ELECTROMAGNETIC REVERSING RELAY

Filed April 5, 1967 3 Sheets-Sheet 1

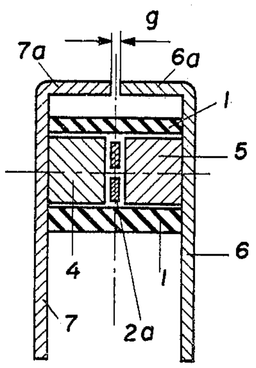

FIG. 1

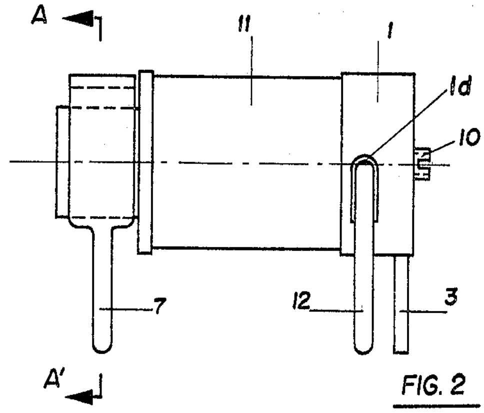

FIG. 2

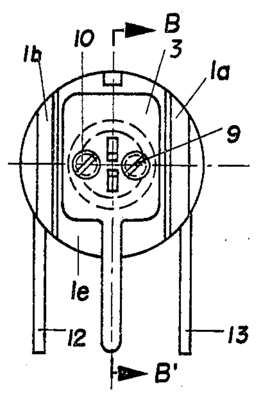

FIG. 3

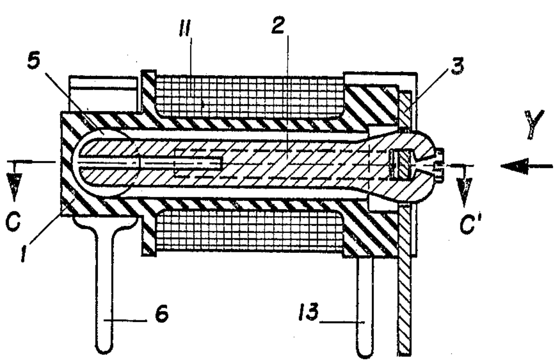

FIG. 4

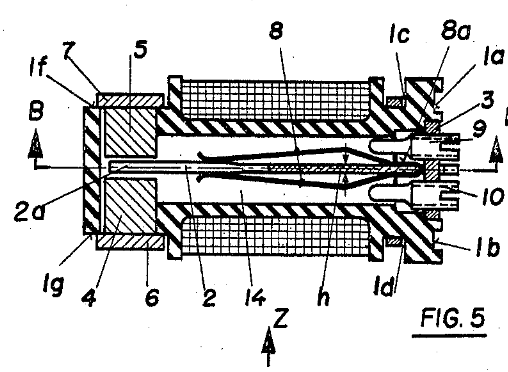

FIG. 5

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Nov. 4, 1969 | H. SAUER | 3,477,045

ELECTROMAGNETIC REVERSING RELAY

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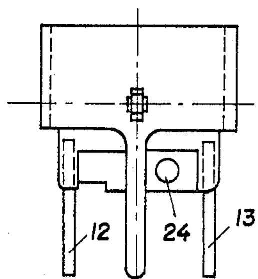

