April 21, 1942. C. E. BRODERS ET AL 2,280,115

DRILLING MACHINE

Filed July 21, 1939 3 Sheets-Sheet 1

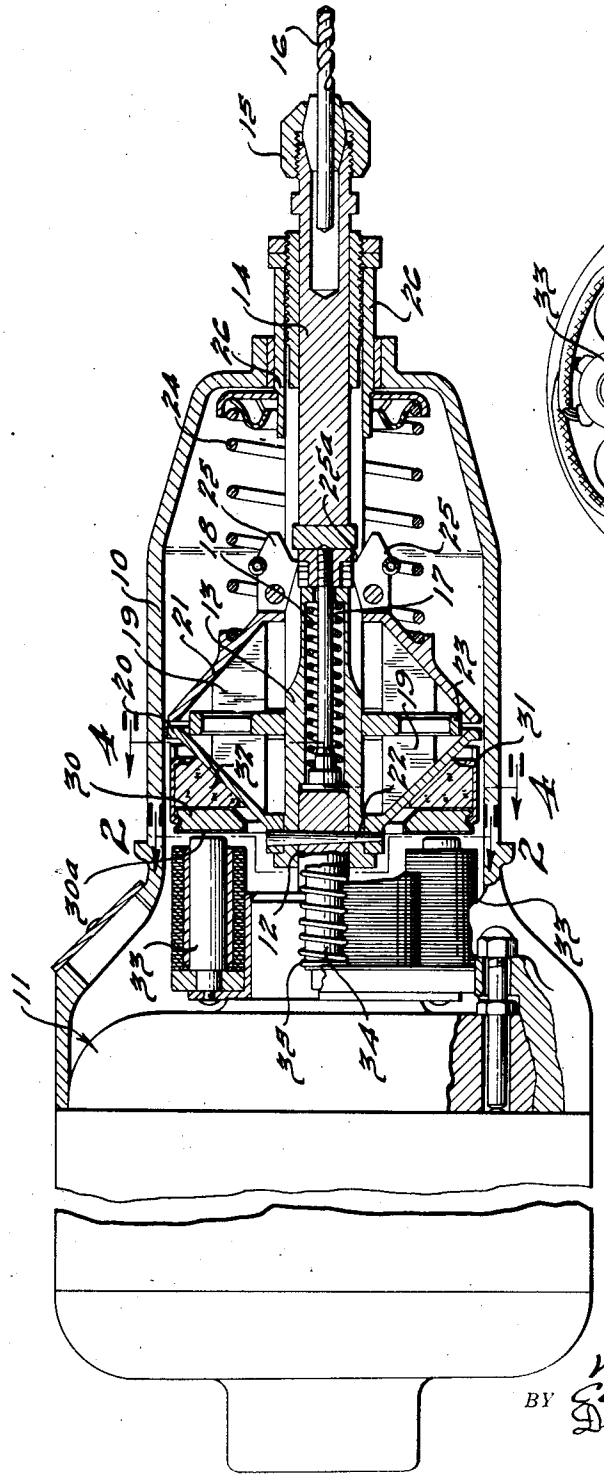


Fig. 1.

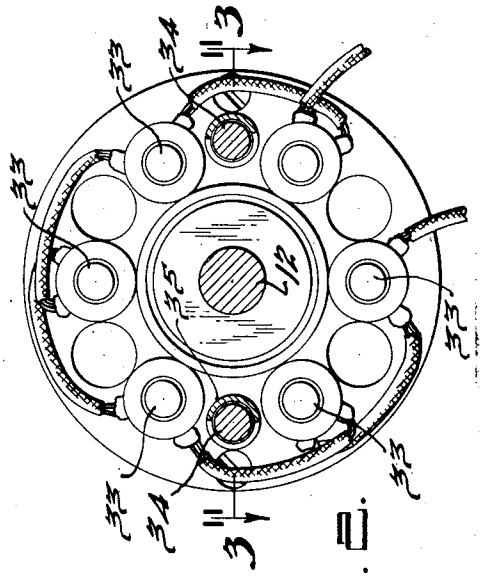


Fig. 2.

