

Sept. 22, 1959

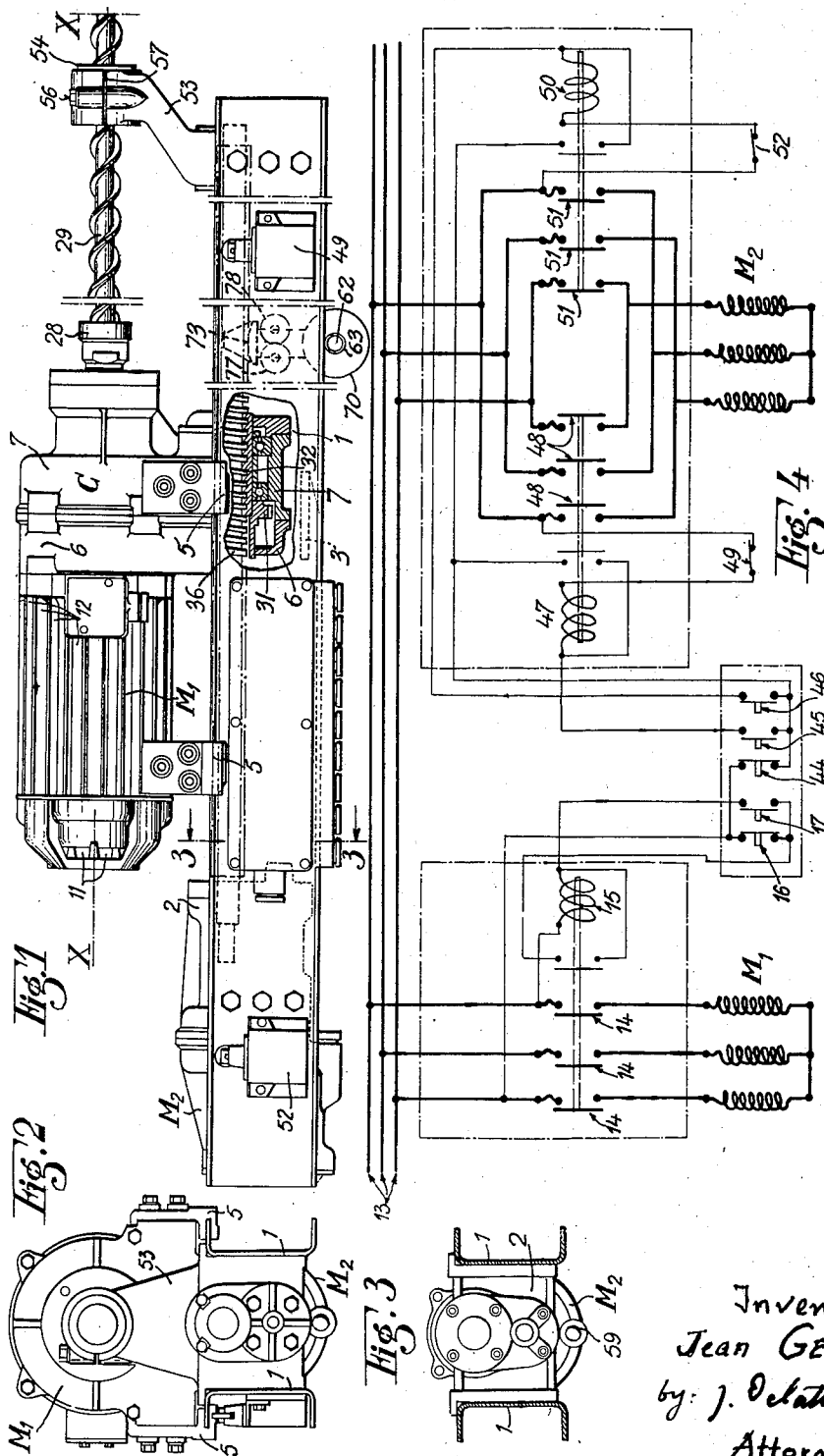
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2,905,440