FIG. 6

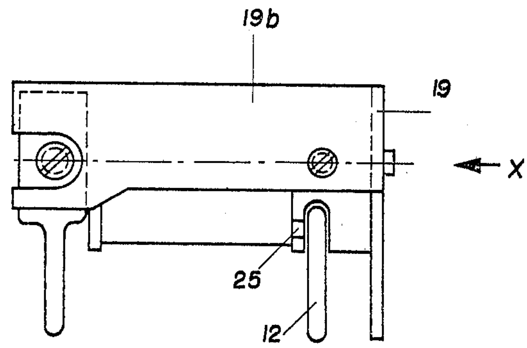

FIG. 7

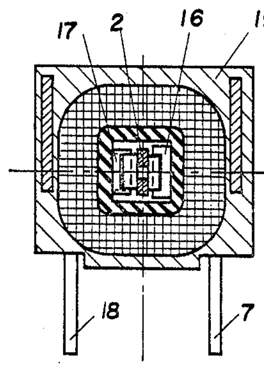

FIG. 8

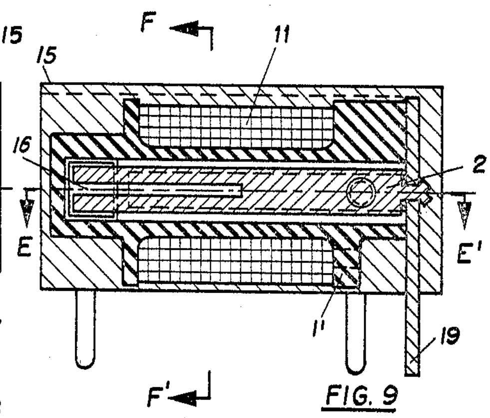

FIG. 9

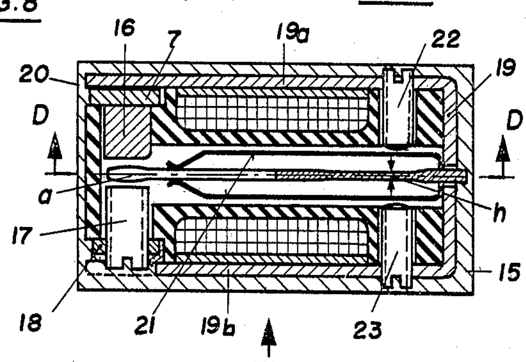

FIG. 10

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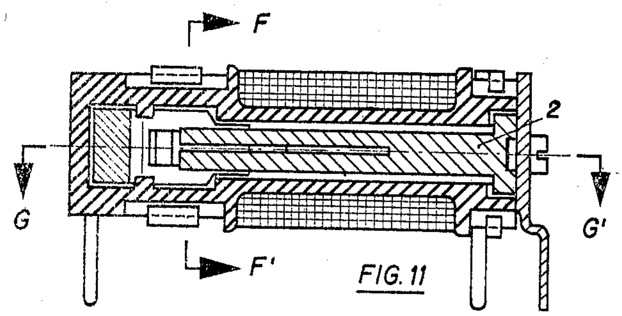

FIG. 11

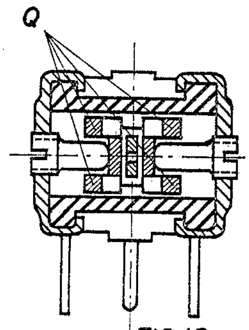

FIG. 12

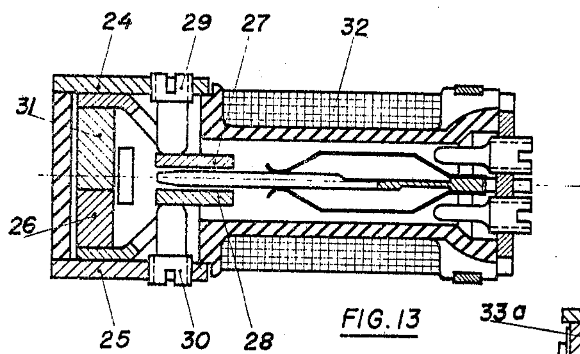

FIG. 13

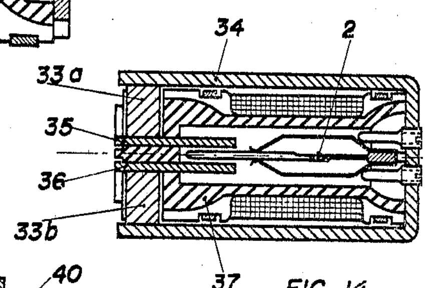

FIG. 14

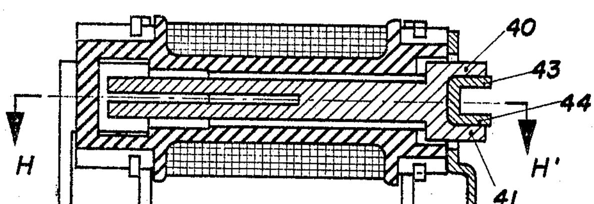

FIG. 15

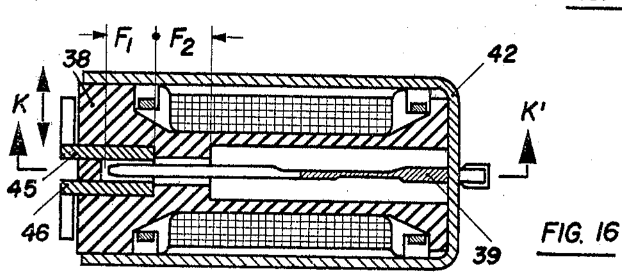

FIG. 16

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3,477,045

ELECTROMAGNETIC REVERSING RELAY

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Claims priority, application Germany, Apr. 12, 1966, S 103,130
Int. Cl. H01h *51/27, 1/66*
U.S. Cl. 335—151 10 Claims

