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MULTI-SPINDLE PORTABLE POWER-OPERATED TOOL

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Fig. 1.

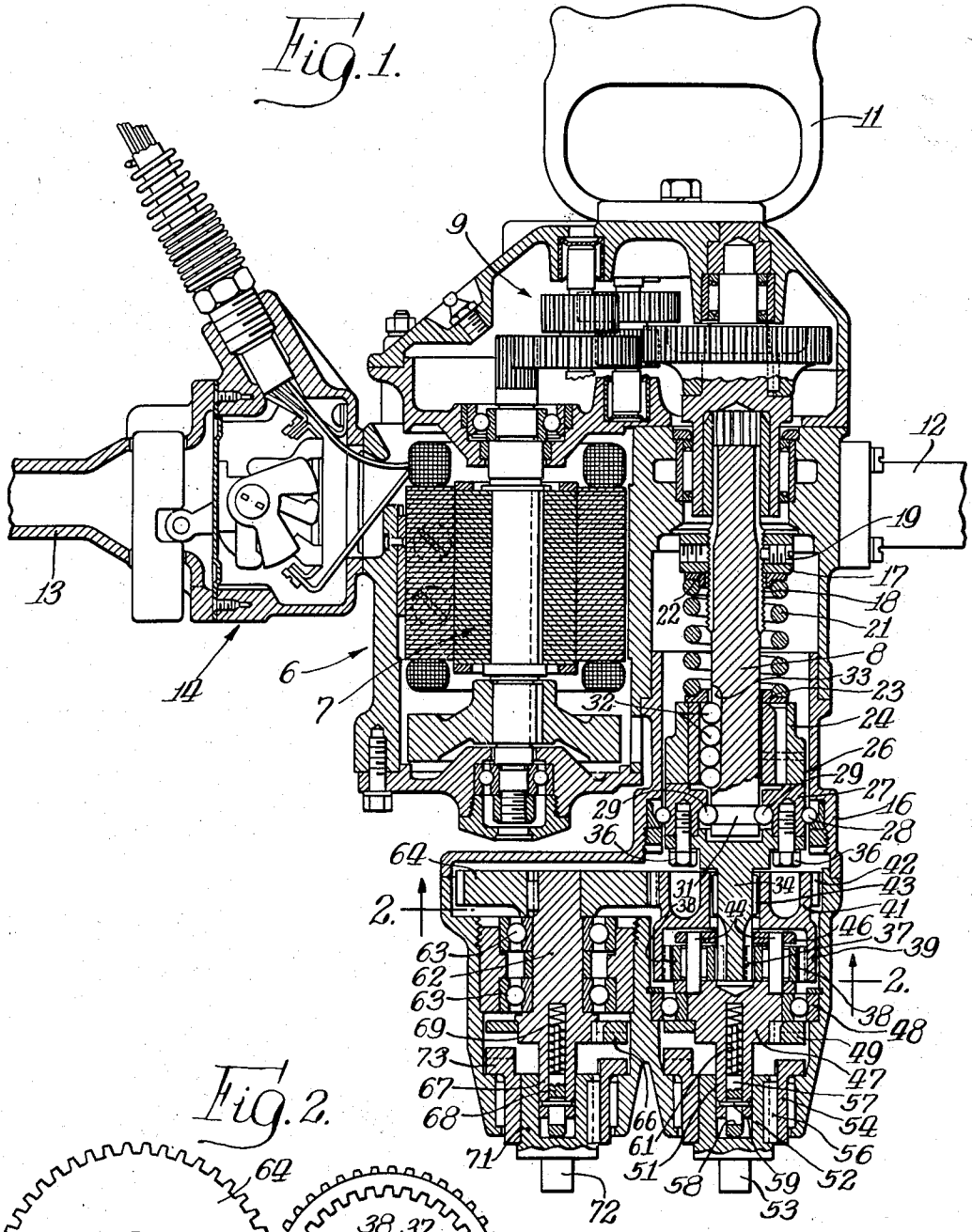
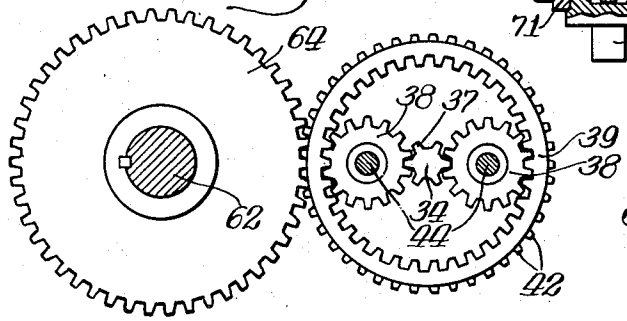


Fig. 2.



