United States Patent

Masuda et al.

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[45] **July 25, 1972**

[54] CONTACTLESS SWITCHING APPARATUS

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[52] **U.S. Cl.** ..... **338/32 H**, 323/94 H

[51] **Int. Cl.** **H01c 7/16**

[58] **Field of Search** ..... 338/32; 324/45, 46; 323/94 H; 317/235 H; 335/1; 307/309

[56] **References Cited**

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J. J. McDowell Magnetoresistive Contact – Less Switch, " IBM Technical Disclosure Bulletin" Vol. 12, No. 3, pp. 436 and 437, Aug., 1969

Primary Examiner—C. J. Albritton

Attorney—James E. Armstrong and Harold C. Wegner

[57] **ABSTRACT**

A contactless switching apparatus wherein a magnetic-containing casing with poles located at both ends and a central space extending along the length of the casing is provided. A bar magnet is positioned in the space of the casing so that the bar magnet can be slidably moved within the casing. A galvano-magnetro effect device is provided at at least one of the poles of the casing or on the bar magnet; the device being positioned in the central space and either fixed at the internal surface of the polar portion of the casing, or being capable of alignment with said internal surface. The switching apparatus is designed so that the device functions when the polar portion of the bar magnet, the polarity of which is opposite to the polarity of the magnet of casing, is opposed to the polar portion of the casing.

