Feb. 21, 1967 E. C. MAGUIRE 3,304,661

WORK MACHINES WITH TOOLS IN PLANETARY AND AXIAL MOVEMENT

Filed Sept. 10, 1964 4 Sheets-Sheet 1

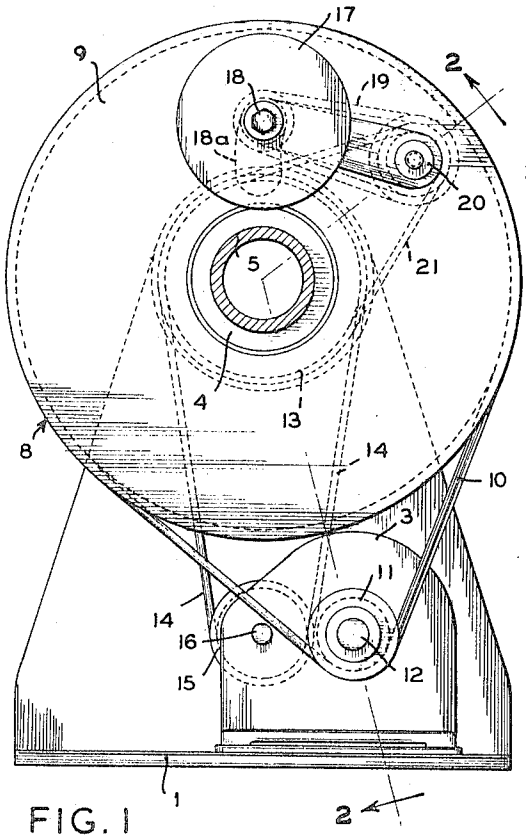


FIG. 1

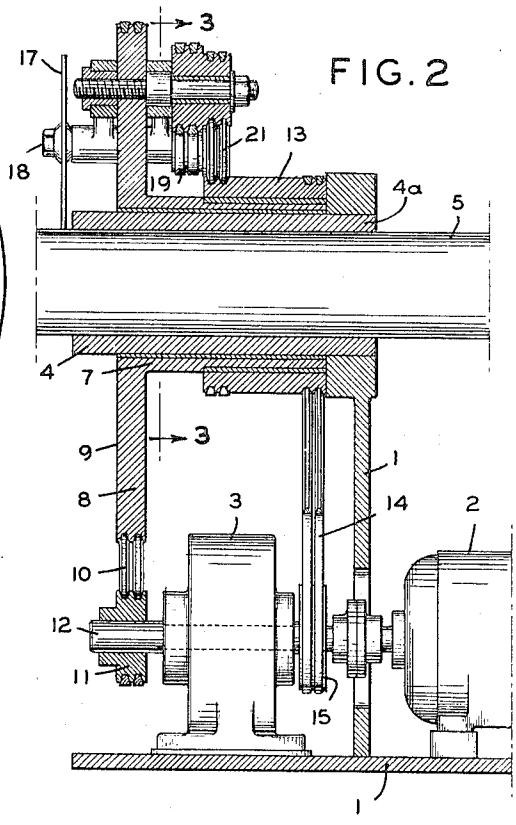


FIG. 2

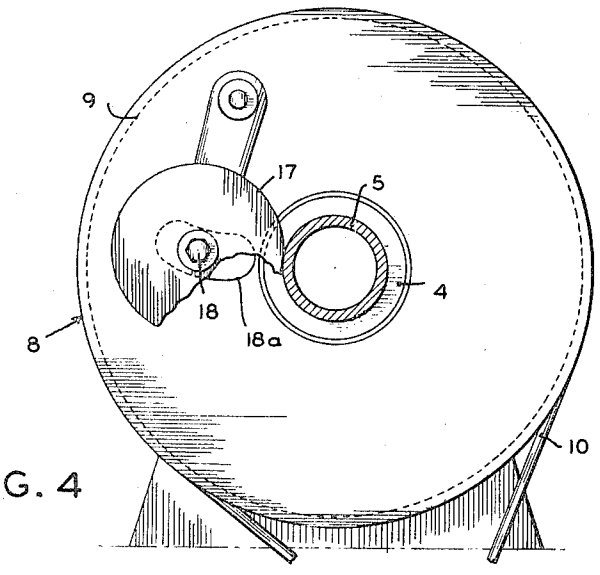


