

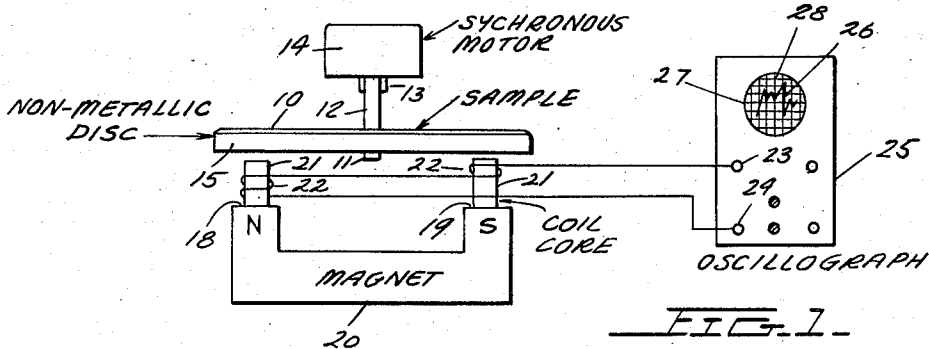
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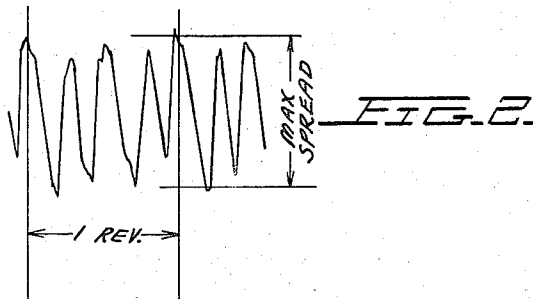
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IDENTOMETER FOR TRANSFORMER STEELS

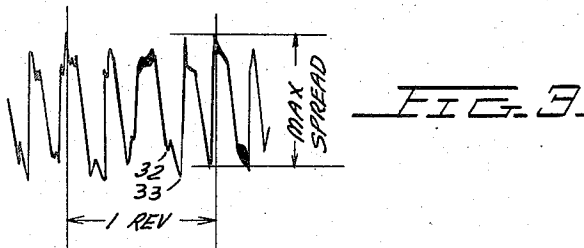
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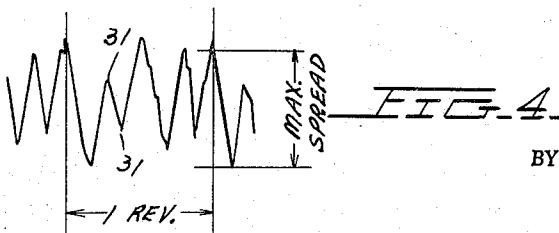
ARMCO 6X



ARMCO 7X



ARMCO 8X



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IDENTOMETER FOR TRANSFORMER STEELS

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5 Claims. (Cl. 324—34)

This application relates to an apparatus and process for identifying various grades of grain oriented transformer steels and more particularly to an apparatus and process which will enable the aforesaid function to be accomplished with a speed and facility applicable to receiving and production inspection.

Grain-oriented steels are an appreciable improvement over steels ordinarily used in making transformer cores and are characterized by high permeability at high inductions and low hysteresis loss. Armco, Hipersil and Corisil are well known trade names of grain-oriented steels.

Heretofore, the most widely used method, and the method adopted by the American Society for Testing Materials for identifying grain-oriented transformer steels was the Epstein Core Loss Test. This test requires the operator to adjust many controls and read many meters as well as perform calculations thereafter in order to determine the grade of steel being tested.

In addition, the test specimen required for the Epstein test was very difficult to prepare. That is, the specimen comprised four elongated bundles arranged in a rectangle. Two of the bundles were made of strips cut in the direction of rolling and the other two bundles were made of strips cut at right angles to the direction of rolling. The bundles formed butt joints at the corners with tough paper of a critical thickness being interposed between adjacent bundles. It was also necessary to reduce magnetization to a minimum, by tapping the joints together, and thereafter clamping the corners to secure rigid joints.

The instant invention comprises a novel apparatus which will enable the operator to identify the grade of grain-oriented steels by referring to a single indicating means which is preferably the screen of an oscilloscope of the type commonly used in a laboratory or TV repair shop. The pattern appearing on the scope due to the test specimen need merely be compared to the patterns obtained by using specimens having known grain orientation. All calculations are eliminated.

In addition to rapidly obtaining the desired information, the apparatus of this invention requires a test specimen which is especially simple to prepare. That is, the test specimen is a single piece having a disk shape with a central opening cut therethrough. A nine inch diameter disk has been found convenient.

