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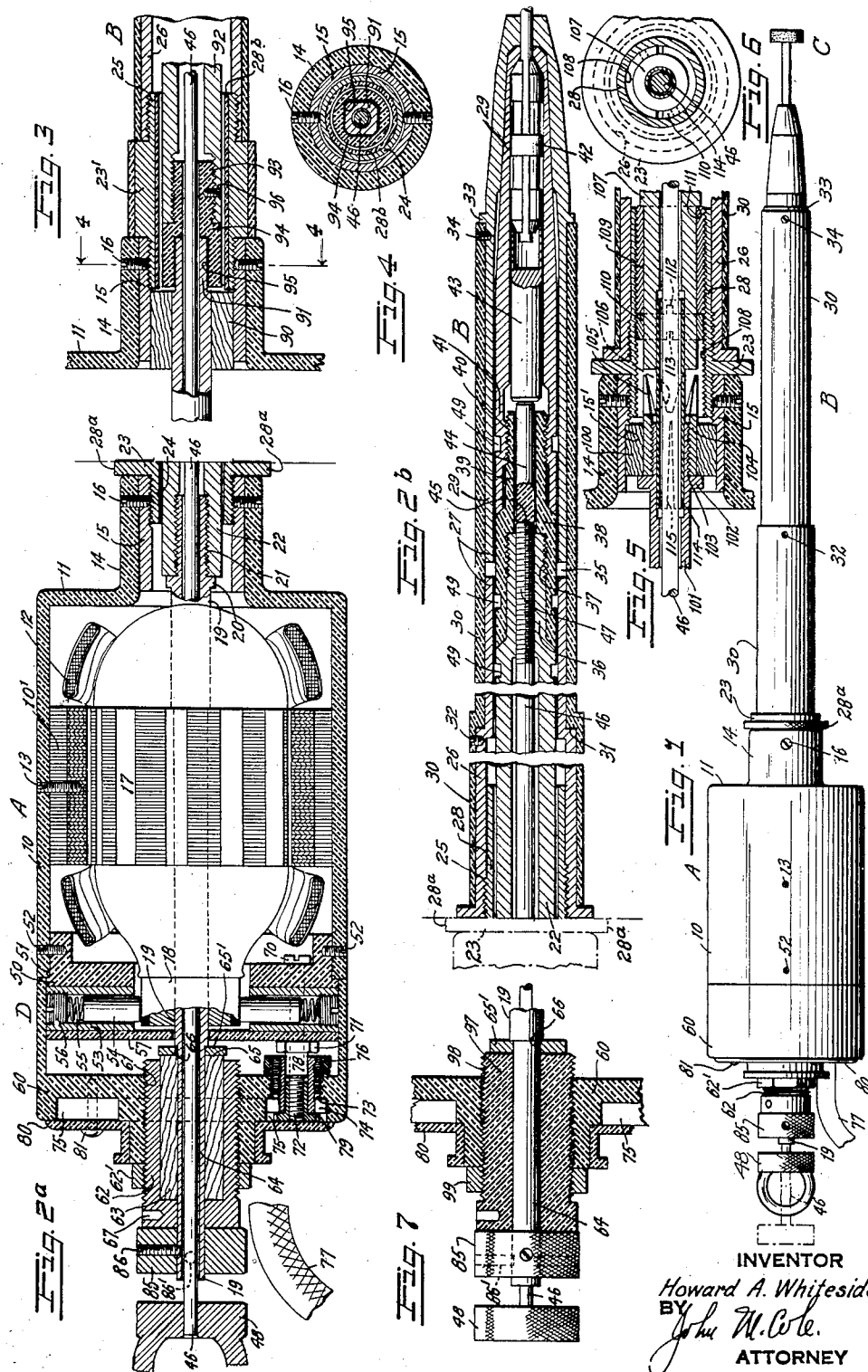
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COMBINED SURGICAL MOTOR AND HANDPIECE

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COMBINED SURGICAL MOTOR AND
HANDPIECE

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The present invention relates to combined surgical motors and hand pieces and is more particularly directed toward the provision of a surgical motor and hand piece of the type wherein the motor shaft and spindle of the hand piece are hollow and the securing and releasing of the tool are under the control of a clutch rod which passes through the motor armature shaft and hand piece spindle.

Hand pieces wherein the coupling and uncoupling of the tool are under the control of a clutch rod passing through the spindle of the hand piece are generally known as Doriot type hand pieces, and the present invention contemplates a motorized Doriot hand piece wherein the motor for operating the tool in the hand piece is directly connected to the hand piece so that the motor and hand piece form a single instrument adapted to be held in the hand while performing surgical operations.

The principal object of the present invention is to provide a combined motor and hand piece wherein a hollow armature shaft and a hand piece spindle are directly connected together and the hand piece clutch may be operated by a clutch rod passing through the armature shaft and into the spindle.

