United States Patent [19]

Sohoma

[11] **3,716,748**

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[54] **SATURABLE REACTOR FOR CORRECTING RASTER DISTORTION**

[75] Inventor: **Takeyoshi Sohoma,** Funabashi, Chiba Prefecture, Japan

[73] Assignee: **Denki Onkyo Co., Ltd.,** Tokyo, Japan

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[30] **Foreign Application Priority Data**

July 24, 1969 Japan 44/73474

[52] **U.S. Cl.** .....**315/27 SR,** 315/27 GD

[51] **Int. Cl.**.....**H01j 29/76**

[58] **Field of Search** .....315/27 SR, 27 GD, 24

[56] **References Cited**

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Primary Examiner—Benjamin A. Borchelt
Assistant Examiner—R. Kinberg
Attorney—James E. Armstrong and Ronald S. Cornell

[57] **ABSTRACT**

A saturable reactor comprising an H-shaped core on which are wound two coils, each coil being divided respectively into two coil parts and each coil part being constituted of symmetrical winding on the left and right arms of a yoke with the coupling part formed on the middle of the aforementioned core as the center. One of the aforementioned coils is constituted so that the magnetic flux generating direction of the pair of coil parts wound on the yoke mentioned above would be identical, while the other coil mentioned above is constituted so that the magnetic flux generating direction of the pair of coil parts wound on the yoke mentioned above would be mutually opposite.