VARIABLE FEED ELECTRIC DRILLING MACHINES

Filed April 3, 1953

4 Sheets-Sheet 1



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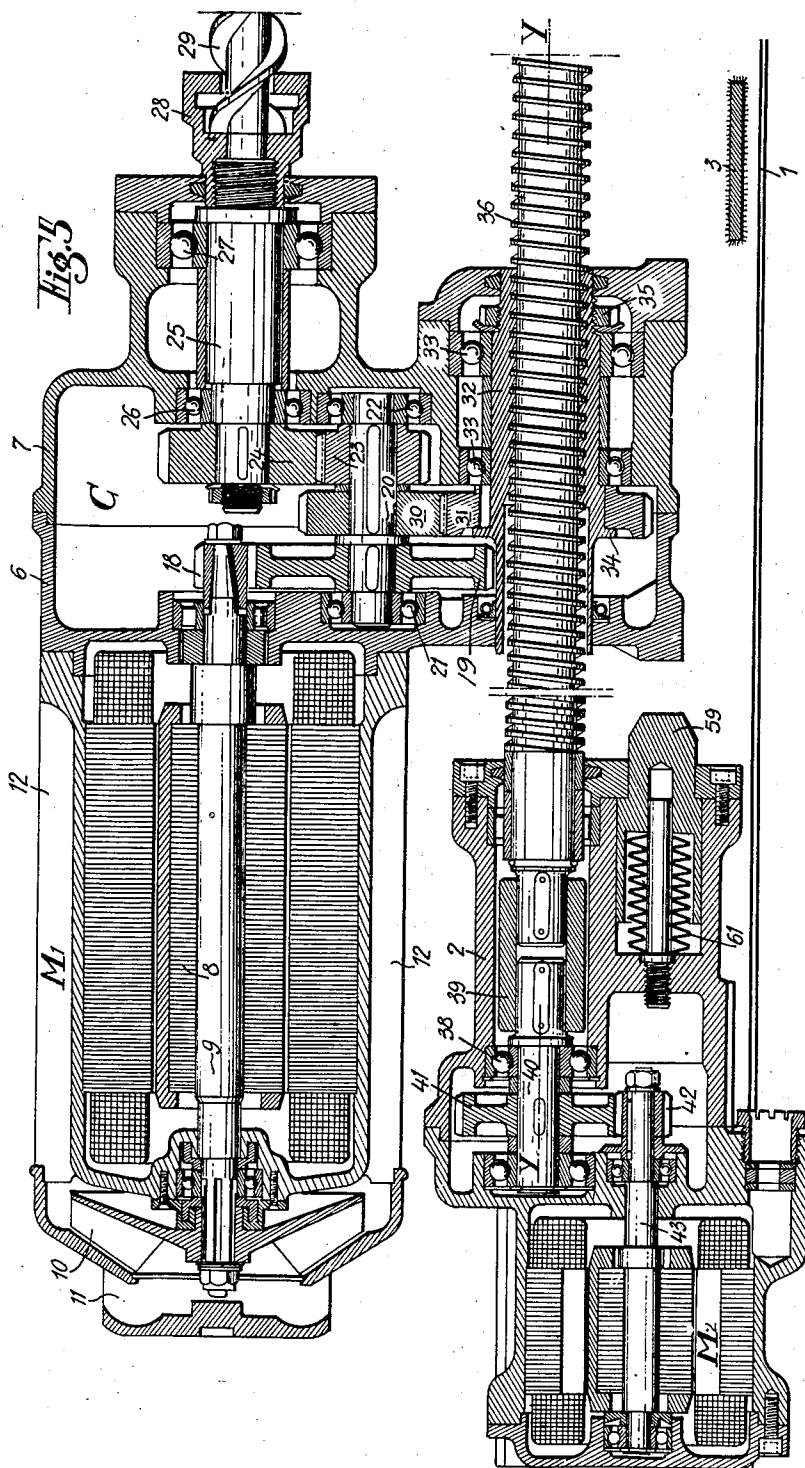
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VARIABLE FEED ELECTRIC DRILLING MACHINES