Another object of the invention is to provide a motorized hand piece of the Doriot type wherein the tool and hand piece are effectively insulated from the electrical parts of the motor so that there is no possibility of current leakage to shock the patient.

A further object of the invention is to provide a surgical motor having a bearing at the rear of the motor, preferably adjustable and oilless, which, together with the tapered bearing in the tip of the tool may carry the rotating parts.

A still further object of the invention is to provide an improved end cap assembly for surgical motors and the like wherein the current supply cord or cable is secured to the end cap in an off-center position so as to permit the clutch rod of the hand piece to extend out through the center of the rear of the motor.

A still further object of the invention is to provide a motorized hand piece of Doriot type wherein the sheath and spindle of the hand piece can be readily removed from the motor casing and armature shaft or replaced in position.

Other and further objects of the invention will appear as the description proceeds.

The accompanying drawings show, for purposes of illustrating the present invention, one of the many possible embodiments in which the inven-

tion may take form, together with modifications of certain parts, it being understood that the drawings are illustrative of the invention rather than limiting the same.

In these drawings:

Figure 1 is an elevational view of a complete motorized hand piece;

Figures 2a and 2b are longitudinal sectional views through the complete motorized tool unit;

Figure 3 is a sectional view through a modified form of construction illustrating a modified motor having a bearing for supporting the front end of the armature shaft;

Figure 4 is a sectional view taken on the line 4—4 of Figure 3;

Figure 5 is a fragmentary sectional view through a motor having a front bearing and a hand piece having adjustment for wear;

Figure 6 is an end view of the hand piece of Figure 5;

Figure 7 is a fragmentary sectional view through a modified form of rear thrust bearing for the motor;

Figures 8a and 8b are longitudinal sectional views through a modified form of complete motorized tool unit;

Figures 9 and 10 are, respectively, end views of the motor unit and the hand piece unit; and

Figure 11 is a section on the line 11—11 of Figure 8b.

The motorized tool unit which is illustrated in Figure 1 may be considered to consist of a motor A and a hand piece B. The hand piece is adapted to carry a tool such as a drill or grinding wheel indicated at C. The motor portion A contains all of the parts ordinarily found in an electric motor, and the speed and direction of rotation of the motor armature may be under the control of a foot controller, and external resistances such as shown in my application Serial No. 113,885 Patent No. 1,836,350, granted December 15, 1931.

The motor A has a rigid self-supporting unitary casing 10 of general cylindrical shape forming a structural part of the motor and directly supporting the field structure. This casing 10 is preferably made out of insulating material such as phenol condensation product reinforced with linen fabric. This material is hard, strong, susceptible of machining to accurate dimension, does not warp, is sanitary, water proof, possesses high insulating qualities and is capable of withstanding shock. The insulating casing forms a structural part of the motor as well as an insulating member to protect against stray currents or leakage. The field structure of the motor is

indicated at 11'. It is provided with bi-polar field windings 12, and may be secured in place in the casing by a quick drying varnish and by anchoring screws 13. The front end 11 of the motor casing is reduced to form a forwardly protruding tubular boss 14 which, in the form of construction here shown, carries an internally threaded hand piece coupling receiving tube or bushing 15. This ring is securely anchored in the insulating casing by headless screws 16.

In the form of construction here shown, the motor armature 17 is provided with a cylindrical type commutator 18 and a hollow steel shaft 19. The front end of the shaft 19 is provided with a collar 20 and is threaded as indicated at 21 to receive the spindle 22 of a Doriot type hand piece B. The hand piece B may be secured to the motor by a coupling 23. One end 24 of the coupling is threaded into the ring 15 while the other end 28 of the coupling is threaded into threads 25 in one of the metal sleeves 26 of a two-part sheath 27 wherein it has a long bearing as indicated. It is knurled as shown at 28a and may carry an outer covering 30 to prevent current leakage. As the armature windings are close to the casing, the armature cannot move to the right far enough to permit the brushes to fall off the commutator when the hand piece is detached.

The sheath 27 consists of a tubular metal member 26 threaded onto the coupling ring, a second tubular metal member 29 and an insulating outer covering 30. The insulating covering 30 may abut against a shoulder 31 carried by the member 26 and these parts may be secured together by screws 32. The metal sheath member 29 is provided with a shoulder 33 abutting against the end of the insulating member 30 and these two parts are fastened together by screws 34. The parts 26, 29 and 30 are of such length that a gap 35 appears between the adjacent ends of the metal members 26 and 29. In this manner the tip 29 of the hand piece sheath is insulated from the coupling ring 23, and the rear of the spindle.

