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E. L. CONNELL

MACHINE FOR DRIVING NUTS, SCREWS, AND THE LIKE

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FIG. 1.

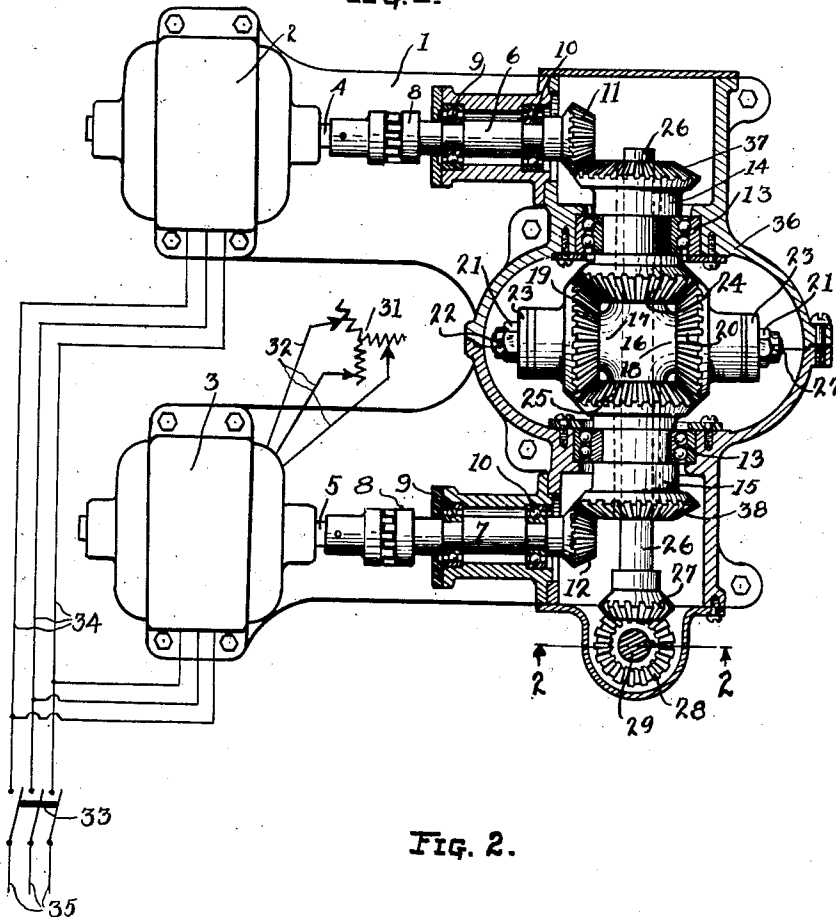
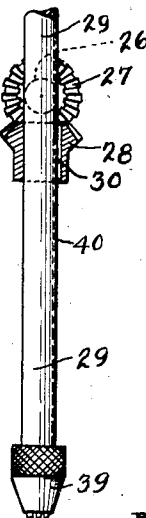
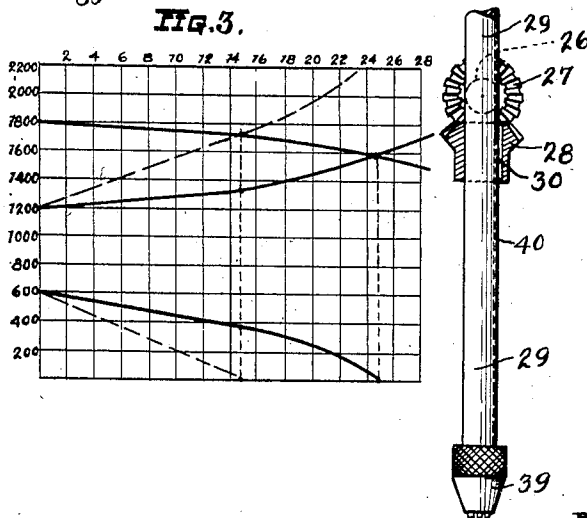


FIG. 2.

FIG. 3.



INVENTOR
Edwin T. Connell
BY Frank M. Slough
HIS ATTORNEY

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EDWIN L. CONNELL, OF EAST CLEVELAND, OHIO.

MACHINE FOR DRIVING NUTS, SCREWS, AND THE LIKE.

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My invention relates to variable speed driving mechanisms and particularly to mechanisms adaptable for the purpose of driving a working spindle for the turning of screws, nuts, bolt, and the like, to a full driven position, as, for instance, for the turning of nuts and bolts adapted to secure heavy metallic frames together, such as the different frame portions of an automobile chassis.

