May 23, 1939. R. K. JEFFREY 2,159,087

DRILLING MACHINE

Original Filed May 14, 1934 5 Sheets-Sheet 1

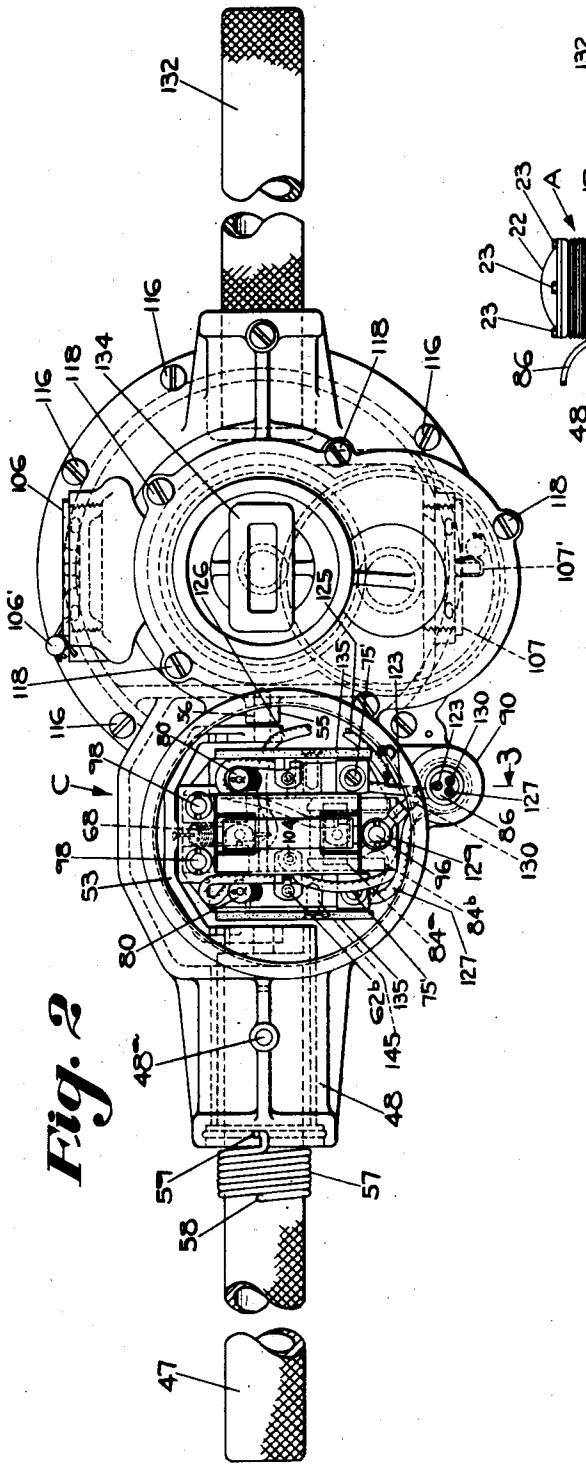


Fig. 2

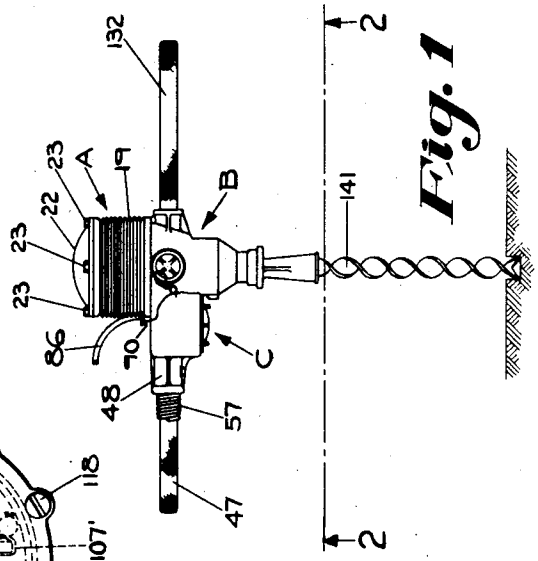


Fig. 1

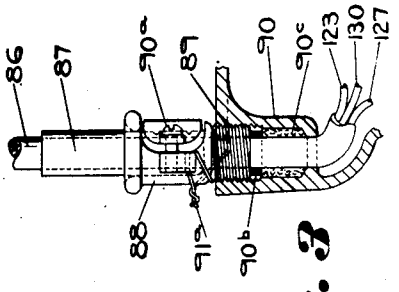


Fig. 3

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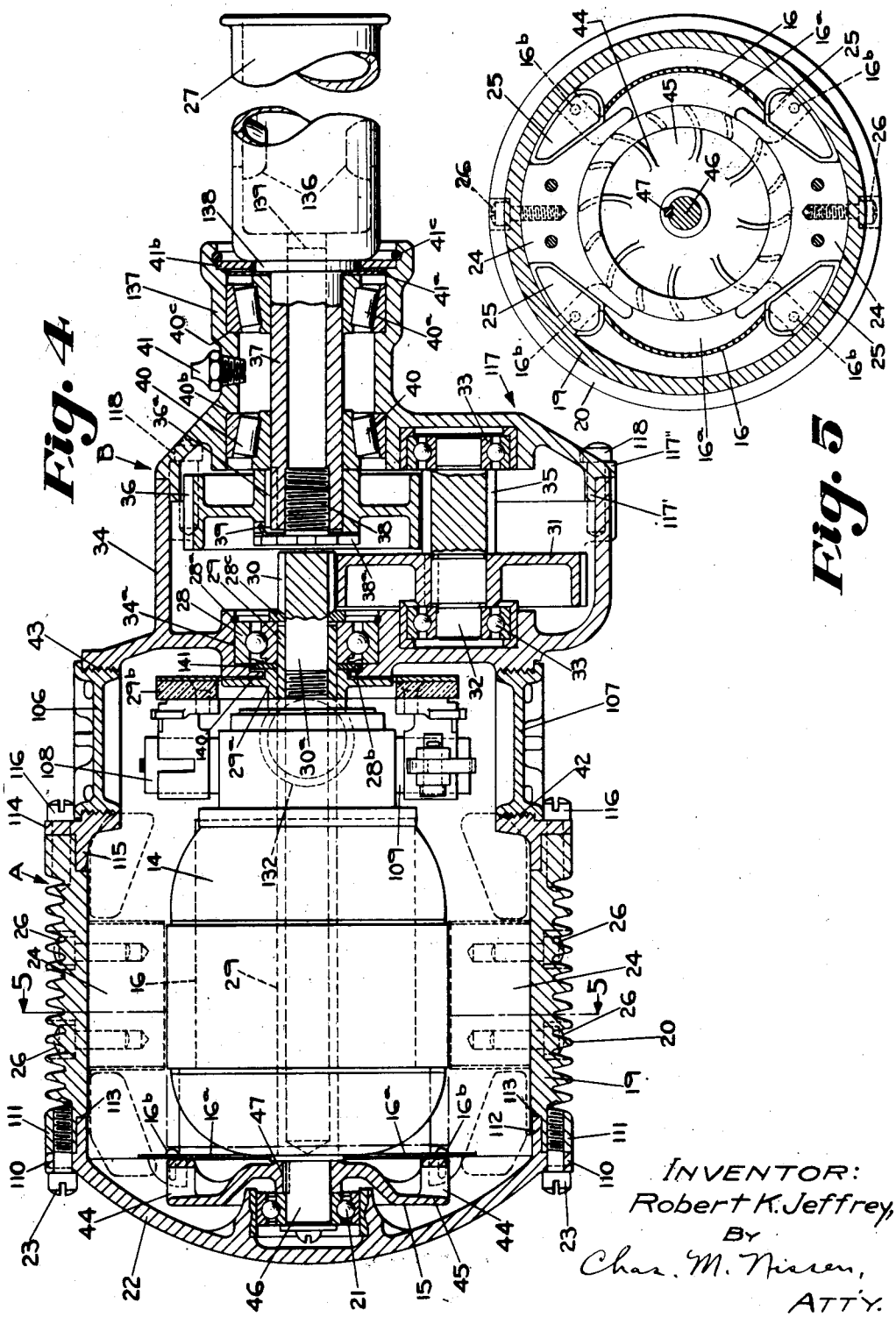