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VARIABLE FEED ELECTRIC DRILLING MACHINES

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4 Sheets-Sheet 3

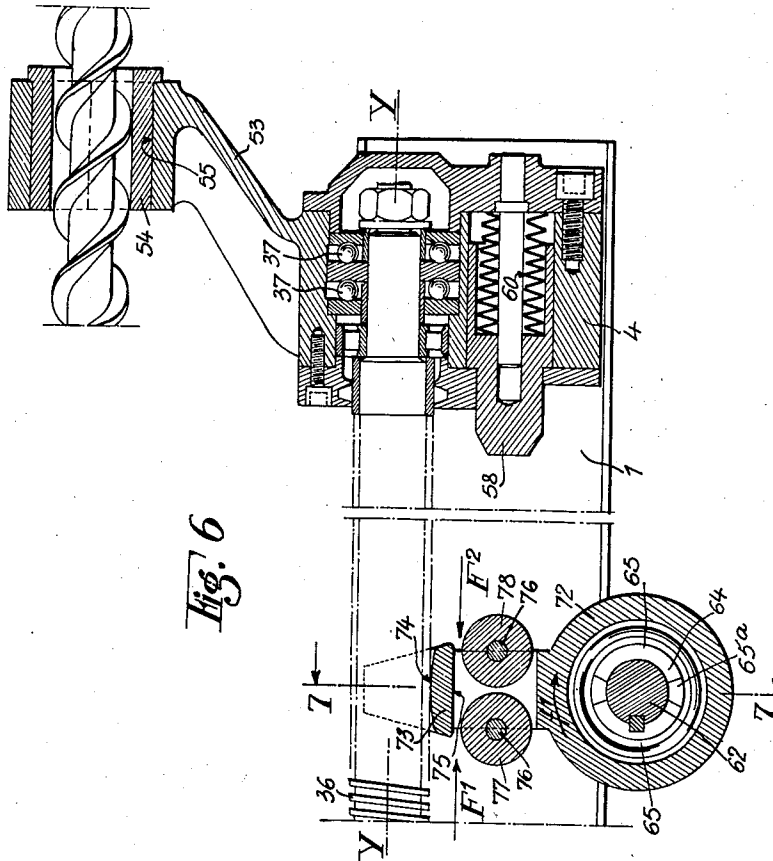
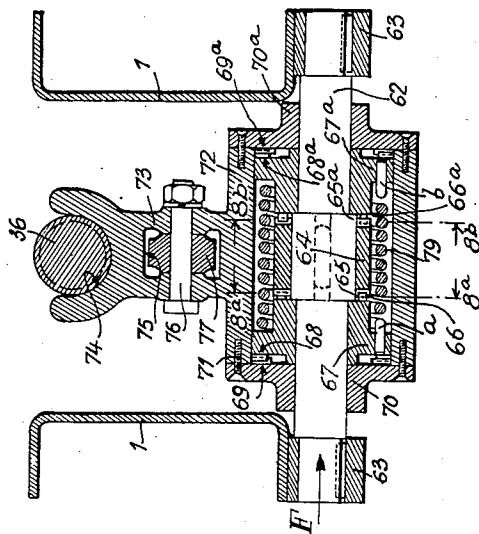


