

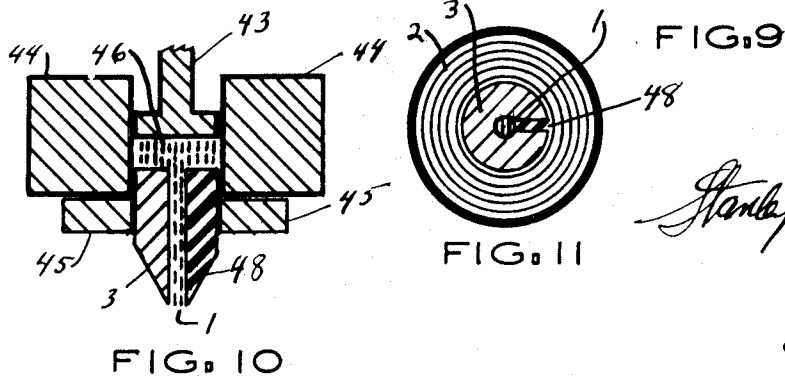
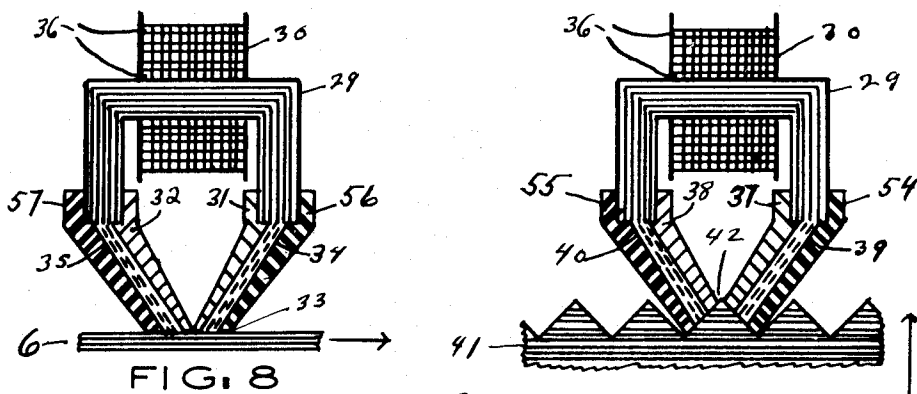
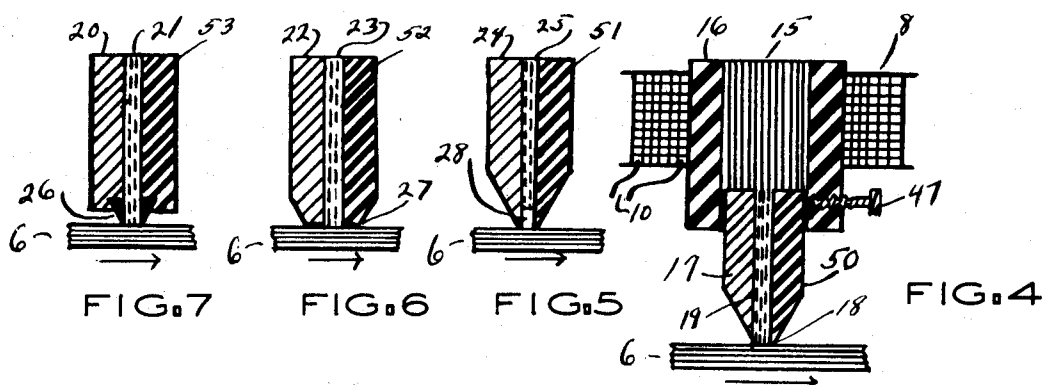
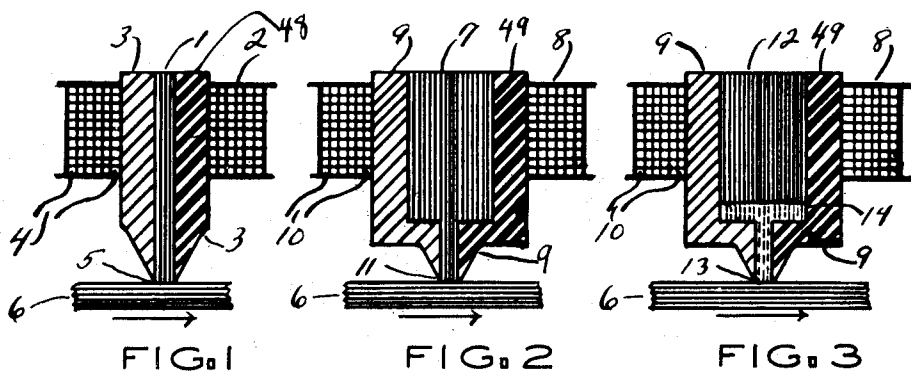
Oct. 31, 1944.