Fig. 4

Fig. 5

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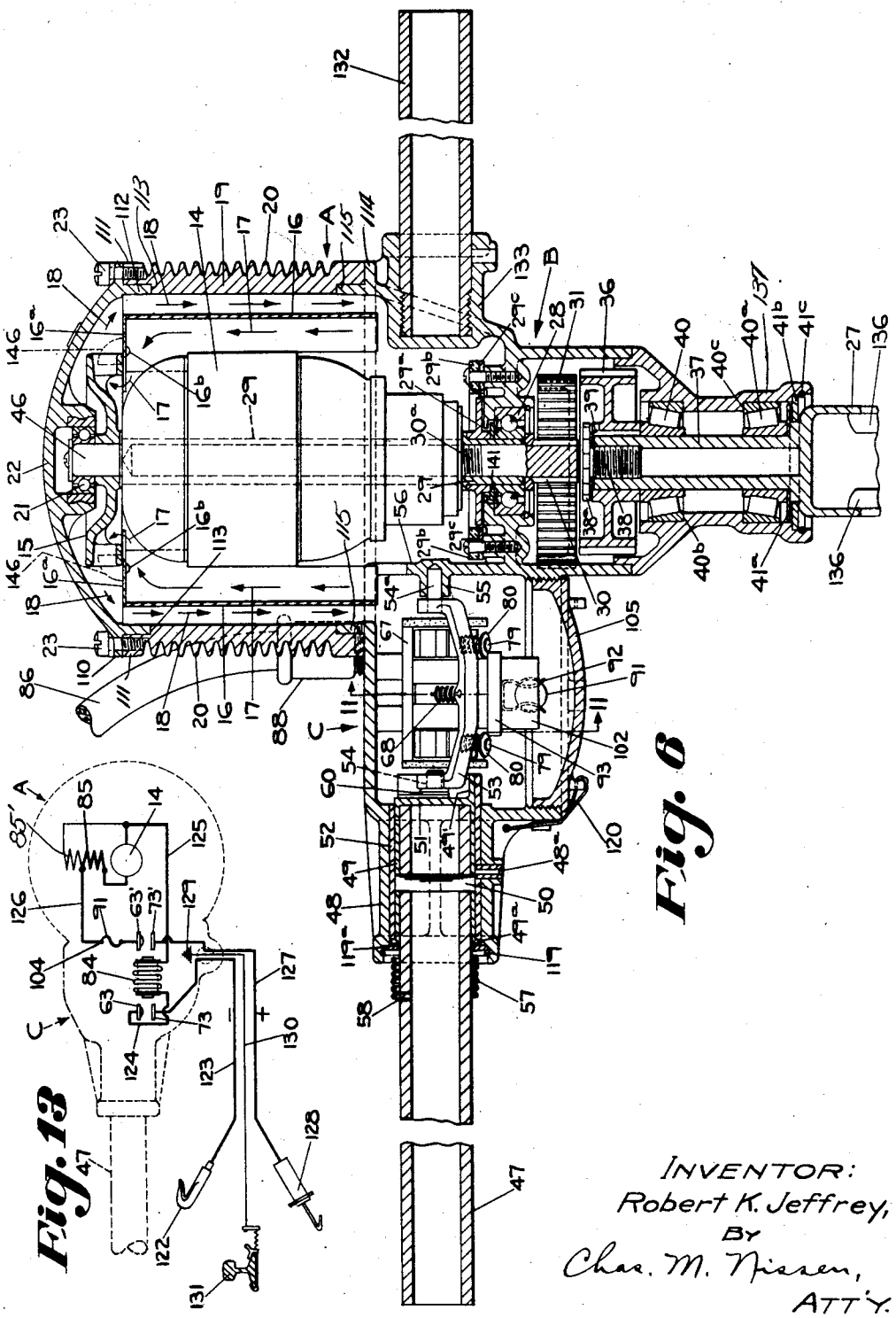