The spindle 22 has a reduced end portion 36 threaded as indicated at 37 to receive an insulating coupling member 38 placed opposite the gap 35. The insulating coupling member 38 has a reduced end portion 39 threaded as indicated at 40 to receive a spindle tip 41. The spindle tip 41 carries a tool gripping clutch 42 and a metal plunger 43 for actuating the clutch in the usual manner. An insulating plunger 44 is carried in the insulating coupling member 38 and is interposed between the metal plunger 43 and the end 45 of a steel clutch rod 46. The clutch rod is threaded into the spindle as indicated at 47, and extends out through the motor armature shaft 19 where it is provided with a knurled head 48 as indicated. In order that the spindle parts 22, 38 and 41 may be tightly secured together, they are provided with wrench receiving cut outs 49.

The motor is provided with a brush rigging and end cap assembly indicated generally by the letter D. These parts are described in detail and claimed in my application for Brush rigging and end cap assemblies for surgical motors and the like, Serial No. 624,739, filed July 26, 1932, patented Jan. 21, 1936, No. 2,028,176.

This brush rigging includes a disk-shaped insulating plate 50 preferably made of the same material as the casing. It has a reduced end portion as shown at 51 to telescope inside the motor casing 10, to which it is secured, after adjustment, by screws 52. The disk carries brush boxes 53 adapted to accommodate the brushes 54,

brush springs 55 and retaining screws 56. The outside diameter of the brush supporting disk 50 is intermediate between the inside and the outside diameter of the motor casing 10 so as to form a shoulder and at the same time accommodate an end cap 60 for the rear end of the motor. The brush rigging disk 50 may, if desired, have a bridging member 57 apertured to receive the shaft, thereby providing a temporary bearing for the shaft when the end cap is removed.

This end cap is preferably made of the same type of material and of the same outside diameter as the motor casing. The parts 10, 50 and 60 are accurately machined to provide an exceedingly close fit. The end cap 60 is threaded as indicated at 61 to receive a sleeve or bearing supporting member 62. This member 62 is made of metal such as aluminum, and a tubular wood bearing 63 is carried in the bearing supporting member 62. This material forms an oilless bearing for the reduced end portion 64 of the armature shaft and the end 65 of the bearing member can be brought against a steel sleeve 65' abutting against the shoulder 66 on the armature shaft so as to provide a thrust bearing for the rear of the motor. This sleeve merely increases the bearing area against the wood bearing and it may be omitted or a larger shoulder provided in the shaft.

The adjustment of this bearing is accomplished by inserting a pin into the hole 67 in the bearing supporting member 62 and turning the bearing support in the threads 61. A lock nut 62' is provided to lock these parts in position after they have been adjusted. The parts are preferably adjusted so that the combined armature shaft and spindle run freely in the bearings provided by the tube 63 and the tip 29 of the hand piece. The thrust bearing 65' serves to receive the thrust produced when the tool is pressed against the teeth or other object with which the tool is being used.

In order to secure the end cap in position and to provide two separate circuits to conduct the current to the brush rigging and field, the brush carrying disk 50 is provided with four rearwardly extending screws, only one of which is shown at 70. These screws are clamped in position by nuts 71 threaded onto the outer ends 72 of the screws and brought against the disk 50. The end cap 60 carries four metal inserts 73 threaded into the material of the end cap and projecting inside the motor casing as indicated. These inserts have heads 74 which enter into an annular channel or recess 75 in the end cap. Each of the inserts is provided with a nut 76 adapted to clamp the desired feed wire in place. The nuts 71 carried by the screws 70 have rearwardly extending reduced portions 78 adapted to fit the inside of the inserts 73 to align the parts, and flanged lock nuts 79 are threaded onto the ends of the screws 72, the flanges of these units overlying the heads 74 of the inserts. This way the end cap 60 and current supply cord 77 are secured to the brush carrying disk 50. This cord is preferably a four conductor rubber covered cable passed through the wall of the end plate, the wires fastened under the nuts 76, and these parts sealed in place by quick drying varnish so that water cannot enter into the motor through the cable hole.

A protective cover plate 80 may be fastened on the end of the cap 60 by screws indicated at 81 so that the nuts 79 are concealed and protected. The armature shaft 19 extends out beyond the end of a bearing support 62 and a knurled finger

grip 85 is secured on the end of the shaft by a lock screw 86. The grip 85 and shaft are drilled as indicated at 86' so that a pin may be passed through the shaft when tightening the spindle in place. It is important that the shaft and spindle be threaded tightly together, as the motor is reversible and to prevent unthreading when adjusting the clutch rod.

The rod 46 extends out beyond the end of the armature shaft and is supplied with the usual knurled finger grip 48. The tool C is fastened in the clutch 42 in the same manner that it is customary in Doriot type hand pieces wherein they do not form a part of the motorized tool unit. It is merely necessary to insert the shank of the tool, grasp the finger grip 85 and adjust the clutch rod by turning on the finger grip or wheel 48.