Fig. 7



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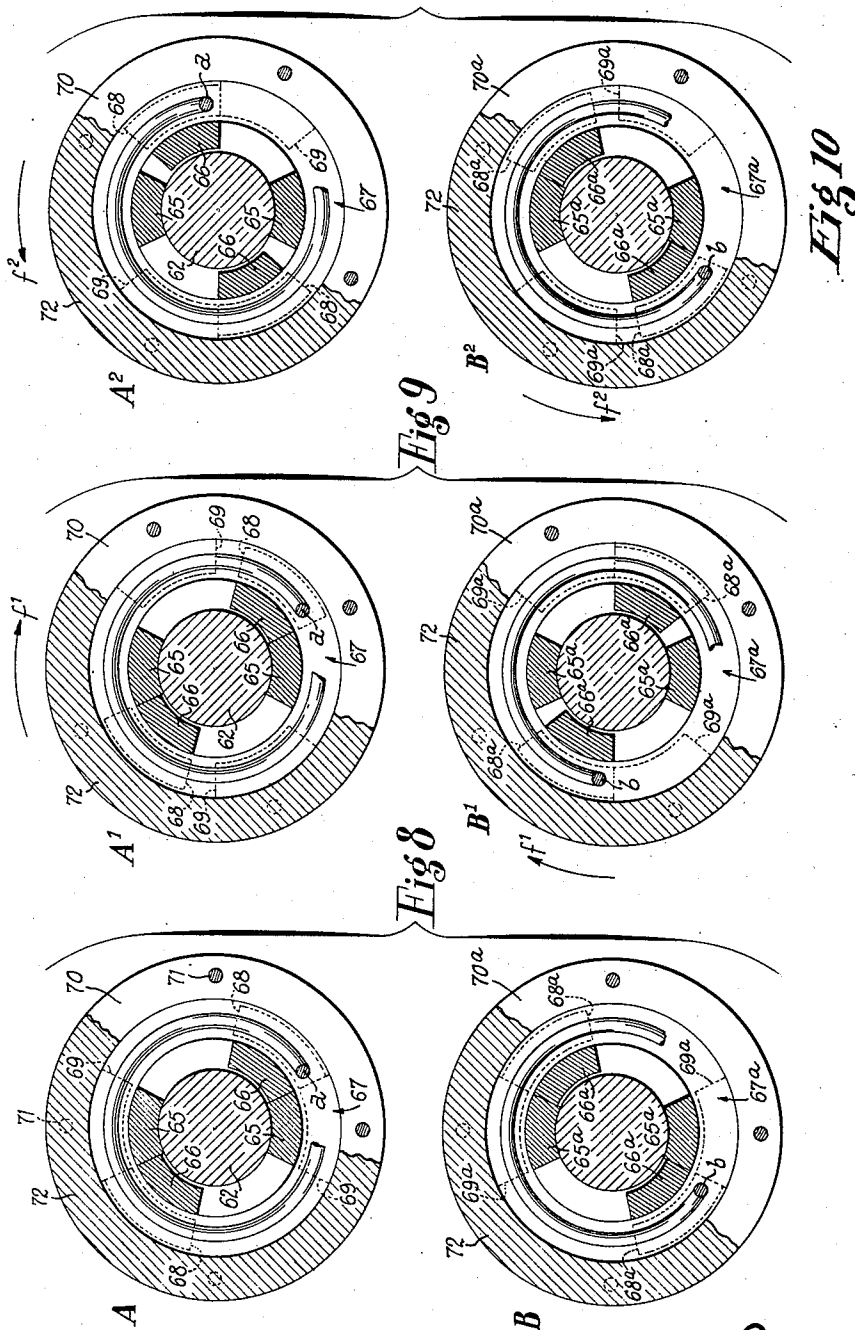
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VARIABLE FEED ELECTRIC DRILLING MACHINES

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VARIABLE FEED ELECTRIC DRILLING MACHINES

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2 Claims. (Cl. 255—47)

The present invention relates to variable feed electric drilling machines.

A variable feed drilling machine is known in which the drill or like tool is driven in rotation by a principal electric motor in which the rotor rotates with normal slip, whereas the longitudinal movements of advance and return are ensured by means of the differential actions of this principal motor and an auxiliary motor in which the rotor has a high slip and which has two drive direction controlled by a contactor-reversing switch.

In a known embodiment of this type of drilling machine, the body of the machine is fixed and the drill is placed at the end of a screw which is subjected to a helicoidal movement composed of a movement of rotation imparted to the screw by the principal motor and a longitudinal displacement, automatically variable according to the hardness of the rocks being drilled, imparted to the screw by the differential actions of the two motors obtained by turning this screw in a rotative nut which is driven in rotation by the auxiliary motor.

This known kind of machine is defective in that for drilling deep holes it is necessary to utilize a very long screw which vibrates and bows if too long. In a modification of this machine this defect could perhaps be overcome by mounting the body of the machine on a slide constituting a horizontal runway suitably supported by means of posts or other means and by utilizing a shorter screw at the end of which is disposed a drill which has as long a length as possible and which may be guided near the work by a support secured to the slide. In this modification, drilling is performed over a length corresponding to the travel of the body of the machine along the slide. The drill is then removed from the screw and left partially engaged in the drilled hole. The screw is moved back with respect to the body of the machine, the latter is fed forward along the support a distance equal to the length drilled, and the drill is once more fixed to the screw and a new drilling operation commences. This latter method has the disadvantage that fairly frequent displacements of the body of the machine are necessary.

