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(54) ELECTROMAGNETIC INDUCTION TYPE ENCODER

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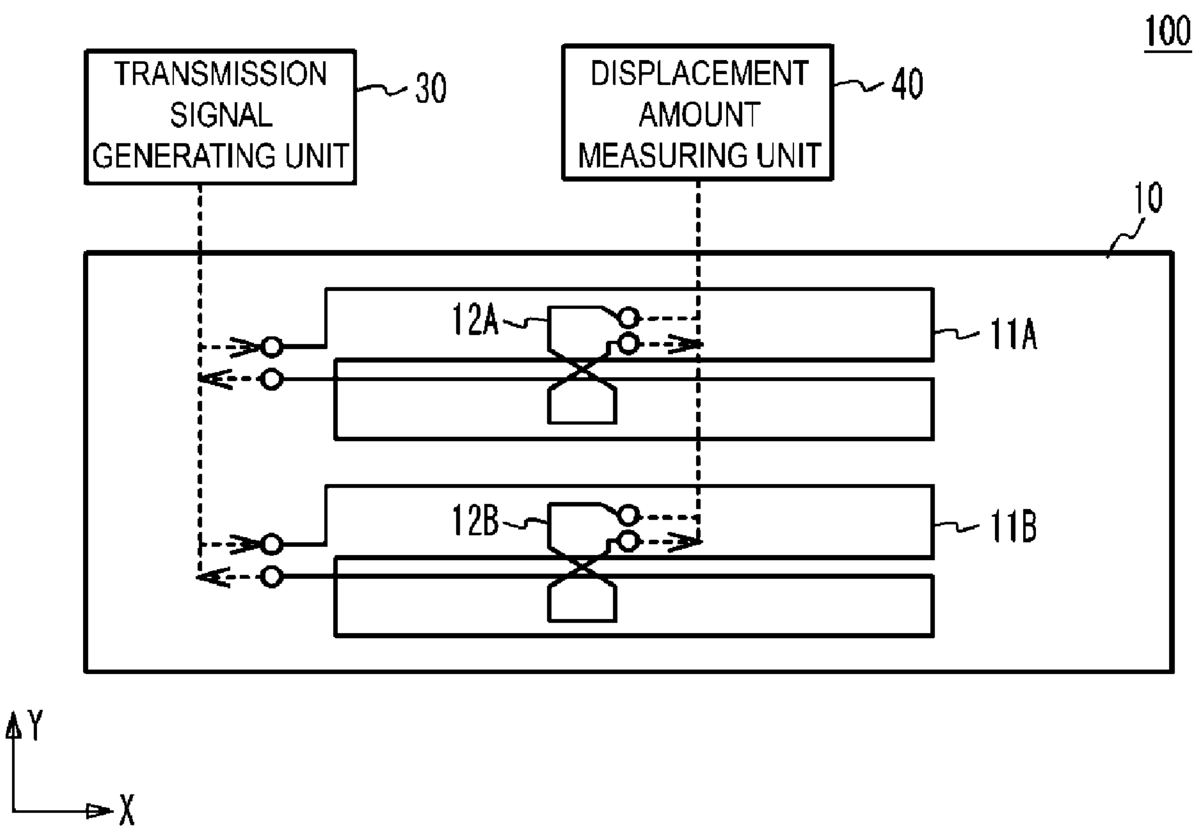
(57) **ABSTRACT**

The electromagnetic induction type encoder includes a detection head and a scale each having a substantially flat plate shape. The detection head and the scale are disposed opposed to one another and relatively move in a measurement axis direction. The scale includes a plurality of periodic elements formed of a conductor periodically disposed in the measurement axis direction. The plurality of periodic elements are coupled with a conductor. The detection head includes a transmitting coil wired so as to generate two or more eddy currents in directions opposite to one another in each of the plurality of periodic elements. The detection head includes a receiving coil. The receiving coil is electromagnetically coupled to magnetic fluxes generated by the plurality of periodic elements to detect phases of the magnetic fluxes.



