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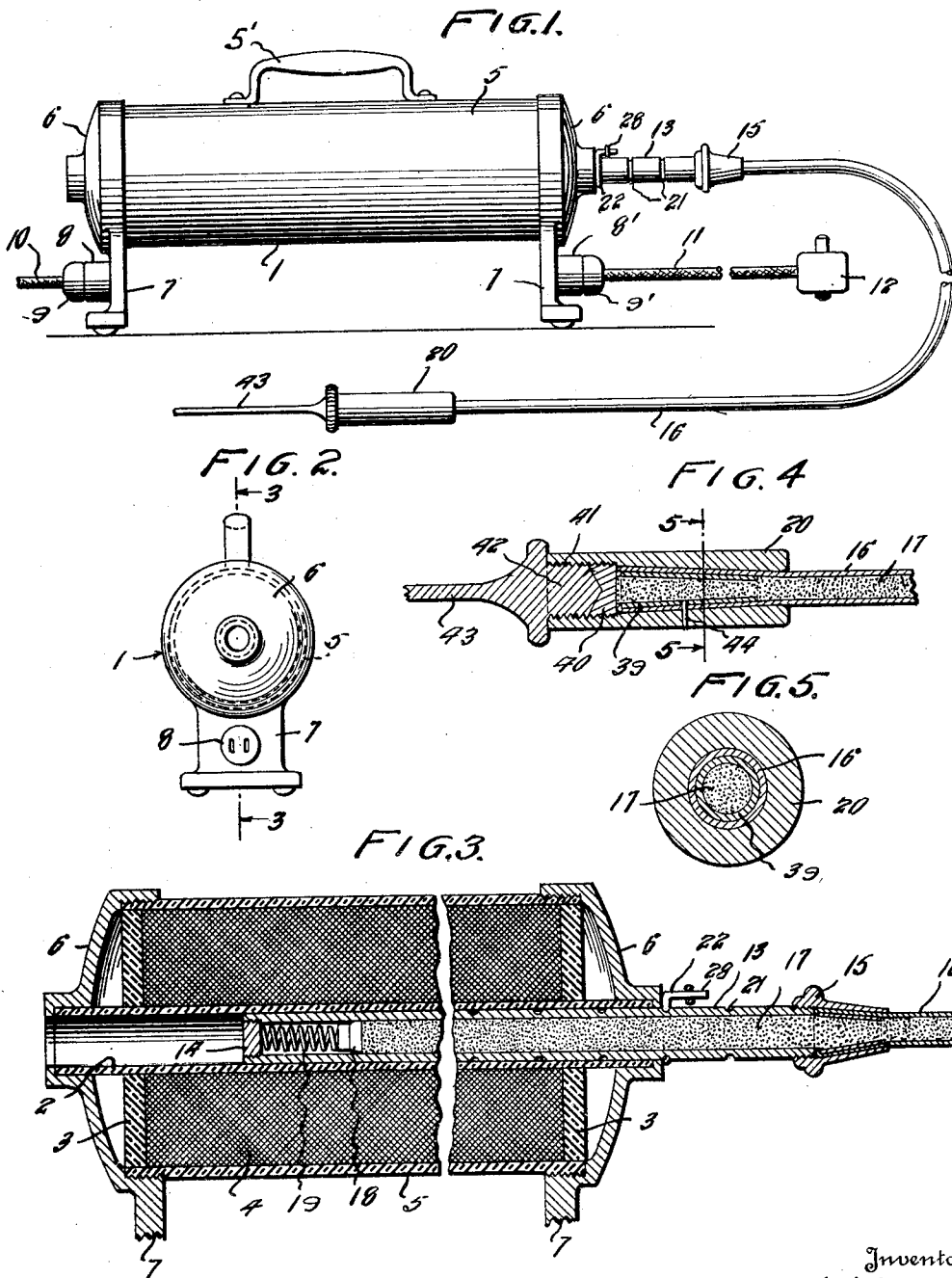
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SURGICAL INSTRUMENT