5 Claims, 13 Drawing Figures

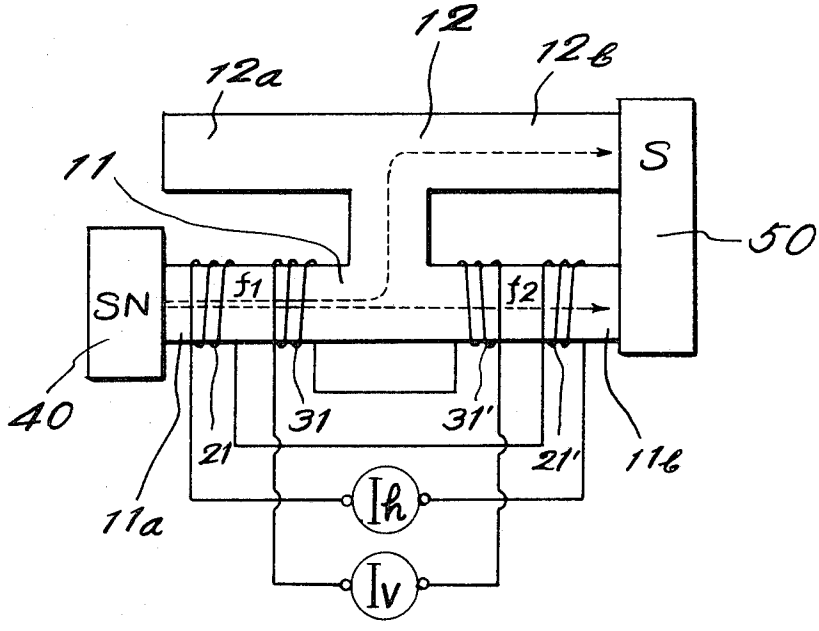


Fig. 1

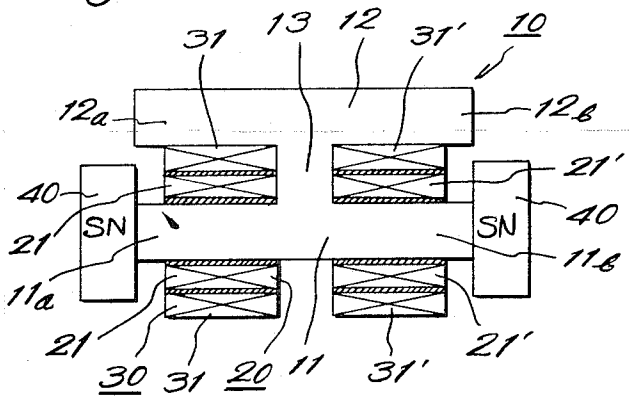


Fig. 2

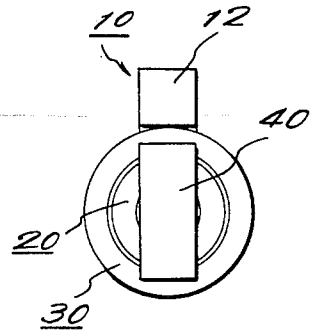


Fig. 3

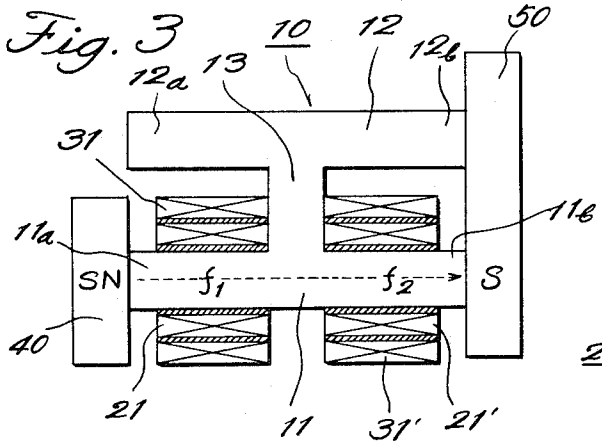


Fig. 4

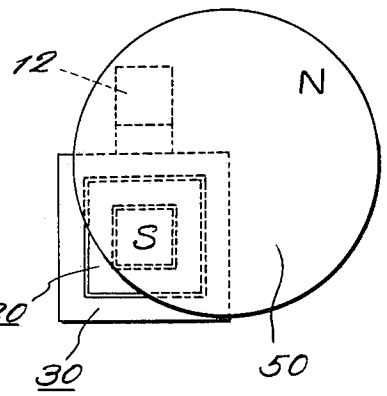


Fig. 5

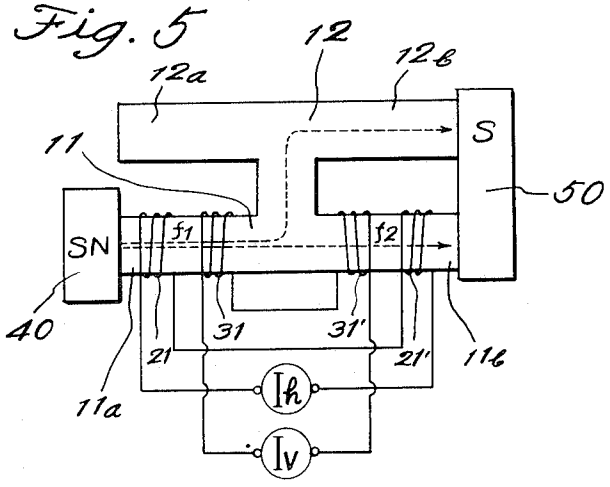


Fig. 6