Fig. 8

Fig. 13

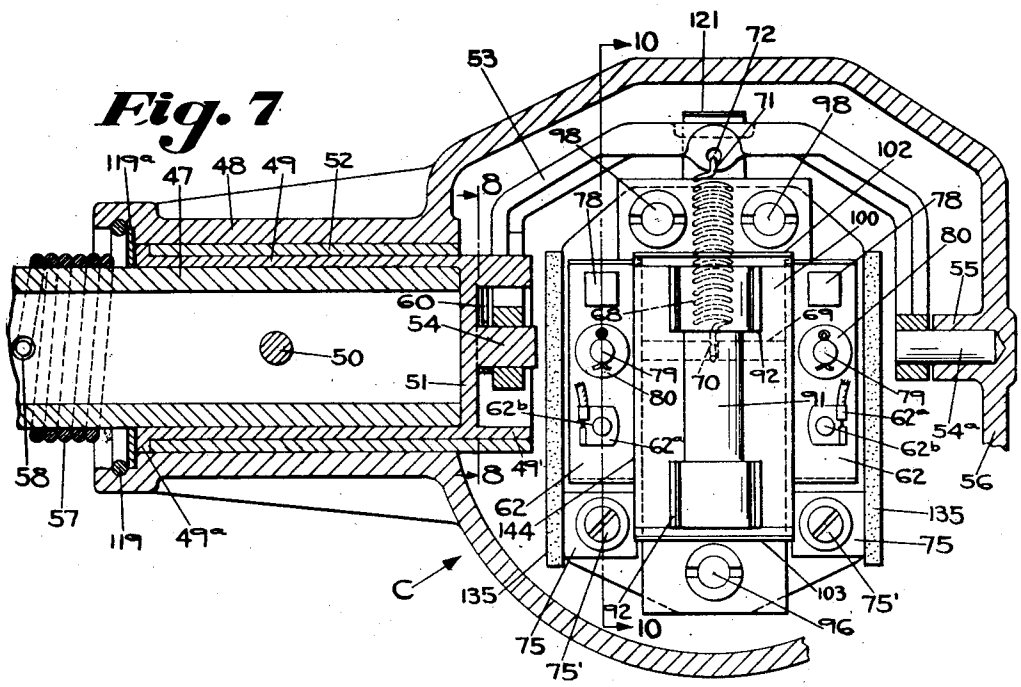
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DRILLING MACHINE

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Fig. 7



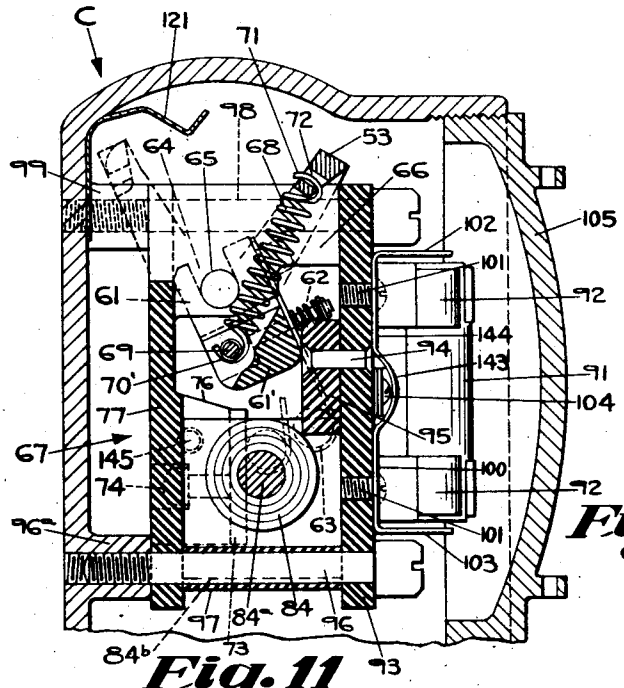


Fig. 11

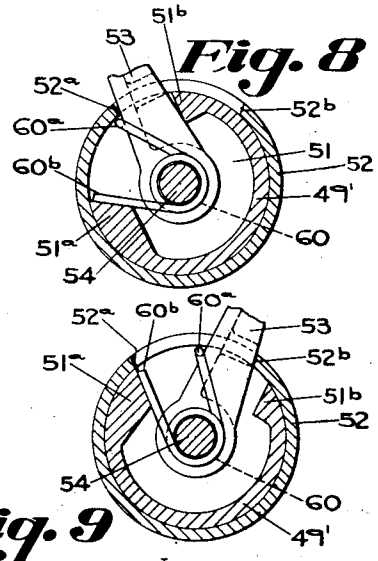


Fig. 8

Fig. 9

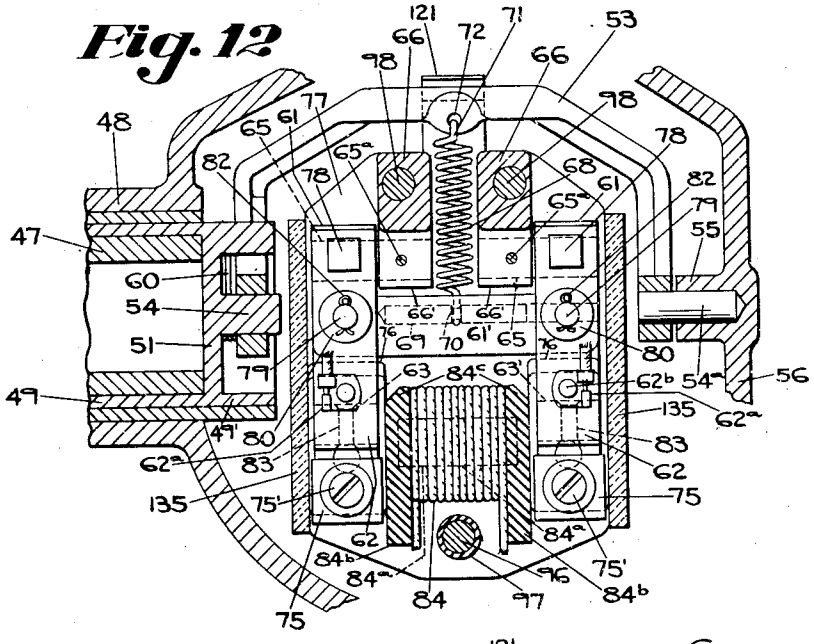
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Fig. 12