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2 Sheets-Sheet 1



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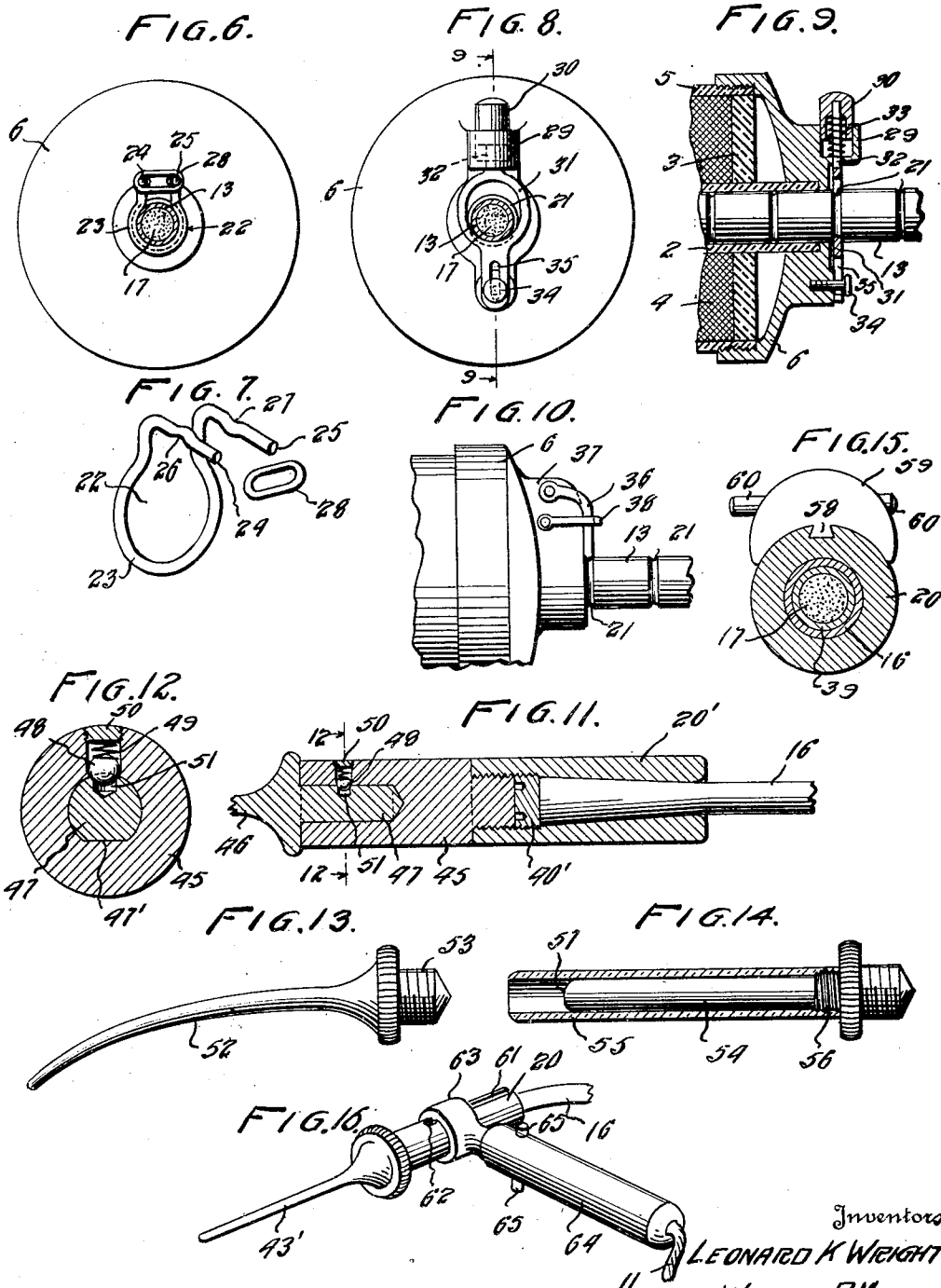
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SURGICAL INSTRUMENT

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This invention relates to surgical instruments, and more particularly to electro-magnetic instruments, of the type suitable for use in extracting chips or slivers of magnetic susceptible material from various portions of the human body.