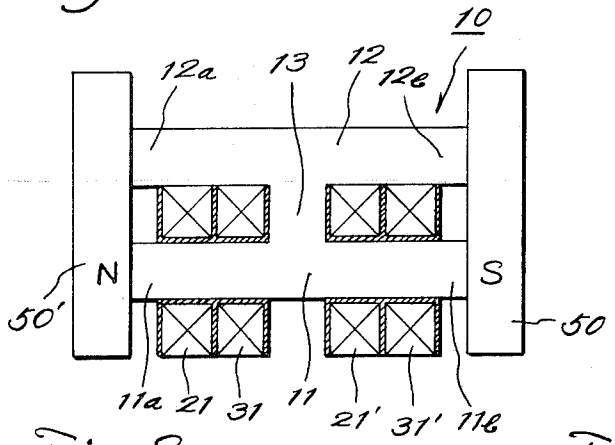


Fig. 7

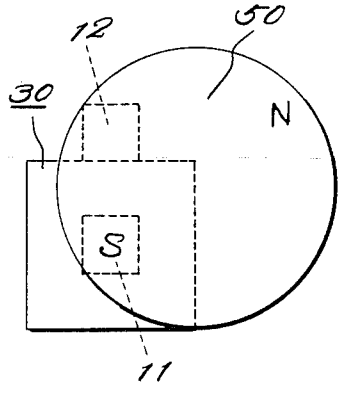


Fig. 8a

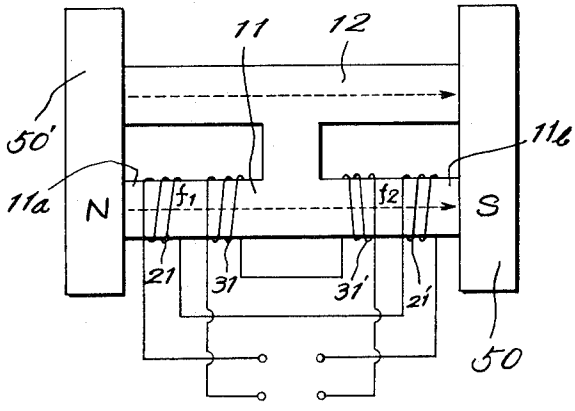


Fig. 8b

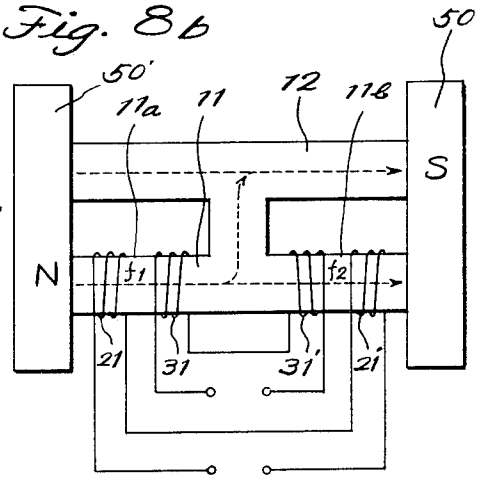


Fig. 8c

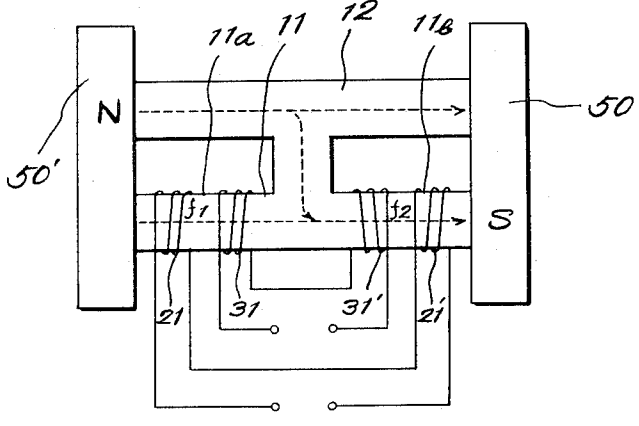


Fig. 9

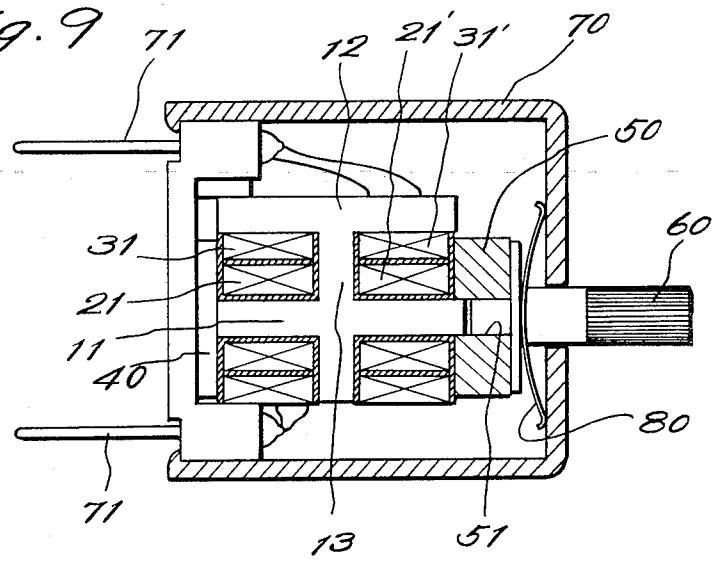
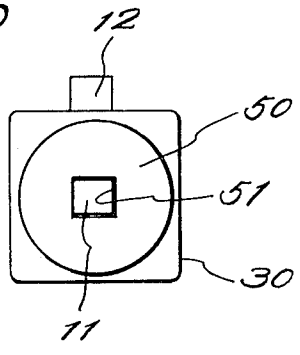