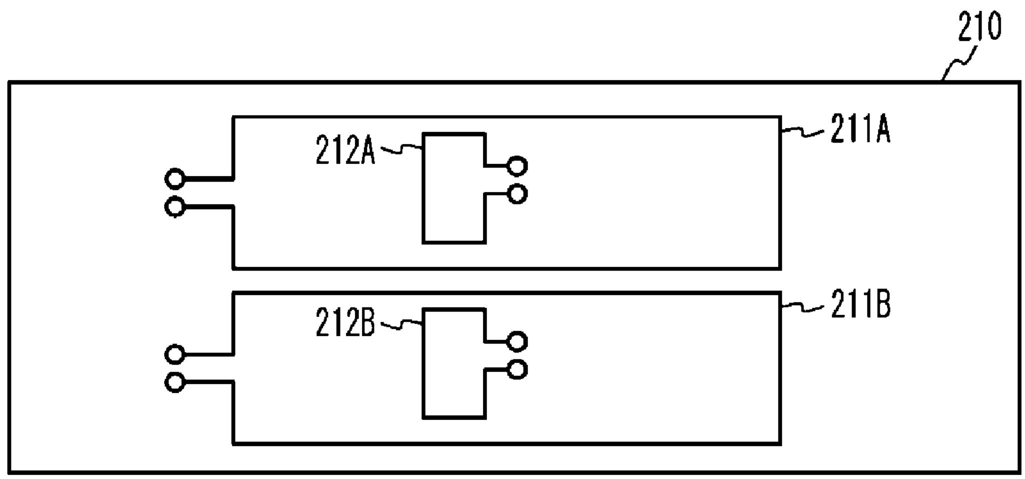

210
211A
212A
211B
212B

FIG. 1A

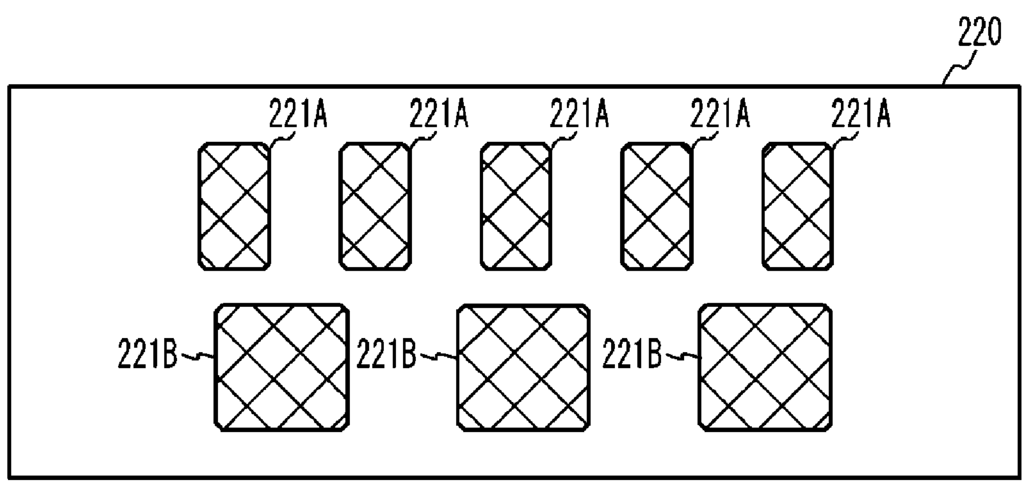

220
221A
221A
221A
221A
221A
221B
221B
221B

FIG. 1B

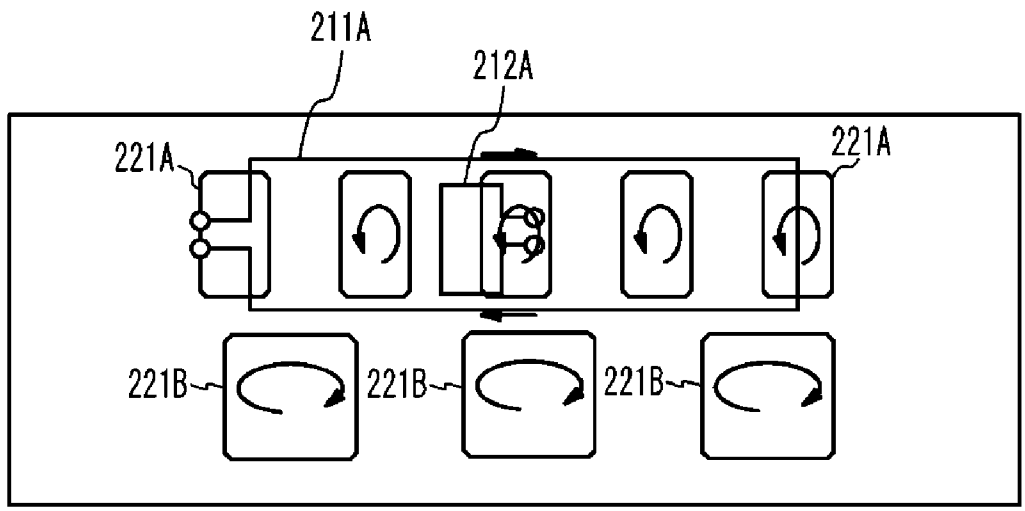


FIG. 2

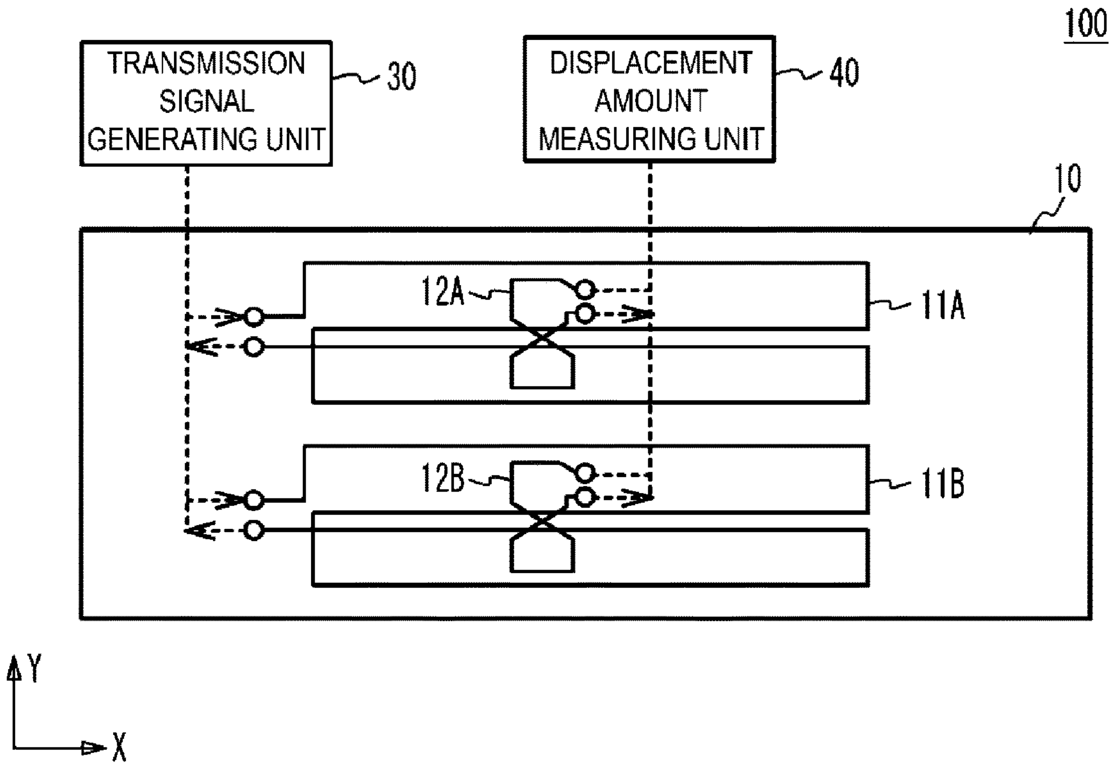

100
TRANSMISSION SIGNAL GENERATING UNIT
30
DISPLACEMENT AMOUNT MEASURING UNIT
40
10
12A
11A
12B
11B
Y
X

FIG. 3A

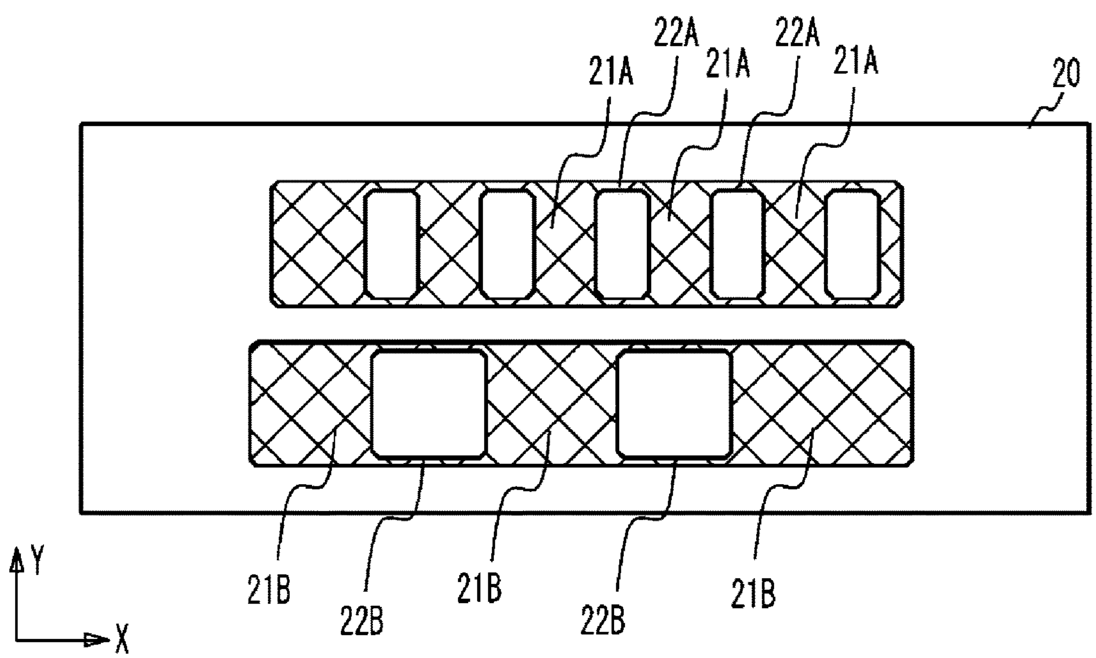

22A
22A
21A
21A
21A
20
21B
22B
21B
22B
21B
Y
X

FIG. 3B

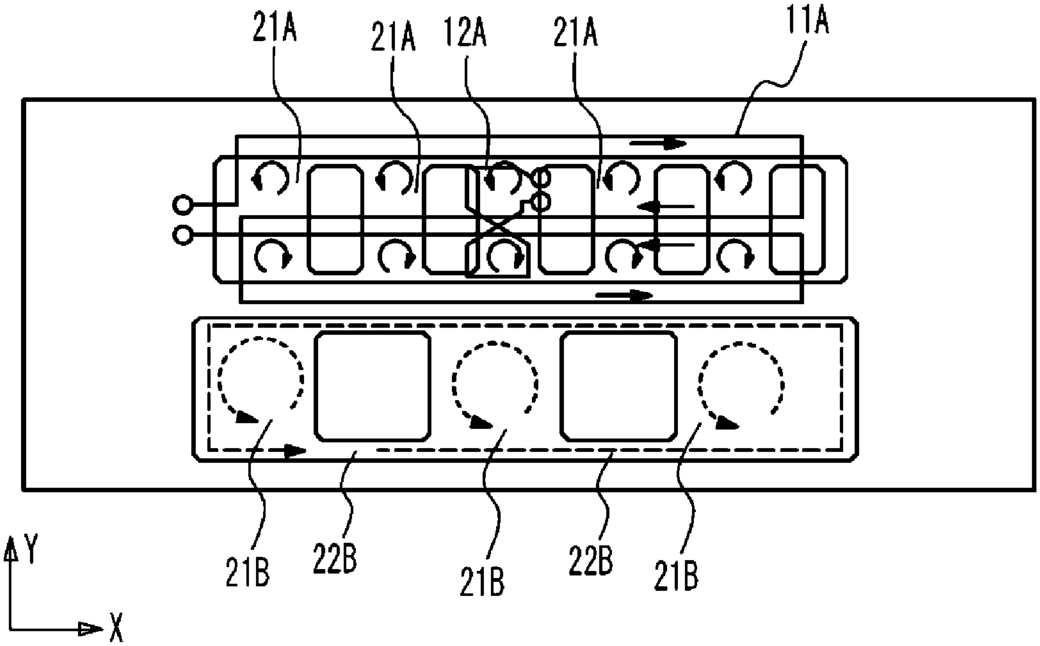


FIG. 4

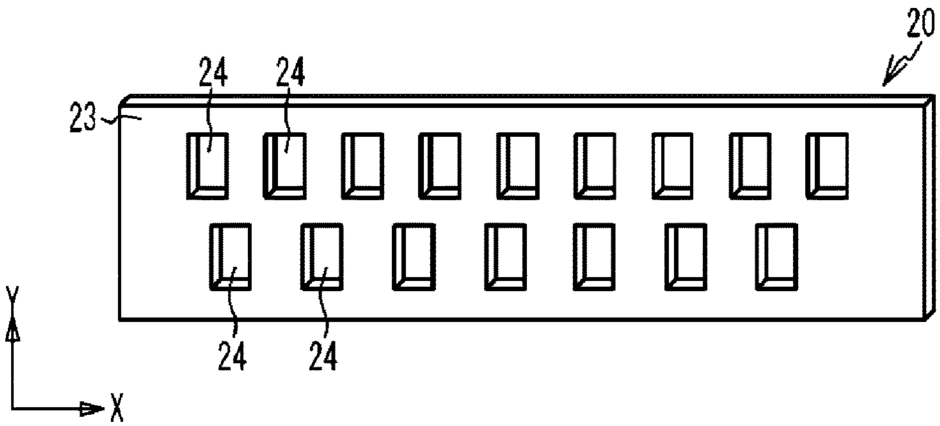


FIG. 5A

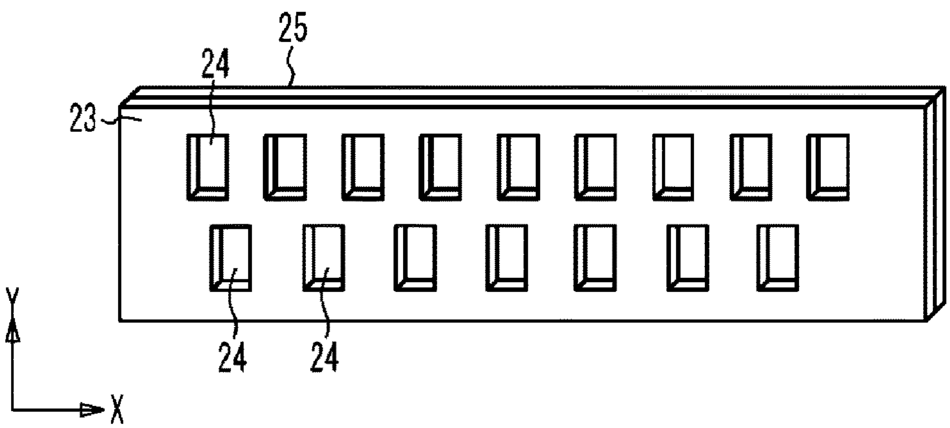


FIG. 5B

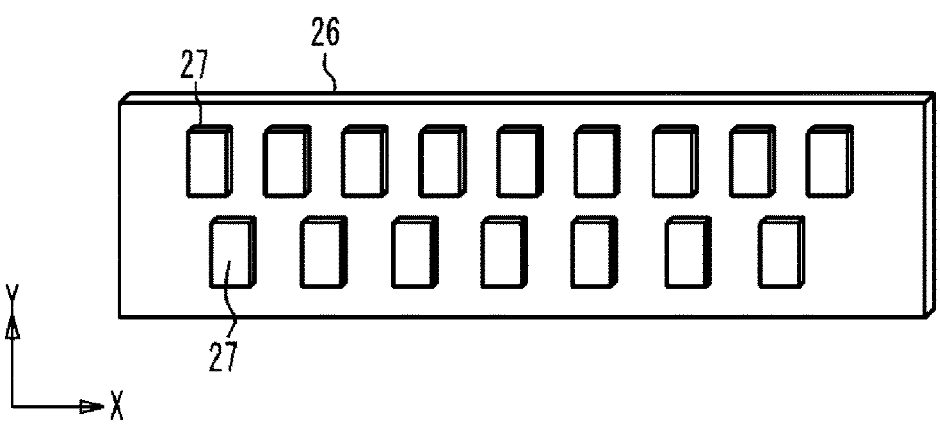


FIG. 5C

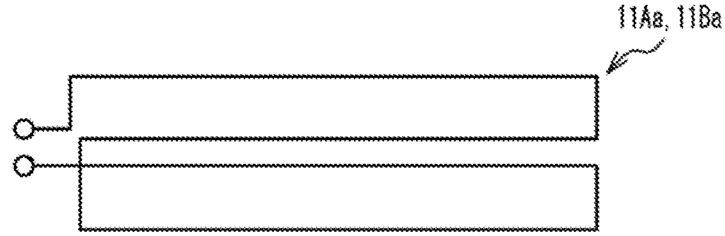


FIG. 6A

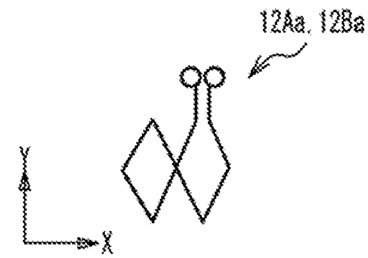


FIG. 6B

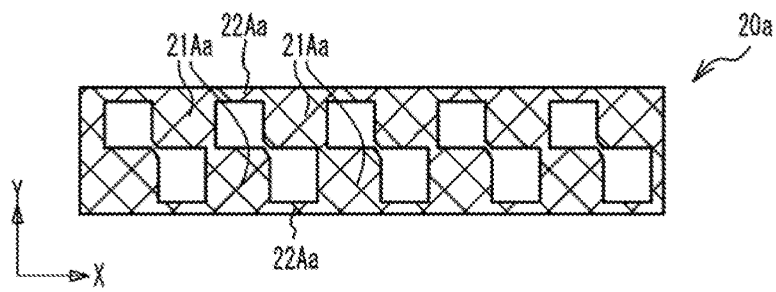


FIG. 6C

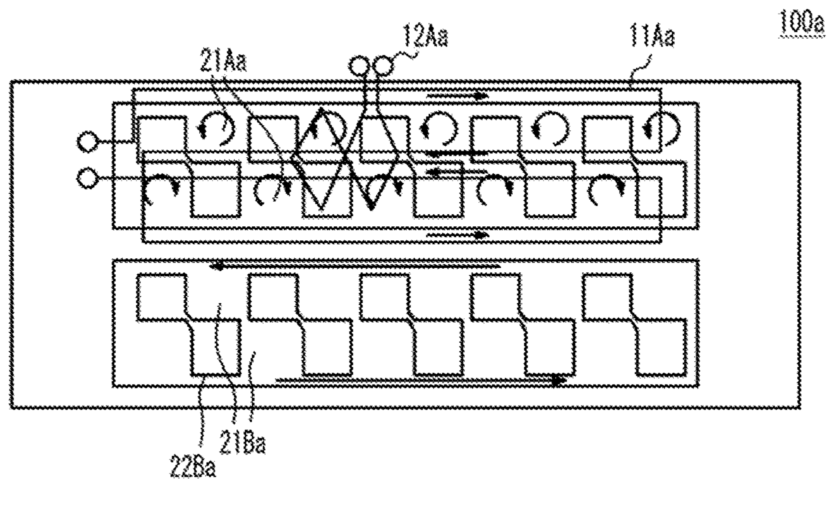


FIG. 6D

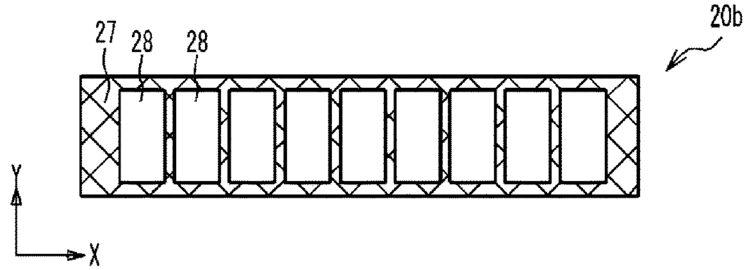


FIG. 7A

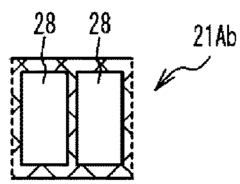


FIG. 7B

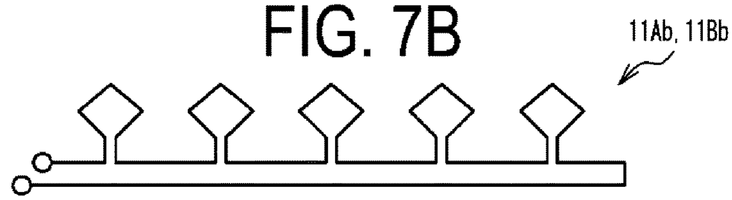


FIG. 7C

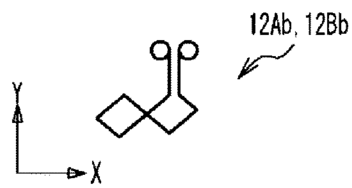


FIG. 7D

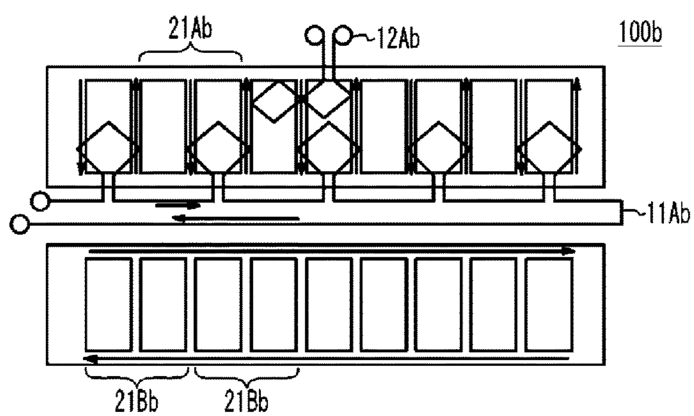


FIG. 7E

ELECTROMAGNETIC INDUCTION TYPE ENCODER

TECHNICAL FIELD

[0001] The present invention relates to an electromagnetic induction type encoder.

BACKGROUND ART

[0002] An electromagnetic induction type encoder utilizing electromagnetic coupling between a detection head and a scale (see, for example, Patent Document 1) has been known.

CITATION LIST

Patent Literature

[0003] Patent Document 1: JP 2000-180209 A

SUMMARY OF INVENTION

Technical Problem