With my apparatus the disk shaped test specimen is positioned so as to be part of the magnetic circuit between the poles of a permanent magnet. The specimen is rotated at a synchronous speed and at right angles to the lines of force of the magnet. Since the specimen comprises a grain-oriented steel the reluctance of the magnetic circuit will vary as the specimen is rotated in accordance with the relative orientation between the grains of the specimen and the lines of force. The varying reluctance will cause a corresponding variation in the magnetic circuit flux.

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A core, having a pickup coil wound thereon, projects from either or both of the magnet poles and also forms part of the magnetic circuit. The changing flux will induce a signal in the pickup coil or coils. This signal is read as an induced voltage by connecting the pickup coil or coils in series across the vertical deflection terminals of an oscilloscope. The magnitude and/or shape of the signal generated by the test specimen is then compared to the signals generated in the pickup coil or coils by specimens of known grades.

If the test specimen is of a poor grade, that is, most of its grain orientation is random, the reluctance of the magnetic path will vary little as the specimen is rotated. Hence, the circuit flux will change very little and the signal induced in the pickup coil will be very low since it is dependent on an inductive effect which is a function of the flux rate of change.

Conversely, if the test specimen is of a high grade, when its grains are aligned in the direction of the lines of force the reluctance of the magnetic circuit will be very low and when the grains are aligned in the opposite direction the reluctance will be very high. Thus, the variation in reluctance, between very high and very low, will cause a rapid rate of change in the circuit flux thereby inducing a large signal in the pickup coil.

Accordingly, a primary object of the instant invention is to provide an apparatus and process for identifying various grades of grain-oriented transformer steel with speed and accuracy.

Another object is to provide an identification apparatus and process requiring the reading of a single indicating device and in which the need for calculations is eliminated.

Still another object is to provide an identification apparatus and process requiring an easily constructed disk shaped specimen of the steel to be identified.

A further object is to provide an apparatus for rotating a specimen at synchronous speed through the lines of force of a magnet to induce a voltage in a pickup coil which is connected to the vertical deflection plates of an oscilloscope and comparing the scope presentation to that produced by specimens of known grades.

A still further object is to provide an apparatus wherein the specimen being tested merely rests on a support rather than being clamped in any manner which might distort the true grain orientation.

These as well as other objects of the instant invention will become more apparent after reading the following description of the accompanying drawings in which:

Figure 1 is a side elevation of the apparatus of the instant invention.

Figure 2 is a typical oscillograph presentation when the test specimen comprises Armco 6x grain-oriented steel.

Figure 3 is a typical oscillograph presentation when the test specimen comprises Armco 7x grain oriented steel.

Figure 4 is a typical oscillograph presentation when the test specimen comprises Armco 8x grain-oriented steel.

Referring to the figures, sample or specimen 10 is a disk shaped member having a central opening through which non-metallic rod 12 passes. Rod 12 is an extension of output shaft 13 of synchronous motor 14 which provides constant speed rotation for non-metallic support disk 15.

Fastening means 11 removably secures support disc 15 to the end of rod 12. Sample 10 merely rests upon support 15. No clamps, which could subject sample 10 to

distorting pressures and thereby upset the degree of orientation, are required.

Support disk 15 is positioned above and parallel to pole faces 18, 19 of U-shaped permanent magnet 20 which are preferably located in the same plane. Magnet poles 18, 19 are located 180° apart and a distance in from the periphery of support 15 with rod 12 being positioned at the midpoint of the line joining the poles 18, 19 so that support 15 runs true to magnet 20.

Cores 21, having pickup coils 22 wound thereon, extend upward from pole faces 18, 19 close to the underside of support disk 15. Pickup coils 22 are connected in series aiding relationship with the series combination being connected across the vertical deflection terminals 23, 24 of oscilloscope 25 so that presentation 26 will appear on the face of the cathode ray tube 27. Grid lines 28 are marked across the face for ready calibration and reading.

With the components oriented as described, specimen 10 and cores 21 comprise a major portion of the magnetic circuit between magnet poles 18, 19. Any change in reluctance of the circuit will result in an inverse change in the number of flux lines or magnetic lines of force in the circuit. Since the flux lines also link the turns of pickup coils 22 any change in flux will result in a signal being induced in the pickup coils 22.

When support 15 is rotated this brings about a corresponding rotation of specimen 10. As specimen 10 is rotated the grain orientation thereof will in varying degrees, depending upon the angular position, be in the same direction or in a direction opposite to the direction of the lines of force generated by magnet 20. The greater the degree of grain orientation in the specimen the higher the grade of steel and the lower will be the reluctance of the magnetic circuit at the angular position where the specimen grain orientation is in the same direction as the flux lines. Conversely, there is an angular position where the specimen grain orientation is opposite to the flux lines and in this position of the specimen the magnetic circuit reluctance will be high with the reluctance being the highest for the best grade of steel.