Fig. 10



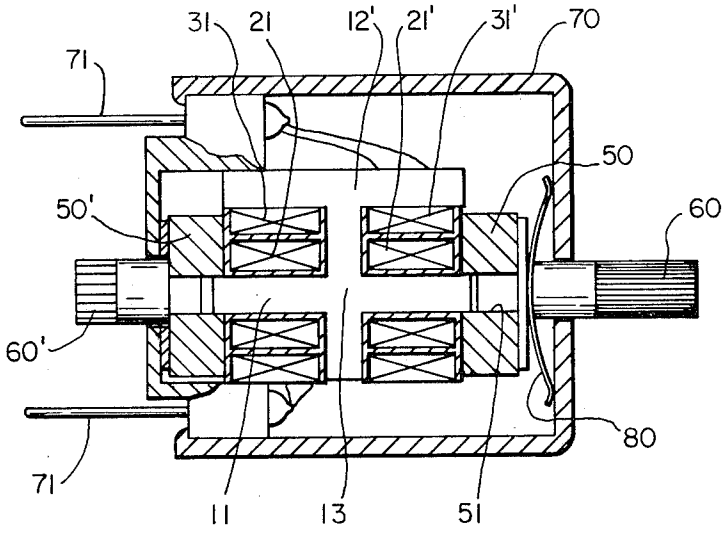


FIG. 11

SATURABLE REACTOR FOR CORRECTING RASTER DISTORTION

BACKGROUND OF THE INVENTION

The present invention relates to a reactor for controlling or modifying "pincushion" type distortion in cathode ray tube displays. It is particularly well suited for use in conjunction with color display tubes.

Pincushion type distortion of cathode ray tube displays has long been recognized. In black-and-white displays, this type of distortion is corrected to a considerable extent through the use of permanent magnets, which are so shaped and fixed in positions relative to the cathode as to produce an appropriate magnetic biasing effect on the cathode ray beam. In the case of color display tubes, which are based on the use of shadow mask or similar principles, however, fixed correcting magnets cannot be used.

One approach, which has been adopted in connection with the correction of pincushion distortion in color displays involves modulation or variation of one of the sweep currents in such a manner as to produce the desired results.

In the arrangement for correction of raster distortion occurring in the vertical direction (e.g., top and bottom pincushion distortion), the cyclically varying vertical scanning current must be modulated at a higher horizontal rate, such as by adding a horizontal rate correction current alternated parabolically to the vertical deflection current.

In the arrangement for the correction of raster distortion occurring in the horizontal direction (e.g., side pincustion distortion), the cyclically varying horizontal scanning must be varied at a lower vertical rate, since the magnitude of a horizontal scanning current is parabolical.

It has further been suggested in the prior art that this modulation be accomplished electromagnetically using a combination of magnetic and electrical circuitry which works on the principle of magnetic saturability.

In general, nominal correction can be produced by this means. There are many kinds of saturable reactor device and circuit connections for correcting pincushion distortion such as those described in U.S. Pat. Nos. 2,906,919, 3,346,765, and 3,444,422.

The existing reactor, as seen in the aforementioned U.S. patents, is composed of a core that mutually couples the two ends of three parallel yokes, a coil is shunt-wound on the two yokes on both sides of the said core in opposite winding direction and is connected in series, and another coil is wound on the center of the said core. Since the vertical deflection current has been applied to one of the above-mentioned coils and the horizontal deflection current has been applied to the other coil, the device has disadvantages as described herein.