FIG. 4

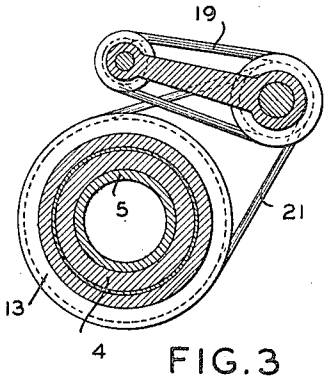


FIG. 3

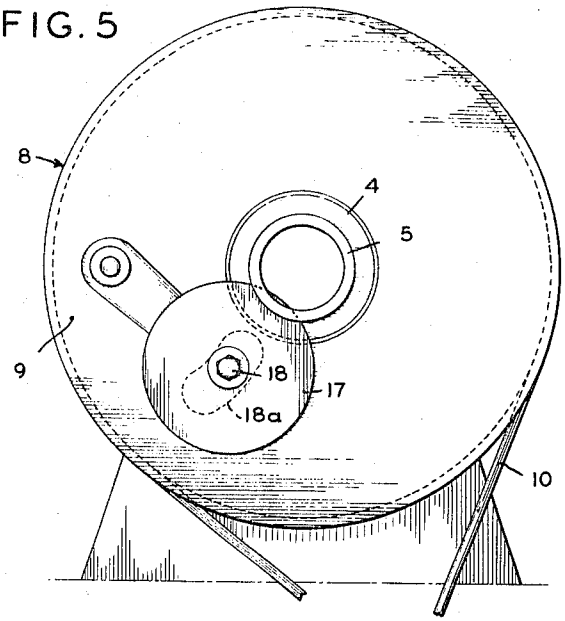
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FIG. 5



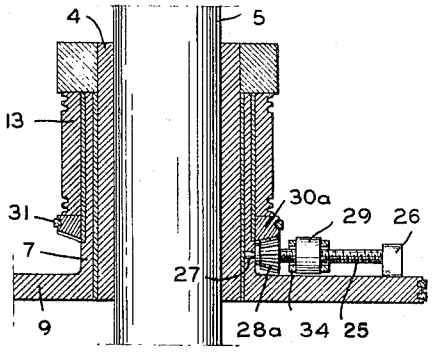
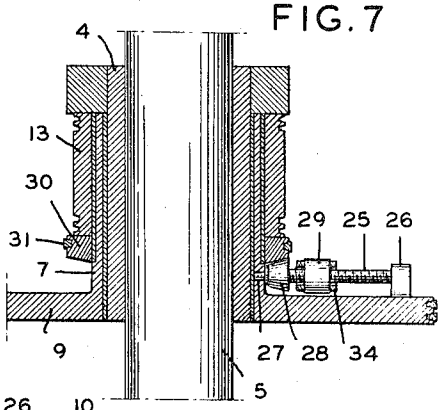