It is quite noticeable that injuries resulting from the chipping and fracturing of alloyed steels and irons, in the various industries, have increased with the increased use of these materials. In many instances these injuries result in serious losses both to the employee and the employer. Besides the direct physical injuries resulting from wounds caused by sharp metallic particles there is a possibility of the wound, no matter how small, becoming infected. Workmen accustomed to having small metallic turnings, shaving etc. contacting with their body, may have small particles of metal embedded in their flesh, which while not visible sometimes results in infections and serious losses.

An object of this invention is to devise a surgical instrument for extracting iron, steel or other particles which may be attracted to a magnet, for use in hospitals, emergency wards, optical rooms, etc.

Another object of this invention is to devise a magnetic surgical instrument lacking many of the disadvantages inherent in the magnetic equipment heretofore employed.

Another object of this invention is to devise a magnetic surgical device that may be easily adjusted to various positions for the extraction of particles from different parts of the human anatomy.

Another object of this invention is to provide an electro-magnet to which is attached means for conducting magnetic force to an applicator or instrument suitable for extracting metal particles from the human body.

Still another object of this invention is to provide a flexible conduit suitable for transmitting magnetic force from a source to a point of application and to so construct said conduit that the same is capable of attachment to a plurality of magnetic applicators or instruments.

With these and other objects in view which may be incident to our improvements, the invention consist in the parts and combinations to be hereinafter set forth and claimed, with the understanding that the several necessary elements comprising our invention, may be varied in construction, proportions and arrangement, without departing from the spirit and scope of the appended claims.

This invention embodies a solenoid which may be constructed of the proper number of turns of wire to secure the desired magnetic effect. Mounted within the solenoid is a slidable core member to which is attached a conduit suitable for conducting magnetic force from said core to a point of application. The core and conduit are preferably formed of tubular members, the tubular member forming the conduit being constructed of flexible materials. Magnetic material, such as iron particles or wire, is placed within these tubular members through which the magnetic force is conducted. The free end of the flexible magnetic conduit is provided with a fitting adapted to receive various applicators or instruments suitable for applying the magnetic attracting force to any desired portion of the body.

This invention also embodies a novel arrangement for varying the magnetic intensity transmitted through said conduit. As is well known when an electric current is conducted through the turns of a solenoid there is a tendency for any magnetic susceptible object to be drawn into the central portion of the solenoid. When a core or body is in the central portion of the solenoid the flux density is at a maximum in the material, and as the material is withdrawn from the central portion of the solenoid the flux density is gradually decreased depending upon the distance of the body from the central portion of the solenoid. This principle is utilized in this invention to vary the magnetic intensity transmitted to the applicator attached to the end of the flexible conduit, and suitable means are provided for retaining the slidable core in any predetermined position.

In order to make our invention more clearly understood we have shown in the ac-

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comparing drawings means for carrying the same into practical effect, without limiting the improvements in their useful applications to the particular construction, which for the purpose of explanation, have been made the subject of illustration.

In the drawings:

Fig. 1 is a side elevation of an electromagnetically operated surgical instrument constructed in accordance with this invention.

Fig. 2 is an end view of the device shown in Fig. 1.

Fig. 3 is a sectional view taken on line 3—3 of Fig. 2, showing the details of construction of the solenoid and the slidable core.

Fig. 4 is a somewhat detailed view of the connection between the flexible conduit and the applicator.

Fig. 5 is a sectional view taken on line 5—5 of Fig. 4.

Fig. 6 shows a somewhat detailed view of a means for retaining a slidable core in a predetermined position.

Fig. 7 is a detailed view of the retaining means unattached.

Fig. 8 is a modified form of the device for retaining the slidable core in a predetermined position.

Fig. 9 is a view of the end portion of the solenoid taken on line 9—9 of Fig. 8 and showing the relation of the modified retaining means to a slidable core member.

Fig. 10 shows still another modified form of core retaining means.

Fig. 11 shows a somewhat detailed construction of the means for connecting the flexible conduit with a modified form of applicator receptacle.

Fig. 12 is a sectional view taken on line 12—12 of Fig. 11 showing the detailed construction of the means for retaining the applicator within its receptacle.

Fig. 13 is a view of a curved applicator such as is employed in this invention.

Fig. 14 shows an applicator with an attached sleeve for use in certain applications of this invention.