S. D. EILENBERGER

2,361,753

MAGNETIC POLE PIECE

Filed Feb. 22, 1943



Stanley D. Eilenberger
INVENTOR
BY *Mumma, Liddy*
and *Glacium*
ATTORNEYS

UNITED STATES PATENT OFFICE

2,361,753

MAGNETIC POLE PIECE

Stanley D. Ellenberger, Kenosha, Wis., assignor
to Wolgen Co., Chicago, Ill., a corporation of
Illinois

Application February 22, 1943, Serial No. 476,750

11 Claims. (Cl. 179—100.2)

This invention relates to improvements in magnetic pole piece construction, for use in magnetic recording, reproduction, or obliteration, and particularly to such pole pieces for use in recording on or reproducing from a magnetic sound carrier in the form of a flat disk, analogous in shape to the ordinary phonograph record in common use, or a circular drum analogous in shape to the cylindrical record ordinarily used on well known dictating machines. In either case the magnetic sound carrier is of magnetic material, such as steel, most of the ferric alloys, and certain nickel-aluminum combinations.

The prior art teaches numerous methods of magnetic recording and reproduction. While these methods offer numerous advantages, two serious disadvantages are, first, rapid wear on the pole piece tip, and second, spreading of the magnetic flux in the region of the pole piece tip.

This invention specifically relates to improvements in pole piece construction designed to overcome these difficulties. This is accomplished by forming the pole piece or the pole piece tip inside a metallic but non-magnetic sheath which is of a material having higher wear resisting qualities than the pole piece itself, so that the pole piece tip cannot wear at a rate faster than the wear on the protecting sheath. At the same time the protecting sheath completely shields the actual pole piece, acting as a conductive shield, thus confining the magnetic field.

Among the numerous objects of this invention are:

First, to provide a pole piece assembly for use in magnetic recording, reproduction, or obliteration which shall be completely shielded and confine all stray magnetic fields.

Second, to provide a pole piece assembly of the class described in (1) above, which will allow the use of a pole piece material having very low or zero magnetic retentivity, such as plasticized powdered iron.

Third, to provide a pole piece assembly of the class described in (1) above, with a protecting sheath having wear resistant qualities, so that the pole piece per se cannot wear faster than the wear resistant sheath.

Fourth, to provide a pole piece assembly of the class described in (1) above, using two pole pieces to form a closed magnetic circuit, suitable for recording, reproduction, or obliteration with closely spaced magnetic sound tracks in the form of a disk or cylinder record.

Fifth, to provide a pole piece assembly of the class described in (1) above, where the pole piece

tip inside the protecting sheath is of uniform diameter for a considerable part of its length, so that normal wear will not change the pole piece tip dimensions.

Sixth, to provide methods or means of combining any or all of the foregoing objects in a single pole piece assembly.

In all forms of magnetic recording it is well known that the pole piece tip dimension must be kept extremely small, in order to record the higher audio frequencies at a reasonable linear sound track speed. This pole piece dimension is a product of actual dimension and linear sound track speed, and should not exceed one-half wave length of the highest frequency it is intended to record. As an example, in order to record a frequency of 10 k. c. at a linear sound track speed of 16" per second, which corresponds to the innermost sound track speed on a disk record traveling at 78 R. P. M., the pole piece dimension in the direction the sound track is moving should not exceed .0008".

A further requirement for such a pole piece is that it have very low magnetic retentivity, and it has been common practice to make such pole pieces from soft iron having relatively low magnetic retentivity, although this has not been found fully satisfactory, as the magnetic sound track, on the other hand, must have relatively high magnetic retentivity, and it has been common practice to use very hard steel or hard magnetizable alloys for this purpose, which provides a high rate of wear on the relatively soft pole piece.

It may readily be seen that such pole piece requirements as extremely small tip dimension and soft iron having low magnetic retentivity are contradictory. While it is quite possible to produce a pole piece having the proper tip dimension, such tips wear rapidly, thus increasing their effective dimension.