In the manufacture of a reactor, coils are fitted to respective yokes of an E-shaped core, and I-shaped cores are coupled on the free ends of the yokes of the E-shaped core in order to magnetically couple the yokes. Using this process, the manufacturing process has been time-consuming, making it unsuited to mass-production. Magnetic flux leakage has been small, since the yokes formed a closed magnetic path. However, since current magnetic flux density in the closed magnetic path varied markedly depending on the infinitesimal differences in the gaps in the magnetic path, the characteristics of individual products lost uniformity because of disparity in the gap arising in the coupled part of the E-shaped core and the I-shaped core.

The present invention offers saturable reactors extremely easy to assemble and manufacture and with uniform quality of individual products.

SUMMARY

In accordance with the invention there is provided a saturable reactor comprising an H-shaped core composed of two parallel yokes and a coupling member that connects the midsections of the said yokes to form left and right arms on either side thereof. The H-shaped core has first and second coils wound around one of the yokes, each coil being divided into two coil parts, and each coil part being constituted of symmetrical winding on the left and right arms of the yoke with the aforementioned coupling part as the center. The first coil is so constituted that, when electric current is made to flow through it, magnetic fluxes are generated at the two coil parts in the same direction, while the aforementioned second coil is constituted so that, when electric current is caused to flow through it, magnetic fluxes are generated at the two coil parts in the opposite directions.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is illustrated in detail in the accompanying drawings in which:

FIG. **1** is a front view of the reactor of the present invention.

FIG. **2** is a side view of the reactor shown in FIG. **1**.

FIG. **3** is a front view of an embodiment of the reactor of the present invention; it shows a longitudinally sliced segment of the coil.

FIG. **4** is a side view of the reactor of FIG. **3**.

FIG. **5** is a diagram of the reactor shown in FIG. **3**.

FIG. **6** is a front view of another embodiment of the reactor of the present invention; it shows a longitudinally sliced segment of the coil. FIG. **7** is a side view of the reactor shown in FIG. **6**.

FIG. **8***a*, FIG. **8***b* and FIG. **8***c*, are diagrams respectively of the reactor shown in FIG. **6**.

FIG. **9** is a front view of another embodiment of the present invention.

FIG. **10** is a side view of the reactor shown in FIG. **9**.

FIG. **11** is a front view of a modification of the embodiment of FIG. **9**.

DETAILED DESCRIPTION

Referring to FIGS. **1** and **2** of the drawings the reactor of the invention is composed of an H-shaped core **10**, a first coil **20** and a second coil **30** wound around the said core and fixed permanent magnets **40** for magnetic biasing, which are attached to the core mentioned above.

The above-mentioned core **10** is composed of two parallel yokes **11**, **12** and coupling part **13** that connects these yokes at their mid-section. The yokes **11**, **12** form the yoke arms **11***a*, **11***b* and **12***a*, **12***b* on the left and right sides of the coupling member **13** which forms the central section.

Of the two coils mentioned above, the first coil **20** is divided into two serially connected coil parts **21**, **21'**, and each coil part **21**, **21'** is separately wound around the left and right arms **11***a*, **11***b* (or **12***a*, **12***b*) of yoke **11** (or **12**) mentioned above, the windings being in the same direction.

Of the two coils mentioned above, the second coil **30** is divided into two serially connected coil parts **31**, **31'**, and each coil part **31**, **31'** is separately wound around the left and right arms **11***a*, **11***b* yoke **11**, mentioned above on which the first coil is wound, the windings being in mutually opposite directions.

The first coil **20** and the second coil **30** are identical in use as those of the conventional reactor in that vertical deflection current is caused to flow through one and the horizontal deflection current is caused to flow through the other. This differs depending on whether the vertical distortion of the raster is to be corrected or the horizontal distortion is to be corrected. In other words, it differs according to the circuit to be connected to the reactor. And such circuits are already publicly known through prior techniques, such as are detailed in the aforementioned U.S. Patents.

Such being the reactor of this invention, flow of horizontal deflection current Ih through the first coil **20** and of vertical deflection current Iv through the second coil **30** induces and superimposes the reverse correction current waveform of the horizontal deflection cycle on the vertical deflection current Iv. At the same time, since core **10** is magnetically biased by the permanent magnet **40**, the amplitude of the aforementioned reverse correction current waveform becomes large at the beginning and the end of the vertical scanning period and small at the center thereof. Also, since the coil parts **31**, **31'** of the second coil **30** are wound so as to be in mutually reverse phases, the phase of the correction current waveform becomes reversed at the beginning and the end of the vertical scanning period.

