Nov. 29, 1949 M. CAMRAS ET AL 2,489,520

METHOD OF MAKING MAGNETIC IMPULSE RECORD MEMBERS

Filed Aug. 7, 1947 2 Sheets-Sheet 1

Fig. 1

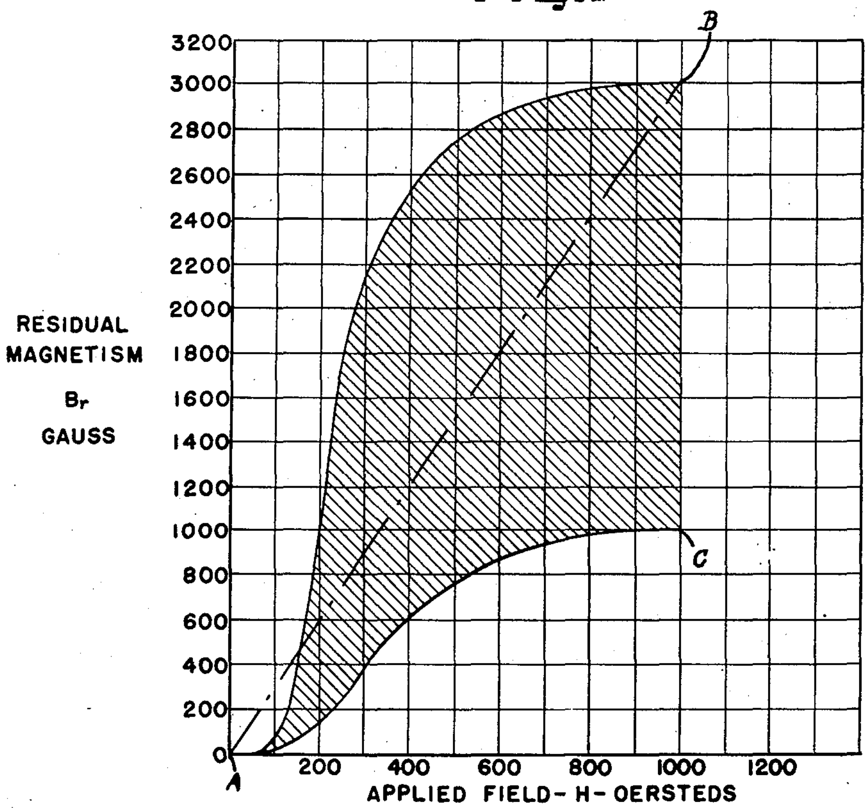
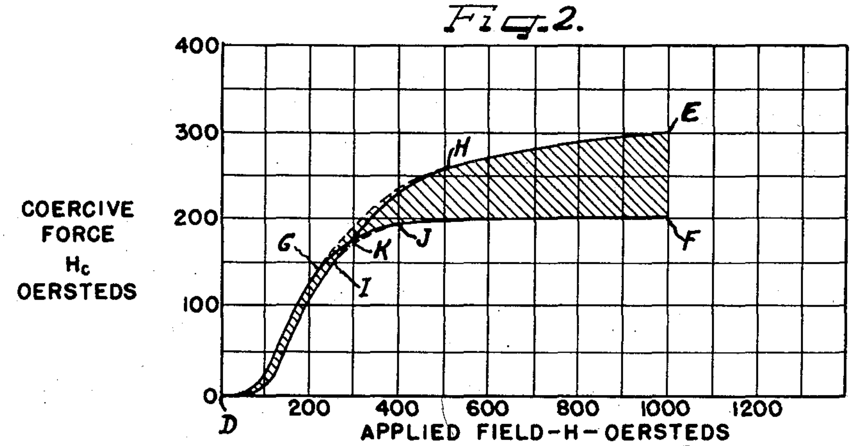


Fig. 2.