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Filed July 21, 1939 3 Sheets-Sheet 2

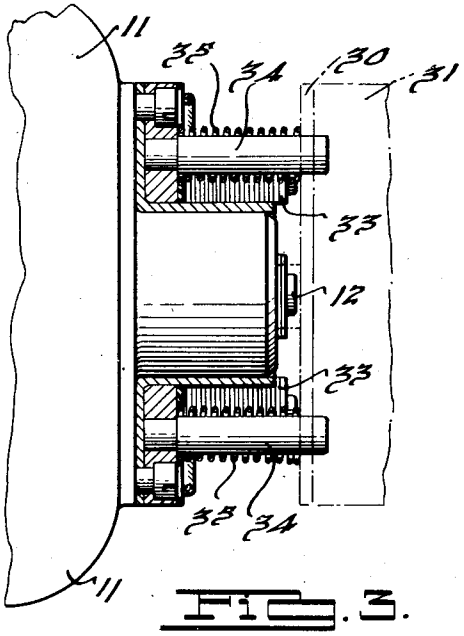


FIG. 3.

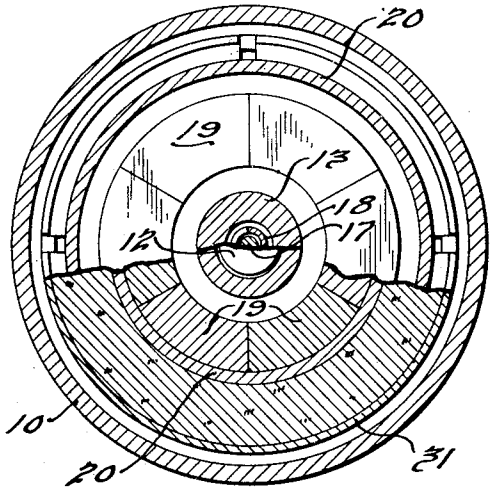


FIG. 4.

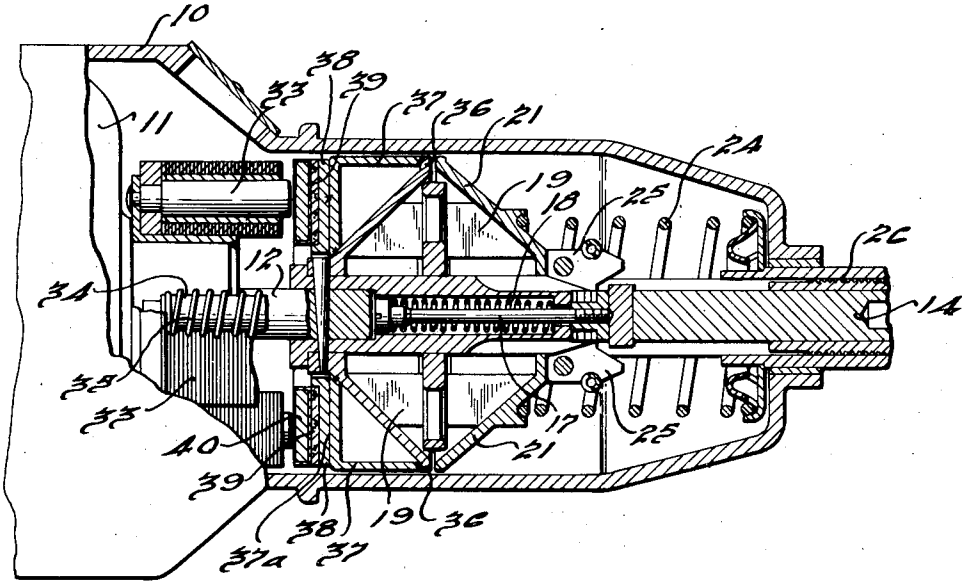


FIG. 5.