[0004] In the electromagnetic induction type encoder with multiple tracks on the scale, an unintended signal is possibly input from a track adjacent to a track being focused. Since the unintended signal causes false detection, sufficiently separating a distance between the tracks is considered to reduce an influence between the tracks. However, when the electromagnetic induction type encoder is attempted to reduce in size, the distance between the tracks cannot be sufficiently ensured possibly.

[0005] According to one aspect, an object of the invention is to provide an electromagnetic induction type encoder that can suppress an influence between tracks.

Solution to Problem

[0006] In one aspect, an electromagnetic induction type encoder according to the invention includes a detection head and a scale each having a substantially flat plate shape. The detection head and the scale are disposed opposed to one another and relatively move in a measurement axis direction. The scale includes a plurality of periodic elements formed of a conductor periodically disposed in the measurement axis direction. The plurality of periodic elements are coupled with a conductor. The detection head includes a transmitting coil wired so as to generate two or more eddy currents in directions opposite to one another in each of the plurality of periodic elements. The detection head includes a receiving coil. The receiving coil is electromagnetically coupled to magnetic fluxes generated by the plurality of periodic elements to detect phases of the magnetic fluxes.

[0007] In the above-described electromagnetic induction type encoder, the scale may be a conductor having the flat plate shape. The scale may have a structure in which a plurality of through-holes are formed in the measurement axis direction.