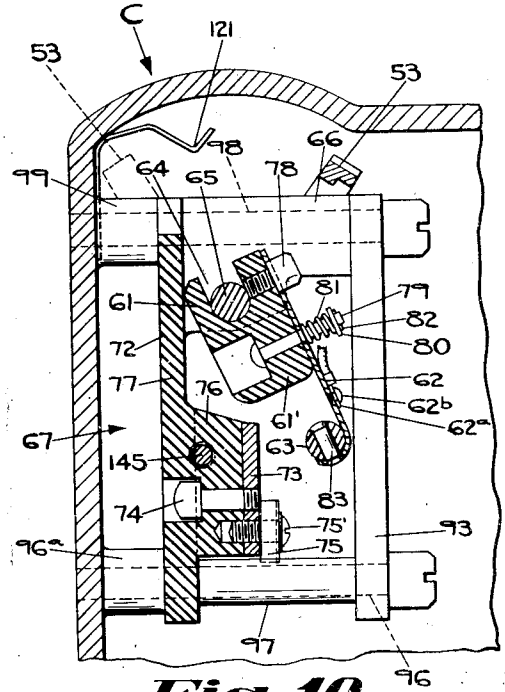


Fig. 10

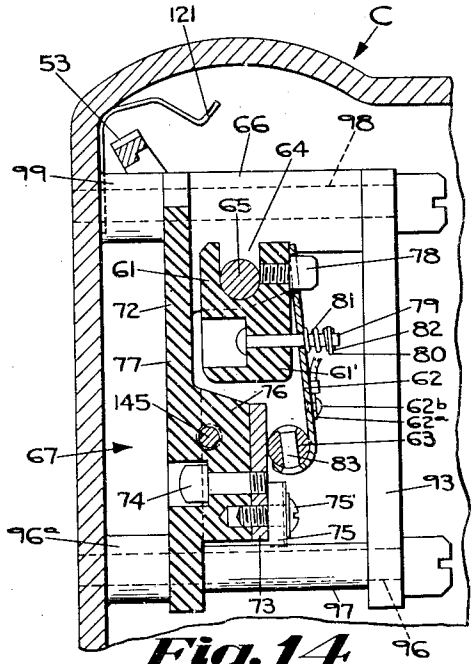


Fig. 14

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UNITED STATES PATENT OFFICE

2,159,087

DRILLING MACHINE

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Application May 14, 1934, Serial No. 725,504
Renewed October 26, 1938

7 Claims. (Cl. 172—36)

The present invention relates to portable drilling units of the manually supported type and although particularly adapted for use in drilling operations in coal mines, it may have a general application.

One of the objects of the present invention is the provision of improved and efficient mechanism for a portable manually supported drilling machine to reduce the weight thereof to a minimum.

More particularly it is the object of the present invention to provide a drilling machine sufficiently light in weight to enable it to be efficiently handled by a single operator without necessitating mounting of the drilling machine on any support.

Another object of the invention is the provision of drill operating mechanism compactly arranged in a flame-proof casing in a drilling machine capable of being manually supported during operation.

Another object of the invention is the provision of controlling mechanism for the motor of a drilling machine, operable by means of a lifting handle to effect starting of the machine, combined with means for automatically stopping the machine upon release of the handle.

A further object of the invention is the provision of improved and efficient electric switch mechanism for controlling an electric motor of a drilling machine, including means for holding the switch closed until opened with a snap action to reduce the arcing to a minimum.

A still further object of the invention is to provide a portable manually supported drilling machine with the center of gravity placed behind the axis of lifting handles to effect such counterbalancing of the weights of the parts of the machine as to facilitate free handling of the machine.

Another object of the invention is the provision of improved and efficient air circulating mechanism about the operating motor of a drilling machine within an enclosing casing to increase the heat radiating capacity of the latter and thereby effect cooling of the motor to prevent overheating thereof during operation of the drilling machine.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings:

Fig. 1 is a plan view of my improved drilling machine with a drill connected thereto in drilling position;

Fig. 2 is an elevational view taken on the line 2—2 of Fig. 1 with the drill removed from its socket and the cover for the switch housing removed to show in elevation the electric switch for controlling the operating motor;

Fig. 3 is a view taken on the line 3—3 of Fig. 2, looking in the direction of the arrows, showing mechanism for clamping to the casing of a machine a power cable of electric wires leading from the source of power to the electric motor of the machine;

Fig. 4 is a longitudinal sectional elevational view of the motor and power transmission mechanism enclosed by a flame-proof casing;

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 4, looking in the direction of the arrows;

Fig. 6 is a sectional plan view of the drilling machine including the air circulating mechanism and the heat radiator for the electric motor;

Fig. 7 is a fragmentary sectional elevation of the switch mechanism and the mechanism for effecting the operation thereof manually to closed position and automatically to open position;

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 7, looking in the direction of the arrows, and showing the relative positions of the switch operating handle and the switch yoke when the switch is closed;

Fig. 9 is a view similar to Fig. 8, but showing the relative positions of the switch operating handle and switch yoke when the switch is in open position;

Fig. 10 is a sectional view taken on the line 10—10 of Fig. 7, looking in the direction of the arrows;

Fig. 11 is a sectional view taken on the line 11—11 of Fig. 6;

Fig. 12 is a sectional view similar to Fig. 7, with certain parts broken away to show more clearly the elements of the switch mechanism;

Fig. 13 is a wiring diagram to illustrate the electrical connections from the source of power to the motor and the electric switch; and

Fig. 14 is a view similar to Fig. 10, but showing the electric switch in closed position.

Referring more particularly to the drawings, it will be observed that the drilling machine shown in plan in Fig. 1 comprises a motor, power transmission mechanism and an electric controlling switch very compactly arranged in a flame-proof casing as shown in Fig. 6. The casing or housing comprises a plurality of compartments detachably connected and arranged and designed for maximum compactness and minimum weight to facilitate handling of the machine during op-

eration. As shown in Fig. 6, A designates the motor compartment, B the power transmission compartment, and C the motor switch compartment. The casing or housing comprising the three compartments or sections A, B and C is preferably constructed except the motor field frame by an assembly of castings of magnesium-aluminum alloy which has the advantage of being very light in weight, easily machined, and having high thermal conductivity or heat radiating capacity for cooling of the motor and preventing overheating thereof.

The motor compartment A is provided with a cover 22 having the shape of a segment of a sphere. The cover 22 is provided with an annular peripheral flange 110 which is adapted to fit against an annular seat at that end of the cylindrical radiator 19 designated 111. By means of cap screws 23 spaced circumferentially around the flange 110, the latter together with the cover 22 may be detachably secured to the end 111 of the radiator 19.

It should be particularly noted that the cover 22 is provided with a cylindrical inwardly extending flange 112 to fit against the annular shoulder 113 with its inner surface flush with the inner cylindrical surface of the radiator 19 which also serves as a casing for the motor as hereinafter more fully explained. The flange 112 is of sufficient length to effect a flame-proof closure for the end 111 of the casing 19 because of the length of the tortuous passageway between the interior of the casing and the outside atmosphere. Consequently, when the drilling machine is used in a gaseous mine and there should be an explosion of a gaseous mixture within the casing no flame can reach the atmosphere outside of the casing even though there should be a gaseous passageway or crevice along the annular spaces between the flange 112 and the end 111 of the radiator 19. As will appear more fully hereinafter, all of the parts enclosing the motor, power transmission mechanism and the switch are so assembled as to provide tortuous surfaces of sufficient length to cool ignited gases before a flame can reach the atmosphere outside of the enclosure.

As shown in Figs. 4 and 6 the compartment B is provided with flanges 114 and 115 similar to flanges 110 and 112 respectively. The compartment B is detachably secured to the compartment A by means of circumferentially spaced screws 116. A flame-proof connection between the compartment B and the compartment A is thus provided with the inner surface of the flange 115 flush with the inner surface of the motor casing.