FIG. 7A

FIG. 7



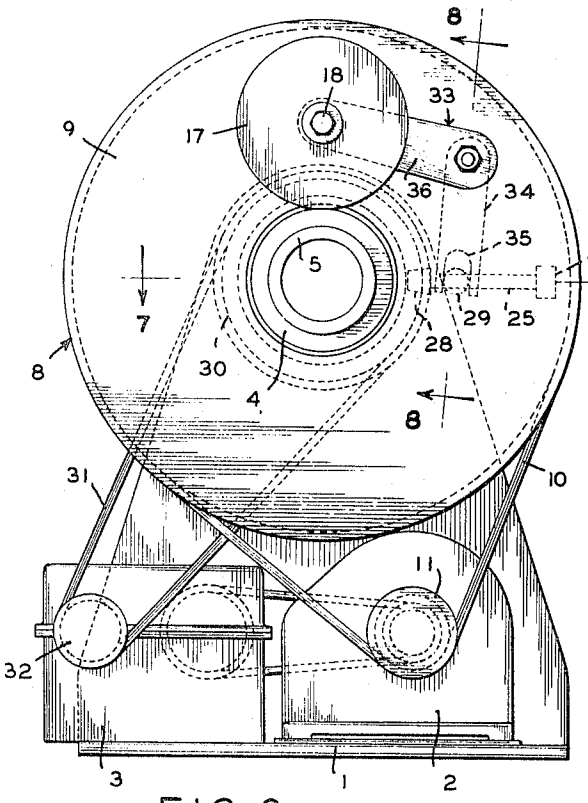


FIG. 6

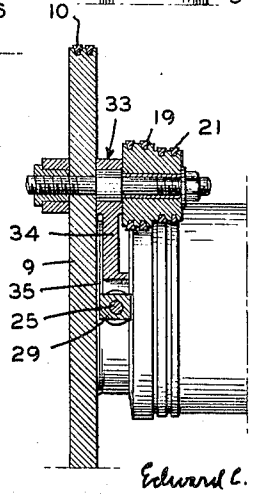


FIG. 8

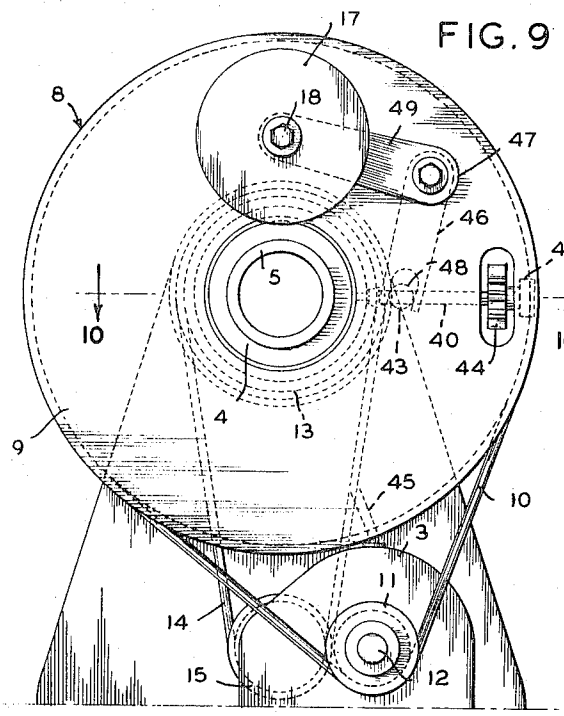
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FIG. 9



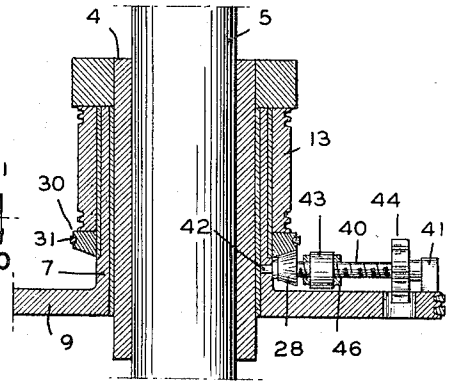
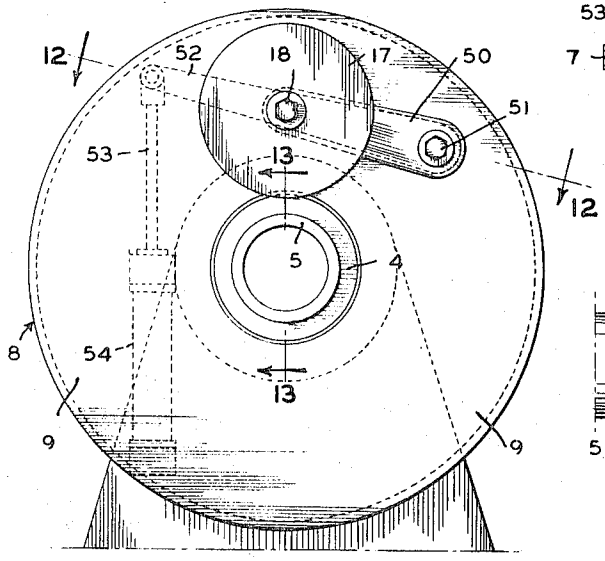