It will be noted that in this form of construction, the armature shaft and tool spindle are supported at only two points, namely in the bearing 63 and in the tapered bearing found in the tip 29. The tool and tip of the hand piece are effectively insulated against leakage of current to shock the patient. The entire hand piece may be easily removed whenever desired.

The user can adjust the bearings without difficulty and in case it is necessary to clean or inspect the commutator or brushes, the clutch rod 46 and finger grip 48, may be removed, the protective cover 80 taken off and the flanged nuts 79 removed from the screws 70. This will permit the removal of the end cap assembly so that the brush rigging may be removed by taking out the screws 52 and the armature and spindle may be withdrawn through the rear or left end of the motor.

Inasmuch as this form of motorized hand piece is a complete unit, the entire motorized tool unit may be sterilized without danger of water getting into the interior of the motor or onto any of the electrical connections.

Inasmuch as the magnetic flux in the field passes through the armature shaft, it is important that the armature shaft and clutch rod have as small clearance as possible so as to avoid an appreciable air gap which would change the flux distribution and relative phase angle of the current in the armature and field circuits. In order that adequate torque may be developed on a shunt wound motor running on alternating current a minimum air gap between the field and armature is essential. This air gap may be about .001 inch. Should the current be accidentally turned on while the hand piece is off, the field will attract the armature so that the stampings contact. The current consumption when the motor is stalled is insufficient to injure the windings from overheating the same.

In the form of construction shown in Figures 3 and 4, it is contemplated that the armature shaft and tool spindle will be supported by a bearing carried in the reduced end portion 14 of the motor casing 10. As there indicated, a wood bearing 90 is placed in the bushing 15.

The front end of the armature shaft is reduced and squared as indicated at 91. The form of coupling and sheath described above may be used, or a longer coupling 23' having a shorter bearing in the sheath. The former construction is generally preferred. Instead, however, of having the spindle 92 identical with the spindle 22, it is, as shown in Figure 3, shortened and threaded at 93 to receive a coupling member 94 having a squared hole 95 at the left to receive the squared

end of the armature shaft. The coupling 94 may be locked to the spindle 92 by a screw 96 if desired.

This type of motor having a bearing at both ends of the armature shaft may also be used with hand pieces other than the Doriot type and may or may not have adjustable thrust bearings at the rear. Where employed with a hand piece which does not have a clutch rod passing through the armature shaft, the shaft is preferably filled with a dummy clutch rod, or made solid.

Figures 5 and 6 show particularly a modified form of front bearing for the motor armature shaft together with an adjustable rear bearing for the hand piece spindle, with driving dog connections between the armature shaft and hand piece spindle. The motor casing 14 may be the same as formerly employed but instead of making the metal sleeve 15 of uniform diameter as indicated in Figures 1 and 3, it is cut back as indicated at 15' to accommodate a bearing 100 made of wood.

The armature shaft 101 has a shoulder 102 held against this wooden bearing by the adjustable bearing at the rear end of the motor. The front end of the armature shaft is threaded as indicated at 103 to receive a toothed coupling 104 which is threaded against the shoulder 102 above referred to. This coupling member has driving dogs 105 adapted to cooperate with similar driving dogs 106 on the spindle 107 of the hand piece. This hand piece may have the form of construction which has been described in detail with respect to Figures 2a and 2b, and the same reference characters are applied to corresponding parts.

When the device is to employ the hand piece spindle bearing of the form shown in Figure 5, the inside of the coupling member 23 is threaded its entire length as indicated in 108 and two threaded rings 109 and 110 are threaded down into this coupling ring. The ring 109 abuts against a shoulder 111 on the hand piece spindle 107 and is provided with a slot 112 so that a screw driver may be passed down outside the spindle to tighten it against the shoulder. This forms an adjustable bearing to compensate for wear in the taper bearing in the tip of the hand piece. The threaded ring 110 is provided with slots 113 so that this ring may be used as a lock nut to secure the other ring against movement.

The teeth 105 on the end of the armature shaft are preferably designed to be at all times housed within the motor casing and the teeth 106 on the hand piece spindle are so located that they are housed at all times within the coupling member 23. In order to prevent chattering between these driving dogs, a shock absorbing device is preferably provided. In the present form of construction this is a small steel tube 114 having a press fit in the rear end of the hand piece spindle and projecting into the armature shaft where it is preferably split as indicated at 115. It provides a friction connection between the parts, and overrunning of the armature shaft relative to the spindle is prevented.

While the form of construction shown in Figures 5 and 6 is especially designed for Doriot type hand pieces directly connected to surgical motors wherein the armature shaft has two bearings in the motor, it will be apparent that many features shown in this construction may be employed in other types of surgical outfits. The shaft bearing arrangement and driving dogs may

be used in other types of surgical motors and hand pieces and other types of surgical outfits, and the adjustable bearing in the hand piece is capable of general application.