The present invention discloses methods of constructing a pole piece where at least a considerable section of the pole piece is confined within a wear resistant non-magnetic metal sheath which serves the dual purpose of protecting the pole piece and completely shielding the pole piece.

It is well known in the art that magnetic shielding may be accomplished in two ways, first, by the use of magnetic material surrounding or enclosing the magnetic field it is intended to shield and, second, by the use of conductive material surrounding or enclosing the magnetic field it is intended to shield. The conductive shield should be a relatively good electrical conductor

and of sufficient thickness to dissipate all of the stray magnetic fields as eddy current loss. In the present invention a third requirement is necessary, that the shielding be wear resistant.

There are numerous such materials available. For example, numerous copper silicon alloys having a hardness on the order of B90 Rockwell and electrical resistivity approximately 6.5 times that of copper. Beryllium copper and numerous aluminum bronze alloys are also suitable for this purpose, it being understood that these materials are mentioned here merely by way of example and that any non-magnetic metal having suitable wear resistant qualities and which is a good electrical conductor may be used for the pole piece sheath.

The pole piece material may be soft iron, as is common practice, or any of the magnetizable materials ordinarily used for this purpose. However, a preferred pole piece material would be plasticized magnetizable powder, such as, for example, plasticized powdered iron, for at least a portion of the pole piece. There are certain disadvantages of using plasticized magnetizable powder, for the entire pole piece, principally the fact that higher recording power is necessary, due to the relatively low permeability of plasticized magnetizable powder, especially plasticized powdered iron. However, plasticized powdered iron has certain advantages not found in other materials. First, such powdered iron has zero magnetic retentivity; second, it has a relatively high saturation point; and third, it may be forced into the pole piece sheath under pressure, which is more satisfactory than producing a pole piece from solid metal where the tip diameter is on the order of .001". It is understood that the use of plasticized powdered iron for part or all of the pole piece is not to be deemed restrictive in any sense, it being understood that other plasticized or solid magnetizable materials may be used without departing from the principles disclosed by this invention.

The design of a pole piece constructed according to this invention may have a uniform diameter for a length great enough that normal wear will not affect the diameter. While prior art teaches numerous methods of supporting a pole piece having small dimensions in one direction only, this invention discloses methods of constructing a pole piece so that it may have small dimensions in two directions, so that it is suitable for recording relatively high audio frequencies on closely adjacent sound tracks. In order to be practical for the purpose intended, such a pole piece tip must be extremely small in diameter, and therefore fragile, and may be compared to a small iron wire having a diameter on the order of .001", or less.

In the past such pole pieces have been possible only by using material having a diameter great enough to be strong mechanically, with a small diameter tip, like the point of a recently sharpened lead pencil. While it is possible to produce a very small diameter pole piece tip by this method, a slight amount of wear increases this diameter. This difficulty will be overcome by my invention, and normal wear will not alter the original pole piece diameter.

A pole piece constructed according to this invention will be completely shielded, so that no stray fields exist in the region of the magnetic sound carrier, which is important if high audio frequencies are to be recorded on closely adjacent sound tracks, as a leakage field would tend

to increase the effective pole piece dimension, irrespective of the actual physical dimension. This is a very important factor if recording is to be accomplished on a disk or cylinder record having sound tracks on the order of .0025" wide, separated by a like distance of .0025", which corresponds to 200 sound tracks per inch. It is understood that these dimensions are given merely by way of example, and that any sound track dimension, sound track spacing, or number of sound tracks per inch giving satisfactory results may be used.

As in all other forms of magnetic field recording, the recording represented by magnetic flux lines in the magnetic sound track may be obliterated preparatory to a new recording, either by exposing the sound tracks to a high frequency alternating current field to completely demagnetize the sound track, or by exposing the sound tracks to a steady D. C. field of sufficient strength to magnetically saturate the sound track. A pole piece assembly similar to that used for recording or reproduction may, if desired, be also used for obliteration, so that the field of obliteration is confined to the region of a single sound track, which is important where obliteration is progressive immediately ahead of recording, as is common practice.

The invention will be best understood from a consideration of the following detailed description in view of the accompanying drawing forming a part of the specification; nevertheless, it is understood that the invention is not confined to the disclosure, being susceptible to such changes and modifications as define no material departure from the salient features of the invention as expressed in the appended claims.