An object of my present invention is to provide mechanism of this general character, which may be employed to exert a sufficient driving torque to turn the nut, bolt, or the like, to "home position," wherein it may not be turned more tightly without danger of breaking a part of the driving mechanism, or of the turned object being driven, or associated part, and which driving mechanism will at the same time permit the sudden stopping of the driving spindle resulting from the driving of the nut, bolt, or the like, to such "home position."

Another object of my invention is to provide an improved driving mechanism, which may be employed to turn a nut, bolt, or like part, to a predetermined, uniform torque.

Another object of my invention is to provide an improved driving mechanism in which the motor element thereof may continue operating after the object has been turned up to the predetermined torque and without a considerable loss of power required to drive the motor element.

Another object of my invention is to provide in a mechanism of the above character, means whereby electric power operating the device taken from the source of electrical current is in part compensated for by electric current returned to the power supply line when the working spindle discontinues its rotation, due to the nut or bolt being driven "home."

Another object of my invention is to provide a driving mechanism of the above character, wherein the rotational speed under different conditions of torque may be varied in a simple and expeditious manner.

Other objects of my invention and the invention itself will be better understood by reference to the accompanying description of an embodiment of my invention, and in which description reference will be had to the accompanying drawings illustrating such embodiment, which drawings are a part of this specification.

Referring now to the drawings:

Fig. 1 is a plan view partly in section of a mechanism embodying my invention;

Fig. 2 shows an elevational view of certain parts, but with a driven pinion thereof shown in longitudinal medial vertical section, and which comprise a working spindle; and

Fig. 3 shows a graph containing curves showing possible properties of a specific embodiment of my invention.

Referring now to the drawings, in all of which like parts are designated by like reference characters, at 1, I show a frame carrying a pair of electric motors 2 and 3 securely bolted thereto, the said motors being of any convenient type and which are herein, for the purpose of illustration, assumed to be alternating current, polyphase motors, but which may be direct current motors or motors of any other type, the said motors driving rotatable shafts 4 and 5 in opposite directions or, when desired, in the same direction. At 6 and 7, I show driven shafts coupled through jaw clutches 8, to the motor driving shafts 4 and 5. The shafts 6 and 7 are rotatably supported in like bearings 9 and 10 and carry at their ends driving pinions 11, for the shaft 6, and 12, for the shaft 7. At 13, I show a pair of bearing elements adapted to support the double ended bevel pinion elements 14 and 15. At 16, I show a spider element having arms 17 and 18, each supporting a bevel pinion, the arm 17 supporting a pinion 19 and the arm 18 supporting a pinion 20. The pinions 19 and 20 are rotatably carried upon the arms and are each held by nuts 21 screw threaded upon the threaded ends 22 of the spider arms, and by thrust bearing elements 23 in position, to be meshed with the opposing bevel gears 24 and 25, each comprising an inner end of its respective bevel pinion element 14 and 15. The spider 16 is keyed to the work shaft 26, which carries at its end a bevel pinion 27 and which meshes with and drives a bevel pinion 28. A work spindle 29 is adapted to reciprocate through an axial opening through the pinion 28, which contains on its inner opening face a projecting key portion 30, and which fits within and slides along a longitudinal groove 40 in the working spindle, the object of this keying connection between the spindle 29 and the pinion 30 being to prevent relative rotation of the spindle and the pinion, at the same

time permitting reciprocation of the spindle within the pinion, whereby positive driving of the spindle by the pinion may always occur in any position of the spindle.

5 For one or both of the motors, I provide means to vary its speed, and comprehended in my invention means to reverse the rotation of one or both of the motors. A speed
10 varying means is indicated diagrammatically at 31 for the motor 3, wherein resistance coils, star connected, may be inserted vari-
15 ably to a greater or less extent in the circuits of the conductors 32, which lead to such so-called "secondary controller" for the motor.
20 At 33, I show an electric switch which may be operated to close or open its contacts to start or stop the motor mechanism by connect-
25 ing or disconnecting the circuit conductors 34 leading to the motors from the circuit conductors 35 leading from the source
30 of electric current, which in the illustrated case may be assumed to be a source of poly-
phase alternating current.

A casing 36 is provided to house the pin-
25 ions, such casing being preferably, as illustrated, substantially lubricant proof and containing bearings as shown at 9, 10 and 13,
30 and not shown but also carrying a bearing for the pinion 28.

