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POWER-OPERATED TOOL HAVING TWO-SPEED ROTARY OUTPUT
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ABSTRACT OF THE DISCLOSURE
A power-operated tool including a pair of alternatively engageable clutches which, when alternatively engaged, transmit different speed rotation to a driven element, and resilient means operable to cause alternative engagement of the clutches.

Background of the invention
The present invention relates to power-operated tools and more particularly to power-operated tools, such as pneumatic and electric hand tools, of the type providing a two-speed rotary output.

Conventionally, power-operated hand tools of the type providing a two-speed rotary output generally have been subject to several deficiencies and disadvantages. More specifically, the speed change means of these conventional tools have been usually subjected to extreme wear during their operation. In addition, the speed change means employed in these conventional tools have been relatively expensive, complex, and unsatisfactorily large.

The principal object of the present invention is to provide a power operated tool including new and improved speed change means, adapted to provide the tool with a two-stage rotary output, which are particularly constructed and arranged to overcome the aforementioned deficiencies and disadvantages.

Summary of the invention
The aforesaid object, and those other objects and advantages of the invention which will be apparent from the following description taken in connection with the accompanying drawings, are attained by the provision of a power-operated tool comprising a driving means, a first driving clutch jaw connected to the driving means to be rotated thereby at a first speed, and a second driving clutch jaw connected to the driving means to be rotated thereby at a second speed different from the first speed.

A rotatable driven element, adapted to rotatably drive a working implement, is connected to a first driven clutch jaw and to a second driven clutch jaw for rotation with these driven clutch jaws. The first driven clutch jaw is adapted for engagement with the first driving clutch jaw; and the second driven clutch jaw is adapted for engagement with the second driving clutch jaw. A resilient means, operable for causing alternative engagement of the first driven and driving clutch jaws and the second driven and driving clutch jaws, respectively, is provided for alternatively engaging such clutch jaws to thereby cause the driven element to be alternatively rotated at the aforementioned first and second speeds.

Brief description of the drawings
FIG. 1 is an external elevational view of a power-operated hand tool including an embodiment of the present invention;
FIG. 2 is an enlarged elevational view, partially broken away and in section, of the forward end of the barrel of the hand tool illustrated in FIG. 1 and showing the driven element being driven through the first driven and driving clutch jaws;
FIG. 3 is a fragmentary elevational view generally similar to FIG. 2, but illustrating the driven element being driven through the second driven and driving clutch jaws;
FIG. 4 is a sectional view taken on line 4—4 of FIG. 2, looking in the direction of the arrows;
FIG. 5 is a sectional view taken on line 5—5 of FIG. 2, looking in the direction of the arrows;
FIG. 6 is a sectional view taken on line 6—6 of FIG. 2, looking in the direction of the arrows; and
FIG. 7 is a fragmentary elevational view of an alternative construction of the second driven and driving clutch jaws.

Brief description of the preferred embodiment
Referring more particularly to the drawings wherein similar reference characters designate corresponding parts throughout the several views, FIG. 1 illustrates a power-operated hand tool designated generally as 10 which comprises a housing or casing formed to include an elongated barrel 12 and a handle 14 depending from the barrel 12. The barrel 12, as indicated in FIG. 1, includes a rearward end 12a and a forward end 12b. Similarly, it will be understood that, in the following description of the tool 10, the forward end of a tool component disposed within the barrel 12 shall be that end of the component most adjacent the barrel forward end 12b, and the rearward end of such tool component shall be that end most adjacent the barrel rearward end 12a.

Although the tool 10 could be pneumatically, electrically, or otherwise suitably powered without departing from either the spirit or the scope of the present invention, it has been illustrated as being powered by a conventional, vane-type, pneumatic motor which is designated generally as 16. The pneumatic motor 16 is disposed within the barrel 12 and comprises a rotor 18 which carries a plurality of vanes and includes an integral, shaft-like extension 20 projecting from each of its opposing ends. The pneumatic motor 16, as will be understood, is connected in a conventional manner to receive pressurized air upon the manual actuation of the trigger 22 which is slidably mounted on the handle 14.