The compartment B comprises two sections 34 and 117, the latter being provided with a cylindrical flange 117' and a peripheral flange 117'' detachably secured to the section 34 by means of the circumferentially spaced screws 118 to form a flame-proof connection between the sections 34 and 117 similar to the flame-proof connections at 114—115 and 110, 112.

The motor compartment A is provided with screw-threaded covers 106, 107 threaded at 43 and 42 respectively into the section 34 as shown in Fig. 4. When these covers are closed they may be locked in closed position by means of the seals shown at 106' and 107' in Fig. 2. When these seals are broken a spanner wrench may be used to open the covers to provide access to the brushes 108 and 109 of the electric motor 14 as shown in Fig. 4. The screw threads at 42 and 43 when the covers are closed afford tortuous lines of contact of sufficient length to make the covers 106 and 107 flame-proof between the interior of the casing and the exterior atmosphere.

In a tubular extension 137 of the section 117 of the compartment B is mounted on the roller thrust bearings 40 and 40a a shaft 37 which is preferably hollow to lessen the weight of the drilling machine while being manually supported for operation. Between the shaft 37 and the drill socket 27 which is mounted at the outer end of the hollow shaft 37 is an annular collar 138 to provide an annular seat for the ring 41a which is held in place against such annular seat when the inner race of the roller thrust bearing 40a is secured to the outer surface of the hollow shaft 37 as shown in Fig. 4. By means of a resilient snap ring 41c a ring shaped plate 41b is held against an annular seat in the outer end of the tubular support 137 with the inner edge of the ring 41b spaced from the peripheral surface of the collar 138 but in contact with the rear end of the annular surface of the drill socket 27 as shown in Fig. 4. When the drill socket rotates the ring 41a rotates with it but this ring does not engage either the ring 41b or the tubular support 137 since it is spaced from both of them. This arrangement provides not noly a seal to prevent the ingress of coal dust or other material into the interior of the compartment B but also affords a tortuous passageway between the interior of the support 137 and the exterior atmosphere of sufficient length to serve as a flame-proof closure in a gaseous mine during operation of the drilling machine. The outer end of the hollow shaft 37 may, if desired, be entirely closed at 139. The inner end is screw-threaded to receive the screw plug 38 which is provided with a head 38a which is so constructed as to enable the lock washer 39 to cooperate therewith and with the hub of the gear 36 to lock the screw plug 38 securely to the hollow shaft 37 to rotate therewith and with the gear 36 which is keyed at 36a to the hollow shaft 37.

The outer races of the roller thrust bearings 40 and 40a fit against annular shoulders 40b and 40c as shown in Fig. 4. The inner race of the roller thrust bearing 40 is secured to the outer surface of the hollow shaft 37 in position for one end of the hub of the gear 36 to abut against the same. It will thus be seen that the screw plug 38 and the lock washer mechanism mounted thereon and associated with the hub of the gear 36, lock the latter against longitudinal displacement relative to the hollow shaft 37. The thrust bearings serve to resist longitudinal displacement of the drill socket relative to the tubular support 137 both when the drill is fed into the mine vein and when it is pulled out of the drill hole.

By referring to Figs. 4 and 6, it will be seen that the drill socket of the shaft 37 is axially alined with the tubular armature shaft 29 which is mounted for rotation in the ball bearing 28 and the section 34 of the compartment B. The shaft 29 on which the armature of the motor is mounted is made hollow throughout almost its entire length so as to assist in reducing the weight of the drilling machine. One end of this hollow shaft is screw-threaded to receive the screw-threaded extension 30a while the extension 46 at the other end may be solid and integral with the hollow shaft as shown in Fig. 4. The extensions 30a and 46 serve respectively as shafts for the pinion 30 and the fan 15 hereinafter more fully described.

Mounted on the shaft 29 is a collar 29ª adjacent to an annular flange 140 on the outer side of which there is located a washer 141 between the hub of the collar 29ª and the inner race of the ball bearing 26. This arrangement serves as a flame-proof connection between the interior chamber in the compartment A and the interior chamber in the compartment B. If the flame-proof connection at 140 is omitted, reliance may be had on the flame-proof connection at 41ª but it is preferred to use both of the flame-proof connections shown in Fig. 4 at 140 and 41ª so that double assurance may be had that any flame produced by an explosion of a gaseous mixture in the compartment A will not find its way through the compartment B to the outside atmosphere. It will also be noted that the hub of the ring collar 29ª serves to space the motor armature in a predetermined position relative to the section 34 of the compartment B. Inasmuch as the end thrust on the armature shaft of the motor is small during rotation, the ball bearings 21 and 28 held in place as shown in Fig. 4 are sufficient to prevent longitudinal movement of the armature shaft 29 relative to the enclosing casing. The ball bearing 21 is mounted in a cup shaped seat at the center of the inner side of the cover 22. The ball bearing 28 is mounted in a cup shaped seat 34ª and it is held in place by the resilient snap ring 28ª. The brush holder support 29ᵇ is ring shaped and secured to the bosses 29ᶜ as shown in Fig. 6, in spaced relation to the collar 29ª which, together with the washer 141, rotates with the hollow shaft 29. The inner race of the ball bearing 28 fits against an annular seat formed by the collar 28ᶜ mounted at the inner end of the pinion 30 on the pinion shaft 30ª which is screw-threaded into the hollow shaft 29 as shown in Fig. 4.

The pinion 30 meshes with a gear 31 mounted on a shaft 32 the ends of which are mounted on the ball bearings 33, 33. The shaft 32 carries a pinion 35 which meshes with a gear 36. It will thus be seen that reduction gearing is provided in the section 34 of the compartment B to serve as power transmission mechanism between the armature shaft 29 and the hollow tool socket shaft 37 with the shafts 29 and 37 in axial alinement with each other.

In Figs. 4 and 6 the tool socket 27 is shown as being provided with interior lugs 136, 136 which are adapted to cooperate with the drill shank to hold the latter in position in the socket during the drilling operation. The lugs 136 may be formed of rivet heads welded or otherwise secured in place as shown in Fig. 4. In Fig. 2 a modified form of drill socket is shown at 134 for receiving the standard type of tapered drill shanks.

In order to support the drilling machine manually during operation with its center of gravity back of the alined hollow handles 47 and 132 or away from the drill socket 27, said handles are connected to the casing of the machine so as to extend in opposite directions as shown in Fig. 1 at right angles to the axis of the motor shaft and of the drill. The handle 132 as shown in Fig. 6 is screw-threaded into the socket 133 of compartment B and the handle 47 is connected to the compartment C so as to be in alinement with the handle 132 along a line intersecting the axis of the motor shaft and extending at right angles thereto at that end of the motor armature which is connected by the extension shaft 30ª to the power transmission mechanism.