- 5 In the form of construction illustrated in Figure 7, the metal bearing member 62 and wood bearing 63 are replaced by a bearing member 97 externally threaded at 98 to cooperate with the threads in the end cap, as before. A locking nut 99 serves to lock these parts together after the bearing has been adjusted.

- In the motorized tool unit of Figures 8a and 8b, the motor unit A' is somewhat similar to the motor unit A and the tool unit B' is somewhat similar to the tool unit B. This tool unit employs two bearings for the armature shaft and two bearings for the spindle of the hand piece.

- The motor casing 120, brush carrying disk 121, and end cap 122 are made of insulating material. The armature shaft 123 is tubular. Its rear end is carried in a bearing 124 in the end cap while its front end carries a socket forming terminal member 125 into which is pressed an insulating driving coupling 126. This coupling has a non-circular opening 127, as appears in Figure 9. The front end 128 of the motor casing 120 is provided with a metal bushing 129 forming a bearing for the armature shaft and a screw threaded coupling ring 130 for the hand piece.

- A disk type commutator 131 is secured to the armature shaft, and in order to keep lubricant off the commutator, an oil thrower 132 is carried by the shaft. The brush disk 121 is secured to the casing by screws, not shown. It carries brush boxes and field connection plugs, one of each of which is shown at 133 and 134, respectively. The brush boxes carry brushes 135, and the field connection plugs 134 carry split pins 136. The brush boxes and pins fit into receptacles 137 and 138 carried by the end cap 122. The current supply wires enter the cap in an off-center hole in a manner similar to that shown in Figure 1. The rear end of the armature shaft carries a finger grip 139. The entire motor is received within a shield 140, preferably made of aluminum.

- The hand piece B' has a one piece outer sheath 150 internally threaded at 151 to receive a threaded coupling member 152. The exposed end of this coupling member is threaded as indicated at 153 to fit the coupling ring 130 carried by the motor. The spindle is rotatably carried in the sheath and arranged to completely insulate the tool and sheath from the armature shaft.

- The front end 154 of the spindle carries the usual clutch 155 and clutch actuating plunger 156, and is threaded at 157 to be coupled to the driving end of the spindle. This portion of the spindle is made of three tubular parts—a metal coupling member 158 threaded to the clutch carrying end 154, and pressed onto the reduced end 159 of an insulating coupling member 160. The rear end of this insulating coupling member is reduced as shown at 161, and receives a front metal coupling member 162, having a shoulder 163 and a driving connection 164 adapted to be non-rotatably received within the insulating coupling 127 carried on the armature shaft. Instead of press fitting the parts 158, 160, and 162 together, they may be threaded, pinned, or molded.

- The rear end of the spindle is carried in bearings formed by two rings 164 and 165 threaded into the coupling member 150. The ring 165 is adjusted to act as a thrust bearing for the shoul-

der 163 of the spindle and the ring 164 acts to lock the other ring in place.

The clutch rod is shown at 170. It is generally similar to the clutch rod shown in Figures 2a and 2b, and fits closely in the armature shaft. It is, however, of considerably smaller diameter than the inside diameter of the metal coupling 162 of the spindle so as to provide air insulation between these parts. It is threaded into a metal sleeve 171 carried inside the insulation member 160, and its front end bears on a plunger 172 similar to the plunger 44. To reduce wear, this plunger 171 is made with metal ends 173 and 174 and an insulating middle portion 175. When the clutch rod is adjusted in the threaded sleeve 171, the plunger 172 moves the plunger 156 to actuate the clutch.

The hand piece just described is adapted for use with direct connected motors and completely insulates the tool and sheath from the motor windings or motor parts. The hand piece can be readily taken apart for cleaning, lubricating and adjustment, and is easily sterilized without impairing the insulating material.

I claim:

1. In combination, an electric motor having a hollow armature shaft, and an external housing supporting the motor field and carrying a bearing for the rear end of the armature shaft, a hand piece having a sheath detachably carried at the front end of the motor casing coaxial with the armature shaft, a hand piece spindle driven by the armature shaft and having a bearing in the front end of the sheath, a tool clutch carried by the spindle, and a clutch actuating rod passing through the armature shaft and carried by the spindle so as to revolve with the armature and spindle, the clutch rod being accessible at the rear end of the motor for actuating the clutch.

2. In combination, an electric motor having a hollow armature shaft, and an external housing supporting the motor field and carrying a bearing for the rear end of the armature shaft, a hand piece having a sheath detachably carried at the front end of the motor casing coaxial with the armature shaft, a hand piece spindle driven by the armature shaft and having a bearing in the front end of the sheath, a tool clutch carried by the spindle, and a clutch actuating rod passing through the armature shaft and carried by the spindle so as to revolve with the armature and spindle, the clutch rod being accessible at the rear end of the motor for actuating the clutch, the armature shaft extending beyond the rear bearing and carrying a collar which affords a grip to hold the shaft stationary while adjusting the clutch rod.