FIG. 10

FIG. 12



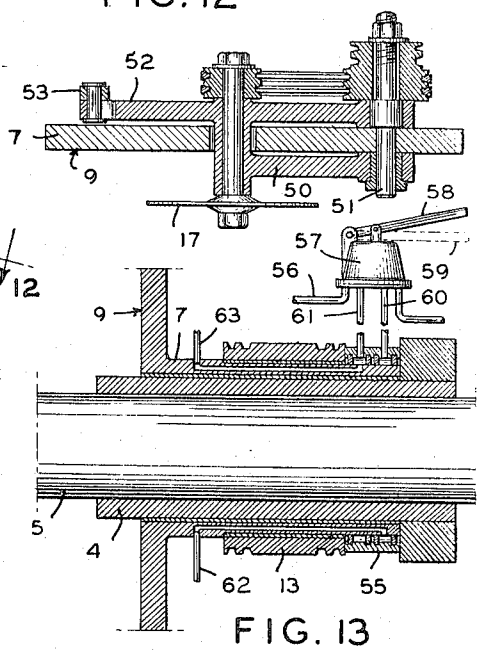


FIG. 11

FIG. 13

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WORK MACHINES WITH TOOLS IN PLANETARY AND AXIAL MOVEMENT

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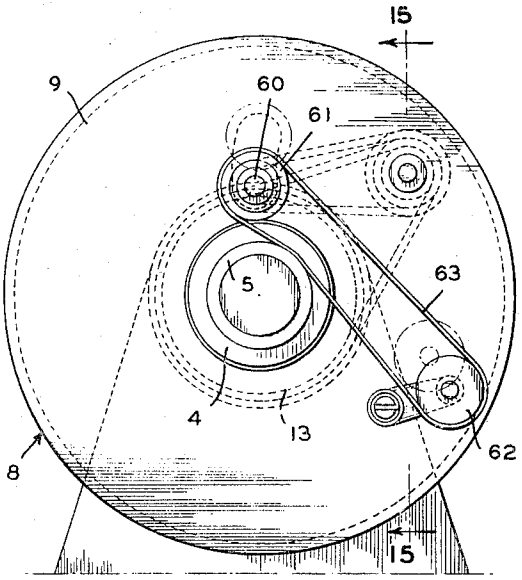


FIG. 14

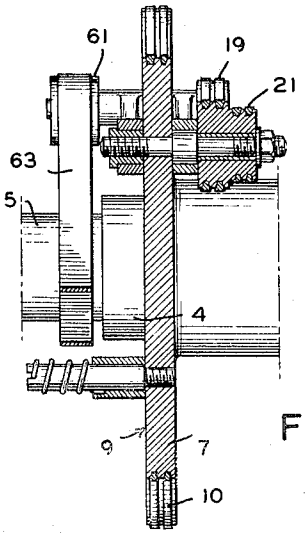


FIG. 15

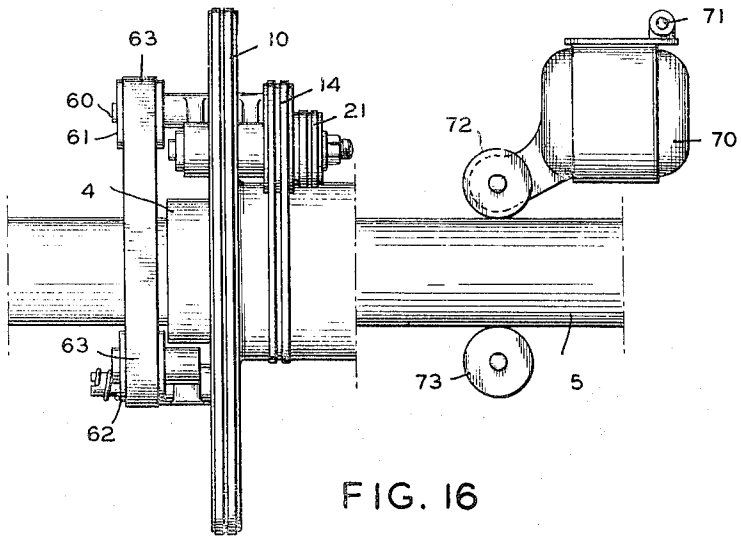


FIG. 16

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Patented Feb. 21, 1967

3,304,661

WORK MACHINES WITH TOOLS IN PLANETARY AND AXIAL MOVEMENT

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Filed Sept. 10, 1964, Ser. No. 395,618
1 Claim. (Cl. 51—90)

