of lattice or similar members **42** lying one on each side of the assembly of

cylinders and united at each end by substantially identical cross members 43, 44. The member 43 is provided with pith or like linings 45 which together with another lining 46 engage the thread 19 and form a nut. The lining 46 is carried by a crosspiece 47 supported at one end on a pin 48 and at the other end by the aid of a spring 49. A hand nut 51 enables the pressure of the lining 46 and hence also of the linings 45 to be regulated. The crosspiece 44 has pith or like linings 52 which engage and constitute a guide bearing working on the cylinder 21.

A mounting for a diamond tool 53 is provided at the middle of the bridge member adjustably arranged so that it can be brought into suitable engagement with the prepared cylinder 24. The mounting comprises a bracket 54 secured by screws to the member 42 so as to be vertically adjustable. On this bracket is pivoted on a vertical axis a bar 55 which can be rocked about its pivot by the aid of two screws 60. Hinged to the bar 55 by crossed thin steel strips 56 is another bracket 57 in a slot in which the toolholder 58 is clamped. The screws 56 enable small adjustments in the alignment of the tool to be effected. A vertical adjustment to suit the diameter of the cylinder 24 can be effected in clamping the holder 58 in position. A screw 59 passes through the bracket 57. By turning this screw beyond the point at which it abuts the surface of the bracket 54 the tool can be lifted from the cylinder 24, while by turning the screw back until it is clear of the bracket 54, the tool will be lowered and left resting on the cylinder 24 under pressure determined by the out-of-balance of the bracket 57 and parts attached thereto.

The tool does not actually cut the cylinder but produces a thread in the nature of an indentation. The pressure required is only a few grams and the mounting is arranged to provide a pressure of this order which can be regulated. To this end a bar 61 to the bracket 57 carries a counterweight 62 while a pan 63 is adjustable along an arm 64 projecting from the bracket 57. Weights can be put on this pan 63 as required. To steady the parts the end of the rod 64 carries a downwardly extending rod 65 connected to the piston of a dashpot 66 secured to one of the members 42. The two members 42 may be coupled together at this location by a cross member 67 to give added rigidity to the structure, though this is not essential.

To prevent rotation of the bridge, a downwardly projecting rod 68 carries a wheel 69 which runs along a straight edge conveniently formed as a channel 71 secured to the base. The downwardly projecting rod 68 could be attached at any convenient point. In the illustrated example it is shown attached to the cross member 43. Consideration will show that the accuracy of the thread produced does not depend on the accurate alignment of the guide 71 provided this does not produce any shocks in movement.

The mode of operation of the apparatus will be readily understood. As shown in the drawings, the parts are in position corresponding to the completion of the thread but to start with they are arranged so that the nut 45, 46 is at the starting end of the thread 19 and the tool 53 is at the desired starting point of the thread to be produced on the cylinder 24. The tool is brought into appropriate engagement and the drive is started, whereupon a corrected copy of the thread 19 will be produced on the cylinder 24.

Owing to the resilience of the pith or like linings 45, 46, 52, it is essential that in operation the cylinders should rotate with the utmost steadiness and that the resistance to motion of the bridge and the parts carried thereby should be uniform. The flywheel 41 assists in obtaining a steady drive, while the nature of the nut and bearing 52 together with the high polish of the cylinder 21 will ensure a low and uniform resistance to the movement of the bridge. To take up backlash in the hinges in the tool mounting a light spring 72 may be connected between a pillar 73 on the bridge member and a suitable point on the tool mounting. As above mentioned, the guide 71 should be smooth, to avoid the imposition of shocks or fluctuating inertia loads at this point. As a safety precaution a micro-switch 74 may be provided engaged by a suitable part of the bridge to stop the drive when the tool has reached the desired limit of travel.

It will be understood that within limits of the adjustment of the toolholder 58 a thread can be produced on any diameter of cylinder and in the example illustrated the cylinder 24 is shown of twice the diameter of the cylinder 18. It will also be understood that though the cylinder 24 may be of solid metal and the thread be produced in the metal, the invention is not so limited. It is possible to provide the cylinder, whether of metal or other material, with a coating of a solidified plastic in which the thread is produced and if the plastic is sufficiently thin and flexible it may afterwards be cut through axially and stripped off. Another possibility is a non-metallic e. g. quartz or glass cylinder with a thin metal coating, e. g. of gold, in which the thread is produced.

What I claim is:

1. Apparatus for the production of screw threads of fine pitch and high accuracy upon a cylinder, comprising a base, supporting means on said base, four bearing bushes spaced apart with their bores accurately in line and positioned with clearance within said supporting means, means including a layer of a material hardened from a fluent into a stable solid form outside said bushes and within said clearance whereby said bushes are held and maintained in said supporting means with their bores accurately in line, a first cylinder mounted within two of said bearing bushes with a good running fit therein, said cylinder having a primary thread on part of its surface lying between said bushes, a third cylinder mounted within the remaining two of said bearing bushes with a good running fit therein, centering means on the adjacent ends of said first and third cylinders whereby to centre and support a cylinder upon which a screw thread is to be produced, means to prevent axial movement of said first and third cylinders in relation to one another and to a cylinder mounted between them, means for positively transmitting rotation from the first cylinder to the cylinder upon which a thread is to be produced and from the last mentioned cylinder to the third cylinder, means for transmitting a uniform rotational movement to one of said cylinders, a nut spanning a plurality of said primary threads and engaging them by a soft resilient material, a bearing with a lining of soft resilient material engaging said third cylinder, a bridge member attached at one end to said nut and at the other end to said bearing, a tool carried by said bridge member and engaging the cylinder on which the thread is to be produced and means preventing the rotation of the bridge member in relation to said base.

2. Apparatus as set forth in claim 1 wherein said supporting means comprises four pillars, one for each of said bearing bushes.

3. Apparatus as set forth in claim 1 wherein each said bearing bush is slidable within an outer bush and the layer of hardened material directly supports the outside of said outer bush.

4. Apparatus as set forth in claim 1 wherein to convey the drive, means are provided comprising a driving shaft journalled in alignment with said first cylinder, a flywheel on said shaft and means conveying rotation from said shaft to said first cylinder.

5. Apparatus as set forth in claim 4 wherein the end of said driving shaft remote from said first cylinder carries a central ball and said support is provided with an accurate plane surface against which said ball abuts, the apparatus also comprising a central ball at the end of said

third cylinder remote from said first cylinder, an accurate plane surface slidably mounted in relation to said base and spring means pressing said last mentioned plane surface against said ball carried by said third cylinder.

6. Apparatus as set forth in claim 1 comprising an arm hinged to said bridge member on an axis substantially parallel to the axis of said cylinders, said arm serving to carry said tool so that it is movable substantially radially in relation to the axis of said cylinders and means for regulating the pressure of the tool against the cylinder on which the thread is to be produced.

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