During operation of the drilling machine the handle 132 remains rigidly connected to the supporting casing but the handle 47 is mounted for limited rotation.

Mounted in the tubular extension 48 of the compartment C is a bushing 52 to serve as a journal bearing for the cup shaped sleeve 49 which is secured by means of the pin 50 to the inner end portion of the hollow handle 47. The bushing 52 is secured to the tubular extension 48 by means of the pin shown at 48ª. A portion of the bushing 52 extends inwardly to form fixed abutments 52ª and 52ᵇ as shown in Figs. 8 and 9, which abutments are stationary relative to the supporting casing or frame of the drilling machine.

The outer end of the sleeve 49 is provided with an annular flange 49ª which is adapted to abut against the outer end of the bushing 52 as shown in Fig. 6. A retaining washer 119ª and a snap ring 119 serve to hold the annular flange 49ª in its position against the outer end of the bushing 52 as shown in Fig. 6.

The outer end of the tubular support 48 is recessed not only to provide annular seats for the washer 119ª and the snap ring 119 but also the inner end of the coil spring 57 which inner end is secured at 59 to the tubular support 48 as shown in Fig. 2. The outer end of the spring 57 is secured at 58 to the tubular handle 47 as shown in Figs. 2 and 6. The inner end 51 of the sleeve 49 is provided with an extension 49′ which is provided with a spring seat 51ª and a movable abutment 51ᵇ. When the handle 47 is released the spring 57 acts to move the abutment carrier 49′ to a position shown in Fig. 9.

Projecting axially from the center of the plate 51 as shown in Fig. 6, is a bearing 54 about which is coiled the intermediate portion of the spring 60, one end of which at 60ᵇ rests against the seat 51ª and the other end of which at 60ª bears against the yoke 53 one end of which is journaled on the bearing 54 and the other end of which is provided with a shaft 54ª which is journaled in the bearing 55 as shown in Fig. 6. The shaft 54ª is in axial alinement with the bearing 54. The yoke 53 is connected to electric switch mechanism for controlling the starting and stopping of the electric motor by means of the circuits and connections diagrammatically illustrated in Fig. 13. When the handle 47 is turned in one direction the switch will be closed and the motor started to operate the drill 141 while the drilling machine is supported manually and fed manually into the coal vein. The rotation of the handle 47 to close the switch places such tension in the spring 57 that when the handle 47 is released by the operator the spring 57 will act automatically to restore the switch to its open position and thereby effect stopping of the motor.

Inasmuch as it is desirable to open the switch with a snap action or effect very quick separation of the contacts of the electric switch in order to reduce the arcing to a minimum when the circuit of the electric motor is broken, compactly arranged automatic switch operating mechanism is mounted in the compartment C and connected to the handle 47 as shown in Figs. 6, 8 and 9.

The switch mechanism is mounted between blocks of insulating material 77 and 93 which are secured to the bosses 96a and 99 by means of the screw-threaded ends of the cap screws 96 and 98 and the insulating spacing tubes 97 and 66 as shown in Figs. 10, 11 and 14.

The spacers 66 may be integral with the insulating block 77 and each provided with a depend-

ing support 66' provided with alined openings for receiving the inner ends of laterally projecting bearings 65, 65 which may be pinned to the support 66' as indicated at 65a in Fig. 12.

As shown in Figs. 10, 11, 12 and 14, insulating blocks 61 are provided with upwardly opening slots or recesses 64 to fit over the bearings 65 from the underside of the latter. The insulating blocks 61 are rigidly connected by the transverse insulating cross-piece 61'. Between the blocks 61 and parallel to the crosspiece 61' is mounted a transverse pin 69 having a groove 70 intermediate its ends for receiving the lower end 70' of the spring 68, the upper end of which is hooked at 71 through the opening 72 at the upper central portion of the yoke 53.

Each of the insulating blocks 61 carries a metallic strip or finger 62 the lower end of which is pinned at 83 to the copper contact 63. At the upper end of each metal strip 62 is a square hole adapted to fit loosely over the squared head 78 of a screw inserted in the upper portion of the block 61 as shown in Figs. 10 and 14. This arrangement prevents the contact carrying strips or fingers 62 from swiveling in its own plane but a limited movement of the strip 62 transversely of its own plane is permitted to secure a wiping action of the contact 63 against the metal plate 73 when the switch is moved from its open position in Fig. 10 to its closed position in Fig. 14.

A pin 79 secured to each block 61 projects through a hole in the strip 62 intermediate its ends. Each pin 79 is provided with a collar 80 with a spring 81 between the same and the outer surface of the strip 62 as shown in Figs. 10 and 14. A cotter pin 82 holds the collar 80 in place. When the block 61 is moved to the position shown in Fig. 14 the spring 81 holds the contact 63 yieldingly against the metal plate 73. As shown in Figs. 10 and 14, the metal plate 73 is secured by means of the cap screw 74 to the base block 76 of insulating material which may be integral with the insulating block 77.

By referring to Fig. 12, it will be seen that spaced-apart electric terminals may be afforded by the metal plates 75, 75 secured to the metal plates 73, 73 by means of the screws 75', 75'. Electric terminals 62a, 62a are riveted to the contact carrying strips 62 as shown at 62b, 62b. As shown in Fig. 13, the switch is two-pole in that one electric conductor extends through the contacts 63, 73 and another conductor extends through the contacts 63', 73', said conductors being respectively connected to the supply mains.

In order to minimize arcing during operation of the switch mechanism, there is mounted between the insulating blocks 77 and 93 within the space between the base blocks 76, 76, a blow-out coil 84 having an iron core 84a the ends of which project through openings into insulating blocks 84b, 84b so as to occupy positions closely adjacent to the points of engagement between the contacts 63 and the plates 73. As shown in Fig. 13 the winding of the blow-out coil 84 is connected in the motor circuit and in series with the two sides of the double-pole switch. When the switch is open the blow-out coil acts to lengthen the arcs between the contact 63 and the plate 73 aiding the disruption of such arcs.

As a precaution against the burning of any of the parts when such arcs are formed upon the breaking of the circuits at the switch contacts in the compartment C, plates 135, 135 of asbestos or other non-inflammable material are secured at 145, 145 to the outer surfaces of the base blocks 76 at the sides of the switch mechanism as shown in Fig. 12. The securing means at 145, 145 may be screws extending into the blocks 76 as shown in Figs. 10 and 14. The end blocks 84b, 84b of the blow-out coil are also preferably made of asbestos or other non-inflammable material.