17 Claims, 10 Drawing Figures

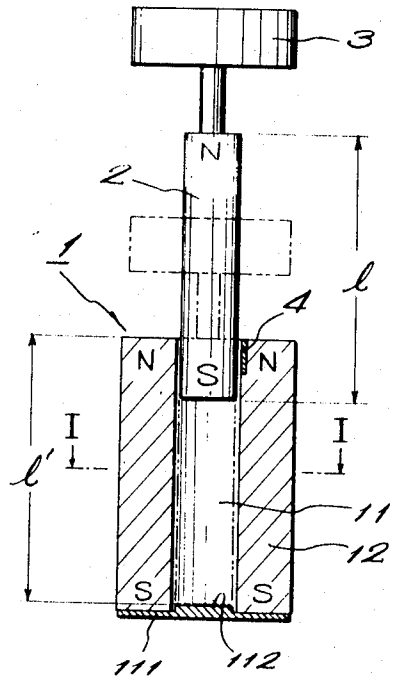


FIG. 1

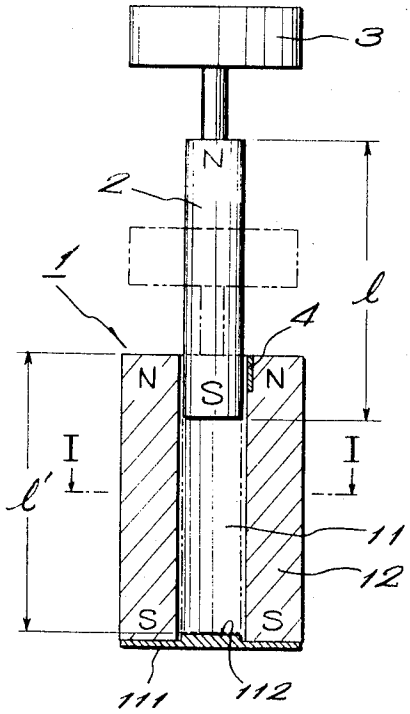


FIG. 3

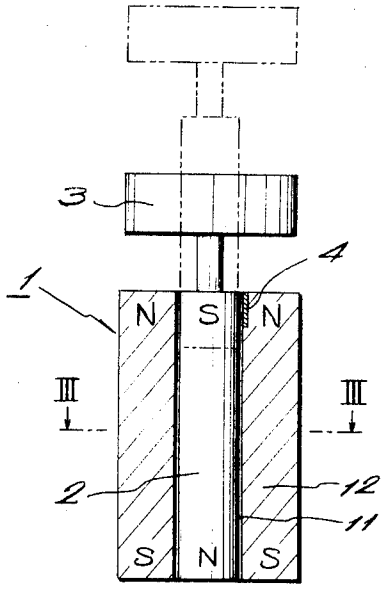


FIG. 2

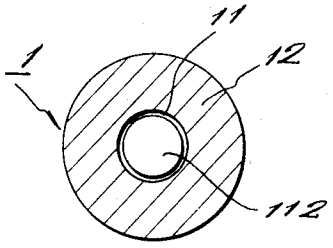


FIG. 4

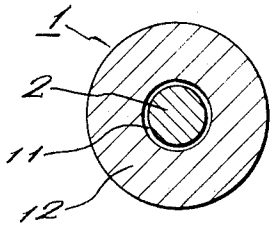


FIG. 5

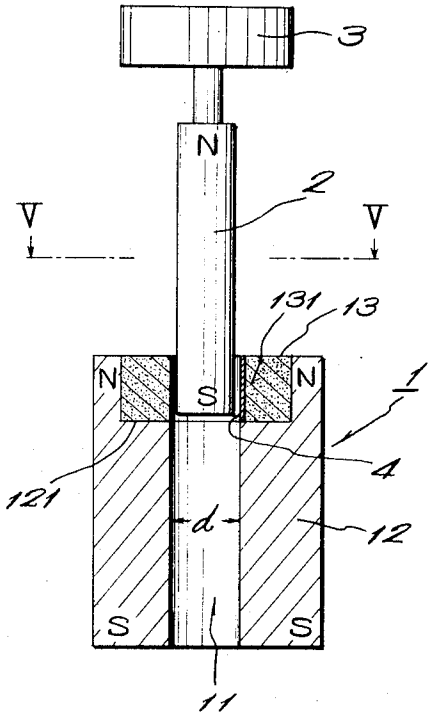


FIG. 7

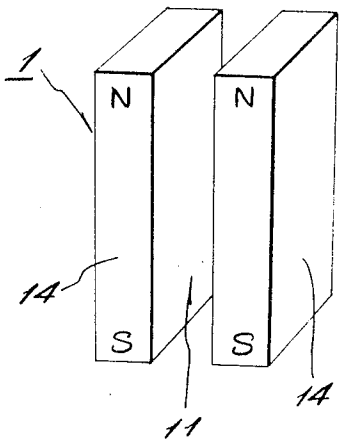


FIG. 6

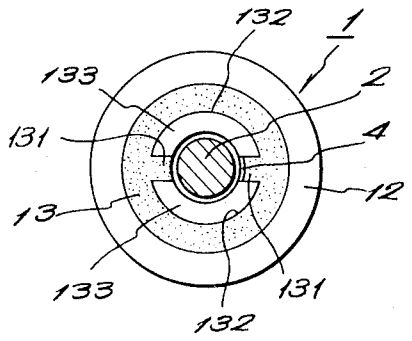
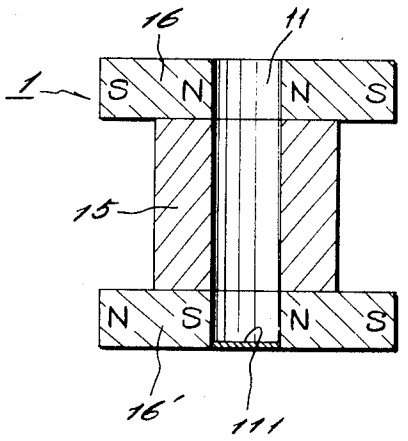