Fig. 15 is a view of an applicator receptacle provided with a switch for controlling the operation of the solenoid.

Fig. 16 shows a modified form of applicator receptacle equipped with a switch for controlling the operation of the solenoid.

Referring to the drawings our invention embodies a source of magnetism which, in this particular instance, is a solenoid 1, adapted to be placed on a table or other suitable supporting means. This solenoid comprises a tube 2 which is preferably constructed of non-magnetic material and on which are mounted two spaced heads or discs 3 formed of rubber, condensed phenolic compounds or other insulating substances. Tube 2, with its heads or discs 3 mounted in place, forms

a spool upon which is wound the magnetizing coil 4.

The winding of the coil 4 will depend upon the type of current supplied to the coil and upon the magnetic force to be generated, among other conditions. Some of the conditions which must be considered in constructing the solenoid coil are the cross-sectional area of the wire, the radii of the windings, the ratio of the length of the coil to its average radius, the diameter of the solenoid, and electrical effects, such as heating and inductance. In some instances the tube 2 should be slotted to allow for expansion and contraction due to temperature changes.

In constructing coils for use with alternating current it is best to provide an extra loop of wire so that the chatter, incident to the alternating current, may be eliminated. Also in the design of coils for alternating current it is customary to place mica, oiled linen, paper, sheet condensed phenolic compounds, sheet rubber etc., between the layers and treat the whole coil with insulating and impregnating varnishes or other compounds. The coil should be constructed in a manner best suited for the purposes for which it is to be used.

A tubular casing 5 is fitted over the end discs 3 so as to completely enclose the coil 4. This casing or shell is preferably constructed of non-magnetic material which has a polish or easily cleaned surface. Supporting end caps 6 are constructed so as to threadedly engage with the shell 5 to enclose the solenoid. It will be noted that the central portion of these caps is provided with flanged openings adapted to receive the ends of the tube 2. Supporting legs 7 are formed integrally with the end caps 6 and serve to support the solenoid. The end caps 6 are securely fastened to the shell 5 so as to provide a tight casing for the solenoid. A compound, such as glycerine and litharge, or shellac, may be applied to the threads when assembling to provide a means of sealing and holding the parts together.

If found necessary the casing may be provided with cooling flanges or other means for radiating heat, but it has been found that the heating effects are not serious, and as the whole device should be capable of easy cleaning it is preferable to have the surfaces smooth and polished. The upper portion of the shell 5 may be provided with a suitable handle 5' so that the solenoid can be easily handled.

The lower portion of each of the legs 7 is provided with plug receptacles 8 and 8' adapted to receive plugs 9 and 9'. One contact of the receptacle 8 is connected to one contact of the receptacle 8' and the other contacts of receptacles 8 and 8' are connected together through the coil 4. With these connections the power line 10 can be plugged

into the receptacle 8 and a control line 11 provided with a switch 12 can be plugged into the receptacle 8' or vice versa. This arrangement provides for ease of control of the apparatus.

Slidably fitted into the tube 2 of the solenoid is a tubular core piece 13. This core piece is preferably formed of an iron or steel tube, but it may be formed of any other ferro-magnetic material. One end of this tube is internally threaded to receive a threaded plug 14 which serves as a closure for the tube. The tube at its other end is externally threaded to receive a fitting or coupling 15 which serves to connect a flexible tubing 16 to the tubular core piece 13.

The other end of the flexible conduit 16 is provided with a combined fitting and closure which will be described later. Thus it will be seen that the tubular core member 13 and the conduit 16 are connected and provided with closures to form a closed compartment. Mounted within this enclosure provided by the core piece 13 and the flexible conduit 16 are a plurality of ferro-magnetic particles 17, such as shown diagrammatically in the several figures of the drawings. While for purposes of illustration this ferro-magnetic material is shown in the form of finely divided particles, we wish it to be understood that they may consist of ferro-magnetic balls, granules, dust, chips small pieces or even bundles of wire. The purpose of the contents of the tubular core 13 and the flexible conduit 16 is to convey the magnetizing force, energy, or flux from the solenoid to the fitting 20 mounted on the end of the flexible conduit 16.