A safety fuse 91 is mounted between clips 92, 92 and connected in the motor circuit as shown in Fig. 13. The compartment C in which the switch mechanism is mounted is provided with a cover 105 screw-threaded to closed position and sealed in closed position as illustrated at 120 in Fig. 6. Access may be had to the interior of the compartment C for renewal of the blown-out fuse 91 by removing the cover 105 but not until the seal 120 has been broken.

Secured to the insulating block 93 by means of the screws 101, 101 is a plate of insulating material provided with upper and lower extensions 102 and 103 at right angles to the block 93 and extending across the outer ends of the clips 92, 92 as shown in Fig. 7 so as to prevent any possibility of grounding of the clips 92, 92 through the heads of the screws 96, 98 to the metal frame or casing of the drilling machine. A connector 104 as shown in Fig. 11 for the conductor 126 shown in Fig. 13 may be mounted back of a curved portion 143 of the shield 144 for protection thereby.

In order properly to space the ends of the iron core 84a of the blow-out coil 84 from the switch contacts 63, 73 a retaining block 95 of insulating material is riveted at 94 to the inner surface of the insulating block 93 as shown in Fig. 11. The lower corners of the block 95 are suitably notched to fit over the beveled upper edges 84c of the rectangular end insulating blocks 84b. The latter are also clamped by means of the screws 96 and 98 between the insulating blocks 93 and 77.

It should be particularly noted that when the cover 105 is removed the entire switch unit may be removed and taken apart for the purpose of repair or replacement. This is particularly true with respect to the contact carrying mechanism because the open slots 64 permit the insulating block 61 together with the crosspiece 61' to be removed from the bearings 65, 65 against the action of the spring 68. If desired, the contact carrier may be readily detached from the hook 70' at the lower end of the spring 68. When the retaining ring 119 shown in Fig. 7 is removed the handle 47 may be removed from the journal bearnig 52 thus disconnecting the handle from the yoke 53 and permitting the removal of the latter from the bearing 55.

When all of the parts of the drilling machine are in assembled relation ready for operation, the electric switch may be closed to effect starting of the motor by rotation of the handle 47 against the action of the spring 57 in an anticlockwise direction as viewed in Fig. 9. When the switch is open the yoke 53 occupies the position shown in Fig. 9 or the position shown in full lines in Fig. 11.

When the handle 47 is rotated in an anticlockwise direction as viewed in Fig. 9 the abutment 51b will engage the yoke 53 to swing the same from its full line position shown in Fig. 11 toward its dotted line position. In doing so, the outer central portion of the yoke 53 engages the free end of the spring clip 121 which is secured to the inner surface of the compartment C as shown in Figs. 7 and 11. However, the yoke 53 clears the spring clip 121 by the time that the spring 68 moves to a position to the left of the

axis of the bearing 65 as viewed in Fig. 11 whereupon the spring 68 is free to act to effect closure of both of the sets of contacts designated 63, 73 and 63', 73' in Fig. 13. When the switch is closed the yoke 53 is held against the fixed abutment 52a with the abutment 51b held manually against the other side of the yoke 53 as shown in Fig. 8. Furthermore, when the switch is closed the spring 60 has one arm 60b resting against the seat 51a and the other arm 60a engaging that side of the yoke 53 remote from the abutment 51b.

When it is desired to open the switch the handle 47 is released whereupon the stored tension in the spring 57 will act automatically to move the carrier 49' in a clockwise direction as viewed in Fig. 9 thereby continuing to move the abutment 51b away from the yoke 53. The yoke 53 moves through a small angle to a position in engagement with the spring clip 121 due to tension in spring 60. At such time the spring 60 does not have sufficient tension to move the yoke 53 past the clip 121. In other words, the clip 121 prevents continued movement of the yoke 53 until a predetermined amount of tension is stored in the spring 60. The purpose of the retarding action of the spring clip 121 is to hold the yoke 53 in such position that the spring 68 may be at the left of the axis of the bearings 65 so that the switch will be held positively closed until it is ready to open with a snap action. That is to say, in order to prevent initial movement of the handle 47 towards switch opening position from causing the contacts 63 and 63' from separating from the plates 73, 73' the spring clip 121 causes the spring 60 to hold the switch positively closed thereby preventing arcing which would occur when the contacts 63, 63' are moved only a short distance from the plates 73, 73'. As rotation of the handle 47 continues in a clockwise direction as viewed in Fig. 8, the abutment 51b moves farther away from the yoke 53, but the latter being held by the spring clip 121 causes increasing tension to be stored in the spring 60 until such tension is sufficient to overcome the holding effect of the spring clip 121. Then the spring 60 moves the yoke 53 from under the spring clip 121, whereupon the spring 68 moves to the right of the center of the bearing 65 as viewed in Fig. 11, whereupon the contacts 63, 63' would be suddenly and quickly withdrawn from the contact plates 73, 73'. When the switch is in open position the yoke 53 will rest against the abutment 52b as shown in Fig. 9 and the crosspiece 61' of the switch contact carrier will abut against the back of the insulating block 95 as shown in Fig. 11.

Fig. 13 shows diagrammatically the circuits and connections for the electric drill motor and the switch for controlling the same. The terminal hook 128 may be connected to a trolley wire in a mine to serve as the connector to the positive supply main 127 which is connected to the plate 73'. The hook 122 may be attached to the rail 131 of the mine track to serve as the connector to the negative supply main 123 which is connected to the contact plate 73. The motor is preferably compound wound so that it will not race under substantially no load and yet be capable of withstanding heavy overloads without overheating.

When the switch is closed the motor circuit may be traced in Fig. 13 to the conductor 127 through contacts 73', 63', fuse 91, conductor 126, series motor winding 85, motor armature 14, conductor 125, blow-out coil 84, contacts 63, 73 and thence to the negative conductor 123. The shunt field coil 85' is also energized as it is shunted across series winding 85 and armature 14.

In order to protect the operator of the drilling machine the casing or frame thereof is grounded by a conductor 130 connected at its outer free end to the rail 131 and at its inner end to the frame or casing of the machine as illustrated diagrammatically at 129 in Fig. 13. This grounding connection may be effected by connecting the conductor 130 to the head of the screw 96 as shown in Fig. 2, which screw is of metal and in metallic contact with the metal frame of the machine.

It should be particularly noted that the cable 86 carrying the three conductors 123, 127 and 130 is connected by means of the connectors shown in Fig. 3 to the compartment C with an airtight fit so that no gas can enter the compartment C or escape therefrom either through the connector or the cable, the latter being impervious to air since it is composed of insulating material with the three separate wires imbedded therein for insulation from each other.