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MULTI-SPINDLE PORTABLE POWER-OPERATED TOOL

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10 Claims. (Cl. 74—665)

This invention relates generally to portable power-operated rotary tools, and more particularly to tools such as nut setters, screwdrivers or the like.

The general object of the invention is to provide a novel tool of the foregoing character having two or more work-driving spindles and arranged to apply equal torque through each spindle, the tool being provided with a kick-out device to disconnect the drive after a predetermined torque resistance is encountered by all of the spindles.

Another important object is to provide a double spindle tool of the foregoing character having novel drive means for the two spindles which permits the drive to either spindle to continue after the other spindle has been stopped by a predetermined torque resistance, the drive means being of a character which provides a gear reduction so that the spindles will operate at reasonable speeds.

An additional object of the invention is to provide a novel multiple spindle tool of the character described in the preceding object but also having releasable positive clutch means associated with each of the spindles so as to facilitate releasing and removal of the tool from the nuts, screws, or other fastening elements.

A further object of the invention is to provide a novel double spindle tool of the foregoing character for simultaneously driving two threaded securing members such as nuts, screws or the like, the tool being adapted to seat both members under equal torque regardless of whether the number of turns required to seat one member differs from the number of turns required for the other member.

Other objects and advantages of the invention will become apparent from the subsequent detailed description taken in conjunction with the accompanying drawing wherein:

Fig. 1 is a longitudinal sectional view through an electrically actuated portable nut setter of the double spindle type comprising one specific embodiment of my invention; and

Fig. 2 is a transverse sectional view taken substantially along the line 2—2 of Fig. 1.

Broadly speaking, my invention involves the use of a drive mechanism comprising a planetary gear transmission interposed between the main drive shaft of the tool and a plurality of work-driving spindles. By means of the drive mechanism, as hereinafter described in detail, each of the work-driving spindles is driven to the same predetermined torque resistance. In other words, when one of the work-driving spindles stops upon encountering slight frictional resistance, the remaining spindles continue to be driven until all the spindles encounter the same slight frictional resistance and thereafter all of the spindles are again driven simultaneously. The main drive means for the tool is provided with a kick-out clutch for disconnecting the drive after all of the work-driving spindles have encountered the same pretermined torque resistance.

Although the invention is hereinafter described in connection with a double spindle nut setter, it is to be understood that by utilizing a plurality of drive mechanisms of the character herein disclosed, the invention is equally adaptable to a tool having more than two work-driving spindles. For example, a three spindle tool would require two such drive mechanisms and a four spindle tool would utilize three drive mechanisms. Also, the principle of my invention may be utilized in tools other than nut setters, e.g. screwdrivers, or the like.

Referring now to the drawing, the invention is illustrated in connection with a double spindle nut setter of the electrically actuated type comprising a tool housing 6 containing an electric motor 7, a main drive shaft 8 parallel to the motor axis, and a plurality of interconnected gears 9 for providing the usual driving connections between the motor 7 and the drive shaft 8 of the tool. Suitable handle members 11 and 12 are attached to the body of the tool, and a movable handle member 13 is also provided to actuate a control switch 14 for starting and stopping the motor. It will be understood that the details of the motor 7, the gear connections 9, and the switch mechanism 14 do not constitute any part of the present invention and, therefore, do not require any further explanation.