35 It will be noted that the driving connections between the pinions 11 and 37, which are carried on the outer side of the pinion
40 element 14, and that for the pinion 12 and pinions 38, carried on the outer end of the pinion
45 element 15, are of the straight bevel type and are reversible, so that power may be transmitted freely in either direction. This
50 is necessary to secure the results sought for in a mechanism of this kind.

55 In operating the driving mechanism, which has just been described, the motors 2 and 3 are driven, preferably at different speeds and preferably in different directions.
60 The mechanism comprising the gear pinions 24, 25, 19 and 20 being a differential gear mechanism, will cause rotation of the spiders
65 16 and its shaft 26 to which said spider is keyed, the speed of rotation of the spider and shaft 26 being that speed which is half of
70 the difference between the speeds of rotation of the two elements 14 and 15 driven by the
75 motors 2 and 3, respectively.

80 The apparatus of my invention is mounted so that the nut or bolt to be turned may be
85 grasped by the clutch 39 carried at the lower end of the work spindle 29, and is preferably mounted on a support comprising an arm
90 pivotally carried on a fixed support, the arm being rotatable radially to permit the clutch
95 39 to be attached to the bolt or nut to be turned. The electric motors being both connected to the source of electric current, when
100 there is no load on the spindle it will rotate at a speed and in a direction determined by
105 the relative characteristics of the two motors

and the setting of the controllers, such as the controller 31 controlling such motors. Whenever the work spindle 29 is driving a
110 nut or bolt or performing other work, its rotation is retarded sufficiently to cause the
115 differential mechanism to function in such a way that one of the motors, for instance the motor 2, will drive the other motor 3 at a rate
120 of speed in excess of that at which it would rotate, except for the retardation exercised
125 on the work spindle 29 by the driving of such nut or bolt. Motor 3 then acts as a generator. If the retarding force exerted on the
130 spindle is sufficient to prevent its rotation, one of the motors, such as the motor 3, will
135 act as a generator and return a larger part of the power to the line. A torque is maintained on the spindle substantially propor-
140 tional to the torque delivered by the motor through the differential mechanism. When-
145 ever the force resisting rotation of the work spindle is insufficient to prevent its rotation, the speed will correspond to the difference in
150 speed of the two elements 14 and 15, and the power transmitted will be the product of the
155 resultant speed and the torque being transmitted. The torque transmitted at all speeds and when the spindle is held stationary with
160 the motors in operation, can be regulated by suitably adjusting the characteristics of the
165 motors as by adjusting the controller 31 for the motor 3.

170 In order to convey a better understanding of the operative principles of this invention, a case illustrating the working out of the
175 same will now be considered. For instance, assuming the source of current to be a poly-phase source of 60 cycle alternating current, and the motors 2 and 3, and the controller
180 31, and interposed gearing being so proportioned and disposed as to exert a maximum "stalling" torque of 50 ft. pounds—
185 if it be assumed that a 50 per cent overload of the motors is permissible at this load, the normal torque rating would be $33\frac{1}{3}$ ft.
190 pounds. Let us further assume that the apparatus should operate at 300 revolutions per minute under no load conditions, which
195 speed represents half of the difference in speed of the two driving gears 24 and 25 of the differential gear mechanism under the
200 conditions above referred to. Assuming no reduction of speed from the pinions 11 and 12 to the meshed pinions 37 and 38, respec-
205 tively, a 600 revolution per minute difference in speed at pinions 37 and 38 would represent a 600 revolution per minute difference
210 in speed of the pinions 11 and 12, which are directly driven by the motor shafts 4 and 5, respectively. 1800 revolutions per minute
215 for the shaft 4 of the motor 2 and 1200 revolutions per minute for the shaft 5 of the motor 3 would fulfill this requirement for a
220 difference of 600 revolutions per minute in motor speeds, and 5 H. P. and 3 H. P. mo-
225

tors for the motors 2 and 3, respectively, would have approximately the desired normal torque rating.

I preferably would make the smaller motor operating at the lower speed of the wound rotor type with a secondary controller, as illustrated. The other motor would preferably be of a standard squirrel-cage type. Although I preferably operate the motors 2 and 3 at different speeds, good results can be obtained with motors of the same inherent speed by choosing proper ratios for the gear trains 11-37 and 12-38 to replace the assumed identical ratios, described and shown herein.