The connector shown in Fig. 3 comprises a tube 88 which is screw-threaded into the socket 90 which may be integral with the casing of compartment C. By screwing the tube 88 into the screw-threaded portion 89 of the socket 90 it engages the packing gland 90b which is located above the packing 90c in the lower cup portion of the socket 90. By means of a split sheath 87 surrounding the cable 86 and extending into the tubular member 88, and a clamp 90a, the cable may be secured against longitudinal movement relatively to the housing of the compartment C. After the connector has been assembled and the cable 86 locked in adjusted position relative to the housing, a seal 91a may be used as shown in Fig. 3 to prevent tampering with the connector.

One of the principal features of the construction shown in Figs. 5 and 6 is the provision of means for effecting internal air circulation about the motor armature for the purpose of cooling the motor or preventing overheating thereof. A multi-step bladed centrifugal fan 15 is connected to the shaft 46 to rotate therewith immediately inside of the cover 22. Baffle plates 16, 16, each having the shape of a segment of a cylinder as shown in Fig. 5 and composed of fiber or other light insulating material, are mounted between the pole pieces 24 and between the field coils 25. At those ends of the baffle plates 16 near the cover 22 are mounted the plane baffle plates 16a which are secured to the inside of the cover 22 by means of brackets 146, and the rivets 16b. The inner edges of the baffle plates 16a are in such positions that they will clear the outer periphery of the fan 15 when the cover 22 is removed.

It will be seen by referring to Figs. 5 and 6 that the baffle plates 16a co-operate with the pole pieces 24 and the windings 25 thereon to close the outer ends of the spaces between the motor armature and the baffle 16 so that when the fan 15 rotates a circulation of air on opposite sides of the motor will be produced in the direction of the arrows 17 and 18. That is to say, when the fan rotates the baffle 16a co-operates with the pole pieces 24 and the windings 25 thereon to compel the air to move into the intake openings of the fan within the periphery thereof so that the air will be thrown out by centrifugal force for inward circulation as indicated by the arrows 18, thus causing the air which has absorbed heat from the armature, to come in contact with the inner surface of the cylindrical radiator 19. The

outer surface is provided with circumferential ribs 20 to increase the outer heat radiating surface.

The radiator 19 constitutes the field frame of the electric motor and is therefore made of iron or steel but the cover 22 and the various other parts of the casing or frame of the machine together with the handles 47 and 132 are preferably made of a light alloy, such as magnesium-aluminum heat-treated. In a drilling machine of the construction shown and described having a compound wound electric motor of one and one-half to two horse-power operated at an applied voltage of 250, the weight of the entire drilling machine, excluding the drill, need be no greater than 38 pounds. The center of gravity in a drilling machine is located back of the handles, or away from the drill socket, to assist in counterbalancing the weight of the auger while a single operator supports the drilling machine during operation and by leaning against it or pushing it feeds the drill into a coal vein.

One of the handles is rotated by the operator who effects starting of the drilling machine and when this handle is released the motor is automatically stopped with a minimum amount or arcing at the switch contacts. Notwithstanding the operation of the interior controlling switch from without the machine the enclosing structure is entirely flame-proof and the electrically operated drill is therefore permissible for operation in gaseous mines. All detachable parts by the removal of which access could be had to the interior of the enclosing structure are preferably locked and sealed against opening by the operator while using the machine for operation in a gaseous mine. It will also be noted that the complete closure of the motor, power transmission mechanism and the motor controlling switch prevents access of dust and dirt to the interior relatively movable parts.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and I therefore wish not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodiment of my invention, what I desire to secure by Letters Patent of the United States is:

1. In a drilling machine, the combination with an electric motor, of means for controlling the operation of said motor, communicating enclosures for said motor and said controlling means, means affording a corrugated exterior surface for that portion of said motor enclosure surrounding the armature of the motor and constituting the field frame thereof, a fan connected to one end of the motor armature, and means comprising baffle plates serving as partitions between said armature and the interior of said casing to provide chambers parallel to the motor axis, said plates being so constructed and arranged as to cooperate with said fan to direct air first across the face of said armature and then across the interior of said casing to dissipate heat generated by said motor, and to circulate air within said controller enclosure.

2. In a drilling machine, the combination with an electric motor, of an enclosure for said motor, means affording a radiating exterior surface for that portion of said enclosure surrounding the armature of the motor and constituting the field frame thereof, a fan connected to one end of the motor armature, and means comprising baffle plates having their edges extending along the field coils of said motor and serving as partitions between said armature and the interior of said casing to provide chambers parallel to the motor axis, said plates being so constructed and arranged as to cooperate with said fan to direct air first across the face of said armature and then across the faces of said field coils and the interior of said casing to dissipate heat generated by said motor.

3. In a portable tool, the combination with a flame proof casing, of a motor in said casing, operating mechanism driven by said motor, a switch for controlling said motor, a flame proof casing for said switch, said two casings having communication whereby the air in each may circulate in the other, and fan means driven by said motor for circulating the air in both of said casings.

4. In apparatus for use in a gaseous mine, the combination with a casing formed into a motor compartment and a gear compartment by a partition, of a motor in said motor compartment, gears in said gear compartment, a shaft extending between said motor and said gears, a drive shaft extending from said casing and driven by said gears, a flame seal between said drive shaft and said casing to provide for rotation of said shaft while restricting egress of any flame from said casing, and a second flame seal between said first named shaft and said partition.

5. In mining apparatus, the combination with a flame proof casing, partition means forming said casing into motor, gear and switch compartments, a motor in said motor compartment, gears in said gear compartment and a switch in said switch compartment, a pair of rotatable shafts, one extending from said gear compartment and operated by said gears and the other extending from said switch compartment and controlling said switch, flame seals for each of said shafts to provide for their turning while resisting egress of any flame from said casing, means connecting said motor and gears, and electrical circuits connecting said switch and motor.

6. In a mining drill, the combination with a flame proof casing, of a motor in said casing, a drill shaft extending from said casing, reduction means interconnecting said motor and drill shaft, a motor control switch in said casing, an operating shaft for said switch extending into said casing, a flame seal for said drill shaft, and a flame seal for said switch operating shaft, said flame seals providing for rotation of said shafts while resisting the egress of any flame from said casing.

7. In a drilling machine, the combination with an electric motor, of a casing for said electric motor, said motor including a stationary field structure attached to said casing and a rotating armature, a fan rotor connected to said armature to be rotated thereby, baffle means in said casing constructed and arranged to guide circulating air across said armature in one direction and in a reverse direction across the casing interior, said baffle means including a portion adjacent the fan rotor to provide a restricted fan inlet leading to said fan rotor through which fan rotor substantially all of the circulated air must pass.

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