FIG. 8



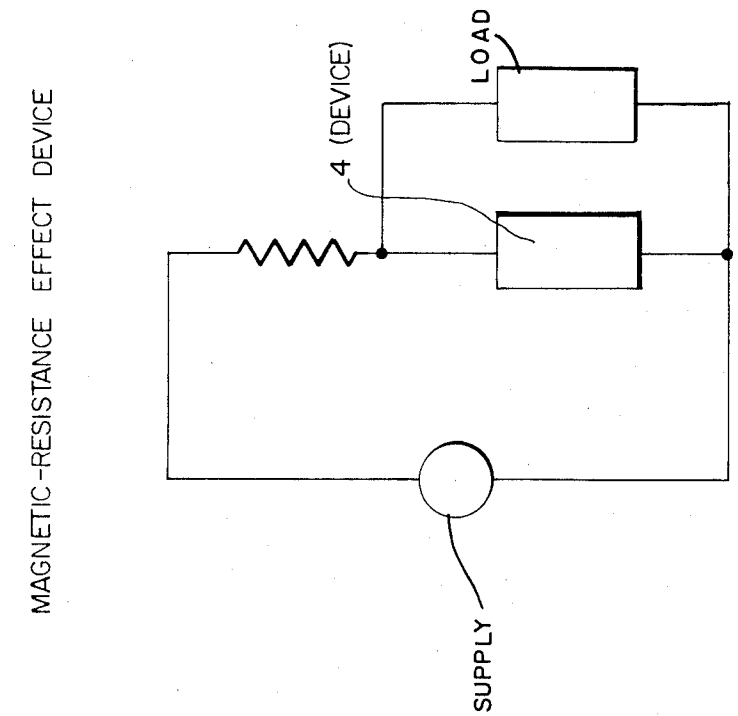

MAGNETIC-RESISTANCE EFFECT DEVICE
4 (DEVICE)
LOAD
SUPPLY

FIG. 10

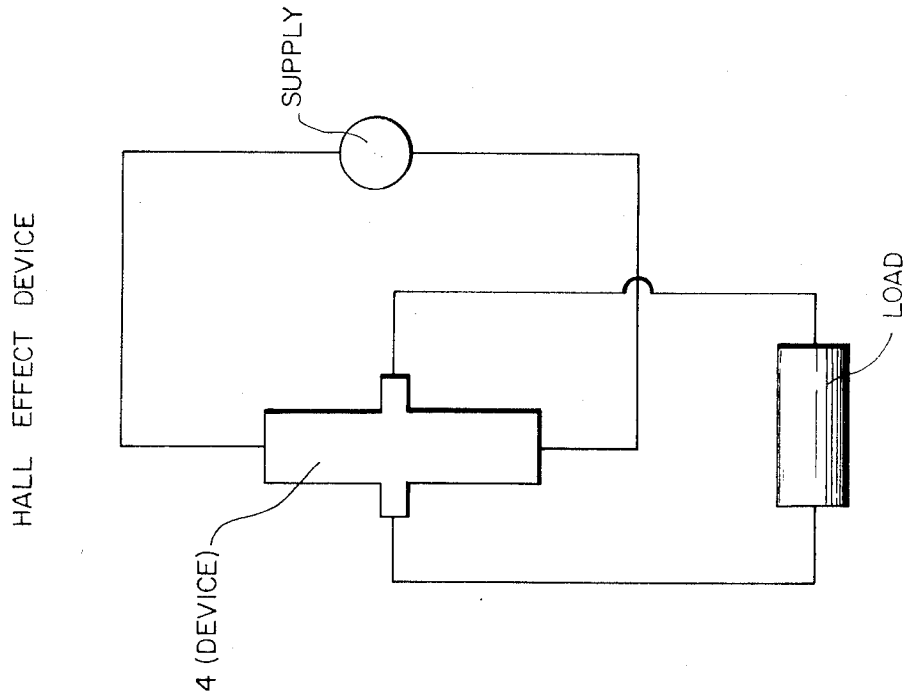

HALL EFFECT DEVICE
SUPPLY
LOAD
4 (DEVICE)

FIG. 9

CONTACTLESS SWITCHING APPARATUS

BACKGROUND OF THE INVENTION

Conventional switching apparatuses have been designed so that the current can be turned on or off by connecting or disconnecting a set of elastic contact pieces to or from mating portions. Accordingly, chattering cannot be avoided. For example, if this type of apparatus is employed in electric equipment, such as a desk type electronic computer, which is sensitive to voltage fluctuation, erroneous operation will result.

Furthermore, conventional push-button switches employing this type of contact pieces have been provided with a bias means such as, for example, a spring mechanism for maintaining the push button at a home position at all times; accordingly, these switches are disadvantageous because they require a number of parts and the cost of production is therefore high.

The present invention provides a contactless switching apparatus which can eliminate these disadvantages.