In order to keep the contents of the tubular core 13 and the flexible conduit 16 in contact with each other, a piston 18 is mounted within the tubular core piece 13 and is forced against the ferro-magnetic particles by means of a spring 19. The spring operated piston 18 exerts a pressure upon the magnetic particles within the core 13 and conduit 16, thereby insuring good metallic contact between the magnetic particles.

In order to provide a flexible tube which may be moved to various positions, rubber or other flexible materials are used. If finely divided material is to be used in the tubular core and flexible conduit, it is necessary that the material forming the flexible conduit have sufficient strength to withstand the pressure exerted by the spring operated piston 18. If fine wire is used in bundle form the material used for the covering of conduit 16 need only be very thin.

When the current is turned on and allowed to flow through the windings of the solenoid there is a tendency for the tubular core 13 to be drawn into the tubular member 2. It is well known that the intensity of the magnetic forces induced in the plunger or core

13 varies with the position of the core or plunger 13 with respect to the solenoid 1. Thus if it is desired to vary the intensity of magnetization induced in the core 13 it is necessary to move it to various positions within the tube 2.

In order to prevent the core 13 from being drawn into the tube 2 where it will receive the maximum magnetizing force the tubular core 13 is provided with a plurality of grooves 21 in which are mounted stop rings or shackles 22. The stop rings or shackles 22 may be made in the form shown in Figure 7 of the drawings. In this construction, a wire 23 is bent into a circular form and is provided with two protruding arms or ends 24 and 25. These arms are provided with indentations or grooves 26 and 27 into which a link 28 is adapted to fit.

When it is desired to lock the tubular core in a predetermined position the shackle 22 is slipped into one of the annular grooves 21 and the link 28 is placed on the arms 24 and 25 and slipped into the grooves provided therein to retain the shackle in position on the core piece 13. When the magnetic force acts to draw the tubular member 13 into the central portion of the solenoid, the shackle 22 abuts against the annular projection on the end cap 6 and serves to prevent the core piece 13 from being drawn all the way into the solenoid 1. Figure 6 shows a spring shackle mounted in operative position on the tubular core 13.

A somewhat modified form of retaining mechanism is shown in Figures 8 and 9 of the drawings. In this form of our invention the end cap is provided with a projection 29 having a channel therein, in which slides an operating button 30. A yoke 31 is positioned about the core piece 13, as shown in Figure 8, and its lower portion is adapted to enter one of the annular grooves formed on the core piece to retain the latter in desired positions. The upper portion of the yoke 31 is provided with a rodlike projection 32 on which is mounted the operating button 30.

Spring means 33 are provided in the channel of the projection 29 and about rod 32 to force the button 30 in an upward position, thereby causing the lower portion of the yoke 31 to engage in one of the grooves of core piece 13. The lower portion of end piece 6 is provided with a projection in which is threadedly mounted a screw 34. The screw 34 projects through a slot 35 in the projection extending from the lower portion of the yoke 31. This slotted connection serves to retain the yoke 31 in operative position.

When it is desired to adjust the position of the core piece 13 within the tube 2 it is merely necessary to press on the button 30, pushing it in a downward direction against the action of the spring 33. By pushing the button 30 downwardly the lower portion of

the elliptical yoke 31 is moved out of one of the grooves 21 thereby permitting free movement of the core piece 13 within the tube 2. When the core piece is adjusted to a desirable position the yoke 31 is allowed to move back to its original position and engage in one of the grooves 21 to prevent movement of the core piece 13.

Still another modification of the retaining means for holding the core piece 13 in predetermined position is shown in Figure 10. In this form a hasp 36 is pivotally mounted on a projection 37 on the end cap 6. The hasp 36 is so constructed that when it is in a downward position it engages in one of the grooves 21 of the core piece 13, as is clearly shown in Figure 10. In order to prevent accidental displacement of the hasp 36 from the grooves 21 a pivoted latch member 38 is provided. In operation the latch member is moved down so as to engage the hasp 36 to retain it in operative position.

It will be readily seen that while any of the stop mechanisms above described prevent the core piece 13 being drawn into the solenoid 1 they permit rotation between the core piece 13 and the tube 2 of the solenoid. This is desirable because in some instances it may be found necessary to rotate the flexible conduit 16 and the core piece 13 to apply the magnetizing force where desired.