3. In combination, an electric motor having a hollow armature shaft, and an external housing supporting the motor field and carrying a bearing for the rear end of the armature shaft, a hand piece having a sheath detachably carried at the front end of the motor casing coaxial with the armature shaft, a hand piece spindle driven by the armature shaft and having a bearing in the front end of the sheath, a tool clutch carried by the spindle, and a clutch actuating rod passing through the armature shaft and carried by the spindle so as to revolve with the armature and spindle, the clutch rod being accessible at the rear end of the motor for actuating the clutch, the armature shaft extending beyond the rear bearing and carrying a collar which affords a grip to hold the shaft stationary while adjusting the clutch rod, the shaft and collar being drilled to

receive a pin whereby the spindle may be tightened onto the shaft.

4. In combination, an electric motor having a hollow steel armature shaft, and an external housing supporting the motor field and carrying a bearing for the rear end of the armature shaft, a hand piece having a sheath detachably carried at the front end of the motor casing coaxial with the armature shaft, a hand piece spindle driven by the armature shaft and having a bearing in the front end of the sheath, a tool clutch carried by the spindle, and a steel clutch actuating rod passing through the armature shaft and carried by the spindle so as to revolve with the armature and spindle, the clutch rod being accessible at the rear end of the motor for actuating the clutch, the air gap between the rod and shaft being narrow whereby the flux distribution is not appreciably disturbed.

5. In combination, an electric motor having a hollow armature shaft, and an external housing supporting the motor field and carrying a bearing for the rear end of the armature shaft, a hand piece having a sheath detachably carried at the front end of the motor casing coaxial with the armature shaft, a hand piece spindle drivingly carried by the armature shaft and having a bearing in the front end of the sheath, the armature shaft and spindle being supported solely by said two bearings, a tool clutch carried by the spindle, and a clutch actuating rod passing through the armature shaft and carried by the spindle so as to revolve with the armature and spindle, the clutch rod being accessible at the rear end of the motor for actuating the clutch.

6. In combination, an electric motor having a hollow armature shaft having a shoulder, and an external housing supporting the motor field and carrying an axially adjustable bearing for the rear end of the armature shaft, and acting against the shoulder thereon, a hand piece having a sheath detachably carried at the front end of the motor casing coaxial with the armature shaft, a hand piece spindle driven by the armature shaft and having a cone bearing in the front end of the sheath against which the adjustable bearing holds the spindle, a tool clutch carried by the spindle, and a clutch actuating rod passing through the armature shaft and carried by the spindle so as to revolve with the armature and spindle, the clutch rod being accessible at the rear end of the motor for actuating the clutch.

7. In combination, an electric motor having a hollow armature shaft, and an external housing supporting the motor field and carrying a bearing for the rear end of the armature shaft, a hand piece having a sheath detachably carried at the front end of the motor casing coaxial with the armature shaft, a hand piece spindle driven by the armature shaft and having a bearing in the front end of the sheath, a plunger actuated tool clutch carried by the spindle, and a clutch actuating rod passing through the armature shaft and threaded into the spindle so as to revolve with the armature and spindle, the clutch rod being accessible at the rear end of the motor, so that it may be threaded back and forth relative to the plunger for actuating the clutch.

8. In combination, an electric motor having a hollow armature shaft, and an external housing supporting the motor field and carrying a bearing for the rear end of the armature shaft, a hand piece having a sheath detachably carried at the front end of the motor casing coaxial with the armature shaft, a hand piece spindle threaded

onto the end of the armature shaft and having a bearing in the front end of the sheath, a tool clutch carried by the spindle, and a clutch actuating rod passing through the armature shaft and threaded into the spindle so as to revolve with the armature and spindle, the clutch rod being accessible at the rear end of the motor so that it may be threaded back and forth for actuating the clutch, the spindle and shaft having devices engageable by tools so that the threaded joint therebetween may be tightened securely.

9. In combination, an electric motor having a hollow armature shaft, and an external housing supporting the motor field and carrying a bearing for the rear end of the armature shaft, a hand piece having a sheath detachably carried at the front end of the motor casing coaxial with the armature shaft, a hand piece spindle driven by the armature shaft and having a bearing in the front end of the sheath, a tool clutch carried by the spindle, and a clutch actuating rod passing through the armature shaft and carried by the spindle so as to revolve with the armature and spindle, the clutch rod being accessible at the rear end of the motor for actuating the clutch, the spindle and sheath being provided with insulating means to prevent the leakage of current to the front end of the spindle or tool.