SUMMARY

The present invention provides a contactless switching apparatus comprised of a bar magnet having different polarities at its opposite ends, a magnetic-containing casing with a central space extending along the length of the casing and different polarities at both of its ends, the poles of which being arranged at least at two positions opposite to each other on both sides of and along the length of the space, an actuating means which moves either the bar magnet or the casing as required so that a specific pole of the bar magnet moves from one pole of the casing to the pole at the opposite end, at least one galvano-magnetro effect device which is fixed either on the bar magnet or on an internal surface of the casing which opposes the space so that the device be positioned at least at one polar portion of the casing, an input power supply connected to said device, and an external load which is actuated with the action of the device in accordance with the density of the magnetic flux, wherein the magnetic flux is concentrated onto the device when the polar portion where the galvano-magnetro effect device is positioned attracts the polar portion of the bar magnet.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated in detail in the accompanying drawings whereof;

FIG. 1 is a cross-sectional front view of the present invention;

FIG. 2 is a cross-sectional plan view of the apparatus along the I—I line shown in FIG. 1;

FIG. 3 is a cross-sectional front view of another embodiment of the present invention;

FIG. 4 is a cross-sectional plan view of the apparatus according to line III—III shown in FIG. 3;

FIG. 5 is a cross-sectional front view of another embodiment of the present invention;

FIG. 6 is a cross-sectional plan view of the apparatus along line V—V shown in FIG. 5;

FIG. 7 is a isometric view of an embodiment of the casing to be used in the apparatus according to the present invention; and

FIG. 8 is a cross-sectional front view of another embodiment of the casing to be used in the apparatus shown in FIG. 8.

FIGS. 9 and 10 show a typical circuit arrangement including a load and supply for a Hall Effect Device and a Magneto-Resistance Effect Device respectively.

DETAILED DESCRIPTION

Referring to FIGS. 1 and 2, there is shown a contactless switching apparatus comprised of casing 1 which comprises a cylindrical magnet 12 with poles N and S at its upper and lower ends, respectively, and axial space 11 extending along the length of the casing, bar magnet 2 which can be slidably moved along said space 11, an actuating means such as, for example, push button 3 which is located at one end of the bar magnet, to move bar magnet 2, and galvano-magnetro effect device 4 such as, for example, a Hall effect device or magnetro-resistance effect device which is fixed at the internal surface of the casing so that the device is positioned at the portion of upper pole N of casing 1.

Bar magnet 2 is energized so that poles N and S are respectively formed at its upper and lower ends. The bar magnet is inserted into the axial space so that polarity S of the inserted end of the bar magnet opposes a pole of opposite polarity of the opening end of casing 1.

Device 4 is connected to the input power supply and loads such as in a conventional circuit arrangement as shown in FIGS. 9 and 10. The load is arranged so that it is actuated by the output of the galvano-magnetro effect of the device.

The Hall voltage increases in accordance with increase of the magnetic flux to be applied when a Hall effect device is employed as the galvano-magnetro effect device and the internal resistance of the device increases in accordance with increase of the magnetic flux to be applied when a magnetro-resistance effect device is employed as said device. Accordingly, with these electrical characteristics, the load such as actuating elements, for example transistors, etc. can be actuated.

In this embodiment, it is desirable to attach non-magnetic bottom 111 on the lower end of space 11 and is more desirable to provide a projection 112, which slightly projects into the space, on bottom 111.

Thus, the inserted end of bar magnet 2 can be prevented from protruding out of the space when bar magnet 2 is pushed down into the space and the bar magnet can be positioned so that it can easily return with projection 112 because pole S of the inserted end of the bar magnet deviates from the lower end pole S of the casing.

In this case, it is desirable that length l between the magnetic poles of the bar magnet be shorter than length l' between the poles of casing 1 by an amount equal to height h of projection 112.

The switching apparatus according to the present invention is as described above. It is arranged and used as shown in FIG. 1. When push button 3 is released, one pole of bar magnet 2 is attracted to a pole of opposite polarity of casing and is secured at the upper specified position, that is, the home position.

Under this condition, device 4 is actuated by the magnetic flux which flows between bar magnet 2 and a pole of the casing and is applied to the device. When bar magnet 2 is slid downwardly, as shown by the dotted line of FIG. 1, by pressing push button 3, the poles of bar magnet 2 oppose the pole of casing having the same polarity; accordingly, the magnetic flux does not flow through device 4 and the device stops functioning.

When push button 3 is subsequently released, the poles of bar magnet 2 are repulsed by lower pole S and upper pole N of casing 1 which opposes the bar magnet and, at the same time, the lower pole S of the magnet is attracted by upper and opposite pole N of the casing. Accordingly bar magnet 2 returns up to the home position. Upon return, device 4 is once again actuated.