The main drive shaft 8 extends downwardly from its driving connection with the motor 7 into the upper portion of a combined clutch and drive mechanism housing 16. An adjusting nut 17 is secured around a threaded portion 18 of the shaft 8 and carries a set screw 19 for locking the nut in any desired position on the shaft 8. A relatively heavy coil spring 21 surrounds the shaft 8 and coacts at its upper end with the nut 17, a thrust collar 22 being interposed therebetween. The lower end of the spring 21 bears against a similair thrust collar 23 which is disposed against a movable clutch element 24 of a kick-out clutch designated generally by the reference numeral 26. A companion clutch element 27 is mounted in cooperating relation below the clutch element 24 and is supported within the housing 16 by means of a ball type radial and thrust bearing 28. Axial movement of the clutch element 27 relative to the drive shaft 8 is prevented by means of a plurality of retaining balls 29 which coact with the clutch element 27 and a grooved portion 31 adjacent the lower end of the shaft 8. The upper clutch element 24 is mounted for rotation with the shaft 8 by means of a splined connection comprising a plurality of balls 32 which extend into a suitable groove in the clutch element 24 and also into a cooperating longitudinal groove 33 in the shaft 8. As will be evident from the drawing, the groove 33 in the shaft 8 is of sufficient extent axially of the shaft to permit a limited degree of axial shifting movement of the clutch element 24 along the shaft 8 and against the tension of the spring 21. It will be seen that by adjusting the position of the nut 17, the tension of the spring 21 can readily be regulated.

A drive spindle or driven member 34 in coaxial relation with the shaft 8 is rigidly fastened by means of a plurality of screws 36 to the clutch element 27 for rotation with the latter, the drive spindle 34 being operatively connected through a drive mechanism to the multiple work-driving spindle arrangement described hereinafter. Normally, the clutch elements 24 and 27 of the kick-out clutch 26 are held in operating engagement by the action of the spring 21 which urges the shiftable clutch element 24 toward the companion clutch element 27 to provide the desired driving connection between the shaft 8 and the spindle 34. However, when the drive spindle 34 encounters a predetermined torque resistance, the coacting portions (not shown) of the clutch elements 24 and 27 cooperate to effect a rearward axial shifting of the

clutch element 24 against the action of the spring 21 so that the normal engagement with the clutch element 27 is disrupted. Thus, the driving connection between the main drive shaft 8 of the tool and the drive spindle 34 is temporarily interrupted so that the nuts, screws, or other fastening devices are tightened or driven to the desired degree of tightness and no further. Any of the de-clutching arrangements well known in the kick-out clutch art may be incorporated in the clutch elements 24 and 27 in order to obtain the desired interruption of the main driving connection, and such structural details form no part of the present invention. For example, the kick-out clutch 26 may conveniently be of the type disclosed in the Levedahl Patent No. 1,744,976 wherein the shiftable clutch element is disengaged from its companion element for approximately one complete revolution of the clutch member by means of a ball cam arrangement. If the tool is not withdrawn from the work by the operator at the completion of this single revolution of the clutch member, the clutch elements are momentarily re-engaged and are again separated by the cam arrangement for another complete revolution. This sequence is repeated until the tool is withdrawn from the work.

As hereinbefore briefly mentioned, the lower part of the housing 16 contains a drive mechanism of the planetary type including a sun gear element, one or more planet gear elements, and a ring gear element assembled in the usual operating relation. The main drive shaft 8 of the tool is connected to one of the planetary elements and the work-driving spindles of the tool are respectively connected to the other planetary elements. Thus, in the embodiment of the invention illustrated herein, a sun gear or pinion 37 is integrally formed on the lower end of the drive spindle 34, and a pair of planet gears or pinions 38 are disposed in operative engagement around the sun gear 37. A ring gear 39 extends concentrically around the sun gear 37 and has its inwardly projecting teeth in operative engagement with the planet gears 38. The ring gear 39 is also provided with an integral upper portion 41 having circumferentially arranged and outwardly projecting gear teeth 42, the entire ring gear being rotatably mounted for movement relative to the drive spindle 34 by means of a needle bearing indicated at 43.