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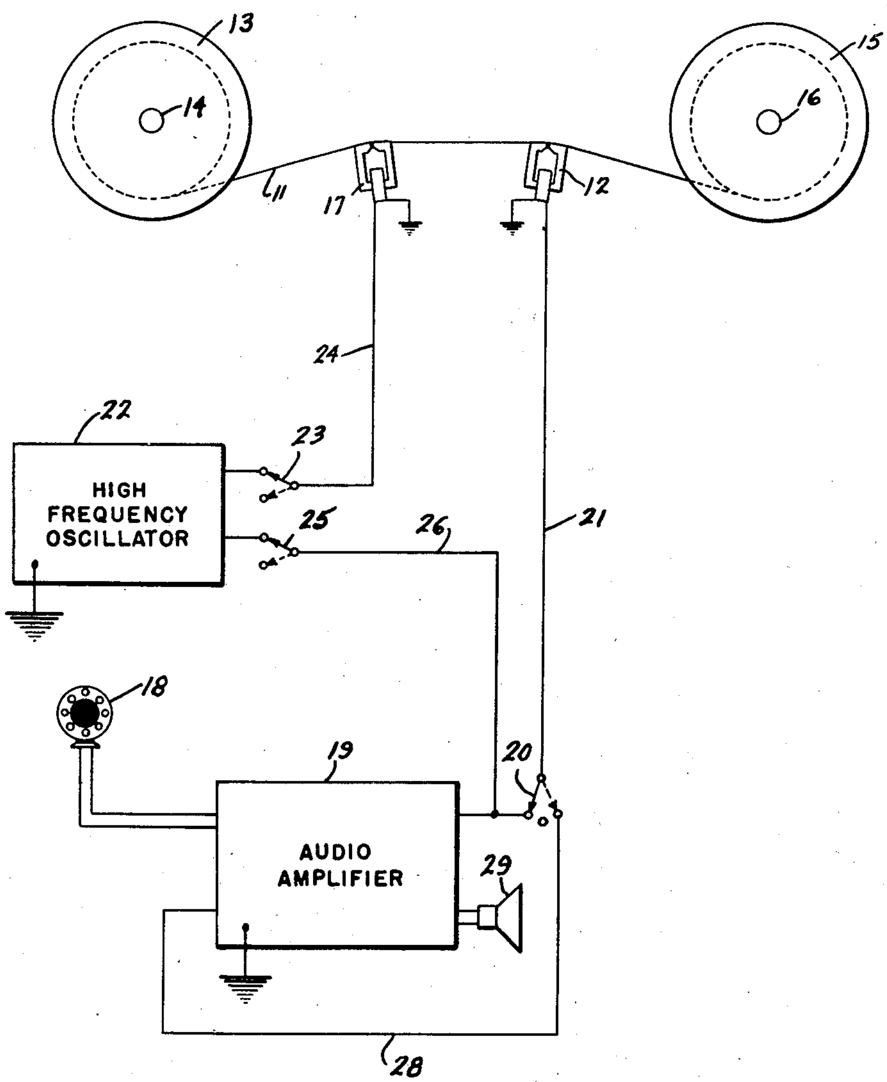
by [signature] Attys.

Fig. 3.



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METHOD OF MAKING MAGNETIC IMPULSE RECORD MEMBERS

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Application August 7, 1947, Serial No. 767,290

5 Claims. (Cl. 148—12)

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This invention relates to a magnetic impulse record member and to a method of making the same. More particularly, the invention relates to a magnetic impulse record member in the form of a wire, tape, ribbon, or the like, formed of normally non-magnetic stainless steel that has been cold worked to impart thereto desirable magnetic properties.

The present invention is a continuation-in-part of our pending application Serial No. 610,678, filed August 13, 1945.

According to our present invention, stainless steel, preferably of the type generally referred to as 18–8 stainless steel, is formed into a magnetic impulse record member by successive series of cold working steps, each series being preceded in each instance by a soft annealing step. By properly controlling the composition of the stainless steel alloy and the conditions under which the cold working and annealing is carried out, a magnetic impulse record member can be obtained that possesses very desirable magnetic properties for use in magnetic sound recorders, and the like.

We have found that the composition of the stainless steel alloy may be varied through a considerable range with respect to the chromium and nickel content, and through a smaller range with respect to the carbon content, provided that the elements are balanced to provide definite stability limits of the austenite toward decomposition on cold working. For instance, the chromium content can be varied between 12 and 25%, the nickel content between 5.5 and 12% and the carbon content between 0.06 and 0.20%, but the nickel content should be relatively lower when the chromium content is relatively higher, and the nickel content should also be lower when the carbon content is higher, at all times, however, keeping the percentages within the broad ranges just given.