[0008] In the above-described electromagnetic induction type encoder, the periodic elements may be conductor parts between the two adjacent through-holes among the plurality of through-holes.

[0009] In the above-described electromagnetic induction type encoder, the periodic elements may be conductor parts surrounding the two adjacent through-holes among the plurality of through-holes.

[0010] In the above-described electromagnetic induction type encoder, the receiving coil may include two or more coils. The two or more coils are configured to detect the respective two or more eddy currents.

[0011] In the above magnetic-electromagnetic induction type encoder, the transmitting coil may have a twisted structure in which two rectangular coils having length directions in the measurement axis direction are arranged and are wired such that currents flow in the respective rectangular coils in opposite directions.

Advantageous Effects of Invention

[0012] The electromagnetic induction type encoder that can suppress an influence between the tracks can be provided.

BRIEF DESCRIPTION OF DRAWINGS

[0013] FIG. **1**A is a diagram illustrating an example of a detection head according to a comparative configuration, and FIG. **1**B is a diagram illustrating an example of a scale according to the comparative configuration.

[0014] FIG. **2** is a diagram illustrating an example of flows of currents.

[0015] FIG. **3**A is a diagram illustrating an example of a detection head according to a first embodiment, and FIG. **3**B is a diagram illustrating an example of a scale according to the first embodiment.

[0016] FIG. **4** is a diagram illustrating an example of flows of currents on the scale when the current is flown through a transmitting coil.