Thus, the specimen of the best grade of steel may be angularly positioned to provide the highest as well as the lowest reluctance path between poles 18, 19 as compared to the reluctance of the paths provided by lower grades of steel. Since all specimens are driven at a constant angular speed the greatest rate of change of flux will take place when the specimen is of the highest grade of grain oriented steel while the slowest rate of change of flux occurs when the specimen is of the lowest grade.

The flux rate of change induces signals in pickup coils 22 which signals are viewed on oscilloscope 25. For most purposes it is sufficient to read the signals merely as a voltage generated by calibrating oscilloscope 25 with grid lines 28 facilitating the reading of the voltages. The greater the deflection the higher the degree of orientation and the lower the core loss.

It is necessary to establish the effect of a generated voltage signal on each oscilloscope 25 by utilizing selected standard samples. In some cases pictures of the scope pattern may prove more exacting than an attempt to count the grid spaces.

In this connection Figures 2-4 illustrate the scope traces obtained by using specimens of Armco transformer steel. Armco grades 6x, 7x, 8x cause the generation of voltages having maximum spreads in the proportions of 13:11:9 respectively, with 6x being the best grade of the three. An experienced operator would soon recognize each grade by some distinguishing feature of its respective trace. For example, the low amplitude humps 31-31 of the type 8x trace and the dips 32 preceding the peaks 33 of the type 7x trace.

It is to be noted that my invention will operate satisfactorily with only one core 21 and pickup coil 22 instead of the two illustrated in Figure 1.

In the foregoing, I have described my invention only in connection with preferred embodiments thereof. Many variations and modifications of the principles of my invention within the scope of the description herein are obvious. Accordingly, I prefer to be bound not by the specific disclosure herein but only by the appending claims.

I claim:

1. An apparatus for identifying the grade of a disk shaped sample of grain-oriented steel; said apparatus comprising a permanent magnet having a pair of pole faces both located in the same plane; a platform of non-magnetic material operatively positioned for supporting said sample in a position such that said sample forms part of the magnetic circuit between said pole faces; a synchronous motor having an output shaft whose axis is perpendicular to said plane and midway between said pole faces; said platform being secured to said shaft for rotation by said motor; a first core projecting from one of said pole faces; a first pickup coil wound about said first core; said first pickup coil having a pair of terminals adapted to be connected to the terminals of a visual indicating means.

2. An apparatus for identifying the grade of a disk shaped sample of grain-oriented steel; said apparatus comprising a permanent magnet having a pair of pole faces both located in the same plane; a platform of non-magnetic material operatively positioned for supporting said sample in a position such that said sample forms part of the magnetic circuit between said pole faces; a synchronous motor having an output shaft whose axis is perpendicular to said plane and midway between said pole faces; said platform being secured to said shaft for rotation by said motor; a first core projecting from one of said pole faces; a first pickup coil wound about said first core; a second core projecting from the other of said pole faces; a second pickup coil wound about said second core; said first and second pickup coils being connected in electrical series with the series connection being adapted for connection to the vertical deflection terminals of an oscilloscope.

3. An apparatus for identifying the grade of a sample of grain-oriented steel; said apparatus comprising a permanent magnet, a support platform, a pickup device, a first means, a second means; said support platform being a disk shaped member comprising a non-magnetic material; said magnet being a U-shaped member; said support platform being operatively positioned to support said sample so that it forms part of the magnetic circuit between the poles of said magnet; said first means rotating said support platform true to said magnet at a constant speed; said second means comprising a core extending from at least one of the poles toward said support platform to a point adjacent thereto; a coil associated with said core.

4. An apparatus for identifying the grade of a sample of grain-oriented steel; said apparatus comprising a permanent magnet, a support platform, a pickup device, a first means, a second means; said support platform being a disk shaped member comprising a non-magnetic material; said magnet being a U-shaped member; said support platform being operatively positioned to support said sample so that it forms part of the magnetic circuit between the poles of said magnet; said first means rotating said support platform true to said magnet at a constant speed; said second means comprising a core extending from at least one of the poles toward said support platform to a point adjacent thereto; a coil associated with each of said cores; said coils being electrically connected in series; a third means operatively connected to said coils for the qualitative and quantitative measurement of signals induced in said coils when said sample is rotated.

5. An apparatus for identifying the grade of a sample of grain-oriented steel; said apparatus comprising a permanent magnet; a pickup device, a first means and a

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second means; said magnet being a U-shaped member;
 a support means for supporting said sample in a position to form a part of the magnetic circuit between the poles of said magnet; said first means being operatively connected to said support means for rotating said sample true to said magnet at a constant speed; said second means comprising a magnetic core extending from at least one of the poles of said magnet toward said sample to a point adjacent to said sample; said pickup device comprising a coil wound on said core; said coil being electrically connectible to the terminals of a visual indicating means.

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