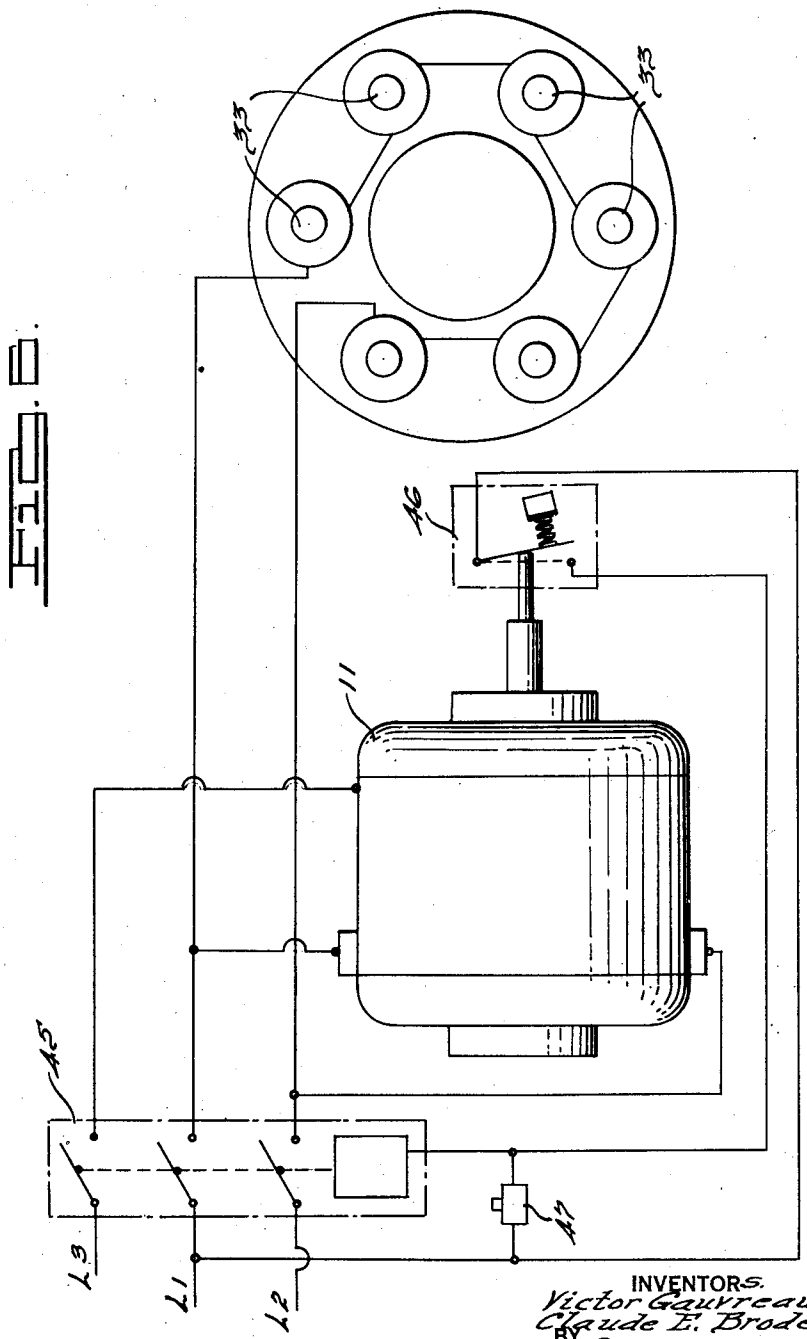
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Filed July 21, 1939 3 Sheets-Sheet 3

FIG. 5.



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2,280,115

DRILLING MACHINE

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10 Claims. (Cl. 77—33)

This invention relates to machines for performing drilling, reaming and similar operations, and more particularly to an improved drilling machine with an automatic feed and return of the drill or other tool used in said machine.

One of the objects of the present invention is to provide an improved drilling machine in which feeding of the drill toward and into the workpiece is effected by means of weights actuated in the feeding direction by the centrifugal force of rotation.

Another object of the invention is to provide a drilling machine of the foregoing character, in which means are provided to reduce quickly the rotative speed of the drill actuating weights after the drilling operation is completed in order to facilitate the return of said weights to their original position for beginning the next operative cycle. In conventional machines of this character, the inertia of the weights and of the motor armature is usually so great that it takes considerable time until the means, usually springs, resisting the feeding movement of the weights are able to return said weights to their original positions, whereby operation of the machine is greatly delayed.

A further object of the invention is to provide a drilling machine including drill-feeding weights and improved braking means therefor.

A still further object of the invention is to provide an improved drilling machine of the character specified in the preceding paragraph, in which machine there are provided improved electromagnetic means for operating said braking means.

A still further object of the invention is to provide improved means for eliminating the residual magnetism in the magnet actuating iron piece or magnet armature.

A still further object of the invention is to provide an improved drilling machine of the foregoing character, in which machine means are provided to prevent operation of the drill-feeding weights at the predetermined minimum rotative speed of the tool carrying spindle, said means being adapted to permit operation of the weights for feeding a tool toward a workpiece when the speed of the shaft exceeds the minimum rotative speeds.

It is an additional object of the present invention to provide an improved drilling or reaming machine of the above character, which is simple in construction, dependable in operation, easy to repair and service, and relatively inexpensive to manufacture.