[0017] FIGS. **5**A to **5**C are diagrams illustrating examples of structures of the scale.

[0018] FIGS. **6**A to **6**D are diagrams for explaining an electromagnetic induction type encoder according to a second embodiment.

[0019] FIGS. **7**A to **7**E are diagrams for explaining an electromagnetic induction type encoder according to a third embodiment.

DESCRIPTION OF EMBODIMENTS

Comparative Configuration

[0020] Prior to a description of embodiments, a comparative configuration will be described. FIGS. **1**A and **1**B are diagrams for explaining an electromagnetic induction type encoder according to the comparative configuration. FIG. **1**A is a diagram illustrating an example of a detection head **210**. FIG. **1**B is a diagram illustrating an example of a scale **220**. The detection head **210** and the scale **220** each have a substantially flat plate shape and are disposed opposed to one another via a predetermined gap.

[0021] As illustrated in FIG. **1**A as an example, the detection head **210** includes, for example, a transmitting coil **211**A and a receiving coil **212**A for a track A. The transmitting coil **211**A constitutes a rectangular coil. The receiving coil **212**A is disposed inside the transmitting coil **211**A.

[0022] As illustrated in FIG. **1**B as an example, in the scale **220**, a plurality of conductors **221**A having a rectangular shape are arranged for the track A at fundamental periods λA along a measurement axis. The respective conductors **221**A are separated from one another and are insulated from one another. The conductors **221**A are each electromagnetically coupled to the transmitting coil **211**A and are electromagnetically coupled to the receiving coil **212**A.