The present invention has for its object to provide a drilling machine having an automatic feed of the foregoing type which includes two electric motors having different rotor slips and improved in such manner as to eliminate the above-described drawbacks exhibited by known machines of this type.

In this machine, which is simple in construction and permits drilling in one operation holes of great length, the drill holder is journaled in a carriage movable along a stand forming a slideway for this carriage, the movements of the carriage along this slideway being dependent on the difference between the rotation of a screw disposed parallel to the slideway and journaled in the stand and the rotation of a nut turned in this screw, and journaled in the carriage, the principal motor having normal rotor slip being carried by the carriage and driving in parallel the drill and the nut, whereas the auxiliary motor having

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high rotor slip and two directions of rotation is secured to the stand and drives the screw in rotation.

Other characteristics will be apparent from the ensuing description. In the accompanying drawings:

Fig. 1 is an elevational view of the machine;
Fig. 2 is a view of the machine at the drill end thereof;
Fig. 3 is a partial sectional view thereof through the line 3—3 in Fig. 1;

Fig. 4 is a diagrammatic layout of the electrical connections of the machine;

Fig. 5 is a partial, vertical, longitudinal, sectional view to an enlarged scale of the carriage and the drive connection between the screw and the auxiliary motor;

Fig. 6 is a similar vertical, longitudinal, sectional view of the front part of the machine;

Fig. 7 is a cross-sectional view along line 7—7 in Fig. 6, taken across a collapsible support-guide for the screw, and

Fig. 8 shows two diagrammatic cross-sectional views of this support-guide along lines 8^a—8^a and 8^b—8^b in Fig. 7 respectively but on a larger scale;

Figs. 9 and 10 show similar groups with the elements in other positions.

As shown in the illustrated embodiment, the machine comprises a frame or stand composed of two U-sectioned members 1 spaced apart at their rear end by a block or housing 2, at intermediate points by stiffening cross-pieces 3, and at the front end by a spacing member 4 (Fig. 6). This stand may be mounted on any suitable support (not shown in the drawings) fixed to the lower web portions of the U-sectioned members 1 and adapted to allow the machine to be directed in any one of several directions for purposes of drilling different holes.

The two U-sectioned members 1 constitute two parallel slideways along which is adapted to slide through the medium of slide members 5 a carriage C comprising two half-casings 6 and 7. On this carriage is fixed the principal electric motor M₁ the rotor of which is represented at 8 (Fig. 5). This motor is preferably of the external ventilator type and its shaft 9 carries at its end a fan 10 which draws air through the end piece 11 and blows it through the longitudinally extending outer ribs 12.

This principal electric motor M₁ is an ordinary, wound-armature, motor and includes a rotor having normal slip and one direction of rotation and is fed by the lead 13 (Fig. 4) through a switch 14 controlled in conventional manner by a relay 15 which is itself under the control of a stop push-button 16 and a start push-button 17.

The shaft 9 of the motor M₁ (Fig. 5) is connected by gears 18, 19 to an intermediate shaft 20 which is journaled, through the medium of ball bearings 21, 22, in the casing 6, 7 of the carriage C. The shaft 20 drives through the medium of gears 23, 24, a shaft 25 which is journaled in ball bearings 26, 27 and at the end of which is secured, by means of a connecting piece 28, a drill 29 the axis XX of which is parallel to the members 1. This shaft 20 also drives, through the medium of further gears 30, 31, a nut 32 which is journaled in the carriage C through the medium of ball bearings 33 and which is held longitudinally of this carriage by abutments 34, 35.