Other objects and advantages of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Fig. 1 is a view showing in a longitudinal section the main portion of the drilling machine embodying the present invention.

Fig. 2 is a sectional view taken in the direction of the arrows on the section plane passing through the line 2—2 of Fig. 1.

Fig. 3 is a sectional view taken in the direction of the arrows on the section plane passing through the section line 3—3 of Fig. 2, and illustrating the electromagnetic means operating the brake of the drilling machine embodying the present invention.

Fig. 4 is a sectional view taken in the direction of the arrows on the broken section plane passing through the broken line 4—4 of Fig. 1.

Fig. 5 is a view similar in part to Fig. 1, showing a drilling machine embodying the present invention and having a brake device of a modified construction.

Fig. 6 is a diagram of the electric circuit controlling the motor and the electromagnets of the device.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation and it is not intended to limit the invention claimed herein beyond the requirements of the prior art.

In the drawings there is shown, by way of example, a drilling machine embodying the present invention. The machine shown in the drawings and hereinafter described is a machine adapted to perform drilling operations. However, it will be understood that the present invention may be successfully applied to reaming, tapping and similar machines, which is to say, machines employing a rotating tool such as a drill, a reamer and the like.

Referring to the drawings and particularly to Figs. 1 to 4 inclusive, the structure illustrated therein comprises a casing 10, at one end of which there is operatively mounted within said

casing an electric motor generally indicated by the numeral 11. The motor 11 is provided with an armature (not shown) mounted on an armature shaft 12, preferably of articulated construction, to the opposite end of which is secured a sleeve 13 drivingly connected with drill holding means including in the present embodiment a coaxial spindle 14 provided with a suitable collet or chuck 14 adapted to receive a drill 16. By virtue of such a construction the armature shaft 12 is positively connected for rotation with the drill 16 and rotation of said shaft is transmitted to the drill. The spindle 14 at its end opposite to the one carrying the chuck 15 is provided with a pin or rod 17 extending through a hole provided in the sleeve 13. A compression spring 18 is carried on the pin or rod 17. The spindle 14 may move longitudinally with respect to the sleeve 13, in which case the spring 18 is compressed thus resisting the longitudinal movements of the spindle 14 in the feeding direction, that is to say, toward and into the workpiece (to the right in Fig. 1). Thus, if by some external means the spindle 14 is moved to the right, the drill 16 will be fed toward and into the workpiece. However, when said means cease to exert feeding force on the spindle 14, the action of the spring 18 will operate to return said spindle into its original position shown in Fig. 1.

Means operating to feed the drill 16 toward and into the workpiece are exemplified in the present embodiment of the invention by a plurality of rotating weights 19 arranged within the cup-shaped members 20 and 21. The member 20 is rigidly secured to the sleeve 13 and armature shaft 12 with the aid of a pin 22, while the member 21 although rotating with said sleeve and shaft is permitted to slide longitudinally thereof. From an examination of Figs. 1 and 5 it can be seen that rotation of the member 21 with the shaft 13 is caused by the fact that said member is, in effect, keyed to said shaft 13 through the dogs 25 hinged on said member 21 and engaging said shaft at the slots thereof in which they are permitted to slide. A disk 23 is provided between the weight members 19 contacting respectively the cup-shaped members 20 and 21.

When the armature shaft 12 and, consequently, the sleeve 13 and spindle 14 rotate, the centrifugal force of rotation operates to push push the weights 19 outwardly. Since the member 20 is longitudinally fixed and the member 21 is free to slide, the outward movement of the weights 19 operates to move said member 21 to the right in opposition to the spring 24. Moving dogs 25 engaging with their shoulders 25a the spindle 14 push the same to the right. When in their feeding movement the dogs 25 reach the sleeve 26, their inclined cam surfaces begin to cooperate with the left end of said sleeve 26, in consequence whereof the dogs 25 move outwardly, disengaging the spindle 14. Undesirable outward movements of the dogs 25 under the centrifugal action of rotation when the shaft is speeded up are prevented by a circular coil spring, see Figs. 1 and 5, embracing said dogs and holding them yieldingly but securely in the slots of the shaft 13. The sleeve 26 is adjustable to suit the length of the hole to be drilled, and it is adjusted so that such disengagement of the dogs 25 occurs when the drilling operation is completed. When the spindle 14 is disengaged as described, the spring 18 operates to withdraw the drill 16 from the work and to return the spindle 14 to its original position in order to prepare the machine for the next operative cycle.