The shaft-like extension 20 is projecting from the forward end of the rotor 18 is connected to an aligned driving shaft 24 such that the pneumatic motor 16 rotatably drives the driving shaft 24 at a speed reduced from the speed of the rotation of the rotor 18. More particularly, as illustrated in FIG. 4, the forward end of such shaft-like extension 20 is provided with circumferential gear teeth 26 which are in meshing engagement with gear teeth 28 circumferentially formed on a pair of driven gears 30 positioned on opposing sides of such shaft-like extension 20. The gear teeth 28 of the driven gears 30 are also in meshing engagement with gear teeth 32 which are integrally formed on the inner surface of the stationary barrel 12 circumferentially around the aforementioned shaft-like extension 20. The driven gears 30, moreover, are rotatably mounted upon individual supporting pins 34 which are carried by the rearward end of the driving shaft 24. The gear teeth 26, the driven gears 30, and the gear teeth 32 thus, as will be understood, cooperate to provide an epicyclic or planetary gearing system for reducing the speed of the rotation transmitted to the driving shaft 24.

The driven or output element of the tool 10 is designated generally as 36 and includes a body 38 and a square drive spindle 40 which is formed integrally with the body 38 and which projects from one end of the latter. The drive spindle 40 is of conventional construction and suited for carrying a working implement such as a conventional socket adapted for rotatably driving a workpiece such as a fastener or the like. The body 38 is mounted.
in an opening 42 formed in the forward end 12a of the barrel 12, with the drive spindle 40 forwardly of the forward end 12a, for rotation and axial slide movement relative to the barrel 12. The rearward end of the body 38 is formed with an enlarged diameter, annular wall 44 which internally defines a cavity 46. The body 38 includes an internally straight splined, axial bore 48 which, as illustrated in FIG. 2, communicates coaxially with the cavity 46.

The present invention, as applied to the illustrated tool 10, comprises the provision of new and improved means for transmitting dual speed rotation from the pneumatic motor 16 to the driven element 36 through the driving shaft 24. More particularly, the forward end of the driving shaft 24 is spline connected to an annular, first or inner driving clutch element 50 such that the latter is rotatable conjointly with the driving shaft 24. The inner driving clutch element 50 is axially retained on the driving shaft 24 by a retaining ring 56 and includes an integral, annular, first or inner driving clutch jaw, designated generally as 52, at its forward end. The inner driving clutch jaw 52, due to the aforementioned spline connection of the inner driving clutch element 50 to the driving shaft 24, is rotated at the speed of the rotation of the driving shaft 24 continuously throughout the rotation of the latter.

An annular supporting sleeve 54, rotatably mounted by ball bearings 68, 70, is positioned circumferentially around the driving shaft 24 for rotation relative to the latter. The driving shaft 24 is provided with circumferential gear teeth 58 which, as shown in FIG. 5, are in meshing engagement with gear teeth 60 circumferentially formed on a pair of driven gears 62 positioned on opposing sides of the driving shaft 24. The gear teeth 60 of the driven gears 62 are also in meshing engagement with gear teeth 65, formed integrally with the aforementioned gear teeth 52, which are located on the stationary barrel 12 circumferentially around the driving shaft 24. The driven gears 62, moreover, are rotatably mounted upon individual supporting pins 64 which are supported at their opposing ends by the supporting sleeve 54. From the foregoing, it will be seen that the gear teeth 58, the driven gears 62 and the gear teeth 65 cooperate to provide a hydraulic or planetary gearing system for reducing the speed of the rotation transmitted from the driving shaft 24 to the supporting sleeve 54.

The annular, second or outer driving clutch element 72 is spline connected to the forward end of the supporting sleeve 54 for conjointed rotation with the latter and is axially retained upon the supporting sleeve 54 by a retaining ring 74. The outer driving clutch element 72 is constructed to include an integral, annular second or outer driving clutch jaw, designated generally as 76, which projects towards the driven element 36 and extends circumferentially around the inner driving clutch jaw 52 in spaced relationship to the latter. Due to the aforementioned spline connection of the outer driving clutch element 72 to the supporting sleeve 54, the outer driving clutch jaw 76 is rotated continuously throughout the rotation of the driving shaft 24 at a speed reduced from the speed of the rotation of the driving shaft 24.