This application is a continuation-in-part of application of Edward Christopher Maguire, deceased, Serial No. 12,031, filed March 1, 1960, now patent No. 3,149,440, dated September 22, 1964.

This invention relates to cutting, polishing and grinding machines of improved structure and function in which the machines themselves are simplified and of increased capacity and improved structure.

In certain cutting, grinding, and related operations as heretofore generally carried out, the piece being operated on is clamped rigidly in place while a revolving cut-off wheel is brought down to engage the work piece cutting through the latter from one side of the other; in such operations, the minimum size wheel required to cut off a round or other section will demand a diameter such that the radius plus the hub is somewhat greater than the piece to be cut; this method in addition to requiring a relatively large diameter wheel also requires considerably more power due to the friction between the wheel face and the work since by cutting straight through the piece, the wheel faces must contact maximum workpiece surface as the wheel cuts further into the metal or other material.

Other common methods of cutting off material employ machines that utilize reciprocating hack saw and revolving band saw operations. Such machines are limited in capacity, are subject to frequent breakdown, and exhibit other defects.

Among the objects of the present invention are machines for cutting, grinding, abrading, polishing and otherwise operating on workpieces that enable smaller workwheels to be employed, minimizing power requirements, reducing friction losses, increasing capacity, and greatly simplifying the structures and operations while resulting in substantial economies.

Other objects and advantages will appear from the more detailed description set forth below, it being understood that this more detailed description is given by way of illustration and explanation, and not limitation, since various changes therein may be made by those skilled in the art without departing from the scope and spirit of the present invention.

In that connection, the drawings show the following. FIGURE 1 is a side elevation of one form of planetary cutting machine in accordance with the present invention. FIGURE 2 is a section on line **2—2** of FIGURE 1 and FIGURE 3 a fragmentary section on line **3—3** of FIGURE 2. FIGURE 4 is a fragmentary section partly broken away showing the cutter at the beginning of the cutting operation while FIGURE 5 is a similar fragmentary section showing the cutter at the conclusion of the cutting operation.

FIGURE 6 is a side elevation of one form of cutter feed mechanism utilizing a friction drive. FIGURES 7 and 8 are fragmentary sections on lines **7—7** and **8—8** respectively of FIGURE 6. FIGURE 7*a* is a modified form of FIGURE 7.

FIGURE 9 is a side elevation of cutter feed mechanism utilizing star-wheel feed control. FIGURE 10 is a fragmentary section on line **10—10** of FIGURE 9.

FIGURE 11 is a side elevation of cutter feed mechanism utilizing pressure-fluid operated cylinder and piston-rod feed control. FIGURE 12 is a fragmentary section on line **12—12** of FIGURE 11. FIGURE 13 is a fragmentary vertical section on line **13—13** of FIGURE 11 illustrating the pressure fluid valve control.

FIGURE 14 is a side elevation of a form of device employed for polishing, and FIGURE 15 is a section on line **15—15** of FIGURE 14. FIGURE 16 is a top plan view of the device in FIGURE 14.