The weight assembly including the weights 19 and the cup-shaped member 21 is returned to its original position by the operation of the spring 24 which, when the rotative speed of said weights is decreased becomes capable of pushing the member 21 to the left, moving at the same time the weights 19 inwardly toward the sleeve 13. Since weights 19 and the shaft by which they are carried are relatively heavy, there is considerable inertia present, and it was found that in conventional machines said inertia caused the rotating parts to continue to rotate after the current is shut off and thus prevented the rapid return of the weights to their initial positions. In operation it will be seen that the switch mechanism operated by the rod 17 operates to cut he supply of current to the electric motor 11, which switch is again closed when the spindle 14 is returned to its original position. However, since after the drilling operation is completed there is nothing to consume the energy of the rotating motor armature and shaft, weights 19, cup-shaped members 20 and 21, the spindle 14 and of the drill 16, the same continue to rotate for a considerable length of time and the spring 24 is unable to return the weight assembly to its original position.

In accordance with the present invention means are provided whereby the rotative speed of the above specified rotating parts is quickly reduced as soon as the drilling operation is completed and the motor switch is opened. The said brake device is rendered inoperative during the drilling operation, that is, when the motor switch is closed.

Referring to the drawings and particularly to Fig. 1, the brake device comprises generally an annular magnet armature plate 30 arranged around the motor armature shaft 12 and sleeve 13. To the plate 30 there is secured with the aid of a retainer ring 31 a suitable frictional element or lining 32 adapted to engage frictionally the outside surface of the fixed cup-shaped member 20. The plate 30 is made preferably of soft iron, and serves as an armature for a plurality of electromagnets 33 arranged around the armature shaft 12 and secured to the structure of the motor 11 in any suitable manner to cause said electromagnets to be stationary with respect to said shaft. The electromagnets 33 are provided with suitable windings which are connected in series or in parallel to each other (see Fig. 2), the electric connection thereof to the source of electric energy being controlled by the motor switch (not shown). A plurality of pins 34, in the present instance two, are secured to the motor housing. Said pins pass through the holes provided in said armature plate 30 and prevent rotation thereof while permitting its sliding toward and away from said cup-shaped member 20.

A coil spring 35 is provided on each of said pins 34, said springs being adapted to bear on the plate 30 and to push the same together with the friction lining 32 into frictional engagement with the cup-shaped member 20. Springs 35 are so selected that they are capable of exerting sufficient force on said armature plate 30 to ensure sufficient friction and braking action between the lining 32 and the member 20, but they are incapable of resisting the action of the electromagnetic means when the same are ener-

gized and operate to attract by their magnetic action the armature plate **30**, pulling the same together with the friction lining **32** away from the member **20**.

It will now be seen in view of the foregoing that when the drilling operation is in progress, at which time the electric motor is operating and the motor switch is closed, the electromagnets **33** are energized and the brake is not in engagement with the member **20**. As soon as the electromagnets **33** are de-energized, which occurs when the drilling operation is completed and the motor switch is opened, the springs **35** press the brake against the cup-shaped member **20** and the operation of said brake quickly reduces the rotative speed of the member **20** and other parts drivingly connected thereto. In consequence of the decrease in rotative speed of the member **20**, the centrifugal force of the members **19** also decreases ,and the spring **24** becomes capable of returning the member **21** to its original position.

Fig. 6 illustrates diagrammatically the electric circuit with the switches controlling the same, whereby the above described functions are performed by the respective mechanisms of the device. The main line consisting of the three conductors L^1, L^2 and L^3 is controlled with the aid of a relay switch **45** which, when opened, stops the motor **11** and also deenergizes the brake operating electromagnets **33** permitting the springs **35** to apply the brake to the member **20**. The circuit to the relay switch **45** is in turn controlled by a switch **46** which is normally closed. The switch **46** may be mounted in any desired manner for actuation upon movement of the rod **17** when the same reaches the end of its forward movement. Various desired mechanical arrangements to accomplish the opening to the switch whereby the rod **17** reaches the end of its forward movement are within the knowledge of those skilled in the art. Also, it is to be understood that any desired type of limit switch may be used to break the circuit after a predetermined movement of the rod **17**. Opening of the switch **46** operates to break the circuit of the relay switch **45** thereby causing opening of said switch, stopping the motor **11** and deenergizing the electromagnets **33**, as mentioned.