When the switching apparatus of the present invention is used, the trigger voltage to open and close the circuit can be obtained by sliding bar magnet 2 with actuating means 3.

Bar magnet 2 can slide in space 11 without contacting the internal surfaces of the casing because each pole end of the casing has the same polarity as that of the opposite pole end as shown in FIG. 1. Accordingly, bar magnet 2 lightly moves and will not wear because it does not encounter friction resistance.

The apparatus of the invention is as described above. It is more advantageous in mechanical construction than the conventional contact switch because the service life can be greatly prolonged by the use of the contactless type of switch. In this apparatus, because bar magnet 2 can be reset to home position without any resetting means, it can be of simple construction, thus permitting mass production at low cost.

The following describes another embodiment of the present invention.

Referring to FIGS. 3 and 4, there is shown an apparatus having a bar magnet 2 which is held in space 11 in the home position under normal operating conditions.

In this embodiment, bar magnet 2 is inserted into space 11 so that the relative positions of polarity of bar magnet 2 are opposite to the relative positions of the polarity of casing 1. In this embodiment, the poles at both ends of bar magnet 2 become opposite to the poles of opposite polarity of the casing 1 when bar magnet 2 is completely inserted into space 11. Accordingly, in this embodiment, the magnetic flux to be applied to device 4 can be varied by moving push button 3 and forcing bar magnet 2 downward to the lower end of casing 1 or alternatively drawing bar magnet 2 upwardly above casing 1.

Any unit which employs the apparatus of this embodiment of the present invention can be made more compact because bar magnet 2 is held in space 11 of casing 1. If bar magnet 2 is drawn out from casing 1 as shown by the dotted line, the magnetic flux applied to device 4 can be greatly varied because the polarity of bar magnet 2, which is at the opposite position to upper pole N of casing 1 where device 4 is provided, becomes the opposite polarity under normal operating conditions and the same polarity when the bar magnet is drawn out.

Referring to FIGS. 5 and 6, there is shown an apparatus which is provided with casing 1 made of a cylindrical magnet and a magnetic ring core at the portion where device 4 is located.

Casing 1 of this embodiment consists of cylindrical magnet 12 with recessed portion 121 at its upper and magnetic ring core 13 which is closely fitted into recessed portion 121. The core 13 is provided with a pair of projections 131 which are oppositely arranged in a radial direction, and a pair of non magnetic arc pieces 133 are mounted at recess 132 of the core which is divided by projections 131 of ring core 13 and positioned along the internal surface of ring core 13 so that a hole with a diameter equal to the diameter between the projections is formed.

Ring core 13 is formed so that the diameter between projections 131 is equal to diameter *d* of a hole which forms space 11 (in this case, the former need not be equal to the latter) and a hole formed by projection 131 and arc piece 133 connects to space 11. Device 4 fixed at one or all of projections 131 and is connected to a power supply and a load which are not shown herein.

The apparatus according to the present invention is as described above. The magnetic flux can be greatly concentrated onto device 4 when one pole of bar magnet 2 is opposed to the upper end of casing 1 with opposite polarity because the magnetic resistance between the projections is low; accordingly, device 4 can be accurately operated.

The casing of the apparatus can be formed as described below. If casing 1 is formed by oppositely arranging a plurality of bar-shaped magnets or plate-shaped magnets 14 as shown in FIG. 7, the magnetic flux concentration effect can be improved. If a plurality of magnets 16 and 16' are provided respectively at upper and lower opening ends of non-magnetic cylinder 15, upper magnet 16 is arranged so as to oppose the same polarity N and lower magnet 16' is arranged so as to oppose the poles of same polarity which polarity is opposite to the polarity of the upper poles. As shown in FIG. 8, the stroke of bar magnet 2 can be determined in accordance with the length of cylinder 15, regardless of the shape of magnet 16.

In this embodiment, the doughnut-shaped magnet with opposite polarity at its internal and external surfaces can be fixed at cylinder 15 so that the center hole of the doughnut-shaped magnet is aligned with the hole of cylinder 15. In this case, one magnet can be fixed at each of the upper and lower ends of the cylinder, respectively.