[0023] The detection head **210** includes, for example, a transmitting coil **211**B and a receiving coil **212**B for a track B. The transmitting coil **211**B and the receiving coil **212**B have configurations similar to the transmitting coil **211**A and the receiving coil **212**A. In the scale **220**, a plurality of conductors **221**B having a rectangular shape are arranged for the track B at fundamental periods λB along the measurement axis.

[0024] When a signal of the track A is desired to be obtained, a current is flown through the transmitting coil **211**A, and an electromotive force generated in the receiving coil **212**A via the conductors **221**A is measured. Ideally, the receiving coil **212**A preferably detects only an influence due to eddy currents generated in the conductors **221**A.

[0025] However, as illustrated in FIG. **2** as an example, flowing the current in the transmitting coil **211**A generates eddy currents in the conductors **221**B. Thus, the receiving coil **212**A is also affected by the eddy currents in the conductors **221**B. It is acceptable if the influence were uniform through the entire scale **220**. However, since the track A and the track B differ in, for example, shapes and positions of the conductors, the influence from the track B becomes strong or weak depending on the scale position. Due to the change in influence, position detection accuracy of the electromagnetic induction type encoder becomes better or worse depending on the position. To suppress the variation in the position detection accuracy, increasing the space between the track A and the track B is considered. However, when attempting to decrease the size of the device, it is possible that a distance between the tracks cannot be sufficiently ensured.

[0026] In the following embodiments, an electromagnetic induction type encoder that can suppress an influence between the tracks will be described.

First Embodiment

[0027] FIGS. **3**A and **3**B are diagrams for explaining an electromagnetic induction type encoder **100** according to the first embodiment. FIG. **3**A is a diagram illustrating an example of a detection head **10**. FIG. **3**B is a diagram illustrating an example of a scale **20**.

[0028] The electromagnetic induction type encoder **100** includes the detection head **10** and the scale **20** that relatively move in a measurement axis direction. The detection head **10** and the scale **20** each have a substantially flat plate shape and are disposed opposed to one another via a predetermined gap as illustrated in FIG. **4**. Furthermore, the electromagnetic induction type encoder **100** includes, for example, a transmission signal generating unit **30** and a displacement amount measuring unit **40**. In FIGS. **3**A and **3**B, an X-axis indicates a displacement direction (measurement axis) of the detection head **10**. Note that, a direction orthogonal to the X-axis in a plane constituted by the scale **20** is defined as a Y-axis.

[0029] The detection head **10** includes, for example, a transmitting coil **11**A and a receiving coil **12**A for the track A. The transmitting coil **11**A has a twisted structure in which two rectangular coils having a length direction in the X-axis direction are arranged in the Y-axis direction and are wired such that currents flow in the respective rectangular coils in opposite directions. In other words, the transmitting coil **11**A includes two-stage coils. The receiving coil **12**A has a twisted structure in which two coils are arranged in the Y-axis direction and are wired such that currents flow in the respective coils in opposite directions. One coil of the receiving coil **12**A is disposed inside one rectangular coil of the transmitting coil **11**A, and the other coil of the receiving coil **12**A is disposed inside the other rectangular coil of the transmitting coil **11**A.

[0030] The scale **20** has a structure in which a plurality of elements arranged at regular intervals are coupled to one another for the track A. In the example of FIG. **3**B, the scale **20** has a structure in which a plurality of periodic elements **21**A, which are conductors and have a rectangular shape, are arranged at the fundamental periods λA along the X-axis direction, and the periodic elements **21**A are coupled with respective coupling portions **22**A as conductors. The periodic elements **21**A are each electromagnetically coupled to the transmitting coil **11**A and is electromagnetically coupled to the receiving coil **12**A. In the Y-axis direction, the coupling portion **22**A has a width smaller than a width of the periodic element **21**A. In the example in FIG. **3**B, end portions in the Y-axis direction of the respective periodic elements **21**A are coupled with the coupling portions **22**A.

[0031] The detection head **10** includes, for example, a transmitting coil **11**B and a receiving coil **12**B for the track B. The transmitting coil **11**B and the receiving coil **12**B have configurations similar to the transmitting coil **11**A and the receiving coil **12**A. The scale **20** has a structure in which a plurality of elements arranged at regular intervals are coupled to one another for the track B. In the example of FIG. **3**B, the scale **20** has a structure in which a plurality of periodic elements **21**B, which are conductors and have a rectangular shape, are arranged at the fundamental periods λB along the X-axis direction, and the periodic elements **21**B are coupled with respective coupling portions **22**B as conductors. The periodic elements **21**B are each electromagnetically coupled to the transmitting coil **11**B and are electromagnetically coupled to the receiving coil **12**B. In the Y-axis direction, the coupling portion **22**B has a width smaller than a width of the periodic element **21**B. The track A and the track B are disposed at a predetermined interval in the Y-axis direction. The fundamental period λA and the fundamental period λB may be different from one another. When the fundamental period λA and the fundamental period λB are the same, the positions of the periodic elements **21**A and the periodic elements **21**B in the X-axis direction may be different.

[0032] When a signal of the track A is desired to be obtained, the transmission signal generating unit **30** generates a single phase AC transmission signal and supplies the signal to the transmitting coil **11**A. In this case, a magnetic flux is generated in the transmitting coil **11**A. Thereby, an electromotive current is generated in the plurality of periodic elements **21**A. The plurality of periodic elements **21**A are electromagnetically coupled to the magnetic flux generated in the transmitting coil **11**A to generate magnetic fluxes that change in the X-axis direction at a predetermined space period. The magnetic fluxes generated by the periodic elements **21**A cause the receiving coil **12**A to generate an electromotive current. The electromagnetic coupling between the respective coils changes according to a displacement amount of the detection head **10**, and a sine wave signal with the same period as the fundamental period λA is obtained. Accordingly, the receiving coil **12**A detects phases of the magnetic fluxes generated by the plurality of periodic elements **21**A. The displacement amount measuring unit **40** can use the sine wave signal as a digital amount of the minimum resolution by electrically interpolating the sine wave signal and measure the displacement amount of the detection head **10**.

[0033] For the track B as well, the transmission signal generating unit **30** supplies the transmission signal supplied to the track A to the transmitting coil **11**B. When the fundamental period λA of the periodic elements **21**A and the fundamental period λB of the periodic elements **21**B are different, the electromagnetic induction type encoder **100** functions as an absolute type encoder.