With respect to the magnetic properties that are desired in a magnetic sound impulse record member for use in a magnetic sound recorder, we have found that the two most important properties to control are the residual magnetism, B_r, and the coercive force, H_c. The low frequency response of the magnetic record member, is, in general, proportional to its B_r, while its high frequency response is improved by a relatively high H_c. Also, in order for the magnetic impulse record member to be relatively permanent in its retention of magnetically recorded impulses, it should have a relatively high coercive force.

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There are other magnetic characteristics that we have found desirable in magnetic impulse record members and that are found in the magnetic impulse record member of our present invention. For one thing, it is not desirable that there should be a straight linear relationship between the applied field and the residual magnetism, or between the applied field and the coercive force. If there were such a linear relationship in the case of residual magnetism, a magnetized portion of the record member would tend to magnetize an adjacent unmagnetized portion of the record member, as for instance an adjacent strand of the wire in the same reel. The curve produced by plotting the residual magnetism against the applied field, therefore, should rise very slowly for values of applied field between about 0 and 100 and then rise rather steeply to values of between 1000 and 3000 gausses at saturation fields. Similarly, the curve produced by plotting coercive force against the applied field rises very slowly from 0 until a value for H of around 100 is reached, and then rises steeply to give a coercive force, H_c, of between 200 and 300 oersteds for saturation fields. Typical curves illustrating these magnetic characteristics are shown in the drawings.

We have further found that in order to produce magnetic impulse record members having these desirable magnetic properties and characteristics, it is necessary to subject the stainless steel alloy from which the record member is to be made to a series of cold working steps in which the final amount of reduction in cross sectional area is at least within the range of between 50 and 95%, preferably in the neighborhood of 65%, and as a result of which the record member is reduced to a diameter or a thickness preferably of not greater than about 0.005 inch. Where the record member in its final form is a wire of circular cross section, the diameter of the wire should preferably be less than 0.005 inch and usually of the order of 0.004 inch, while if the record member in its final form is a tape or sheet, the thickness of the tape or sheet should also be less than 0.005 inch, and usually of the order of 0.001 to 0.004 inch. We have found that even though the composition of the alloy and the percentage reduction effected by cold working are identical in two wires of different diameters, the smaller diameter wire, if within the ranges indicated, may have magnetic properties imparted to it that render it eminently suited for use in magnetic sound recorder devices, whereas the wire of a diameter lying substantially outside of the specified diameters, as for instance one having a final diameter of 0.04 inch, will not attain those same desirable magnetic properties. Accordingly, the diameter, or thickness, of the magnetic impulse record member must be kept within the limits herein specified for maximum development of its desirable magnetic properties.

It is therefore an important object of this invention to provide a magnetic impulse record member having magnetic properties and characteristics peculiarly adapting it for use in magnetic sound recorders and the like.

It is a further important object of this invention to provide an elongated magnetic impulse record member in the form of a wire, tape, ribbon or the like, of a diameter or thickness of the order of 0.004 inch and formed of a normally non-magnetic chrome-nickel steel that has been cold worked to impart thereto particularly desirable magnetic properties.

It is a further important object of this invention to provide a method of producing an elongated magnetic impulse record member, starting from a non-magnetic, chrome-nickel steel of such composition as to be susceptible of acquiring desirable magnetic properties upon being cold worked, and cold working the alloy to produce such magnetic properties.

It is a further important object of this invention to provide a method of making a magnetic impulse record member from a normally non-magnetic stainless steel, the analysis of which is controlled within certain limits as to chromium, nickel and carbon so that the alloy is capable of having imparted thereto the desired magnetic properties, and then effecting the reduction of the cross-sectional area of blank of such alloy by a series of cold working steps each series being preceded by a soft annealing step and including a final reduction of between 50 and 95% to produce a member having at least one dimension reduced by cold working to not greater than about 0.004 inch and possessing the desired magnetic properties and characteristics.

Other and further important objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

On the drawings:

Figure 1 is a chart of curves obtained by plotting residual magnetism against applied fields up to 1000 oersteds showing optimum, minimum and maximum values of residual magnetism and showing a shaded area between such curves representing residual magnetism values and characteristics found suitable in magnetic impulse record members of our invention.