In accordance with the present invention, a machine is provided for operating on a workpiece with a tool rotating in peripheral contact with the workpiece. The workpiece is held conveniently in position on a work-holding member or arbor supported on a base. Desirably the work-holding member or arbor has a turret member having a face portion on which the tool is mounted, such mounting depending on the type of tool to be employed. Thus for rotating tools for cutting, abrasive, and similar work it is convenient to mount a lever pivotally on the face of the turret so that the lever pivots or reciprocates toward and away from the workpiece and a tool mounted on the lever may be positioned for operating on the work. Desirably means are provided on the turret for automatically and progressively moving the tool toward the peripheral surface of the workpiece which surface may be either externally or internally of the workpiece. In addition to cutting, abrading, contouring, and polishing sections, or articles exteriorly, similar operations may be carried out interiorly of large tubular sections. In power operation, power is supplied to operate the turret and tool; illustratively a motor is mounted on a base or arbor and power connections supplied between the motor and the tool to rotate the latter both axially and planetarially, and between the power source and the turret member to supply power for movement of the cutter or other tool toward the workpiece for operating contact therewith and to maintain cutting or polishing operation of tool on workpiece.

Thus in exterior contact between tool and workpiece, the tool has planetary movement around the work at the same time that it is urged into cutting or polishing other operating contact and while the tool is rotating axially to effect the operation. Or when the tool moves interiorly of large tubular work it may cut off or contour interiorly of the work while the tool rotates on its own axis and also in interior circular peripheral contact with the work and while being urged toward the work.

The tool may of course be of different and varying types, particular utility being obtained in cutting, abrading, contouring, polishing and analogous operations exteriorly or interiorly. While a primary function is to cut off round sections of pipe, tubing and barstock, the invention may be equally adapted to handling other articles of any cross-sectional shape such as triangular, rectangular, square, hexagonal, octangular, or irregular in cross section. These shapes may be composed of any desired types of materials such as metal, plastics that are hard or less rigid, fusible and infusible plastics, synthetic resins and polymers, glass, concrete, rubber, cork etc. The tool for cutoff purposes may be of abrasive, metal, diamond etc. For polishing, any of the usual polishing wheels may be used or polishing belts may be employed for example to buff, grind or polish the outside of round sections. To illustrate the invention it will be sufficient to utilize a round metal tubular member and show various operations as carried out thereon.

In general, it may be said that there is selection of three distinct tools applicable to sanding or polishing: namely, abrasive belt, cotton or sisal buff, and abrasive wheel. There are a wide variety of such tools available on the market that may be readily used in abrasive and polishing operations.

Considering first planetary operating mechanism, used for butting a tubular member, and referring now to FIGURES 1 to 5, base **1** supports drive motor **2** which latter is coupled to gear reducer **3**. Tubular member **4** is supported above and on base **1**. Member **4** may be provided with a 3 or 4-jaw or other chuck **4a** of conventional design to hold the workpiece **5** in position. Turret **7** is mounted for revolution on horizontal member **4**, the turret **7** having pulley segment **8** with face portion **9** on which the tool is placed as explained below together with the mechanism for progressively advancing the tool into the work.

Turret **7** is powered by means of belts **10** and pulley **11** on the slow speed shaft **12** of gear reducer **3**.

Sheave or pulley **13** is mounted for rotation on turret **7** and is driven by belts **14** from driving pulley **15** on the high speed or input shaft **16** of gear reducer **3**. The tool, here illustrated by cutter wheel **17**, is mounted for rotation on spindle **18** in suitable bearings and is driven by belts **19** from pulley **20** the latter being rotated by belts **21** from sheave **13**. At the beginning of the cutting operation cutter wheel **17** is about to contact workpiece **5**, while at the end of the cutting operation as shown in FIGURE 5 it has completed the cutting operation. In FIGURE 1 the cutter has been moved in guide slot **18a** to retracted position while the workpiece is being positioned.

Thus it will be seen, to cut off a piece of stock **5**, the stock is advanced so that the proper length projects from tubular member **4** and is clamped to prevent rotation. The motor is started and the turret revolved carrying the rapidly axially rotating cut-off wheel around the axis of the work in a planetary path. The cutter wheel advances toward the center of the work in an arc described about the lever pivot (the lever being described below with respect to the automatic progressive advancement of the tool into the workpiece). The wheel thus makes a cut around the entire periphery of the work. This description will illustrate the structure and operation of the cut-off operation in planetary movement exteriorly around a stationary workpiece. And it will be seen that in such operation in which the tool revolves in planetary motion around the workpiece, while spinning on its own axis, highly improved cutting is obtained with a smaller cutting wheel under more economical control.