When the basic waves only of the reverse correction current are taken out with a tuning circuit, sine wave current of forward correction, i.e., correction current of waveform that can be substituted for the approximately parabolic current, is obtained. This allows correction of the vertical raster distortion. Since the operation and application of the reactor described in the foregoing are already publicly known through prior techniques, detailed descriptions will be omitted.

As has been clarified by the foregoing descriptions and diagrams, the reactor related to the present invention uses the H-shaped core **10**, for which reason it offers the advantage of easy fitting of the first coil **20** and the second coil **30** on the arms **11**a and **11**b of the yoke **11**. Also, as the magnetic path is of the open type, it offers the advantage of the absence of any effect on the characteristics of individual products even when there are slight difference in the gaps between the pair of yokes **11**, **12**.

Of course, in the open magnetic path, such as is the case with the reactor of the present invention, the magnetic flux leakage becomes large, but this disadvantage can easily be eliminated by providing a magnetic shield for the outer casing of the reactor.

Consequently, the reactor of this invention offers the benefits of allowing mass production in a simple and facile manner and of uniform characteristics of individual products.

In the embodiment shown in FIGS. **3** to **5**, a reactor with fixed permanent magnet **40** and rotary movable magnet **50**, which has greater excitation force than the fixed magnet, mounted on the H-shaped core **10** is shown.

The fixed magnet **40** mentioned above is mounted so that the magnetic pole will be adjacent to the arm **11***a* of that side of yoke **11** on which the coil is wound, while the movable magnet **50** mentioned above is rotatably mounted on the end of the yoke on the opposite side from the aforementioned fixed magnet **40**.

The movable magnet **50** mentioned above is of disc form, is magnetized in the direction of the diameter and is made in such a way that the ends of the two yokes **11**, **12** of the core mentioned above are in contact with the face of the disc.

The reactor shown in this embodiment has, as stated above, the fixed magnet **40** and the movable magnet **50** mounted on the two ends of core **10**. For this reason, the yoke **11** of the core **10** with coil wound around it is given magnetic biasing by the two magnets **40** and **50**, and at the same time, the magnetic biasing points of arms **11***a*, **11***b* of the yoke **11** can be made unequal by the rotation of the movable magnet **50**.

In other words, if the magnetic pole touching the yoke **11** of the fixed magnet **40** is assumed to be N, the magnetic biasing points of arms **11***a*, **11***b* of the yoke **11** may be varied as hereunder described. As shown in FIG. **3**, when the magnetic pole S of the movable magnetic **50** is brought into contact with the tip of the yoke **11**, the magnetic flux f_2 that flows through the arm **11***b* becomes larger than the magnetic flux f_1 that flows through the other arm **11***a*, since the excitation force of the movable magnet **50** is greater than that of the fixed magnet **40**. By this, the magnetic biasing point of the arm **11***b* becomes deeper than that of the arm **11***a*.

Also, as shown in FIG. **5**, when the magnetic pole S of the movable magnet **50** is brought close to the yoke **12**, the volume of the magnetic flux f_2 that flows through the arm **11***b* becomes less than the magnetic flux f_1 that flows through the other arm **11***a*. For this reason, the magnetic biasing point of arm **11***b* becomes shallower than that of the other arm **11***a*.

Consequently, since it is possible with the reactor of the present invention to make the amplitude of the above-mentioned correction current asymmetrical at the start and end of a vertical scanning period by means of the rotation of the movable magnet **50**, it is possible to correct the vertical (top and bottom) distortion of the display when it is asymmetrical. With the reactor used for the embodiment it is, of course, possible to make the magnetic biasing points of arms **11***a* and **11***b* identical by means of the rotation angle of the movable magnet **50**. The reactor may also be used for correcting the horizontal (left and right) distortions.