Figure 2 is a chart of curves obtained by plotting coercive force against applied fields up to 1000 oersteds, showing optimum, minimum and maximum values of coercive force, and showing a shaded area between such curves representing coercive force values and characteristics found suitable in the magnetic impulse record member of our invention.

Figure 3 is a schematic illustration of a typical magnetic sound recorder system utilizing a wire record member of our invention.

We may use as the starting material a stainless steel alloy within the following broad ranges of percentages by weight:

	Per cent
Chromium	12 to 25
Nickel	5.5 to 14
Carbon	0.06 to 0.20
Accessory elements, (maganese, silicon, nitrogen, titanium, columbium, molybdenum and impurities like sulphur and phosphorus)	Less than 8.5
Iron, balance	

In general, the constituents which we prefer to vary in maintaining the proper balance of the alloy are nickel, carbon, chromium and iron.

Accessory elements, such as manganese, silicon and nitrogen, are ordinarily held substantially constant at the usual commercial levels, including less than 2.0% manganese, less than 0.75% silicon, and less than 0.30% nitrogen. Nitrogen and manganese can be substituted for part of the carbon or nickel in effecting a balanced alloy. The nitrogen range can extend from 0.003% to 0.30%. Elements commonly used for purposes other than control of the magnetic properties may also be present in the alloy as, for example, titanium and/or columbium, in amounts ordinarily used for "stabilization." Thus, titanium may be present in amounts equivalent to four times the carbon content or up to about 0.8%, and columbium may be present in amounts equivalent to eight times the carbon content or up to about 1.6%. Molybdenum up to 3% may be used to improve corrosion resistance. These elements and the small content of deoxidizers and impurities, such as sulphur and phosphorus, normally present in commercial steels have been grouped together for purposes of this specification as "accessory elements." The sulphur and phosphorus contents should be less than about 0.04% each.

The term "accessory elements" as used herein and in the claims, therefore designates ingredients such as specified in the preceding paragraph, other than chromium, nickel, carbon, and iron, which may be present in commercial stainless steels.

A very suitable stainless steel alloy falls within the following ranges of percentages by weight:

	Per cent
Chromium	12 to 25
Nickel	5.5 to 14
Carbon	0.06 to 0.20
Manganese	Less than 2.00
Sulphur	Less than 0.04
Phosphorus	Less than 0.04
Silicon	Less than 0.75
Iron, balance	

Within the broad ranges specified, an increase or decrease in the percentage of chromium has approximately the same effect as one-third the corresponding increase or decrease in the percentage of nickel. In other words, if, as we have found, the nickel content should be about 9% for a chromium content of about 18%, then if the chromium were decreased to about 12%, representing a decrease of around 6% from the mean, the nickel content should be increased to about 11%, representing an increase of about 2%.

With a chromium content lying between 17.5% and 19.5%, the nickel content should be higher when the carbon content is lower and vice versa, within the following limits:

0.06 to 0.08% carbon—9.0 to 11% nickel
0.08 to 0.10% carbon—8.5 to 10% nickel
0.10 to 0.15% carbon—8.0 to 9.5% nickel
0.15 to 0.20% carbon—7.5 to 9.0% nickel

Giving effect to these relationships, we have found the following narrower ranges to be preferred:

	Per cent
Chromium	17.5 to 19.5
Nickel	7.5 to 11.0
Carbon	0.06 to 0.20
Iron, balance except for accessory elements	

In selecting a specific alloy composition within the above preferred range, if the carbon content is on the low side, the nickel content should be on the high side, as indicated by the table showing the relationship between carbon and nickel contents. It is only where the chromium lies outside of the range of 17.5 to 19.5% that nickel outside of the range of 7.5 to 11.0% might be desirable, and in that case a low nickel content will be used with a high chromium content, and vice versa, but still within the broad range first above given.