For starting the device the reset button **47** is depressed long enough to reestablish the circuit and to start up the motor. As soon as this is done the rod operating the switch **46** is withdrawn therefrom, and the switch spring operates to close said switch and to maintain it closed until the circuit is again interrupted as previously explained.

In order to decrease the effect of the residual magnetism of the armature plate **30**, said plate is provided with a covering of non-magnetic material, preferably in the form of plating **30***a* which may be of any suitable nonmagnetic metal such as copper, chromium or the like. It is preferable to use chromium plating, since the same provides a hard surface which increases the wearing quality of the plate.

The structure illustrated in Fig. 5 is substantially similar to the structure illustrated in Figs. 1 to 4 inclusive, the difference between the two structures consisting chiefly in the construction of the brake device and the cup-shaped member corresponding to the cup-shaped member **20** of the structure of Figs. 1 to 4. Referring to Fig. 5, said cup-shaped member comprises a member **36** substantially identical in its construction with the member **20**, to which member **36** there is secured an annular member **37** made preferably by stamping from sheet metal and secured to said member **36** by spot welding. The surface **37***a* of the member **37** is straight and it extends perpendicularly with respect to the armature shaft **12**. To said member **37** there is secured at said surface **37***a* a disk **38** to which disk is secured a friction disk **39** of any suitable friction material such as cork or the like. An armature plate **40** is movable and, being acted upon by the electromagnets **33** and the springs **35**, it moves into and out of frictional engagement with the friction disk or lining **39**. In other words, while in the structure of Figs. 1 to 4, the lining is non-rotating and is secured to the armature plate **30**, in the structure of Fig. 5 the friction lining **39** is carried by the cup-shaped member and rotates therewith, the armature plate **40** being non-rotating.

If desired, the electric motor **11** may be arranged in such a way as to have two speeds, a low speed and a high speed. The weights movable by the centrifugal force of rotation to feed the drill and the spring yieldably resisting such movements may be so selected that the centrifugal force of said weights is insufficient to overcome the resistance of the spring at the low speed, but is capable of doing so as soon as the speed of the motor increases. The motor is continuously run at low speed. The advantage of such a construction lies in the fact that the armature, the weights and other rotating parts continue to rotate at all times and do not stop after every drilling operation. Therefore, it is not necessary to accelerate such parts from rest for drilling each and every hole. The function of the brake in such a construction is similar to the function of the brake in the structures illustrated and described above, the main difference lying in the fact that in such a modification the brake is to reduce the speed of the rotating parts only until the same reaches the low speed of the motor.

We claim:

1. In a drilling machine, a drill holding means, a rotatable weight adapted to feed said means longitudinally by the centrifugal force of rotation, a brake adapted to act on said weights to reduce the rotative speed thereof, and electromagnetic means acting on said brake to render the same inoperative during the feeding of the drill holding means.

2. In a drilling machine, a rotatable drill holding means, a rotatable weight adapted to feed said means longitudinally by the centrifugal force of rotation of said weight, a brake associated with said drill holding means and adapted to act on said weight to reduce the rotative speed thereof, a plurality of electromagnets adapted to be energized during the feeding operation, and a plate on said brake, said plate being adapted to be attracted by said electromagnets for rendering said brake inoperative.

3. In a drilling machine, a rotatable shaft, a drill holding means rotatable with said shaft, a cup secured to said shaft, a plurality of weights rotatable with said cup and adapted to feed said drill holding means longitudinally toward a workpiece by the centrifugal force of rotation of said weights, a non-rotating brake including a plate and a friction element secured to said plate and adapted to engage said cup frictionally, electromagnetic means adapted, when energized in response to movement of said drill holding means,

to act on said plate and to pull the brake away from said cup, and means adapted to cause frictional engagement of said cup by said brake when said electromagnetic means are de-energized in response to movement of said drill holding means.

4. In a drilling machine, a rotatable shaft, a drill holding means rotatable with said shaft, a cup secured to said shaft, a plurality of weights rotatable with said cup and adapted to feed said drill holding means longitudinally toward a workpiece by the centrifugal force of rotation of said weights, a non-rotating brake including a plate and a friction element secured to said plate adapted to engage said cup frictionally, electromagnetic means adapted, when energized, to act on said plate and to pull the brake away from said cup, and spring means adapted to maintain frictional engagement of said cup by said brake when said electromagnetic means are de-energized, and switch means for said electromagnetic means adapted to be actuated by said drill holding means.