Fig. 3 shows theoretical curves, illustrating the relations between speed and torque of the two motors of this description. Referring to this figure, the maximum working torque or stalling torque, is that torque at which the speed of the motor acting as a generator equals that of the motor, and by means of the secondary controller, or like controlling means, this torque can be adjusted to meet any requirement within the capacity of the machines. For instance, if a certain nut to be turned by the work spindle requires a setting torque equivalent to 15 ft. pounds at the motor, the secondary resistance controller 31 is adjusted to bring the two speed torque curves together at this torque, as indicated by the intersection of the two top curves at the dotted line A extending from the torque valve 15, the intersection of these curves is that condition for stalling of the working spindle, because the speed of this spindle is proportional to the difference between the motor-generator speeds. The two lower curves represent these differential speed torque characteristics of the work spindle in terms of motor-generator speed and torque. As we have assumed no speed reduction between the motors and differential elements 14 and 15, the actual values of torque on the work spindle will be double that shown and the speed will be one-half. Ordinarily, the nut or bolt will require very little torque until it reaches full driven position, so that until this position is reached, the speed will be near the maximum obtained without load. For the final setting, much greater torque is available at low speed and at standstill.

Although I have described my invention in an embodiment employing alternating current motors, I wish it to be understood that I may use motors disposed as are the motors 2 and 3 of Fig. 1, but which are direct current motors having the same relative speed characteristics as described herein for the motors 2 and 3, and whose speed may be varied in any of the well-known ways for varying the speed of such motors, as, for instance, by introducing resistance in the circuit of the field or armature, or both,

in accordance with the recognized practice. The motor 3 of such a set will return current to the line, to which both motors are preferably connected, in multiple or series circuit. My invention comprehends such an arrangement, and I hereby disclose it for the purpose of conveying an understanding of the scope of my invention.

I find that with the mechanism of my invention, nuts and bolts may be driven "home" efficiently, with dispatch and to a uniform predetermined torque, which torque may be indicated in any of the well-known ways, without the necessity of providing friction clutches, or the like, to limit the driving torque, and which in practice overheat and are soon worn out and at the same time require an excessive power to operate them.

Although I have described but a single embodiment of my invention and, for the purpose of imparting a better understanding of the same, have described a specific case wherein my invention is employed, I do not wish to be limited to any values, mode of operation, or results incidental to such a case, or to the operation recited, as I am aware that numerous and extensive departures may be made therefrom but without departing from the spirit of my invention.

What I claim is:

1. In a machine for driving screws, nuts and the like, of the type employing a working spindle which must drive to a standstill and exert considerable torque without rotation, driving mechanism therefor comprising two electric motors adapted to be driven from a common source of current, shafts therefor, reversible driving means differentially joining the motor shafts, one of said motors adapted to be driven through said differential driving means by the other motor to cause it to generate current whenever the spindle is restrained from free rotation while exerting torque on the spindle, and circuit connection adapted to communicate the generated current to the source of current.

2. In a machine for driving screws, nuts and the like, of the type employing a working spindle which must drive to a standstill and exert considerable torque without rotation, driving mechanism therefor comprising two electric motors adapted to be driven from a common source of current, shafts therefor, reversible driving means differentially joining the motor shafts, one of said motors adapted to be driven through said differential driving means by the other motor to cause it to generate current whenever the spindle is restrained from free rotation while exerting torque on the spindle, and circuit connections adapted to communicate the generated current to the source of current, and means for regulating the

speed torque characteristics of at least one of said motors so that the torque exerted on the working spindle at standstill may be regulated, whereby the working spindle will
5 cease rotation when the driving torque exerted upon it reaches the desired limit.

3. In a machine for driving screws, nuts and the like, of the type employing a working spindle which must drive to a standstill
10 and exert considerable torque without rotation, driving mechanism therefor comprising two electric motors, shafts therefor, reversible driving means differentially joining the motor shafts, one of said motors adapted
15 to be driven through said differential driv-

ing means by the other motor to cause it to generate current whenever the spindle is restrained from free rotation while exerting torque on the spindle, and means for regulating the speed torque characteristics of at
20 least one of said motors so that the torque exerted on the working spindle at standstill may be regulated, whereby the working spindle will cease rotation when the driving torque exerted upon it reaches the de-
25 sired limit.

In testimony whereof I hereunto affix my signature this 20th day of November, 1925.

EDWIN L. CONNELL.