As a specific example, the following is given:

Example 1

The starting material was a rod of $^9/_{64}$ inch in diameter having the following analysis:

	Per cent
Chromium	18.01
Nickel	8.63
Carbon	0.12
Manganese	0.52
Sulphur	0.016
Phosphorus	0.017
Silicon	0.48
Iron, balance	

A rod of this analysis and of the diameter specified was hydrogen annealed at between 1950 and 2050° F. for a sufficient length of time, usually a matter of seconds, to give it a dead soft anneal. The rod was then treated in a sequence of steps as follows:

(1) Draw to effect a reduction of approximately 75% in cross sectional area.
(2) Anneal in hydrogen at 1950 to 2050° F.
(3) Draw to effect a reduction of approximately 75%.
(4) Anneal in hydrogen at 1950 to 2050° F.
(5) Draw to effect a reduction of approximately 75%.
(6) Anneal in hydrogen at 1950 to 2050° F.
(7) Draw to effect a reduction of approximately 75%.
(8) Anneal in hydrogen at 1950 to 2050° F.
(9) Draw to effect a reduction of approximately 65% to produce a wire having a diameter of about 0.004 inch.

If the last anneal in the foregoing sequence of steps is carried out at a temperature close to 1950° F., the record member so produced will have residual magnetism values lying on the curve AB of Figure 1 and coercive force values lying on the curve DF of Figure 2; whereas if the last anneal is carried out at a temperature close to 2050° F., the record member so produced will have residual magnetism values lying on the curve AC of Figure 1 and coercive force values lying on the curve DE of Figure 2. These curves and the areas defined thereby will be more fully explained hereinafter.

Example 2

The starting material was a rod of $^9/_{64}$ inch diameter having the following analysis:

	Per cent
Chromium	18.20
Nickel	8.40
Carbon	0.20
Iron, balance except for accessory elements	

The rod was subjected to the same sequence of steps as those numbered (1) through (8) of Example 1, but in step (9) was cold drawn to effect a reduction of approximately 84% to produce a wire having a diameter of about 0.004 inch. With an applied field of 1000 gausses, the finished wire showed a coercive force, H_c, of 300 and a residual magnetism, B_r, of 2400. A wire produced in the same way except for a final reduction of 77%, instead of 84%, showed an H_c of 300 and a B_r of 1700 with an applied field of 1000 gausses.

Example 3

The starting material was a rod of $^9/_{64}$ inch diameter having the following analysis:

	Per cent
Chromium	18.5
Nickel	8.8
Carbon	0.14
Iron, balance except for accessory elements	

The rod was subjected to the same sequence of steps numbered as (1) through (6) of Example 1, but in step (7) was cold drawn to effect a reduction of approximately 95% to produce a wire having a diameter of about 0.004 inch. With an applied field of 1000 gausses, the so finished wire showed a coercive force, H_c, of about 300 and a residual magnetism, B_r, of 1250.

Example 4

A $^9/_{64}$ inch rod was used having the following analysis:

	Per cent
Chromium	18.73
Nickel	9.06
Carbon	0.12
Iron, balance except for accessory elements	

Using the same sequence of steps as steps (1) through (9) of Example 1, a wire of 0.004 inch diameter was produced having an H_c of 265 and a B_r of 1000 for an applied field of 1000 gausses.

Example 5

The rod started with had the following analysis:

	Per cent
Chromium	18.6
Nickel	9.4
Carbon	0.06

The rod was subjected to the same sequence of steps (1) through (9) of Example 1 to produce a wire of 0.004 inch diameter having an H_c of 250 and a B_r of 1000 with an applied field of 1000 gausses.

Example 6

The starting rod had the following analysis:

	Per cent
Chromium	17.87
Nickel	9.23
Carbon	0.105
Iron, balance except for accessory elements	

The rod was subjected to the same sequence of steps (1) through (9) of Example 1 to produce a wire of 0.004 inch diameter having an H_c of 250 and a B_r of 1500 with an applied field of 1000 gausses.

Example 7

The starting rod had the following analysis:

	Per cent
Chromium	18.67
Nickel	9.31
Carbon	0.085
Iron, balance except for accessory elements	

The rod was subjected to the same sequence of steps (1) through (9) of Example 1 to produce a wire of 0.004 inch diameter having an H_c of 250 and a B_r of 1200 with an applied field of 1000 gausses.

In general, the dimensions of the rod or other blank used as the starting material for our method are unimportant. Originally, the alloy is in the form of an ingot. The ingot may be reduced to some suitable dimensions by any hot or cold forging operation. For wire drawing, however, the starting point is usually a rod having a diameter of ¼ inch or less.