The planet gears 38 are mounted for rotation about a pair of axial pins 44, the pins 44 and the gears 38 being disposed in a pair of recesses 46 in the head or planet carrier portion of a first work-driving spindle 47 which is coaxial with the shaft 8 and the spindle 34. As will be readily understood, rotation of the spindle 47 is effected in response to orbital movement of the planet gears 38 about the sun gear 37. The work-driving spindle 47 is mounted in a bearing unit 48 secured within the casing 16, and a clutch element 49 is keyed to the spindle 47 for rotation therewith. A tubular projection 51 depends from the spindle 47 for operatively mounting a complementary shiftable spindle portion 52 having a square drive 53 adapted to mount a socket, screwdriver, or other tool member. A clutch element 54 is rigidly fastened to the spindle portion 52 by a key 56 so that upon axial sliding movement of the spindle portion 52 on the tubular extension 51 of the spindle 47, engagement and disengagement of the clutch element 54 with the clutch element 49 may be readily effected. A guide pin 57 having a slot 58 is operatively disposed within the bore of the tubular extension 51 and is retained therein by means of a transverse rivet 59 extending through the tubular extension 51 and the slot 58 whereby to permit limited relative movement between the pin 57 and the tubular extension 51. A compression spring 61 disposed within the bore of the tubular extension 51 coacts through the guide pin 57 with the shiftable spindle portion 52 whereby the clutch elements 54 and 49 are normally retained in disengaged relation. However, it will be seen that when

the operator presses the tool axially against the work, the spindle portion 52 will be urged rearwardly against the action of the spring 61 for engaging the clutch elements 54 and 49 in order to provide a continuous driving connection from the main drive shaft 8 through the drive spindle 34, the work-driving spindle 47, and the spindle portion 52 to tighten the nut or other fastening element.

In a laterally extending portion of the casing 16, a second work-driving spindle 62 is rotatably mounted by bearing units 63 on an axis parallel to the axis of the first work-driving spindle 47. A driving connection to the spindle 62 is provided by means of a gear 64 secured at the upper end of the spindle 62 and meshed with the external teeth 42 on the upper portion 41 of the ring gear, a gear reduction preferably being provided therebetween. A non-shiftable clutch element 66 is keyed to the spindle 62, and the latter is also provided with a depending tubular extension 67 containing a slotted guide pin 68 and a compression spring 69 just as in the case of the first-described work-driving spindle. An axially shiftable spindle portion 71 having a square drive 72 and having keyed thereto a clutch element 73 is likewise mounted on the tubular extension 67 as in the previously described first work-driving spindle.

The pairs of clutch elements 54—49 and 66—73 as described above constitute in effect a releasable positive clutch for each of the work-driving spindles, each clutch being operatively engageable in response to manually exerted axial pressure of the tool against the work and each clutch being disengaged when such manual pressure is released. It will be apparent that this arrangement permits the tool members carried on the drives 53 and 72 to be easily engaged with the fastening elements without stopping the tool motor. However, the provision of a releasable positive clutch for each work-driving spindle has the additional advantage of facilitating rapid and easy disengagement of the tool from the work. In multiple spindle tools there is frequently noted a tendency for the sockets or other tool members to be clamped to the nuts, screws, or other fastening elements upon completion of the tightening operation so that removal or release of the tool from the work is often difficult. It is possible that a drive mechanism involving a gear reduction, such as in a planetary system, may contribute to this difficulty, but by interposing releasable positive clutches between the spindles and the drive mechanism, I am able to overcome this objectionable tendency toward clamping or sticking. In other words, as soon as the fastening elements are all tightened to the same degree as evidenced by the operation of the kick-out clutch 26, the operator can then release axial pressure of the tool against the work whereupon the releasable positive clutches 54—49 and 66—73 are automatically disengaged and the spindle portions 52 and 71 are freed from all torque conditions so that the tool can be easily removed from the work.

From the foregoing description it will be seen that in the preferred embodiment of the invention the main drive shaft of the tool is operatively connected through a kick-out clutch to the sun gear of the planetary gearing. One of the pair of work-driving spindles is mounted coaxially with the main drive shaft and drive spindle and has a driving connection with the planet gears, while the other work-driving spindle has a driving connection through a ring gear. Thus, when one of the fastening elements being driven by the work-driving spindles is tightened sufficiently to produce a slight frictional resistance, operation of this spindle ceases and by reason of the drive mechanism described the operation of the other spindle continues at a faster rate until its fastening element is tightened to an equal extent. Thereafter the torque is equally distributed and both spindles operate until both fastening elements are tightened to the same predetermined extent and both work-driving spindles encounter the same predetermined torque re-

sistance. Thereupon the kick-out clutch **26** is actuated and the driving connection between the main drive shaft **8** and the drive spindle **34** is disrupted.