In the drawing:

Figure 1 represents one form of a pole piece constructed according to this invention.

Figure 2 represents a modified form of the pole piece shown by Figure 1.

Figure 3 represents a modified form of the pole piece shown by Figure 2.

Figure 4 represents an alternate form of pole piece construction according to this invention, having a separate tip section.

Figure 5 represents a modified form of pole piece tip for use with the pole piece assembly of Figure 4.

Figure 6 represents a further modified form of pole piece tip for use with the pole piece assembly of Figure 4.

Figure 7 represents a further modified form of pole piece tip for use with the pole piece assembly of Figure 4.

Figure 8 shows two pole pieces arranged for monoplane recording on a flat surface such as an ungrooved disk or cylinder.

Figure 9 shows a modified form of the assembly shown by Figure 8, for use on a pregrooved disk or cylinder.

Figure 10 shows in schematic form a plunger and die arrangement which may be used in constructing pole piece tips according to this invention.

Figure 11 is a top cross section view of Figure 1.

Referring now particularly to Figure 1, which shows one form of complete pole piece assembly, where 1 represents the soft iron magnetic pole piece, 3 the non-magnetic metal sheath surrounding the pole piece, 2 the coil normally associated with a magnetic recording, reproducing, or obliterating assembly, 4 the leads from coil 2,

which may be connected to a suitable amplifier or other source of voltage, depending upon the manner in which the magnetic head is used, 5 represents the point of magnetic contact between the pole piece 1 and the magnetic sound track 6 and 48 an insulated gap, which may be air or any diamagnetic material inserted in a longitudinal slot provided in sheath 3, the purpose of insulated gap 48 being to prevent the effects of a shorted turn around pole piece 1.

The pole piece dimensions in Figure 1 are grossly exaggerated for reasons of clarity, it being understood that pole piece 1 may have any desired dimension. Also, Figure 1 illustrates the non-magnetic metallic sheath 3 converging to a relatively small area at point 5. It is understood that other shapes may be used, so that pole piece sheath 3 covers a greater area at point 5, where such design is possible or necessary, this factor being dependent upon the use for which the assembly is intended and the type of record carrier used.

Referring now to Figure 2, a modified form of the assembly of Figure 1 is shown, where pole piece 7 has a relatively large diameter section in the field of coil 8, with a tip dimension at point 11 similar to that represented by point 5 in Figure 1. Connecting leads to coil 8 are represented by 10 and the non-magnetic metallic casing is represented by 9, while 6 is again the magnetic sound track and 49 a longitudinal insulated gap similar to gap 48 in Figure 1.

In Figure 3, the assembly is almost identical to that shown in Figure 2 except that plasticized powdered iron, as represented by 14, is used for the tip material, while the balance of the pole piece 12 is of soft iron or other magnetic material. Point 13 represents a like dimension to point 11 in Figure 2, all other reference numerals being the same as in Figure 2.

In Figure 4, a modified assembly is shown where the upper part of the casing 16 is of insulating material and the pole piece tip assembly is a separate unit having a plasticized powdered iron core 19 and a non-magnetic metallic sheath 17, where pole piece 19 is in magnetic contact with the balance of the pole piece represented by 15 and is held in place by set screw 47, it being understood that any other means of holding the pole piece tip section in place may be used, including permanent methods of fastening. Longitudinal insulated gap 50 is similar to gap 48 in Figure 1 and gap 49 in Figures 2 and 3.

In Figure 5, a modified tip for use in the assembly of Figure 4 is shown, where 24 represents the non-magnetic metallic sheath, 25 a plasticized iron core or pole piece, 28 a small air gap between pole piece 25 and magnetic sound tracks 6 and 51 a longitudinal insulated gap.

In Figure 6, a further modified form of pole piece tip is shown where 22 represents a non-magnetic metallic sheath, 23 the plasticized powdered iron core, 27 the point of contact between the non-magnetic sheath 22, pole piece 23, and sound track 6, the longitudinal insulated gap being represented by 52. In Figure 6 contact point 27 represents a broader area of contact between the non-magnetic sheath and the sound track than was the case in tip assemblies shown previously, it being understood that this contact area may be as great as desired, including areas greater than the diameter of the sheath stem. This factor is dependent on whether the pole piece tip assembly is used as its own guide in a pre-grooved record carrier, thus necessitating small

overall tip dimensions, or on a flat surface where larger overall tip dimensions are permissible, it being understood that the actual pole piece dimensions are in no way affected by the contact area dimensions of the sheath.