To facilitate the adjusting of the core piece 13 in the solenoid the former may be provided with indicia to indicate the magnetic force induced into the core at each of the several positions at which the core piece may be retained.

While we have described and shown the preferred forms of retaining mechanisms, we do not wish to hold ourselves to any particular device, as it is within our conception to utilize a core with teeth provided thereon, similar to a rack, which can be operated by a pinion or other adjusting wheel. It is also possible to prevent the core 13 being drawn into the solenoid by merely drilling or providing holes in the core piece in which a pin or cotter may be inserted to serve as a stop mechanism.

As previously mentioned the free end of the flexible conduit 16 is connected to a fitting 20. The manner of connecting the conduit to the fitting 20 is more clearly shown in Figure 4. As shown in this figure the fitting 20 is provided with a tapered opening into which the end of the flexible conduit 16 extends. A tapered shell 39 is inserted within the end of the conduit 16 to force the latter into a tight connection with the inner walls of the tapered opening of the fitting 20. As is shown in Figure 4, a threaded plug 40 is inserted into the threaded opening 41 of the fitting 20. This plug 40, when in place, serves to retain the tapered shell 39 in operative position to insure a tight connection be-

tween the flexible conduit 16 and the fitting 20. The plug 40 also serves as a closure for the conduit 16. A pin 44 is extended through the fitting 20 into the tapered shell 39 to prevent any undesirable movement between the conduit 16 and the fitting 20.

The threaded opening 41 is adapted to receive the threaded end 42 of an instrument or applicator. As shown in Fig. 4 the end 42 of the instrument 43 is conical shaped and the plug 40 is provided with a conical recess against which the end 43 abuts. This form of construction insures good metallic contact between the parts 40 and 43. The abutting surfaces need not necessarily be conical however, but may be flat as shown in Fig. 11.

The instruments or applicators 43 may be of a variety of shapes and forms so as to meet the various purposes for which they are designed. It is highly desirable that they be detachably connected to the fitting 20 so that before and after use they may be removed and sterilized.

A somewhat modified arrangement for connecting the applicators or instruments to the flexible conduit 16 is shown in Figures 11 and 12. In this form of our invention the conduit 16 is connected to the fitting 20' in a manner similar to that shown in Figures 4 and 5. A threaded plug 40' is mounted within the threaded end of the fitting 20' somewhat similar to the plug shown in Figures 4 and 5. The threaded end of an adapter 45 is inserted in the threaded opening of the fitting 20'. This adapter is provided with a socket into which ends of instruments or applicators 46 may be inserted.

As shown in the drawings the connection between the adapter 45 and the instrument 46 is by means of a bayonet joint. The plug extension 47 of the instrument 46 is of a cross section which when inserted within the socket in the adapter 45 will prevent rotation between the instrument 46 and the adapter, that is a flat portion 47' is provided. In order to prevent the instrument 46 from being accidentally displaced from the socket in the adapter 45 the plug 47 is provided with a recess into which a spring operating ball 48 is forced. A passage is provided in the adapter 45 into which the ball 48 is placed. The lower portion of the passage is provided with a flange or seat to prevent the ball passing into the socket, formed in the adapter. A spring 49 acts to force the ball 48 onto its seat and is held in position by a removable plug member 50, which is threadedly secured within the adapter 45.

Thus when the projection 47 is inserted within the socket of the adapter 45 the ball 48 is forced upwardly until engaged by the recess 51 formed in the projection 47 whereupon it drops into this recess to prevent the instrument 46 being accidentally removed. The ball when seated, together with plug 50, 130

seals the passage sufficiently to allow the adapter to be subjected to sterilization without damaging the spring operated ball mechanism.

5 With the use of the adapter 45 instruments 46 provided with the bayonet means of attachment may be utilized as well as instruments provided with the screw threaded at-
10 taching means. The bayonet type of connection has some advantages over the screw threaded type particularly that of rapid action. For instance, to connect an instrument having a bayonet type connection it is merely necessary to push it into place, and to dis-
15 connect it from its receptacle it is merely necessary to pull it out, whereas for connecting and disconnecting instruments of the screw threaded type it is necessary to rotate the instrument several times.