The nut 32 is screwed on a screw 36 having an axis YY disposed parallel to the members 1. This screw 36 is journaled at the front end (Fig. 6) in the spacing member 4 through the medium of a thrust ball bearing 37, whereas at the rear end it is centred (Fig. 5) in a ball bearing 38 carried by the block 2. Inside this block the screw 36 is connected by a sleeve 39 to a shaft 40 which is connected in rotation by means of gears 41, 42 to a shaft 43 of the auxiliary electric motor M₂ the housing of which is fixed to the block 2.

This auxiliary motor has a high rotor slip namely a large variation of the speed for a given variation of the torque, and two directions of rotation. The types of such reversible motors are well known; this motor M_2 can be, for instance, an asynchronous squirrel cage motor. It is controlled by a stop push-button 44, a feed push-button 45 and a return push-button 46 (Fig. 4). The feed push-button 45 is in series with the coil 47 of a control contactor 48 for the feed or forward travel rotation of the motor M_2 and an end of forward travel switch 49. This switch, which is ordinarily closed, is placed on the slide-way or frame in such position as to be encountered and opened by the front slide member 5 of the carriage C at the end of the latter's forward travel. Similarly, the return push-button 46 is wired in series with the coil 50 of a second control contactor 51 of the motor M_2 for the return travel rotation thereof, and an end of return travel switch 52. This switch 52, which is ordinarily closed, is placed on the slideway or frame in such position as to be encountered and opened by the rear slide-member 5 of the carriage C at the end of the latter's return or rearward travel.

The machine operates in the following manner:

Let it be supposed that the carriage is at the end of its rearward travel and the switch 52 is open. To effect a working or forward travel of the carriage, the push-button 17 of the motor M_1 and the forward travel push-button 45 of the motor M_2 are pushed. The end of forward travel switch 49 is then closed and the energized relay closes the forward travel contactor 48. Let it, moreover, be supposed that the nut 32 is driven by the motor M_1 at a speed N_1 in a clockwise direction when this nut is viewed from the rear end of the machine, that the screw 36 has a left-hand thread and a lead of p , and, finally, that the motor M_2 drives this screw at a speed N_2 , the direction of rotation of the screw 36 being, if the motor M_2 rotates for forward travel, clockwise when viewing the screw from its rear end. Under these conditions, the carriage C and in consequence the drill 29 are fed forward at a speed $(N_2 - N_1)p$. The movement is discontinued automatically at the end of the travel by the opening of the switch 49.

For the sake of simplification, it will be assumed that the gear trains 31, 30, 23, 24 have a transmission ratio equal to 1 (one). Under such assumption, the speed of rotation of the drill 29 is equal to N_1 and the advance for each rotation of said drill is equal to

$$\frac{(N_2 - N_1)p}{N_1}$$

To obtain the return travel it suffices to push the push-button 46 (the end of rearward travel switch 52 being at this moment closed). The relay 50 is energized and the rearward travel contactor 51 is closed. The movement of rotation of the screw 36 is then reversed and the return travel is effected at a high speed: $(N_2 + N_1)p$. At the end of the travel the switch 52 is opened by the carriage and, as the motor M_2 is no longer fed, the carriage stops.

The auxiliary motor M_2 and the principal motor M_1 develop torques which are proportional to the feed

$$\frac{(N_2 - N_1)p}{N_1}$$

during one rotation of the screw and the hardness of the material to be drilled, but the motor M_2 possesses a mechanical characteristic (ratio of torque to speed) which diminishes more quickly than that of the principal motor M_1 i.e. dn/dT is much greater for the motor M_2 than for the motor M_1 .

$$\frac{dN_2}{dT_2} > \frac{dN_1}{dT_1}$$

This ratio is in the form usually used in calculus, where d is a symbol denoting variations; the term dN rep-

resents speed variations and the term dT represents variations of the torque; the ratio of the variation dN with respect to the variation dT represents mathematically the derivative of the relation between the speed N and the torque T . Thus the difference $(N_2 - N_1)$ diminishes with the feed when the hardness of the material to be drilled increases so that the energy delivered to the drill 29 remains substantially constant when the hardness of said material increases or decreases.

At each instant, the torques of the motors are proportional to the efforts of resistance (longitudinal effort on advance opposed by the material to be worked on by the drill and resistant torque opposed by said material on rotation of said drill), the ratios of proportionality depending on the gear transmissions and being such that, except for the factor of efficiency, the motive power is equal to the power of resistance.