In each of the foregoing examples the draw was effected at ordinary room temperatures, which, in general, would be from 15 to 30° C. and certainly below 50° C. While the upper limit of the temperature of the wire during the preliminary cold drawing steps is not particularly critical, the temperature during the final reduction step should certainly be below its transformation point, which is around 1200° F. in order to have the most favorable magnetic properties imparted to it as a result of the final cold working step. The final reduction step should be a reduction in cross-sectional area to about 50 to 95%, and preferably about 65%. There should be no final annealing step after the final reduction step since if a sufficiently high temperature is used to effect a soft anneal, the magnetic properties would be destroyed. It is possible to heat treat at a relatively low temperature, such as between 800 and 1200° F., after the final reduction step without harming the magnetic properties of the wire, but we prefer to omit any final annealing step entirely.

It will be understood that similar magnetic properties can be obtained if, instead of cold drawing, the material is subjected to an equivalent amount of cold forging, rolling, swaging or extruding. Where the final form of the magnetic impulse record member is that of a circular wire, the diameter should be of the order of 0.004 inch and in any event less than 0.010 inch. In the case of ribbons, tapes or sheets, the thickness should be less than 0.010 inch and preferably of the order of from 0.001 to 0.004 inch.

We have found that the two most important magnetic properties to be controlled in the magnetic impulse record member of our invention, are residual magnetism and coercive force. In general, the record member should be capable of reaching a residual magnetism of between 1000 and 3000 gausses when the applied field is of the order of 1000 oersteds and should be approximately saturated at that value for the applied field. Figure 1 shows limiting curves AB and AC representing maximum and minimum values of residual magnetism, B_r, obtained by plotting residual magnetism against the applied field, expressed in oersteds and denoted by H. The shaded area between the curves AB and AC represents values that have been found suitable in the case of magnetic impulse record members of our invention. While it will be understood that the curves AB and AC can be extended out to the right of the points B and C, the extended portions of these curves would be substantially flat and are therefore not significant. Accordingly, the area defined by the curves AB and AC will be considered as the shaded area lying between these curves and to the left of the ordinate joining the points B and C.

The slope of the curves AB and AC is particularly significant. As shown, for a relatively low intensity of applied field, as for instance a field below 100 oersteds, the residual magnetism is correspondingly low. This is very important, since it means that for low applied field, the record member does not become appreciably magnetized. Consequently, the record member is not easily magnetized by the proximity of magnetic fields of low intensity, as would be the case if there were a more nearly linear relationship such as represented by the dot-dash line AB shown in Figure 1. Other magnetic impulse record members that we have tested more closely approximate the slope of the dot-dash line AB for low intensity of applied field and are objectionable for that reason, since they tend to become magnetized by stray fields.

On the other hand, as the applied field increased in value above 100 oersteds, the slope of the curves AB and AC rises quite steeply, so that at fields of moderate intensity, say between 500 and 1000 oersteds, there is a corresponding substantial residual magnetism of the order of between 1000 and 3000 gausses. These are values that are readily obtained by the ordinary construction of recorder heads in magnetic sound recorders.

Figure 2 shows in solid line two curves, DF and DE that represent the values obtained by plotting coercive force, H_c, against applied field, H, for magnetic impulse record members having a coercive force at saturation within the desired limits of 200 to 300 oersteds. Since the curves DE and DF intersect, as at K, two areas would, in fact, be defined by these curves, but in order to include points plotted for values obtained in the testing of other satisfactory magnetic impulse record members included in the foregoing examples, smooth composite curves have been formed by joining the solid line portions DG and HE by a dotted line portion GH, and by joining the solid line curves DI and JF by a dotted line portion IJ, and the area so included between composite curves DGHE and DIJF has been shaded. This shaded area represents values for coercive force that has been found satisfactory for magnetic impulse record members of our invention.

It is preferable for ease of erasing the recorded magnetic impulses that the coercive force, H_c, of the record member be not over 300, but except for this reason the coercive force could be higher. In general, with lower annealing temperatures, around 1950° F., higher residual magnetism values, B_r, and lower coercive force values, H_c, are obtained. Such control of the annealing temperature used, therefore, affords a way of varying these magnetic properties for the same composition of alloy.