It will be seen that my invention provides a multi-spindle tool by means of which a plurality of fastening elements can be tightened to the same predetermined torque resistance whereupon the main drive of the tool is disconnected. Consequently, all of the fastening members such as nuts, screws or the like are tightened under equal torque regardless of whether the number of turns required to seat one fastening element differs from the number of turns required for any of the other fastening elements. It will readily be understood that the combination of the kick-out clutch with the planetary drive provides a highly effective and compact operating arrangement adapted to handle any possible combination of equal or unequal tightening requirements of the plurality of fastening elements.

Another important feature of the invention resides in the fact that the planetary gear arrangement provides a substantial gear reduction between the main drive shaft **8** and the work-driving spindles so that the latter are always operated at reasonable speeds. Because of the fact that this gear reduction is disposed between the kick-out clutch **26** and the work-driving spindles, it is possible to operate the main drive shaft **8** at a greater speed and under less load with the result that the kick-out clutch has an increased life or, in some cases, even a lighter clutch can be used than would normally be required. Thus, the combination of the drive mechanism with the gear reduction feature provides substantial advantages not previously available in multi-spindle tools of this general type. In addition, the provision of releasable positive clutches for each of the work-driving spindles overcomes any possible effect of the gear reduction arrangement on the releasability of the tool from the work.

Although the invention has been described herein with particular reference to a preferred structural embodiment, it will be understood that other modifications and alternative constructions may also be resorted to without departing from the scope of the invention as defined in the appended claims.

I claim:

1. In a power-operated rotary tool, a driven member, planetary gearing comprising a sun gear, a planet gear, and a ring gear, said driven member being connected to one of said gears, a pair of spindles having their axes parallel and transversely spaced and being respectively connected to the other two gears, a pair of tool-supporting and driving elements mounted on the respective spindles, said planetary gearing providing a reduction in speed between said driven member and said elements, and clutch means for operatively engaging said elements with the spindles on relative axial movement therebetween.

2. A power-operated rotary tool comprising a motor having a motor shaft, a driven member disposed on an axis parallel to and spaced from the motor shaft, gear means operatively interconnecting said motor shaft and said driven member, planetary gearing including a sun gear connected to said driven member, a planet gear, and a ring gear, a first spindle disposed coaxially with said driven member and carrying said planet gear, a second spindle having its axis parallel to and spaced from the axis of said first spindle, a pair of intermeshing gears respectively connected to said second spindle and to said ring gear and providing a driving connection therebetween, and a pair of tool-supporting and driving elements mounted on the respective spindles.

3. A power-operated rotary tool comprising a motor having a motor shaft, a drive shaft disposed in parallel side-by-side relation with said motor shaft, gear means interconnecting said motor shaft and one end of said drive shaft, a driven member extending coaxially at the opposite end of said drive shaft, spring clutch means normally connecting said drive shaft and said driven member, planetary gearing including a sun gear connected to said driven member, a planet gear, and a ring gear, a first spindle disposed coaxially with said driven member and carrying said planet gear, a second spindle having its axis parallel to and spaced from the axis of said first spindle, a pair of intermeshing gears respectively connected to said second spindle and to said ring gear and providing a driving connection therebetween, and a pair of tool-supporting and driving elements mounted on the respective spindles, said clutch means being disengageable when the torque resistance for both spindles exceeds a predetermined value but remaining engaged when the torque resistence of only one spindle exceeds such value and said planetary gearing providing a reduction in speed between said driven member and said elements whereby to diminish the wear on said clutch means.

4. In a power-operated rotary tool, a driven member, planetary gearing comprising a sun gear mounted on said driven member, planet gears, and a ring gear, a first spindle carrying said planet gears and driven thereby, a second spindle having its axis parallel to and transversely spaced from the axis of said first spindle and having a driving connection with said ring gear, a pair of tool-supporting and driving elements mounted on the respective spindles, said planetary gearing providing a reduction in speed between said driven member and said elements, and clutch means for operatively engaging said elements with the spindles on relative axial movement therebetween.