Various mechanical accessories complete the machine. At the front end of the machine (see Figs. 1, 2 and 6) is provided a drill guide composed of a support 53 forming part of, or attached to, the spacing member 4, and a detachable bushing 54, clamped in a housing 55 by means of a screw 56 which tightens the collar portion of the support which is split at 57. At the front and rear of the machine are two resilient end of travel stops comprising a piston 58 (Fig. 6) or 59 (Fig. 5) slidably mounted in opposition to a series of resilient washers 60 or 61, in the spacing member 4 or in the rear block 2. Lastly, one or several support-guides of the screw 36 are provided. This or these support-guides prevent the screw from sagging or vibrating and are pivotally retractable to make way for the passage of the carriage C in both its directions of movement. A support-guide of this kind is illustrated in Figs. 6 and 7 and diagrammatic views thereof are shown in Figs. 8 to 10.

A support-guide comprises a transverse horizontal shaft 62 keyed in brackets 63 fixed under the U-sectioned members 1 of the frame. On this shaft 62 is keyed an abutment sleeve 64 provided at each end with teeth 65 or 65^a. These teeth co-operate with conjugate teeth 66 or 66^a provided on two collars 67 and 67^a rotatively mounted on the shaft 62. These collars 67 and 67^a are provided not only with teeth 66 or 66^a but also, on their other ends, with other teeth 68 or 68^a (Fig. 7) co-operating with teeth 69 or 69^a (Figs. 8 and 10) provided on the inner faces of two plates 70 and 70^a. These plates are attached, by screws 71 or other means, to a barrel member 72 which is in this way rotatively mounted on the shaft 62. Angular movements of this barrel are allowed by free spaces provided between the teeth of the different pieces, but are limited by the teeth provided on the sleeve 64. The barrel member 72 is integral with an arm 73 which terminates in the form of a fork 74 which serves as a support for the screw 36. Below this fork the arm 73 includes a slot 75 in which are rotatively mounted about pins 76 two rollers 77 and 78 which protrude from the arm 73 on its front and rear sides with respect to the machine at points at which they would be encountered by the carriage C. The device is completed by a spring 79 wound around the sleeve 64. The ends of this spring are connected to the collars 67 and 67^a respectively at a and b .

The support-guide is shown diagrammatically in Fig. 8 at A and B, the toothed members being viewed in the direction of arrow F (Fig. 7) and the views A and B representing the dispositions of the teeth pertaining to the collars 67 and 67^a respectively. In Fig. 9, at A¹ and B¹ there are shown the same members in the positions they assume when the support-guide is encountered by the carriage in the direction of arrow F¹ (i.e. from the rear to the front of the machine). The same members in the positions they assume when the carriage C encounters the support-guide in the direction of arrow F² are shown at A² and B² in Fig. 10.

This support-guide device operates in the following way:

In its active position, it is in the position shown in Figs. 6 to 8. The collars 67 and 67^a, urged by the spring 79 in opposite directions, abut by means of their teeth 66 and 66^a against the teeth 65, 66^a of the sleeve 54. When the carriage C moves forward in the direction of arrow F¹ (Fig. 6), it encounters the roller 77 and causes the arm 73, the barrel member 72, and the plates 70, 70^a, to pivot about the shaft 62 in the direction of arrow f¹ (Fig. 9). In the course of this motion, the collar 67 cannot rotate since its teeth 66 abut against the teeth 65 on the sleeve 64, and the teeth 69 of the plate 70 can move in the gap or free space between teeth 68 (compare the identical positions of the teeth 66 and 68 of the collar 67 in the positions A and A¹ in Figs. 8 and 9). On the other hand, the teeth 69^a of the plate 70^a abut against the teeth 68^a of the collar 67^a, which is driven in rotation, its teeth 66^a passing through the free space. The point *a*, at which the spring 79 is attached to the collar 67, does not, therefore, move. The point *b*, however, at which the spring 79 is attached to the collar 67^a passes from the position *b* (Fig. 8, B) to the position *b*¹ (Fig. 9, B¹). The spring is in this way tightened and is ready to spring back and return the guide-support to the position shown in Figs. 6 and 7 when the latter is passed by the carriage. During the return motion of the support-guide, the collar 67 is still held by the sleeve 64 and does not move, the end of the spring remains at *a*, but the collar 67^a is returned to its original position in the opposite direction to arrow f¹ under the action of the spring 79. As the teeth 68^a are abutting against the teeth 69^a of the barrel member 72, the latter is returned to the position shown in Figs. 6 and 7, and, as the end of the spring *b*¹ (Fig. 9, B¹) is returned to *b* (Fig. 8, B), the tension of the spring 79 resumes its initial value.