In Figure 7, a further modified tip assembly is shown where 20 represents the non-magnetic metallic sheath, 21 the plasticized powdered iron core, 26 a wear resisting insert, which may be a very hard non-magnetic alloy or a jewel, such as sapphire, or a synthetic jewel, and 53 the longitudinal insulated gap. As previously mentioned in connection with Figure 6, the contact area of such a jewel may be anything desired. Also, the manner of fastening such a jewel may be as desired, the usual method being to crimp the jewel in place permanently.

In Figure 8, two pole pieces are shown arranged for recording on a flat sound track, it being assumed that a lead screw or separate guide pin will be used to guide the magnetic head assembly. Pole piece 29 may be of soft iron, in magnetic contact with pole piece tip sections 34 and 35, which are completely enclosed by non-magnetic metallic sheaths 31 and 32, (except for the longitudinal insulated gaps 54 and 55) which are in turn crimped or fastened in some other manner to pole piece 29. Coil 30 and connecting leads 36 are similar to the coil assemblies previously described. It is understood that numerous variations and alternate arrangements exist for using two pole pieces of the class shown and described in connection with Figures 1 through 7, inclusive.

Figure 9 shows one such modified arrangement, which is similar to that shown by Figure 8, except that pole piece sheaths 37 and 38 (which have longitudinal insulated gaps at 56 and 57) are designed to rest in two grooves of a pre-grooved record carrier 41, so that the triangular section 42 becomes the magnetic sound track, all other features being the same as described in connection with and shown by Figure 8.

Figure 10 shows a suggested method which may be used to force plasticized powdered iron in the opening provided in the center of the non-magnetic metallic sheath. The die section is represented by 44, having a closely fitting plunger 43, while 46 represents the plasticized powdered iron being forced through non-magnetic sheath 3, which is held in place by clamping ring 45. It is understood that this arrangement is suggestive of methods which may be used for forcing plasticized powdered iron into the center opening of the non-magnetic sheath, to form the pole piece.

In Figure 11, a top cross section view of Figure 1 is shown. The dimensions and numerals are the same as those used in Figure 1, it being understood that Figure 11 is intended to show the use of an insulating gap 48 in the non-magnetic metallic sheath 3, for a length greater than the length occupied by the coil 2, such insulated gap being designed to prevent the effect of a shorted turn around pole piece 1, it being further understood that an insulated gap may be similarly included in the construction of the non-magnetic sheaths shown in Figures 2 through 9, inclusive, such insulated gap being represented by numerals 49, 50, 51, 52, 53, 54, 55, 56, and 57, all of which serve an identical purpose, but differ in shape according to the design of the non-magnetic metal sheath. It is understood that an insulated gap is an essential feature of the non-magnetic metal sheath, acting to prevent the ef-

fect of a closed electrical circuit around the pole piece, it being further understood that such an insulating gap may be of air, or of any diamagnetic material, such as, for example, Bakelite, mica, varnish, etc.

From the foregoing detailed description it is evident that complete shielding of the pole piece is accomplished, it being understood that the non-magnetic metallic sheath is in all cases constructed with a wall thickness sufficient to accomplish complete shielding for any given stray field strength present.

It is also evident that this invention makes possible the use of soft pole piece material, including plasticized powdered iron, or other magnetizable plasticized powder, by protecting the pole piece in such a manner that it cannot wear faster than the rate of wear on the protecting sheath, which may be made much greater than the rate of wear would be on the pole piece per se. Also, the pole piece tip section, having a uniform diameter, will not alter its dimensions with wear, but will preserve a constant dimension, irrespective of its own resistance to wear.

Furthermore, this invention makes practical the use of such material as plasticized magnetizable powder as a pole piece, or pole piece tip, by providing a sheath to confine the plasticized magnetizable powder. Without such a confining sheath, plasticized magnetizable powder would not be practical in such small dimensions as contemplated by this invention.

In all of the foregoing examples a recording, reproducing, or obliterating electromagnet having a single coil is referred to, and such a single coil is shown in the drawing. It is understood that a separate coil may be used to furnish a polarizing flux while recording, as is common practice, or, the signal voltage may be superimposed on a D. C. voltage used to produce such a polarizing flux, as is also common practice.