[0034] FIG. **4** is a diagram illustrating an example of flows of currents on the scale **20** when the current is flown through the transmitting coil **11**A. In each of the periodic elements **21**B of the scale **20**, an eddy current as indicated by the dotted line attempts to flow in a direction opposite to a flow of a current at a part closest to the track B in the transmitting coil **11**A. However, in the present embodiment, since the respective periodic elements **21**B are coupled to one another with the coupling portions **22**B, a substantially uniform current as indicated by the dashed arrow flows through a wide range of a region in the track B of the scale **20**. Thus, the state in which the influence from the track B becomes strong or weak depending on the scale position is reduced. That is, the influence between the tracks is suppressed. As a result, the measurement accuracy of the electromagnetic induction type encoder **100** is improved.

[0035] In the periodic element **21**A, currents flowing in opposite directions occur at two different parts in the Y-axis direction. Specifically, in each periodic element **21**A, the eddy currents in the directions opposite to one another occur at the positions corresponding to the respective rectangular coils of the transmitting coil **11**A. Receiving the eddy currents at the respective coils of the receiving coil **12**A allows detecting the signals. In this way, the eddy currents in the directions opposite to one another are generated at the respective parts displaced in the Y-axis direction in the region (conductive region) connected in the Y-axis direction. Accordingly, even when the respective periodic elements **21**A are coupled to one another, the respective eddy currents are electromagnetically coupled to the respective coils of the receiving coil **12**A, and thus the signals can be detected.

[0036] FIG. **5**A is a diagram illustrating an example of the structure of the scale **20**. As illustrated in FIG. **5**A as an example, the scale **20** may have a structure in which a plurality of rectangular through-holes **24** are formed on a flat plate-shaped conductor **23** so as to be separated from one another along the X-axis direction. The formation of the through-holes **24** along the X-axis direction constitutes the track A. In the track A, parts between the two through-holes **24** function as the periodic elements **21**A. The formation of rows of the plurality of through-holes **24** along the X-axis direction so as to be displaced in the Y-axis direction constitutes the track B. In the example of FIG. **5**A, the periodic elements **21**A and the periodic elements **21**B are arranged at different fundamental periods.

[0037] As illustrated in FIG. **5**C as an example, in a configuration in which a plurality of conductors **27** are pasted on a base material **26**, a bonding step with, for example, an adhesive is required, and further positional accuracy may be problematic. In contrast, in the structure in the example of FIG. **5**A, the through-holes **24** are formed in the integrally molded conductor **23**. This eliminates the need for pasting the plurality of members together. As a result, the manufacturing process can be simplified, thereby ensuring cost reduction. Moreover, since an influence of the positional accuracy caused by the pasting does not occur, the reliability is improved. In addition, since the adjacent grids are connected together, strength is improved.

[0038] As illustrated in FIG. **5**B as an example, the scale **20** may have a structure in which the conductor **23** of FIG. **5**A is pasted to a base material **25**. In this case, the strength is further enhanced.

Second Embodiment

[0039] FIGS. **6**A to **6**D are diagrams for explaining an electromagnetic induction type encoder **100*a*** according to the second embodiment. FIG. **6**A is a diagram illustrating an example of a shape of a transmitting coil. FIG. **6**B is a diagram illustrating an example of a shape of a receiving coil. FIG. **6**C is a diagram illustrating an example of a shape of a scale. FIG. **6**D is a diagram illustrating an example of directions of currents.

[0040] As illustrated in FIG. **6**A as an example, in the second embodiment as well, shapes of transmitting coil **11**Aa and **11**Ba are similar to those of the first embodiment. The electromagnetic induction type encoder **100*a*** differs from the electromagnetic induction type encoder **100** according to the first embodiment in that the shapes of the scale and the receiving coil are different.

[0041] As illustrated in FIG. **6**B as an example, receiving coils **12**Aa and **12**Ba have a twisted structure in which two coils are arranged in the X-axis direction and are wired such that currents flow in the respective coils in opposite directions. Both coils of the receiving coil **12**Aa extend over both rectangular coils of the transmitting coil **11**Aa. Both coils of the receiving coil **12**Ba extend over both rectangular coils of the transmitting coil **11**Ba.

[0042] As illustrated in FIG. **6**C as an example, periodic elements **21**Aa do not have the rectangular shapes as illustrated in FIG. **3**B but have shapes such that two rectangles disposed at different positions in the Y-axis direction are coupled by being displaced in the X-axis direction. A distance between centers of the two rectangles in the X-axis direction is substantially the same as a distance between centers of the two coils of the receiving coil **12**Aa in the X-axis direction. With the periodic elements **21**Aa having such shapes, in a case where one coil of the receiving coil **12**Aa is positioned in one rectangle of the periodic element **21**Aa, the other coil of the receiving coil **12**Aa is positioned in the other rectangle of the periodic element **21**Aa. The respective periodic elements **21**Aa are coupled with coupling portions **22**Aa as conductors. In the Y-axis direction, the coupling portion **22**Aa has a width smaller than a width of the periodic element **21**Aa. In the example in FIG. **6**C, end portions in the Y-axis direction of the respective periodic elements **21**Aa are coupled with the coupling portions **22**Aa.

[0043] For the track B, periodic elements **21**Ba and coupling portions **22**Ba have the same structure as the periodic elements **21**Aa and the coupling portions **22**Aa. A fundamental period of the periodic elements **21**A and a fundamental period of the periodic elements **21**Ba may be the same or different similarly to the first embodiment.

[0044] When the transmission signal generating unit **30** supplies a single phase AC transmission signal to the transmitting coil **11**Aa, a magnetic flux is generated in the transmitting coil **11**Aa. Thereby, an electromotive current is generated in the plurality of periodic elements **21**Aa. As illustrated in FIG. **6**D as an example, in each of the periodic elements **21**Ba of a scale **20***a*, an eddy current attempts to flow in a direction opposite to a flow of a current at a part closest to the track B in the transmitting coil **11**Aa. However, in the present embodiment, since the respective periodic elements **21**Ba are coupled to one another with the coupling portions **22**Ba, a substantially uniform current flows through a wide range of a region in the track B of the scale **20***a*. Thus, the state in which the influence from the track B becomes strong or weak depending on the scale position is reduced. That is, the influence between the tracks is suppressed. As a result, the measurement accuracy of the electromagnetic induction type encoder **100***a* is improved.