While as shown above the mechanism operates for planetary cutting off and related operations such as contouring, abrading, polishing and analogous work it is desirable to employ mechanism for automatic feed of the tool such as cut-off wheel toward or into the work. A variety of types of such mechanisms are available and will be illustrated below.

Referring first to FIGURES 6 to 8, these illustrate a friction drive unit for progressively moving the tool toward the workpiece **5**, the latter as indicated above in connection with FIGURES 1 to 4 being a tubular member. Threaded shaft **25** is placed on face **9** of turret **7** in a direction radial to the axis of the turret, shaft **25** being mounted in bearing **26** at one end and in bearing **27** at the other. Shaft **25** carries conical member **28** fixedly mounted thereon to turn with shaft **25**, while nut **29** is mounted on shaft **25** close enough to element **9** of turret **7** so that rotation of shaft **25** will advance nut **29**. Conical member **28** engages frictionally against conical pulley **30** mounted on turret **7**, for rotation thereon, by belt **31** running over pulley **32** operated from gear box **3**. Here the lever in the form of bellcrank **33** has arm **34** provided with opening **35** which embraces nut **29**. The other arm **36** of the bellcrank carries cutter wheel **17** thereon.

In this arrangement, power is taken off the output shaft of the gear reducer to an adjustable speed drive unit so that the output speed can be varied while the input speed is constant. As illustrated above, belt **31** drives conical pulley **30** which frictionally moves conical member **28**. The latter rotates shaft **25** which advances nut **29**. The latter moves bellcrank **33** so that wheel **17** is fed toward workpiece **5**. The rate of feed can be varied by varying the adjustable speed unit. After a cut is completed the drive motor is reversed to return the cut-off wheel to its former position ready for the next cut. Alternatively, the friction faces may be replaced with bevel gears to provide positive drive as shown in FIGURE 7*a*, which is exactly like FIGURE 7 except that conical member **28** is replaced by bevel gear **28a** and conical pulley **30** is replaced by conical gear **30a** meshing with bevel gear **28a**.

Referring now to FIGURES 9 and 10, these illustrate the utilization of a star-wheel drive mechanism. Axially rotatable threaded shaft **40** is mounted in bearings **41**, **42** on turret **7** in a direction radial to the axis of the turret shaft **40**. Nut **43** closely adjacent element **9** of turret **7** is movable on shaft **40** upon axial rotation of the latter. Star wheel **44** is fixedly attached on shaft **40** so that its rotation will move shaft **40** and advance nut **43**. Indexing pin **45**, is mounted on the case of motor **2**. Arm **46** of bellcrank **47** has opening **48** which embraces nut **43**, the other arm **49** of bellcrank **47** carrying cutter wheel **17** pivoted thereon.

This type of arrangement is analogous to that of the preceding friction drive feed except that the conical friction drive members and the adjustable speed drive unit are not used, and the actuating screw shaft is driven by means of the star wheel. At each revolution of the turret the star wheel is actuated by means of the indexing pin which latter advances the star wheel the distance between teeth. Otherwise the structure is the same as in FIGURES 6–8.

Now, referring to FIGURES 11 to 13, these illustrate the utilization of a pressure fluid cylinder and piston actuated feed of the tool. Lever **50** is pivoted at **51** on turret face **9** and outer end **52** of lever **50** is pivotally connected to piston **53** actuated by fluid pressure cylinder **54**, the latter being rigidly mounted on turret face **9**. Cutter wheel **17** is pivotally mounted on lever **50** between the ends thereof, so that movement of lever **50** by controlled fluid pressure operation in cylinder **54** will move tool **17** to and from the workpiece. Any appropriate type of conventional revolving gland or joint **55** may serve as a source of air for these purposes, to bring air to and from the cylinder from an outside source.

FIGURE 13 illustrates the one form of valve control of the air, using a four-way valve to the air supply (not shown) and cylinder **54**. The valve controls air flow to each side of the piston in the cylinder to feed the cutting wheel toward the workpiece or to retract it at the end of the cutting operation. Compressed air enters at **56** to four-way valve **57** controlled by a handle which in one position **58** feeds air to move the cutting wheel into contact with the work for cutting, while in the other position **59** feeds air to produce retraction of the cutting wheel from the workpiece. The air connecting lines **60** and **61** serve to carry the air to and away from air passages **62** and **63** in the usual type of revolving packing association, the passages then connecting one to each end of cylinder **54**.