FIGS. **6** to **8** show a reactor with movable magnets **50**, **50'** mounted on the two ends of the core **10**. While the pair of movable magnets **50**, **50'** mentioned above are of disc form, they are also magnetized in the direction of diameter. They are, moreover, mounted on the core in such a manner that they simultaneously touch the two yokes **11** and **12** of the core **10**.

Consequently, the reactor shown in the embodiments of the invention cited above is magnetically biased by means of the pair of movable magnets **50**, **50'** and is capable of making the magnetic bias points of the two yoke arms **11***a*, **11***b* with coils wound around them simultaneously shallow and deep by the rotation of the movable magnets. In addition, the reactor is capable of making the magnetic biasing points of the two yoke arms **11***a*, **11***b* mentioned above relatively unbalanced. Adjustment of the magnetic biasing points of the reactor in the embodiments of the invention is accomplished as hereunder described.

To make the magnetic biasing points of the two yoke arms **11***a*, **11***b* identical, movable magnets **50**, **50'** are rotated, as shown in FIG. **8**, so that magnetic poles of different polarity will come adjacent to the two ends of the yoke **11** on which coils are mounted. As this will make f_1 and f_2, magnetic fluxes that that flow through the yoke arms **11***a* and **11***b* of identical volume, correction of distortion becomes possible if the pincushion distortion in the vertical direction (top and bottom) or in the horizontal direction (left and right) is symmetrical. Also, when the above-mentioned pair of movable magnets **50**, **50'** are rotated in the same direction by the same angle, the volume of magnetic fluxes f_1 and f_2 that flow through the above-mentioned yoke arms **11***a*, and **11***b* can be reduced by the same volume. By this means, the magnetic biasing points of the yoke arms **11***a* and **11***b* can be made shallower while maintaining the same relationship.

At the above condition, in other words, the magnetic biasing points of yoke arms **11***a*, **11***b* are deepest under the state shown in FIG. **8***a* and become shallower as the movable magnets **50**, **50'** are rotated.

As the magnetic poles of the movable magnets **50**, **50'** cease to face each other, when one or the other of the movable magnets is rotated, it becomes possible to make the magnetic biasing points of the two arms **11***a*, **11***b* of the yoke **11** relatively unbalanced.

As shown in FIG. **8***b*, when the movable magnet **50** on the side of the yoke arm **11***b* is rotated to bring the magnetic pole S closer to the yoke **12**, the magnetic flux f_1 that flows through the yoke arm **11***a* becomes larger than the magnetic flux f_2 that flows through the other yoke arm **11***b*. Therefore, the magnetic biasing point of the yoke arm **11***a* can be made deeper than that of the yoke arm **11***b*. On the contrary, if the movable magnet **50'** on the side of the yoke arm **11**a is rotated, as shown in FIG. **8***c*, to bring the magnetic pole N closer to the yoke **12**, magnetic flux f_1 that flows through the yoke arm **11***a* becomes less than the magnetic flux f_2 that flows through the yoke arm **11***b*, and the magnetic biasing point of yoke arm **11***b* can be made deeper. Consequently, if the movable magnet is rotated as in FIG. **8***b* and FIG. **8***c*, correction of vertical (top to bottom) and horizontal (left to right) pincushion distortion of asymmetrical form becomes possible. If, therefore, the reactor of the embodiments of the invention should be used, the absolute value of the degree of correction of symmetrical or asymmetrical pincushion distortion can be adjusted with the reactor itself.

In FIGS. **9** and **10**, there is shown a reactor with a fixed magnet **40** and a movable magnet **50** mounted on the core **10** as in the case of reactor in FIG. **3**. The movable magnet **50** in the embodiment has an aperture **51** formed on the mid-section of its disc, and this aperture **51** is fitted onto the yoke arm **11**b of the yoke **11** so as to allow rotation thereof which makes it possible to mount it on the core **10**. A knob shaft **60** is fixed in the aperture **51** of the movable magnet **50**, and turning of this knob shaft **60** executes rotation of the movable magnet **50**.

In the embodiment, the reactor is housed in the casing **70** made of an insulating material, and the knob shaft **60** protrudes out of the case **70**.