5. In a power-operated rotary tool, a power-operated drive shaft, a driven member, a spring clutch normally connecting said drive shaft and said driven member, a planetary gearing comprising a sun gear driven by said driven member, a planet gear, and a ring gear, a pair of spindles having their axes parallel and transversely spaced and being respectively connected to said planet gear and to said ring gear, and a pair of tool-supporting and driving elements mounted on the respective spindles, said clutch being disengageable when the torque resistance for both spindles exceeds a predetermined value but remaining engaged with the torque resistance of only one spindle exceeds such value and said planetary gearing providing a reduction in speed between said driven member and said elements whereby to diminish the wear on said clutch.

6. In a power-operated rotary tool, a power-operated drive shaft, a driven member, planetary gearing comprising a sun gear connected to said driven member, planet gears, and a ring gear, a pair of spindles having their axes parallel and transversely spaced and being respectively connected to said planet gears and to said ring gear, said planetary gearing when one spindle is stopped by a predetermined torque resistance being adapted to continue to drive the other spindle until the latter encounters an equal torque resistance, a pair of tool-supporting and driving elements mounted on the respective spindles, and disengaging clutch means normally providing a driving connection between said drive shaft and said driven member and releasable by the torque resistance to said driven member caused by the torque resistances of both of said spindles, said planetary gearing providing a reduction in speed between said driven member and said elements whereby to diminish the wear on said clutch means.

7. In a power-operated rotary tool, a driven member, planetary gearing comprising a sun gear, a planet gear, and a ring gear, said driven member being connected to one of said gears, a pair of spindles having their axes parallel and transversely spaced and being operatively connected to the other two gears, a pair of tool-supporting and driving elements mounted on the respective spindles, said planetary gearing providing a reduction in speed between said driven member and said elements,

and releasable positive clutch means interposed between said spindles and said other two gears, said clutch means being operatively engageable for driving the spindles in response to axial pressure of the tool against the work and being disengageable upon release of said pressure.

8. In a power-operated rotary tool, a driven member, planetary gearing comprising a sun gear mounted on said driven member, a planet gear, and a ring gear, a first spindle connected to said planet gear, a second spindle having its axis parallel to and transversely spaced from the axis of said first spindle and having a driving connection with said ring gear, a pair of tool-supporting and driving elements mounted on the respective spindles, said planetary gearing providing a reduction in speed between said driven member and said elements, and releasable positive clutch means interposed respectively between said first spindle and said planet gear and between said second spindle and said ring gear, said clutch means being operatively engageable for driving the spindles in response to axial pressure of the tool against the work and being disengageable upon release of said pressure.

9. A power-operated rotary tool comprising a motor, a driven member, gear means connecting said motor with said driven member and providing a reduction in speed therebetween, planetary gearing including a sun gear connected to said driven member, a planet gear, and a ring gear, a first spindle carrying said planet gear and driven thereby, a second spindle having its axis parallel to and transversely spaced from the axis of said first spindle and having a driving connection with said ring gear, and a pair of tool-supporting and driving elements mounted on the respective spindles, said planetary gearing providing a further reduction in speed between said driven member and said elements.

10. In a power-operated rotary tool, a power-operated drive shaft, a driven member, a spring clutch normally connecting said drive shaft and said driven member, planetary gearing comprising a sun gear driven by said driven member, a planet gear, and a ring gear, a pair of spindles having their axes parallel and transversely spaced and being respectively connected to said planet gear and to said ring gear, a pair of tool-supporting and driving elements mounted on the respective spindles, said spring clutch being disengageable when the torque resistance for both spindles exceeds a predetermined value but remaining engaged when the torque resistance of only one spindle exceeds such value and said planetary gearing providing a reduction in speed between said driven member and said elements whereby to diminish the wear on said spring clutch, and releasable positive clutch means interposed between the respective spindles and the planet gear and ring gear connected thereto, said positive clutch means being operatively engageable for driving the spindles in response to axial pressure of the tool against the work and being disengageable upon release of said pressure.

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