20 Instruments or applicators of all types and forms may be used in connection with our invention. For instance, sharp pointed instruments may be used when it is necessary to insert the same into a wound to withdraw
25 small particles. In some cases it may be necessary to use long curved instruments 52, such as shown in Figure 13. Although the instrument 52 is shown provided with a screw threaded connecting end 53, it is to be under-
30 stood that any and all types of instruments may be provided with either the bayonet type of connection or the screw threaded type.

For certain types of operations it is desirable and sometimes necessary to equip an
35 instrument with a guard or mask. An embodiment of this form of our invention is shown in Fig. 14 of the drawings, in which an instrument 54 shown equipped with a screw threaded connecting means by way of
40 illustration, is surrounded by a tubular guard 55. This guard or mask may be formed of any material suitable for the purpose, and is preferably secured to the instrument by means of screw threads 56, although any
45 other type of connection will suffice.

In using this guarded instrument, it is centered over the embedded particles and the current turned on so that the particles are attracted to the point 57 and held there. The
50 instrument can be withdrawn from the wound without any danger of the small particles being scraped off of the instrument as may easily happen with an unprotected instrument. The shield also may be used to
55 protect blood vessels from being pierced by the action of the particles when attracted to and moving toward the magnetized instrument end.

It is sometimes desirable to have the solenoid control switch in a location easily
60 reached by the operator. This can be accomplished by having a switch mounted on the instrument receptacle. An embodiment of this detail of our invention is shown in Fig.
65 15 in which the fitting 20 is provided with a

dovetail groove or slot adapted to receive a dovetail projection 58 extending from a switch body 59 carrying a push button 60 and mounted on the fitting 20 and held in position by means of the lug 58. For purposes
70 of illustration the switch is shown to be of the push button type but we wish it to be clearly understood that it may be of any type desirable or suitable for the purpose.

A modified form of solenoid control switch
75 is shown in Fig. 16. This form employs a handle or grip which is attached to the instrument receptacle, and serves as a means for holding and guiding the instrument during operation. The fitting 20 is provided
80 with a slot or groove 61 which receives a lug 62 carried by the yoke 63 of the handle or grip 64. This lug and slot connection serves to retain the parts rigidly connected to each other. The handle 64 is equipped with a push
85 button switch 65 which is adapted to make and break an electrical connection between the two wires located in the conduit 11.

With either this or the previously described construction, the current supplied to
90 the solenoid can be easily controlled by the operator without removing his hand from the handle or the receptacle for the instrument. Such an arrangement is particularly
95 desirable when it is necessary to alternately open and close the electrical circuit through the solenoids over a plurality of short time intervals.

When our invention is to be used to remove
100 any metallic particles from a portion of a person's body, the several parts are assembled as shown in Fig. 1. The solenoid 1 may be placed on a table or stand near the operating table or chair. The core 13 is moved to
105 the position in the tube 2 of the solenoid at which the desired magnetic force will be induced in the core. This position may be determined by experiment or by indicia on the tubular core member 13.

After the tubular core 13 is adjusted to the
110 proper position it is secured in position by any of the forms of locking or retaining devices hereinbefore described. An instrument formed of ferro-magnetic material of
115 the types described and suitable for the particular operation to be performed, is sterilized or otherwise treated to prevent the introduction of undesirable organisms into the wound. After the instrument or applicator
120 has been rendered sterile it is placed in the receptacle mounted on the end of the flexible conduit 16.

When desired the electrical circuit through
125 the solenoid is completed by closing the proper switch which as described may be located in the fitting mounted on the end of conduit 16 or in the handle for holding and guiding the instrument. The instrument is then in-
130 serted in the wound to gather the magnetical-

ly attracted particles and after gathering the same is withdrawn.

Any particles adhering to the instrument can be removed therefrom merely by breaking the electrical circuit through the solenoid which stops the magnetization of the core and instrument.

Since the conduit between the core 13 and the fitting 20 is flexible, the instrument rigidly connected to the fitting 20 can, together with the fitting, be moved to any desired position and the magnetic susceptible particles can be approached in any direction regardless of the position of the solenoid. It can easily be seen that our novel form of conduit permits many types of magnetic operations to be performed which were heretofore considered impracticable because of the impossibility of moving a heavy bulky electromagnet to various positions.