5. In a drilling machine, a rotatable shaft, a drill holding means rotatable with said shaft, a cup secured to said shaft, a plurality of weights rotatable with said cup and adapted to feed said drill holding means longitudinally toward a workpiece by the centrifugal force of rotation of said weights, a brake including an armature plate and a friction element secured to said plate and adapted to engage said cup frictionally, electromagnetic means adapted, when energized, to act on said armature plate and to pull the brake away from said cup, a plurality of stationary pins engaging said plate to prevent rotation thereof, and a corresponding plurality of coil springs on said pins, said springs being adapted, when said electromagnetic means are de-energized, to maintain frictional engagement of said cup by said friction element, energizing and de-energizing of said electromagnetic means being done in response to the longitudinal movements of said drill holding means.

6. In a drilling machine, a rotatable shaft, a drill holding means rotatable with said shaft, a cup secured to said shaft, a plurality of weights arranged within said cup around said shaft and rotatable therewith, said weights being adapted to feed said drill holding means toward a workpiece by the centrifugal force of rotation of said weights, a brake including an iron plate and a friction lining secured thereto, said friction lining being adapted to engage said cup frictionally, a plurality of stationary electromagnets adapted when energized to attract said iron plate thus pulling the friction lining away from said cup, a plurality of stationary pins positively engaging said plate to prevent rotation thereof but permitting sliding thereof to and away from said cup, a coil spring on each of said pins adapted, when the electromagnets are de-energized, to push said friction lining into engagement with said cup, energizing and de-energizing of said electromagnets being responsive to the movements of said drill holding means.

7. In a drilling machine, an electric motor having an armature shaft, a drill spindle rotatable with said shaft, a cup-shaped member secured to said shaft concentrically thereof, a plurality of weights arranged within said member around said shaft and rotatable therewith, said weights being adapted to feed said drill spindle toward a workpiece by the centrifugal force of rotation of said weights, a brake assembly including an annular armature plate loosely mounted on said shaft and a friction lining secured thereto, said lining adapted to engage the outside surface of said cup-shaped member, a plurality of stationary electromagnets arranged around said shaft and adapted to be energized when said electric motor is operating, said electromagnets adapted when so energized to act on said armature plate and to pull said brake assembly away from said cup-shaped member, means preventing rotation of said plate, and spring means adapted to maintain frictional engagement of said cup-shaped member by said lining when said electromagnets are not energized, said drill spindle being effective to control energizing and de-energizing of said electromagnets.

8. In a drilling machine, an electric motor having an armature shaft, a drill spindle rotatable with said shaft, a cup-shaped member secured to said shaft concentrically thereof, a plurality of weights arranged within said member around said shaft and rotatable therewith, said weights being adapted to feed said drill spindle toward a workpiece by the centrifugal force of rotation of said weights, a brake assembly including an annular armature plate loosely mounted on said shaft and a friction lining secured thereto, said lining adapted to engage the outside surface of said cup-shaped member, a plurality of stationary electromagnets arranged around said shaft and adapted to be energized when said electric motor is operating, said electromagnets adapted when so energized to act on said armature plate and to pull said brake assembly away from said cup-shaped member, a plurality of stationary pins engaging said plate and preventing rotation thereof permitting at the same time sliding thereof toward and away from said cup-shaped member, and a coil spring on each of said pins adapted to press the brake assembly against said cup-shaped member, said spindle being effective to control energizing and de-energizing of said electromagnets.

9. In a drilling machine, a rotatable shaft, a drill spindle rotatable with said shaft, a member concentric with said shaft, secured thereto and having a cup-shaped depression concentric with said shaft on its side adjacent to said drill spindle, its opposite side being perpendicular to said shaft, a plurality of weights arranged in said depression and adapted to rotate with said shaft and to feed said drill by the centrifugal force of rotation of said weights toward a workpiece, a non-rotating brake including a straight annular armature plate and a straight lining secured thereto, said lining adapted to engage said member frictionally at the straight surface thereof, electromagnetic means adapted to be energized and de-energized in response to movements of said spindle and further adapted when energized to act on said armature plate and to pull said brake away from said member, and means adapted to maintain the engagement of said member by said brake when said electromagnetic means are de-energized.

10. A structure as defined by the preceding claim 9, said member being built-up from a plurality of stamped pieces, whereby non-operative inertia of the machine is greatly reduced.

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