It is further understood that this invention is not restricted to the use of plasticized magnetizable powder nor of any particular pole piece material, nor any particular sheath material, it being understood that both such parts may be constructed of any materials that will satisfy the requirements previously set out.

The above examples are for the purpose of illustrating some of the methods and means by which the broad purposes of this invention may be carried out and are not to be deemed as restrictive in any manner. Other modifications and alternatives will occur to those skilled in the art without departing from the scope of the invention as defined by the following claims.

I claim:

1. In a magnetic recording or reproducing system including a magnetizable record carrier having a plurality of sound tracks and at least one recording, reproducing or obliterating electromagnet, a longitudinally slotted non-magnetic metallic sheath enclosing at least part of the pole piece for said electromagnet and terminating in a jewel constituting a wear resisting tip.

2. In a magnetic recording or reproducing system including a magnetizable record carrier having a plurality of sound tracks and at least one recording, reproducing or obliterating electromagnet, a magnetic pole piece for said electromagnet having a relatively small uniform diameter polar extension, at least part of said polar extension being formed of plasticized magnetizable powder and at least part of said polar extension

being enclosed within a longitudinally slotted non-magnetic metallic sheath.

3. In a magnetic recording or reproducing system including a magnetizable record carrier having a plurality of sound tracks and at least one recording, reproducing or obliterating electromagnet, a magnetic pole piece for said electromagnet having a polar extension of smaller diameter than the body of said pole piece, at least part of said polar extension being formed of plasticized magnetizable powder and at least part of said polar extension being enclosed within a longitudinally slotted non-magnetic metallic sheath.

4. In a magnetic recording or reproducing system including a magnetizable record carrier having a plurality of sound tracks and at least one recording, reproducing or obliterating electromagnet, a magnetic pole piece for said electromagnet, at least part of said pole piece being formed of plasticized magnetizable powder and enclosed within a longitudinally slotted non-magnetic metallic sheath.

5. In a magnetic recording or reproducing system including a magnetizable record carrier having a plurality of sound tracks and at least one recording, reproducing or obliterating electromagnet, a magnetic pole piece for said electromagnet, at least part of said pole piece being formed of plasticized magnetizable powder and enclosed within a non-magnetic metallic sheath terminating in a jewel constituting a wear resistant tip.

6. In a magnetic recording or reproducing system including a magnetizable record carrier having a plurality of sound tracks and at least one recording, reproducing, or obliterating electromagnet, a magnetic pole piece for said electromagnet, having a part of said pole piece mounted within the coil associated with said pole piece and in fixed relation thereto and having a removable part of said pole piece mounted externally to said coil, said removable part comprising a plasticized magnetizable powdered core and a non-magnetic metallic sheath enclosing at least part of said core, the two parts of said pole piece being in magnetic contact when joined together.

7. In a magnetic recording or reproducing system including a magnetizable record carrier having a plurality of sound tracks and at least one recording, reproducing or obliterating bi-polar electromagnet having inwardly converging polar extensions, a non-magnetic metallic sheath enclosing at least part of each of said polar extensions, the polar extremities of said polar extensions being in instantaneous magnetic relation to a part of one of said sound tracks moving tangentially to said polar extremities.

8. In a magnetic recording or reproducing system including a pregrooved magnetizable record carrier having a plurality of sound tracks and at least one recording, reproducing or obliterating bi-polar electromagnet having inwardly converging polar extensions, a non-magnetic metallic sheath enclosing at least part of each of said polar extensions, the polar extremities of said polar extensions engaging at least one of said grooves and being in instantaneous magnetic relation to a part of one of said sound tracks moving tangentially to said polar extremities.

9. The method of forming a magnetically shielded wear resistant polar extension for an electromagnet for use in magnetic recording, reproducing or obliteration, which comprises the step of injecting plasticized magnetizable powder into and filling at least part of the longitudi-

nal hollow opening of a non-magnetic metal sheath.

10. A method of forming a magnetic sheath, wear resistant polar extension and an electro-magnet for use in magnetic recording, reproducing or obliterating, which comprises the step of forcing plasticized powdered iron into and filling at least part of the long hollow opening of a non-magnetic metal sheath.

11. A method of forming a magnetic sheath, wear resistant polar extension and an electro-magnet for use in magnetic recording, reproducing or obliterating, which comprises the step of forcing plasticized magnetizable powder into a restricted passage in a non-magnetic metal sheath.

STANLEY D. EILENBERGER.