[0045] In the periodic element **21**Aa, currents flowing in opposite directions occur in each rectangular region. Specifically, in each periodic element **21**Aa, the eddy currents in the directions opposite to one another occur at the positions corresponding to the respective rectangular coils of the transmitting coil **11**Aa. Receiving the eddy currents at the respective coils of the receiving coil **12**Aa allows detecting the signals. In this way, the eddy currents in the directions opposite to one another are generated at the respective parts displaced in the Y-axis direction in the region connected in the Y-axis direction. Accordingly, even when the respective periodic elements **21**Aa are coupled to one another, the respective eddy currents are electromagnetically coupled to the respective coils of the receiving coil **12**Aa, and thus the signals can be detected.

Third Embodiment

[0046] FIGS. **7**A to **7**E are diagrams for explaining an electromagnetic induction type encoder **100***b* according to the third embodiment. FIG. **7**A is a diagram illustrating an example of a shape of a scale. FIG. **7**B is a diagram illustrating an example of a shape of each periodic element. FIG. **7**C is a diagram illustrating an example of a shape of a transmitting coil. FIG. **7**D is a diagram illustrating an example of a shape of a receiving coil. FIG. **7**E is a diagram illustrating an example of directions of currents.

[0047] As illustrated in FIG. **7**A as an example, a scale **20***b* has a structure in which a plurality of rectangular through-holes **28** are formed on a flat plate-shaped conductor **27** so as to be separated from one another along the X-axis direction. In this configuration, as illustrated in FIG. **7**B as an example, the track A includes a periodic element **21**Ab configured of the two through-holes **28** and a conductor part surrounding the two through-holes. The respective periodic elements **21**Ab are coupled to one another to obtain the structure of FIG. **7**A. For the track B, periodic elements **21**Bb have the same structure as the periodic elements **21**Ab. A fundamental period of the periodic elements **21**Ab and a fundamental period of the periodic elements **21**Bb may be the same or different similarly to the first embodiment.

[0048] As illustrated in FIG. **7**C as an example, a transmitting coil **11**Ab has a wiring structure in which coils are arranged at a double pitch of the through-holes **28**, and the respective coils are coupled so that directions of currents in the respective coils become the same.

[0049] As illustrated in FIG. **7**D as an example, receiving coils **12**Ab and **12**Bb have a twisted structure in which two coils are arranged in the X-axis direction and are wired such that currents flow in the respective coils in opposite directions. The pitches of the respective coils of the receiving coils **12**Ab and **12**Bb are set equal to the pitches of the respective through-holes **28** in the scale. In a case where one coil of the receiving coil **12**Ab is positioned in one rectangle of the periodic element **21**Ab, the other coil of the receiving coil **12**Ab is positioned in the other rectangle of the periodic element **21**Ab.

[0050] When the transmission signal generating unit **30** supplies a single phase AC transmission signal to the transmitting coil **11**Ab, a magnetic flux is generated in the transmitting coil **11**Ab. Thereby, an electromotive current is generated in the plurality of periodic elements **21**Ab. As illustrated in FIG. **7**E as an example, in each of the periodic elements **21**Bb of the scale **20***b*, an eddy current attempts to flow in a direction opposite to a flow of a current at a part closest to the track B in the transmitting coil **11**Ab. However, in the present embodiment, since the respective periodic elements **21**Bb are coupled to one another, a substantially uniform current flows through a wide range of a region in the track B of the scale **20***b*. Thus, the state in which the influence from the track B becomes strong or weak depending on the scale position is reduced. That is, the influence between the tracks is suppressed. As a result, the measurement accuracy of the electromagnetic induction type encoder **100***b* is improved.

[0051] In the periodic element **21**Ab, currents flowing in opposite directions occur in each rectangular region. Specifically, in each periodic element **21**Ab, the eddy currents in the directions opposite to one another occur at the positions corresponding to the respective rectangular coils of the transmitting coil **11**Ab. Receiving the eddy currents at the respective coils of the receiving coil **12**Ab allows detecting the signals. In this way, the eddy currents in the directions opposite to one another are generated at the respective parts displaced in the X-axis direction in the region connected in the X-axis direction. Accordingly, even when the respective periodic elements **21**Ab are coupled to one another, the respective eddy currents are electromagnetically coupled to the respective coils of the receiving coil **12**Ab, and thus the signals can be detected.

[0052] Although the embodiments and examples according to the invention have been described above, it is to be understood that the invention is not limited to the specific embodiments and examples and that various changes and modifications may be made in the invention within the scope of the invention described in the claims.

REFERENCE SIGNS LIST

[0053] **10** Detection head
[0054] **11** Transmitting coil
[0055] **12** Receiving coil
[0056] **20** Scale
[0057] **21** Periodic element
[0058] **22** Coupling portion
[0059] **23** Conductor
[0060] **24** Through-hole
[0061] **25** Base material
[0062] **26** Base material
[0063] **27** Conductor
[0064] **30** Transmission signal generating unit

[0065] **40** Displacement amount measuring unit

[0066] **100** Electromagnetic induction type encoder

1. An electromagnetic induction type encoder comprising:

a detection head and a scale each having a substantially flat plate shape, the detection head and the scale being disposed opposed to one another and relatively moving in a measurement axis direction, wherein

the scale includes a plurality of periodic elements formed of a conductor periodically disposed in the measurement axis direction,

the plurality of periodic elements are coupled with a conductor,

the detection head includes a transmitting coil wired so as to generate two or more eddy currents in directions opposite to one another in each of the plurality of periodic elements, and

the detection head includes a receiving coil, the receiving coil being electromagnetically coupled to magnetic fluxes generated by the plurality of periodic elements to detect phases of the magnetic fluxes.

2. The electromagnetic induction type encoder according to claim **1**, wherein

the scale is a conductor having the flat plate shape, the scale having a structure in which a plurality of through-holes are formed in the measurement axis direction.

3. The electromagnetic induction type encoder according to claim **2**, wherein

the periodic elements are conductor parts between the two adjacent through-holes among the plurality of through-holes.

4. The electromagnetic induction type encoder according to claim **2**, wherein

the periodic elements are conductor parts surrounding the two adjacent through-holes among the plurality of through-holes.

5. The electromagnetic induction type encoder according to claim **1**, wherein

the receiving coil includes two or more coils, the two or more coils being configured to detect the respective two or more eddy currents.

6. The electromagnetic induction type encoder according to claim **1**, wherein

the transmitting coil has a twisted structure in which two rectangular coils having length directions in the measurement axis direction are arranged and are wired such that currents flow in the respective rectangular coils in opposite directions.

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