10. In combination, an electric motor having a hollow armature shaft, and an external housing supporting the motor field and carrying a bearing for the rear end of the armature shaft, a hand piece having a sheath detachably carried at the front end of the motor casing coaxial with the armature shaft, a hand piece spindle driven by the armature shaft and having a bearing in the front end of the sheath, a tool clutch carried by the spindle, a clutch actuating rod passing through the armature shaft and carried by the spindle so as to revolve with the armature and spindle, the clutch rod being accessible at the rear end of the motor for actuating the clutch, and a current supply cord carried by the rear end of the motor housing and extending out at one side of the axis of the motor.

11. A combined motor and hand piece comprising a motor having an external housing consisting of a cup-shaped end cap carrying a bearing for the rear end of the armature shaft, a cup-shaped casing to which the hand piece is secured, the bearings for the armature shaft of the motor and the spindle of the hand piece being water tight and the housing parts abutting end to end and totally enclosing all electrical parts of the motor and being characterized by the absence of openings, whereby the entrance of water into the combined unit is effectively prevented.

12. A combined motor and hand piece for surgical tools comprising a motor having an external housing consisting entirely of rigid self-sustaining insulating material to which the hand piece is secured, the bearings for the armature shaft of the motor and the spindle of the hand piece being water tight and the housing including a cup-shaped end cap and a cup-shaped casing abutting end to end and totally enclosing all electrical parts of the motor and being characterized by the absence of openings, whereby the entrance of water into the combined unit is effectively prevented.

13. In combination, an electric motor having a hollow thin walled steel shaft, a steel rod passing through the shaft and substantially filling the hole therein so that flux distribution is not substantially disturbed, a spindle drivingly connected to the shaft and into which the clutch rod is

threaded, and a tool clutch carried by the spindle and actuated by the clutch rod.

14. In combination, an electric motor having a hollow thin walled steel shaft, a steel rod passing through the shaft and substantially filling the hole therein so that flux distribution is not substantially disturbed, a spindle drivingly connected to the shaft and into which the clutch rod is threaded, the exposed ends of the shaft and rod having accessible finger grips so that the shaft may be held while the rod is turned, and a tool clutch carried by the spindle and actuated by the clutch rod.

15. In combination, an electric motor having a hollow thin walled steel shaft, a steel rod passing through the shaft and substantially filling the hole therein so that flux distribution is not substantially disturbed, a multiple part spindle drivingly connected to the shaft and into one part of which the clutch rod is threaded, and a tool clutch carried by the front part of the spindle and actuated by the clutch rod, the front part of the spindle and the actuating mechanism of the tool clutch being insulated from the driving part of the spindle and from the clutch rod to prevent current leakage to the tool.

16. In a combined motor and hand piece for surgical tools and the like, a hand piece sheath having a front cone bearing, a tool spindle carried in said bearing, and a motor having an armature shaft drivingly connected to the tool spindle, said motor having a casing for supporting the hand piece sheath and an adjustable bearing at the rear end of the motor which supports the rear end of the armature shaft, the armature shaft having a shoulder against which the bearing is adjusted.

17. In a combined motor and hand piece for surgical tools and the like, a hand piece sheath having a front cone bearing, a tool spindle carried in said bearing, and a motor having an armature shaft drivingly connected to the tool spindle, said motor having a casing for supporting the hand piece sheath and an oilless adjustable wood bearing at the rear end of the motor which supports the rear end of the armature shaft, the armature shaft having a shoulder against which the bearing is adjusted.

18. In a combined motor and hand piece for surgical tools and the like, a hand piece sheath having a front cone bearing, a tool spindle having a tool clutch and carried in said bearing, a motor having a hollow armature shaft onto which the tool spindle is threaded, said motor having a casing for supporting the hand piece sheath and an adjustable bearing at the rear end of the motor which supports the rear end of the armature shaft, the armature shaft having a shoulder against which the bearing is adjusted, and a clutch rod passing through the hollow armature shaft and attached to the spindle for actuating the clutch.

19. A combined motor and hand piece for surgical outfits and the like, comprising a motor having an armature shaft, and a hand piece having a spindle drivingly connected with and carried by the armature shaft, the shaft and spindle being solely supported by a bearing at the front end of the spindle and another bearing at the rear of the motor.

20. A combined motor and hand piece for surgical outfits and the like, comprising a motor having an armature shaft, and a hand piece having a spindle drivingly connected with and carried by the armature shaft, the shaft and

spindle being solely supported by a cone bearing at the front end of the spindle and another bearing at the rear of the motor, the rear bearing being adjustable to hold the spindle against its bearing.

21. A combined motor and hand piece for surgical outfits and the like, comprising a motor having a hollow armature shaft, a hand piece having a spindle threaded onto the armature shaft, the shaft and spindle being solely supported by a bearing at the front end of the spindle and another bearing at the rear of the motor, and a clutch rod extending through the shaft and threaded into the spindle.