As indicated by the curves on the drawings, the material is practically saturated at fields of around 500. This makes for ease of erasing the magnetically recorded impulses, especially by the use of a high frequency field, which has been found the most desirable type of field to use from the standpoint of low noise level.

In use, the magnetic impulse record members of our invention are magnetized in accordance with the magnetic impulses which the members are subjected. Our invention is therefore intended to include such magnetized record members.

As diagrammatically illustrated in Figure 3 of the drawing, the magnetic impulse record member 11 is arranged to have intelligence recorded thereon by passing the record member over a head 12 which varies the magnetic state of an incremental length of the record member 11 in accordance with time variations of the intelligence. In reproduction, the record member 11 is again passed over the head 12 in the same direction and the condition or state of the record member along the incremental length thereof is reproduced as a signal, thereby converting the variations in the magnetic state of the record member along its length to a time varying signal corresponding to the recorded intelligence.

A wide variety of apparatus has been developed in the past for effecting such operations, but the details of such apparatus form no part of the present invention. One of the common systems includes transferring the magnetic impulse record member 11 from a storage reel 13 mounted on a shaft 14 to a take-up reel 15 mounted on a shaft 16. The shaft 16 may be driven by any suitable source of power (not shown), and the shaft 14 may have a braking force applied in any suitable manner (not shown) to apply a slight tension to the impulse record member 11 as it passes first over a demagnetizing head 17 and then over the recording and play back head 12. The demagnetizing head 17 is for the purpose of uniformly demagnetizing the magnetic impulse record member 11 before a magnetic record is made thereon by the head 12. When an audible signal is to be magnetically recorded on the traveling record member 11, it is first converted by a microphone 18 into a fluctuating electric current which is then amplified by an audio amplifier 19, and is then fed through a switch 20 and an input circuit 21 to the head 12. A source of high frequency electric current such, for example, as the high frequency oscillator 22, is connected to the erase head 17 through switch 23 and an energizing circuit 24. This conditions the record member 11 immediately prior to recording by demagnetizing it. High frequency current from the oscillator 22 is also fed through switch 25 and a circuit 26 to the input circuit 21 of the recording head 12 to superimpose a high frequency bias current on the signal and thereby improve the recording characteristics of the apparatus.

After a magnetic record is made on the record member 11 by varyingly magnetizing succeeding incremental lengths thereof, the member 11 is rewound onto the storage reel 13 with switches 23 and 25 in their dotted line positions and with switch 20 in its intermediate open circuit position. Thereafter, if it is desired to play back the record which has been made on the record member 11, the member 11 is again transferred from the storage reel 13 to the take up reel 15, but this time the switches 20, 23 and 25 are placed in their respective dotted line positions so that no high frequency energy is fed to either

the erase head 17 or the recording and play back head 12. The varying magnetic state of the record member 11 induces an electric current in the signal coil of the head 12, and this current is fed through the circuit 21 and the switch 20 (in its dotted line position) through the circuit 28 to the input side of the audio amplifier 19. The output of the audio amplifier is connected to a loud speaker 29 which converts the fluctuating electric signal current into an audible signal corresponding to the original signal previously recorded.

We claim as our invention:

1. The method of making a magnetic impulse record member, which comprises successively and repeatedly soft annealing at a temperature of between about 1950° and 2050° F. and cold working a normally austenitic chromium-nickel alloy having an analysis within the following percentages by weight:

	Per cent
Chromium	12 to 25
Nickel	5.5 to 14
Carbon	0.06 to 0.20
Iron, substantially the balance,	

keeping the percentage of nickel low when the percentage of carbon is high and keeping the percentage of nickel low when the percentage of chromium is high and vice versa within the above specified ranges, and effecting a final cold work reduction of between 50 and 95% in cross-sectional area, with no subsequent annealing, to produce a member having at least one dimension less than 0.005 inch and having a residual magnetism, B_r, for a given applied field, H, lying within the area defined by the curves AB and AC and the ordinate joining the points B and C of Fig. 1 and a coercive force, H_c, for a given applied field, H, lying within the area defined by the curves DGHE and DIJF and the ordinate joining the points E and F of Fig. 2 of the accompanying drawings.