While air operated mechanism is illustrated, other pneumatic arrangements may be used and hydraulic or other liquid pumps may also be used.

Referring now to FIGURES 14 to 16, these illustrate the external polishing machine in which it may be briefly first explained that an idler pulley and stud assembly are added to the turret face and an abrasive belt threaded around pulleys and into contact with the workpiece. Where polishing is limited to an area equal to the width of the belt, the workpiece is clamped against movement while the turret revolves about the work and the belt is moving in polishing contact across the work. It may be said that the polishing belt assembly describes a planetary movement around the workpiece at the same time that it polishes across it. But there is no progressive movement of the belt along the workpiece.

However where polishing action is desired along a length of workpiece greater than the width of the polishing belt, the workpiece may be mounted for movement forwardly on the horizontal member desirably at a predetermined rate so that its entire surface is polished by the belt as the assembly revolves about it.

In FIGURES 14 to 16, the same structure as in FIGURES 1 to 3 is employed insofar as there is a base support for the motor which latter is coupled to a gear reducer. Also the tubular member is supported above and on the base, and said tubular member may carry the chuck of conventional design for holding the workpiece stationary if the piece is not to move during polishing. Where the piece is to move forwardly during polishing, any conventional mechanism for moving it forwardly may be used. Thus as illustrated in FIGURE 14, motor **70** pivot-mounted at **71** drives feed pulley **72** that urges workpiece **5** forwardly, the workpiece moving over idling pulley **73**. Such forward movement may be continuous or intermittent. As in FIGURE 1, turret **7** is mounted for revolution on horizontal member **4**, turret **7** having face portion **9** on which the polishing attachment is placed, as described below. As in FIGURE 1 turret **7** is powered by means of the belt and pulley on the slow speed shaft of the gear reducer **3**. Sheave or pulley **13** is mounted, as in FIGURE 1, for rotation on tubular member **4** and is driven by belts **14** from the driving pulley on the high speed or input shaft of the gear reducer.

For polishing, stud assembly **60** including driving pulley **61** is mounted for belt driving rotation on stated turret face **9** and idler pulley **62** is pivot-mounted and spring-loaded on turret face **9** so that abrasive belt **63** may be threaded around the pulleys and workpiece **5** as shown. The power connections for polishing for revolution of the turret and sheave are the same as in FIGURE 1, but in the machine of FIGURE 14, revolution of sheave **13** (FIGURE 1) is connected to cause revolution of driving pulley **61** so that the belt travels in polishing motion across the surface of the workpiece, while revolution of the turret carries the polishing assembly circumferentially around the workpiece. As shown in dotted lines in FIGURE 14, the belt may be moved into retracted position when the workpiece is being fed forward prior to the start of the polishing operation.

Any of the machines and methods set forth above, may use a single source of power as illustrated, or multiple sources of power may be employed as for operation of turret and tool.

Having thus set forth the invention, what is claimed is:

A polishing machine for operating on a workpiece having an axial center by a planetary moving polishing tool, said machine including a base, a horizontally disposed tubular member supported on said base against movement thereon, adjustable chuck means associated with said tubular member for holding a workpiece therein, a turret member carried on said tubular member for rotation thereon in a plane fixed angularly with respect to said chuck means, said turret member having a face portion, a lever mounted on a lever pivot on one side of said face portion only, for reciprocating movement of the lever toward and away from said tubular member, a polishing tool mounted directly on said reciprocating lever, means mounted on the face portion of said turret member for progressively moving said polishing tool inwardly toward said tubular member to polish said workpiece, power means for rotating said turret member upon said tubular member, power means for rotating said polishing tool, whereby planetary movement of the polishing tool around the workpiece proceeds while the polishing tool rotates on its axis and revolves with said turret member; in which power is transmitted to the means on the turret for progressively moving the tool through a friction drive mechanism.

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