A support or supporting shaft 78, provided with axially extending, straight splines 80 substantially throughout its length, is spline connected at one end in the bore 48 in the body 38 of the driven element 36. The opposing end of the supporting shaft 78, as illustrated in FIG. 2, includes an integral, axially extending, reduced diameter, mounting pin 82 which is supported within a supporting bushing 84. The supporting bushing 84 is provided on the forward end of the driving shaft 24, such that the supporting shaft 78 and the driving shaft 24 may be simultaneously rotated at different speeds. An annular, first or inner driving clutch element 86 is spline connected to the latter mentioned end of the supporting shaft 78 such as to be axially movable on, but rotatable with, the supporting shaft 78. The inner driving clutch element 86 includes an integral, annular, first or inner driving clutch jaw, designated generally as 88, which has jaw teeth 88a adapted to interengage with the jaw teeth 52a of the inner driving clutch jaw 52 such that rotation may be transmitted from the driving shaft 24 to the supporting shaft 78 through the interengaging jaw teeth 88a, 52a. The jaw teeth 88a, 52a, moreover, are particularly constructed of an angled configuration such that, when the torque of the driven element 36 (and hence that of the supporting shaft 78) increases to a predetermined torque, the axial force generated by the interengaging jaw teeth 88a, 52a moves the inner driven clutch element 86 axially away from the inner driving clutch element 50, thus causing the jaw teeth 88a, 52a to be disengaged.

The axial movement of the inner driven clutch element 86 on the supporting shaft 78 is limited by the retaining rings 90, 92 which are rigidly carried by the supporting shaft 78 and, respectively, positioned forwardly and rearwardly of the inner driven clutch element 86. The retaining rings 90, 92 are arranged such that the axial movement of the inner driven clutch element 86 is limited to movement between a position, as shown in FIG. 2, wherein the inner driving clutch jaw 88 is in engagement with the inner driving clutch jaw 52 and a position, as illustrated in FIG. 3, wherein the inner driven clutch jaw 88 is out of engagement with the inner driving clutch jaw 52. An annular, second or outer driven clutch element 94 is spline connected to the supporting shaft 78, intermediate the retaining ring 90 and the driven element 36, for axial slideable movement on, and rotation with, the supporting shaft 78. The outer driven clutch element 94 includes an integral, annular, second or outer driven clutch jaw, designated generally as 96, which extends circumferentially around the inner driven clutch jaw 88 and has jaw teeth 96a adapted for interengagement with the jaw teeth 76a of the outer driving clutch jaw 76. The jaw teeth 96a, 76a, as illustrated in FIGS. 2 and 3, are each formed of an angled configuration generally similar to the construction of the aforementioned jaw teeth 88a, 52a of the inner driven and driving clutch jaws 88, 52, respectively. However, it will be understood that outer driven and driving clutch jaws having jaw teeth of either suitable or planet-gear system for reducing the speed of the rotation of the driving clutch jaws 96, 76. For example, FIG. 7 illustrates clutch jaws 112, 114, which, respectively, include square jaw teeth 112a, 114a that could be alternatively employed.

The outer driven clutch element 94 is axially movable on the supporting shaft 78 between a position as illustrated in FIG. 3, 80 by a retaining ring 100. The retaining ring 100 engages the outer driving clutch jaw 76 and a position, as illustrated in FIG. 2, wherein the outer driven clutch jaw 96 is out of engagement with the outer driving clutch jaw 76.

A resilient means is provided for causing alternative engagement of the inner driven and driving clutch jaws 88, 52 and the outer driven and driving clutch jaws 96, 76. This resilient means comprises a plurality of toggle springs 98, disposed in accurately spaced relationship between the inner and outer driven clutch elements 86, 94, which are each located at their opposing ends to the clutch elements 86, 94. More particularly, as illustrated in FIGS. 2 and 3, each of the toggle springs 98 includes a coiled end 100 which is retained within an arcuate recess 101 formed in the inner driven clutch element 86 and an opposing coiled end 102 which is retained within an arcuate recess 103 formed in the outer driven clutch element 94. The toggle springs 98 thus serve to connect the inner and outer driven clutch elements 86, 94 such that movement of either of the driven clutch jaws 88, 96 out of engagement with its respective one of the driving clutch jaws 52, 76 simultaneously, and automatically, moves the other of the driven clutch jaws 88, 96 into engagement with the other of the driving clutch jaws 52, 76. The toggle springs 98, furthermore, oppose the
axial movement of the inner driven clutch jaw 88 from the inner driving clutch jaw 52.