2. The method of making a magnetic impulse record member, which comprises successively and repeatedly soft annealing at a temperature of between 1950° and 2050° F. and cold working a normally austenitic chromium-nickel alloy initially in the form of a rod of about ⅛" diameter having an analysis within the following percentages by weight:

	Per cent
Chromium	12 to 25
Nickel	5.5 to 14
Carbon	0.06 to 0.20
Iron, substantially the balance,	

keeping the percentage of nickel low when the percentage of carbon is high and keeping the percentage of nickel low when the percentage of chromium is high and vice versa within the above specified ranges, and effecting a final cold work reduction of between 50 and 95% in cross-sectional area, with no subsequent annealing, to produce a wire of circular cross-section having a diameter of about 0.004 inch and having a residual magnetism, B_r, for a given applied field, H, lying within the area defined by the curves AB and AC and the ordinate joining the points B and C of Fig. 1 and a coercive force, H_c, for a given applied field, H, lying within the area defined by the curves DGHE and DIJF and the ordinate joining the points E and F of Fig. 2 of the accompanying drawings.

3. The method of making a magnetic impulse

record member, which comprises successively and repeatedly soft annealing at a temperature of between about 1950° and 2050° F. and cold working a normally austenitic chromium-nickel alloy having an analysis within the following percentages by weight:

	Per cent
Chromium	17.5 to 19.5
Nickel	7.5 to 11
Carbon	0.06 to 0.20
Iron, substantially the balance,	

keeping the percentage of nickel low when the percentage of carbon is high and keeping the percentage of nickel low when the percentage of chromium is high and vice versa within the above specified ranges, and effecting a final cold work reduction of between 50 and 95% in cross-sectional area, with no subsequent annealing, to produce a member having at least one dimension less than 0.005 inch and having a residual magnetism, B_r, for a given applied field, H, lying within the area defined by the curves AB and AC and the ordinate joining the points E and F of Fig. 1 and a coercive force, H_c, for a given applied field, H, lying within the area defined by the curves DGHE and DIJF and the ordinate joining the points E and F of Fig. 2 of the accompanying drawings.

4. The method of making a magnetic impulse record member, which comprises successively and repeatedly annealing and cold drawing a chromium-nickel-iron alloy having an analysis within about the following ranges of percentages by weight:

	Per cent
Chromium	17.5 to 19.5
Nickel	7.5 to 11.0
Carbon	0.06 to 0.20
Iron, substantially the balance,	

keeping the percentage of nickel toward the lower side of its specified range when the percentage of carbon is toward the higher side of its specified range and vice versa, annealing within the temperature range of about 1950° to 2050° F. between successive cold drawing steps, effecting a reduction in cross-sectional area of between about 50% and 95% in the final cold drawing step without subsequent annealing to produce a wire of circular cross-section having a diameter of the order of 0.004 inch, and for the composition of alloy selected controlling the temperature of the last anneal before the final cold drawing step and the extent of the last cold reduction so as to impart to said wire magnetic properties eminently suiting the same for use as a magnetic impulse record member, said properties including inappreciable residual magnetism for an applied field below 100 oersteds but substantial residual magnetism of the order of between 1000 and 3000 gausses for applied fields of between 500 and 1000 oersteds and a coercive force at saturation of at least 200 oersteds.

5. The method of making a magnetic impulse record member, which comprises successively and repeatedly annealing and cold working a chromium-nickel-iron alloy having an analysis within about the following ranges of percentages by weight:

	Per cent
Chromium	17.5 to 19.5
Nickel	7.5 to 11.0
Carbon	0.06 to 0.20
Iron, substantially the balance,	

keeping the percentage of nickel toward the lower side of its specified range when the percentage of carbon is toward the higher side of its specified range and vice versa, annealing within the temperature range of about 1950° to 2050° F. between successive cold working steps, effecting a reduction in cross-sectional area of between about 50% and 95% in the final cold working step without subsequent annealing to produce a member having at least one dimension less than 0.005 inch, and for the composition of alloy selected controlling the temperature of the last anneal before the final cold working step and the extent of the last cold reduction so as to impart to said member magnetic properties eminently suiting the same for use as a magnetic impulse record member, said properties including inappreciable residual magnetism for an applied field below 100 oersteds but substantial residual magnetism of the order of between 1000 and 3000 gausses for applied fields of between 500 and 1000 oersteds and a coercive force at saturation of at least 200 oersteds.

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