When, on the other hand, the carriage C moves rearward in the direction of arrow F² (Fig. 6) the guide-support pivots in the direction of arrow f² and the different members pass from the positions A and B in Fig. 8 to the positions A² and B² in Fig. 10. The operation is similar to the above-described operation, but the roles of the teeth of the plates 70, 70^a and the collars 67, 67^a are reversed, and it is the end *a* of the spring which moves.

The invention is not limited to the details of construction herein described and illustrated which have been given merely by way of example.

What we claim is:

1. In a variable feed electric drilling machine, of the type which includes a principal electric rotary motor, an auxiliary reversible electric rotary motor, said two motors having rotors with different rotor slips, and an electric contactor reversing switch connected with said auxiliary motor and adapted to reverse the direction of rotation of said auxiliary motor, in combination: a frame comprising two parallel, spaced, longitudinal slideways; two spaced coaxial longitudinal bearings secured to the ends of said frame; said auxiliary motor being attached to the rear end of said slideways; a carriage supporting said principal motor; two thrust bearings on said carriage; slide members mounting said carriage for sliding movement on and along said slideways; a drilling tool holder rotatably

mounted in said carriage; a first set of driven rotary means connecting said tool holder with said principal motor, said motor rotating said tool holder by said first set of driven means; a nut journaled in said thrust bearings on said carriage, said nut being rotatable on said carriage and prevented from moving longitudinally with respect to said carriage; a second set of driven rotary means connecting said nut with said principal motor, said motor rotating said nut by said second set of driven means; a screw parallel to said slideways and rotatably mounted in said coaxial bearings secured to said frame; said nut threadingly engaging said screw; a third set of driven rotary means connecting said screw with said auxiliary motor; said auxiliary motor rotating said screw by said third set of driven means; the displacements of said carriage along said slideways depending upon the difference between the speeds of rotation imparted to said screw on said carriage and to said nut on said frame by said auxiliary and principal motors respectively; at least one intermediate support-guide for said screw, said support-guide being pivotably mounted on said frame, said support-guide being retractable downward in said frame to allow the free passage of said carriage in its forward and rearward movements on and along said slideways.

2. A drilling machine as claimed in claim 1, in which said support-guide comprises: a shaft attached to said frame transversely of said slideways; an oscillating arm mounted on said shaft; a fork at the end of said arm and adapted to guide and support said screw; a sleeve keyed on said shaft; two circular plates coaxial with said shaft, disposed at both ends of said sleeve and attached to said arm; two collars rotatably mounted around said shaft at both ends of said sleeve, between said sleeve and said plates; a helical spring wound around said sleeve and connected by its ends with said collars, and tightened upon any relative rotation, outside their normal position, of said collars around said shaft, said normal position corresponding to that in which said fork guides and supports said screw; first abutment teeth at each side of said sleeve; second abutment teeth on each inner face of said collars and adapted to engage said first teeth; third abutment teeth on the side faces of said collars; fourth abutment teeth on the inner faces of said plates and adapted to engage said third teeth; circumferential clearances being provided between said first and second teeth, and between said third and fourth teeth, whereby, on the one hand, one of said collars can rotate in one direction over a limited angle with respect to the sleeve and the other collar can rotate in the opposite direction over an equal angle with respect to the sleeve, and, on the other hand, each of said plates can rotate over the said limited angle with respect to its cooperating collar in the direction in which said cooperating collar cannot rotate.

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