The drive element 36 is biased from the outer driven clutch element 94 by a relatively light coil spring 104, loaded in in a 46 cc circumferentially around the supporting shaft 78, which is arranged such that its opposing ends engage the body 38 and an annular seal plate 106 rigidly mounted upon the supporting shaft 78. The annular wall 44 of the driven element 36 is, of course, constructed of suitably enlarged dimensions to prevent the coil spring 104 from coming in engagement with the inner driven element 36 from the tool 10. The rearward end of the annular wall 44 and the forward end of the outer driven clutch element 94 include annular portions 116, 118, respectively, arranged to cause rearward movement of the drive element 36 (i.e., movement of the driven element 36 against the coil spring 104) to provide continual rearward movement of the outer driven clutch element 94. The extent of the rearward movement of the driven element 36 is, however, limited to movement to a position wherein, as illustrated in FIG. 2, the coil spring 104 is fully compressed; and the outer driven and driving clutch jaws 96, 52 are suitably spaced such that the rearward movement permitted by the coil spring 104 is not sufficient to cause engagement of the clutch jaws 96, 52. Thus, as will be seen, engagement by a socket or other working implement carried by the square drive 40 with a workpiece moves the outer driven clutch element 94 rearwardly to a cocked or set position, but does not engage the clutch jaws 96, 52.

The annular wall 44, furthermore, carries an annular plate 108 which is adapted for engagement with an annular projection 110 formed circumferentially around the front of the outer driven clutch element 94 such that, with the outer driven and driving clutch jaws 96, 52 in engagement as shown in FIG. 3, forward movement of the driven element 36 draws the outer driving clutch element 94 forwardly to disengage the clutch jaws 96, 76.

In the operation of the tool 10, the rotor 18 is rotated in a conventional manner by pressurized air which is supplied to the pneumatic motor 16 upon the manual actuation of the trigger 22. The shaft-like extension 20 projecting from the forward end of the rotor 18 cooperates with the reduction gearing system formed by the gear teeth 26, 32 and the driven gears 30 to translate the rotation of the rotor 18 into reduced speed rotation of the driving shaft 24. The inner driving clutch jaw 52, due to the aforementioned splined connection of the inner driving clutch element 50 to the driving shaft 24, is rotated at the reduced speed rotation of the driving shaft 24 continuously around the rotation of the latter.

Simultaneously, the driving shaft 24 rotatably drives the supporting sleeve 54, at a speed reduced from that of the driving shaft 24, through the reduction gearing system formed by the gear teeth 58, 65 and the driven gears 62. The outer driving clutch jaw 76, due to the aforesaid splined connection of the outer driving clutch element 72 to the supporting sleeve 54, is rotated at the speed of the supporting sleeve 54 continuously throughout the rotation of the latter.

The jaw teeth 88a, 52a of the inner driven and driving clutch jaws 88, 52, respectively, are normally in engagement such that the driven element 36 is normally rotatably driven at the speed of the rotation of the driving shaft 24. Thus, when a working implement (such as a conventional socket) carried by the square drive 40 is engaged with a fastener or other workpiece which is to be rotatably driven, the fastener is initially rotated at the speed of the rotation of the driving shaft 24. The initial engagement of the socket with the fastener, however, urge the gear teeth 36 rearwardly in the barrel 12 and, through the portions 116, 118 of the anvil 36 and the outer driven clutch element 94, thereby moves the outer driven clutch element 94 to a position wherein the outer driven clutch jaw 96 is in its cocked or set position. The clutch jaws 52, 76, 88, 96 are thus at this time, in the positions illustrated in FIG. 2.