Should it be found necessary to change instruments while operating, the same can be easily accomplished with either the screw threaded connected instruments or with the bayonet connected instrument, the latter being capable of quicker changes.

If it is necessary to vary the intensity of the magnetism induced in the core 13 for any reason whatever, the same can be effected by merely changing the position of the core 13 with respect to the tube 2 on which the coil of the solenoid is wound. After the core 13 is moved to its new position it can be retained in place by utilizing any of the locking or retaining means hereinbefore described.

In operation a magnetic field is generated in the tube 2 by the current flowing through the coil of the solenoid. As the core 13, constructed of magnetically susceptible material is placed in the magnetic field, the magnetic lines of force flow through the same and render it magnetic. The magnetism induced in the particles in the core 13 is conveyed through the particles in the conduit 16 to the fitting on the end thereof and thence into the instrument metallically connected to the fitting.

Our invention, as is obvious from the foregoing description, provides a surgical instrument having a rather wide range of utility. It provides an apparatus capable of efficiently extracting metallic particles from the flesh of a human body.

The flexible cable-like conduit employed in our invention together with the quickly detachable instruments or applicators cooperate to produce results heretofore unattainable with magnetic instruments. Also the novel means for varying the magnetic forces induced in the core piece, and the conveniently mounted solenoid control switch cooperate with the other parts of our invention to produce an easily, conveniently, and rapidly operated device.

While we have shown and described the

preferred embodiment of our invention, we wish it to be understood that we do not confine ourselves to the precise details of construction herein set forth, by way of illustration, it is apparent that many changes and variations may be made therein, by those skilled in the art, without departing from the spirit of the invention, or exceeding the scope of the appended claims.

We claim:

1. A surgical instrument comprising a source of magnetic force and means for conducting said magnetic force from said source to a point of application, said means comprising a flexible casing containing a plurality of ferro-magnetic particles.

2. A surgical instrument comprising a source of magnetism and means for transmitting magnetism from said source to a point of application, said means comprising a flexible tubular member containing a plurality of magnetic particles, and means for retaining said particles in a compact condition.

3. A surgical instrument comprising a source of magnetic force and means for conducting said magnetic force from said source to a point of application, said means comprising a flexible tubular member containing a plurality of magnetic particles and spring operated means for exerting pressure on said particles for retaining the same in contact with each other.

4. A surgical instrument comprising a solenoid, a movable core adapted to be moved in and out of said solenoid, means having metallic contact with said core for transmitting magnetic force induced in said core to a point of application, said means comprising a flexible casing containing a plurality of magnetic particles, the casing being connected to said core and other means for retaining said core in a predetermined position in said solenoid.

5. A surgical instrument comprising a solenoid, a movable core mounted therein, said core comprising a tubular member, a flexible conduit connected with said tubular member, a plurality of magnetic particles in said tubular member, said flexible conduit adapted to transmit magnetism from said solenoid to an applicator attached to said flexible conduit.

6. A surgical instrument comprising a solenoid, a moveable core mounted therein, said core comprising a tubular member, a flexible conduit connected with said tubular member, a plurality of magnetic particles in said tubular member and said flexible conduit, adapted to transmit magnetism from said solenoid to an applicator attached to said flexible conduit, and spring operated means in said tubular member adapted to force said magnetic particles into contact with each other.

7. A surgical instrument comprising a solenoid, a tubular movable core adapted to be moved in and out of said solenoid, a flexible casing connected to said core, a fitting adapted to receive an applicator connected to said casing, said casing and core being filled with magnetic particles, a removable plug positioned in the end of the core opposite the end of said casing, a spring operated piston positioned in the core, the spring bearing against said plug and said piston, said piston in contact with the magnetic particles so as to force the same against an end of said fitting.

8. A surgical instrument comprising a source of magnetic force, means for conducting said magnetic force from said source to a point of application together with means for controlling the intensity of the magnetic force, said conducting means comprising a flexible casing containing a plurality of magnetic particles.

In testimony whereof we affix our signatures.

LEONARD KAY WRIGHT.
WILLIAM P. MACLEOD.