The movable magnet **50** mentioned above is pressed against the core **10** with the leaf spring **80** so that it will not undergo automatic rotation, while the lead-out wires of the first coil **20** and the second coil **30** are connected to terminals **71** of the case **70**.

In the embodiment, arrangements are made so that the movable magnet **50** will rotate with yoke **11** of the core **10** as the pivotal point. Consequently, the magnetic flux f_1 that flows through the yoke arm **11***a* of the yoke **11** is determined by which magnetic pole of the movable magnet **50** is closer to the yoke **12**. In other words, if the magnetic pole N is now adjacent to yoke **11** of the fixed magnet **40**, the magnetic flux f_2 that flows through the yoke arm **11***b* is reduced when the pole S of the movable magnet **50** draws closer to yoke **12** but on the other hand, the magnetic flux f_2 that flows through yoke arm **11***b* increases as pole N of the movable magnet **50** draws closer to the yoke **12**.

Consequently, the volume of magnetic flux f_2 that flows through the yoke arm **11***b* can be varied by the rotation of the movable magnet **50**. As a result, it is possible to make the volume of magnetic flux f_2 that flows through the yoke arm **11***b* identical with that of magnetic flux f_1 that flows through the yoke arm **11***a*, or to make the volume of magnetic flux f_2 either larger or smaller than the magnetic flux f_1.

The movable magnet shown in the present embodiment may also be applied to the reactor shown in FIG. **6**. In this case, movable magnets are fitted onto the two ends of the yoke **11**.

FIG. **11** depicts a modification of the embodiment of FIG. **9** wherein fixed magnet **40** is replaced by another movable magnet **50'** provided with knob shaft **60'**. While several embodiments of the invention have been shown and described, other variations will be readily apparent to those skilled in the art. Therefore, the invention is not limited to these embodiments but is intended to cover all such variations as may be within the scope of the invention defined by the following claims:

What is claimed is:

1. A raster distortion correcting reactor comprising an H-shaped core comprised of a pair of parallel, spaced yokes connected at their mid-sections by a coupling member, one of the yokes having wound thereon first and second coils, said coils each being divided into two coil parts and each coil part being constituted of a symmetrical winding on the yoke arms on opposite sides of said coupling member, the first coil being so constituted that, when electric current is caused to flow through it, magnetic fluxes generated in the two divided coil parts assume the same direction, while said second coil is so constituted that, when electric current is caused to flow through it, magnetic fluxes will be generated in opposite directions in the two divided coil parts.

2. A raster distortion correcting reactor in accordance with claim 1, and further comprising a fixed magnet mounted on one end of the H-shaped core, a disc-shaped movable magnet rotatably mounted on the other end of said core, said fixed magnet being fixed with one of its magnetic poles closely facing one end of the yoke of said core on which said coils are wound, and said disc shaped movable magnet being magnetized in the direction of its diameter with the face of the disc being arranged in such a manner that it directly touches both the other end of said yoke on which said coils are wound and the adjacent end of the other yoke.

3. A raster distortion correcting reactor in accordance with Claim 1 and further comprising two disc-shaped movable magnets rotatably mounted on the ends of said H-shaped core, said movable magnets being magnetized in the direction of their diameter and the disc surfaces being so arranged as to rotate in close contact with the ends of the two yokes of the above-mentioned core.

4. A raster distortion correcting reactor in accordance with claim 1 and further comprising a first magnet fixedly mounted on one end of the H-shaped core and a second, disc-shaped movable magnet rotatably mounted on the other end of said core, said fixed magnet being fixed to one end of the coil-wound yoke of the core with its magnetic poles in close contact with the yoke end, said movable magnet having a central aperture and being magnetized in the direction of its diameter, and the other end of said coil wound yoke being telescoped into said central aperture of said movable magnet.

5. A raster distortion correcting reactor in accordance with claim 1 and further comprising two disc-shaped movable magnets magnetized in the direction of their diameters said magnets being arranged on the two ends of said H-shaped core, said movable magents each having apertures in the centers of the disc faces and being rotatably mounted with said apertures in close contact with the ends of the coil-wound yoke of said core.

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