As the fastener is rotatably driven through the inner driven and driving clutch jaws 88, 52, it becomes progressively tightened and thereby loads the supporting shaft 78 and the supporting shaft 78 progressively increase until they attain the aforementioned predetermined torque. Thereupon, the inner driven clutch jaw 88 moves out of engagement from the socket 56. The inner driven clutch element 86 and the inner driven clutch jaw 88 is moved from the position illustrated in FIG. 2 to the position illustrated in FIG. 3. Simultaneously with this movement of the inner driven clutch element 86, and as the coiled ends 101 of the toggle springs 90 move by the centers 105 of such toggle springs, the outer driven clutch element 94 is moved by the toggle springs 98 towards the outer driving clutch element 72 to engage the clutch jaws 76, 96. Thus, the clutch jaws 52, 76, 88, 96 are then in the positions illustrated in FIG. 5; and the workpiece is thereafter rotated at the speed of the rotation of the supporting sleeve 54 through the clutch jaws 76, 96.

When the socket or other working implement is removed from the driven workpiece, the coil spring 104 urges the driven element 36 forwardly. During this forward movement of the driven element 36, the stop plate 108 and the projection 110 cooperate to provide simultaneous forward movement of the outer driven clutch element 94. Thus, the outer driving clutch jaw 96 is drawn from engagement with the outer driving clutch jaw 76 whereupon the toggle springs 98, as the coiled ends 102 move by the centers 105 thereof, move the inner driven clutch element 86 to return the inner driven clutch jaws 88 into engagement with the inner driving clutch jaw 52. The tool 10 is then ready to commence another cycle of operation.

From the aforesaid, it will be seen that I have provided new and improved means for accomplishing all of the objects and advantages of my invention. It will be understood, however, that, although I have illustrated and hereinbefore specifically described only a single embodiment of my invention, my invention is not limited merely to this single embodiment but contemplates other embodiments and variations which utilize the teachings and concepts of my invention.

Having thus described my invention, I claim:
1. A power-operated tool, the combination comprising:
   driving means;
   an inner driving clutch jaw connected to said driving means to be rotated by said driving means at a first speed;
   an outer driving clutch jaw disposed circumferentially of said inner driving clutch jaw and connected to said driving means to be rotated by said driving means at a second speed different from said first speed;
   a rotatable driven element adapted to rotate the working implement with said inner driven clutch jaw connected to said driven element for rotation therewith and adapted for engagement with said inner driven clutch jaw;
   an outer driving clutch jaw connected to said driven element for rotation therewith, said outer driving clutch jaw being disposed circumferentially of said inner driven clutch jaw and being adapted for engagement with said outer driving clutch jaw; and
   resilient means operable for causing alternative engagement of said inner driven and driving clutch jaws and said outer driven and driving clutch jaws, respectively.

2. A power-operated tool according to claim 1, wherein said inner and outer driven clutch jaws are movable into and out of engagement with said inner and outer driving clutch jaws, respectively; and
said resilient means comprises a spring connected to movably connect said driving means such that said driving shaft is rotatably driven by said driving means;

an inner driven clutch jaw being adapted for engagement with said inner driven clutch jaw;

and means for connecting said outer driving clutch jaw to said driving shaft such that said outer driving clutch jaw is rotatably driven by said driving shaft at a speed different than the speed of the rotation of said inner driving clutch jaw;
a rotatable driving element adapted for rotatably driving a working implement;
an inner driven clutch jaw connected to said driven element for rotation therewith and adapted for engagement with said inner driven clutch jaw;
an inner driven clutch jaw connected to said driven element for rotation therewith and adapted for engagement with said inner driven clutch jaw;

and resilient means operable for causing alternative engagement of said inner driven and driving clutch jaws and said outer driven and driving clutch jaws, respectively.

5. A power-operated tool according to claim 4, wherein one engaging pair of said clutch jaws are constructed such that they are automatically disengaged in response to a predetermined torque of said driven element.

6. A power-operated tool according to claim 4, wherein said means connecting said driving shaft to said driving means and means connecting said outer driving clutch jaw to said driving shaft each including a reduction gearing system.