For the apparatus shown in FIG. 3, device 4 can be provided at the upper and lower ends of casing 1. The apparatus shown in FIG. 5 can be provided with at least two projections 131 and ring core 13 can be directly mounted on cylindrical magnet 12. In this case, it is easy to make casing 1 because magnet 12 need not be provided with recessed portion 121. The device can be mounted to the polar portion of the bar magnet when casing 1 is movable with respect to the bar magnet.

In each embodiment described above, bar magnet 2 can be fixed and casing 1 can be moved with respect to the bar magnet or the bar magnet and casing can each be arranged to move in opposing directions.

What is claimed is:

1. A contactless switching apparatus comprised of
   a. a bar magnet with opposite polarities at its pole ends,
   b. a magnetic-containing casing having at least a first side and a second side and provided with a center space for receiving the bar magnet,
   c. magnetic pole ends positioned on both sides of and along the length of said casing, the pole ends positioned along the length of said casing being of opposite polarity, and those polar portions opposing each other being of identical polarity,
   d. an actuating means for alternatively positioning a magnetic pole of the bar magnet opposite to the magnetic poles of the casing positioned along the length of the casing, and
   e. at least one galvano-magnetro effect device positionable adjacent at least one polar portion of the internal surface of the casing which opposes the central space.

2. A contactless switching apparatus according to claim 1, wherein the galvano-magnetro effect device is connected to an input power supply and a load which is actuated by response of the device to magnetic flux.

3. A contactless switching apparatus according to claim 1, wherein the casing is formed with a continuous cylindrical magnet having an axially positioned central space and the opposing portions of identical polarity are opposite portions of the continuous cylindrical magnet.

4. A contactless switching apparatus according to claim 3, wherein a ring core is mounted on at least one receiving end of the cylindrical magnet, the ring core being provided with at least one pair of projections which are oppositely arranged in a radial direction, and at least one device is fixed to at least one of the projections.

5. A contactless switching apparatus according to claim 4, wherein a recessed portion is formed at the receiving end of the cylindrical magnet and the ring core is fitted onto the recessed portion.

6. A contactless switching apparatus according to claim 4, wherein the distance between the projections of the ring core is made equal to the diameter of the actually positioned central space of the cylindrical magnet.

7. A contactless switching apparatus according to claim 4, wherein a non-magnetic arch-shaped piece is positioned so that a space with a diameter equal to the distance between the projections is formed on the recessed surface of the ring core, said recessed surface being divided by the projections of the ring core.

8. A contactless switching apparatus according to claim 1, wherein the casing is formed by at least two bar magnets which are oppositely arranged with a space therebetween, the opposing polar portions of which being of the same polarity.

9. A contactless switching apparatus according to claim 1, wherein the casing is formed with at least two plate magnets between which a space is formed, the opposing polar portions of the plate magnets being of the same polarity.

10. A contactless switching apparatus according to claim 1, wherein the bar magnet is inserted in and received by the space of the casing so that the polarity of the magnetic pole of the inserted end is opposite to that of the magnetic pole of the receiving end of the casing.

11. A contactless switching apparatus according to claim 1, wherein the polar portions of both magnetic pole ends of the bar magnet are arranged so that the polar portions of the bar magnet are attracted by both magnet pole ends of the casing.

12. A contactless switching apparatus according to claim 11, wherein at least one device is provided respectively at both magnetic pole ends of the casing.

13. A contactless switching apparatus according to claim 1, wherein the casing is arranged so that the bar magnet is slid by the actuating means and the device is mounted on the internal surface of the casing.

14. A contactless switching apparatus according to claim 1, wherein the bar magnet is arranged so that the casing is slid by the actuating means and the device is mounted on the bar magnet.

15. A contactless switching apparatus according to claim 1, wherein doughnut-shaped magnets are respectively positioned at both ends of a non-magnetic cylinder so as to correspond to the receiving space of the cylinder, the magnets being constructed and arranged so that their internal and external surfaces form poles of opposite polarity.

16. A contactless switching apparatus according to claim 1, wherein a bottom is provided at one open end of the central space.

17. A contactless switching apparatus according to claim 16, wherein a projection which slightly projects into the central space is provided in the interior of the bottom.

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