22. An electric motor for combined electric motors and hand pieces, said motor comprising a field structure, an armature, an armature shaft, and a casing for the motor, said casing having a front end wall provided with an axially extending tubular support for the stationary part of the hand piece, the armature shaft extending into the tubular support and having means for detachably connecting it to the spindle of the hand piece, the shaft, when the spindle is disconnected, being supported solely by a bearing at the rear end of the motor.

23. An electric motor for combined electric motors and hand pieces, said motor comprising a field structure, an armature, an armature shaft, and a casing for the motor, said casing having a front end wall provided with an axially extending tubular support for the stationary part of the hand piece, the armature shaft extending into the tubular support and having means for detachably connecting it to the spindle of the hand piece, the shaft, when the spindle is disconnected, being supported solely by a bearing at the rear end of the motor, the shaft having a shoulder against which the bearing is adjusted to take rearward thrust.

24. An electric motor for combined electric motors and hand pieces, said motor comprising a field structure, an armature, an armature shaft, and a casing for the motor, said casing having a front end wall provided with an axially extending tubular support for the stationary part of the hand piece, the armature shaft extending into the tubular support and having means for detachably connecting it to the spindle of the hand piece, the shaft, when the spindle is disconnected, being supported solely by a bearing at the rear end of the motor, the shaft having a shoulder against which the bearing is adjusted to take rearward thrust, the armature windings extending nearly to the front of the motor so that the sliding of the armature shaft forwardly is prevented.

25. A surgical tool comprising an electric motor and hand piece of the type having a sheath, a rotating spindle in the sheath and carrying a tool clutch actuated by a threaded clutch rod extending rearwardly, the motor having an insulating casing to which the sheath of the hand piece is secured and an armature shaft to which the spindle of the hand piece is secured and through which the clutch rod extends, and insulating means isolating the clutch and sheath and the armature shaft and clutch rod.

26. A surgical tool comprising an electric motor and hand piece of the type having a sheath, a rotating spindle in the sheath and carrying a tool clutch actuated by a threaded clutch rod extending rearwardly, the motor having an insulating casing to which the sheath of the hand piece is secured and an armature shaft to which the

spindle of the hand piece is secured and through which the clutch rod extends, and insulating means isolating the clutch and sheath and the armature shaft and clutch rod, said insulating means including a sliding insulating plunger between the end of the clutch rod and the clutch.

27. A surgical tool comprising an electric motor and hand piece of the type having a sheath, a rotating spindle in the sheath and carrying a tool clutch actuated by a threaded clutch rod extending rearwardly, the motor having an insulating casing to which the sheath of the hand piece is secured and an armature shaft to which the spindle of the hand piece is secured and through which the clutch rod extends, and insulating means isolating the clutch and sheath and the armature shaft and clutch rod, said insulating means including a spindle part in the form of an insulating coupling intermediate the motor connected end and the clutch carrying end of the spindle.

28. A surgical tool comprising an electric motor and hand piece of the type having a sheath, a rotating spindle in the sheath and carrying a tool clutch actuated by a threaded clutch rod extending rearwardly, the motor having an insulating casing to which the sheath of the hand piece is secured and an armature shaft to which the spindle of the hand piece is insulatedly secured and through which the clutch rod extends, an insulating coupling intermediate the motor connected end and the clutch carrying end of the spindle and supporting the threaded clutch rod out of contact with the spindle, and an insulating plunger between the clutch rod and clutch.

29. In combination, an electric motor having a hollow armature shaft and an external housing consisting entirely of rigid self-sustaining insulating material, a hand piece having a metal sheath detachably secured to the housing and a hollow spindle drivingly connected with the armature shaft, the spindle having a rear metal part drivingly connected to the armature shaft, a forward metal part and insulating means between the two parts, a tool clutch in the forward part, a clutch actuating plunger slidably carried in the forward part, a slidable insulating plunger bearing on the clutch actuating plunger, and a clutch rod extending through the armature shaft and threaded into the spindle to the rear of insulating plunger and bearing therein, the clutch rod being also insulated from the forward metal part of the spindle.

30. A surgical tool comprising a motor unit having a tubular armature shaft carried in bearings, and a hand piece unit having a sheath detachably secured to the casing of the motor unit and detachably coupled to the armature shaft when the sheath is secured to the casing, and the hand piece having a shaft-driven spindle carried in a bearing in the front of the sheath and a tool clutch actuated by a clutch rod extending through the armature shaft.

31. A surgical tool as set forth in claim 30 characterized in that insulating material is interposed between the armature shaft and spindle and between the clutch and clutch rod so that current leakage to the tool and sheath is prevented.

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