7. A power-operated tool according to claim 6, wherein said inner and outer driven clutch jaws being movable into and out of engagement with said inner and outer driving clutch jaws, respectively; and said resilient means comprises a spring connected to move each of said driven clutch jaws into engagement with the corresponding one of said driving clutch jaws when the other of said driven clutch jaws is moved out of engagement with the other of said driving clutch jaws.

8. A power-operated tool according to claim 6, wherein said inner and outer driven clutch jaws are movable into and out of engagement with said inner and outer driving clutch jaws, respectively; and said resilient means comprises a plurality of arcuate spaced springs connected to said inner and outer driven clutch jaws.

9. In a power-operated tool, the combination comprising:

means for drivably connecting said driving shaft to said driving means such that said driving shaft is rotatably driven by said driving means;

an inner driven clutch jaw connected to said driving shaft to be rotatably driven thereby;

an outer driven clutch jaw disposed circumferentially around said inner driven clutch jaw;

means for connecting said outer driving clutch jaw to said driving shaft such that said outer driving clutch jaw is rotatably driven by said driving shaft at a speed different than the speed of the rotation of said inner driving clutch jaw;
a rotatable driving element adapted for rotatably driving a working implement;
a supporting shaft connected to said driven element for rotation therewith and disposed end-to-end with said driving shaft;
an inner driven clutch jaw carried by said supporting shaft for rotation therewith and axial movement thereon;
said inner driven clutch jaw being adapted for engagement with said inner driven clutch jaw;
an outer driven clutch jaw carried by said supporting shaft for rotation therewith and axial movement thereon, said outer driven clutch jaw extending circumferentially around said inner driven clutch jaw and being adapted for engagement with said outer driving clutch jaw; and

springs means connected to said inner driven clutch jaw and said outer driven clutch jaws for moving each of said driven clutch jaws into engagement with the corresponding one of said driving clutch jaws when the other of said driven clutch jaws is moved out of engagement with the other of said driving clutch jaws.

10. A power-operated tool according to claim 9, wherein:
said inner driven and driving clutch jaws are constructed to be automatically disengaged in response to a predetermined torque of said driven element.

11. A power-operated tool according to claim 9, wherein:
said means connecting said driving shaft to said driving means and said means connecting said outer driving clutch jaw to said driving shaft each including a reduction gearing system.

12. A power-operated tool according to claim 9, wherein:
each of said driven clutch jaws and said driving clutch jaws being of annular configuration; and

said spring means comprises a plurality of arcuate spaced springs connected adjacent their opposing ends to said inner driven clutch jaw and said outer driven clutch jaw.

13. A power-operated tool according to claim 9, wherein:
said driven element is mounted for axial movement; resilient means for biasing said driven element from said supporting shaft; and

means for connecting said driven element to said outer driven clutch jaw such that movement of said driven element by said biasing means moves said outer driven clutch jaw from engagement with said outer driving clutch jaw.

14. In a power-operated tool, the combination comprising:

driving means;
a rotatable driving shaft;

means for drivably connecting said driving shaft to said driving means such that said driving shaft is rotatably driven by said driving means;

a first driving clutch jaw connected to said driving shaft to be rotatably driven thereby;
a second driving clutch jaw;

means for connecting said second driving clutch jaw
9 to said driving shaft such that said second driving clutch jaw is rotatably driven by said driving shaft at a speed different than the speed of rotation of said first driving clutch jaw;
a rotatable driven element adapted for rotatably driving a working implement;
a first driven clutch jaw connected to said driven element for rotation therewith and adapted for engagement with said first driving clutch jaw;
a second driven clutch jaw connected to said driven element for rotation therewith and adapted for engagement with said second driving clutch jaw; and resilient means operable for causing alternative engagement of said first driven and driving clutch jaws and said second driven and driving clutch jaws, respectively.

15 A power-operated tool according to claim 14, wherein:
said resilient means is adapted to engage each engaging pair of said clutch jaws in response to relative movement of the other engaging pair thereof out of engagement.

16 A power-operated tool according to claim 14, wherein:
one engaging pair of said clutch jaws being constructed such that they are automatically disengaged in response to a predetermined torque of said driven element.

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