ABSTRACT OF THE DISCLOSURE

An electromagnetic changeover or reversing relay is provided comprising a bobbin or coil which serves as a protective tube for the contacts against adverse environmental influences. Interiorly and in longitudinal relationship to the bobbin or coil there is a contact blade made of ferromagnetic material and which acts not only as the contact member, but as the armature of the magnetic circuit. The fixed contacts cooperating with the contact blade are directly mounted on one end of the bobbin or coil.

This invention relates to polarized and unpolarized electromagnetic reversing relays wherein the coil and the contacting members separate the chamber containing the contacts from the winding space and from the ambient atmosphere and wherein the contact force of the operating blade may be adjusted from the outside.

Relays in which the chamber containing the contacts is separated from the winding space are known as "reed" relays. In such relays the member carrying the contacts is a glass tube and a contact blade of ferromagnetic material is fused into each end of the tube. This protects the contact chamber from being affected by environmental contamination and particularly by organic deposits from the coil. This advantage is gained at the expense of the following drawbacks:

After assembly there is no possibility of adjusting the contacts so that the operational and release characteristics of the relay vary considerably.

The energizing power is relatively high because the iron cross section of the contact blade is necessarily small to permit deflection of the blade without undue force.

The controlled power is low because the conductor cross section and the contact gap must likewise be relatively small.

The relay is limited to make contacts since changeover or break contacts impose additional limitations relating to contact pressure, magnetic flux paths and efficiency, besides naturally being so complicated that two normally open reed elements are generally used instead of one changeover contact, one element being held in operational position by a permanent magnet and caused to release when the coil is excited by a current of given polarity and magnitude, while the other contact element is made to operate. If the excitation of the coil is so high that the magnetic field it generates substantially exceeds the permanent magnet field, then the break contact will either fail to release or it will close again after briefly releasing.

Other relays in which the contacts are substantially protected from contamination by organic deposits from the coil windings as well as from the ambient atmosphere also require supplementary means for enclosing the contact chamber. For instance, the relay described in United States Letters Patent No. 2,675,440 requires a protective tube provided with a fixing flange, two insulating foils, a radially adjustable plug and an insulating member for separating two contact parts as well as the associated fastening means. Such relays are relatively expensive and they likewise share the drawback that the interior of the

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coil which is magnetically the most effective zone is occupied by the protective tube.

The present invention eliminates these drawbacks and utilizes the available space more efficiently, besides providing greater contacting reliability and a wider applicational range because the proposed arrangement is applicable with the same advantage to unpolarized relays and to polarized relays in which the contact blade may occupy one, two or three positions of rest and the contact pressures can be preset as desired.

In general, a novel electromagnetic reversing relay according to the invention has a contact blade with a slit adjustable ferromagnetic spring in a chamber with a coil winding around it and a ceramic coil holder or bobbin at one end with metallized surfaces and depending tags, the coil holder being filled with a protective gas or the relay parts are embedded in a castable resin or in a thermoplastic material. Pressure of the contact blade can be preset from the exterior, the contact blade being exposed to the magnetic field of permanent magnets which constitute electrical contacts cooperating with the contact blade. The adjustable springs conduct magnetic or electric current or both.

In the drawings:

FIG. 1 is a sectional view taken on the line A–A′ of FIG. 2;

FIG. 2 is a side view of an electromagnetic relay embodying the invention;

FIG. 3 is an end view taken in the direction of Y of FIG. 4;

FIG. 4 is a section taken on the line B–B′ of FIGS. 3 and 5;

FIG. 5 is a sectional view taken on the line C–C′ of FIG. 4;

FIG. 6 is an end view taken in the direction of X in FIG. 7;

FIG. 7 is a side view in the direction of W in FIG. 10 but without showing embedding material;

FIG. 8 is a cross sectional view taken on the line F–F′ of FIG. 9;

FIG. 9 is a cross sectional view taken on the line D–D′ of FIG. 10;

FIG. 10 is a cross sectional view taken on the line E–E′ of FIG. 9;

FIG. 11 is a cross sectional view of a further modification;

FIG. 12 is a sectional view taken on the line F–F′ of FIG. 11;

FIG. 13 is a cross sectional view taken on the line G–G′ of FIG. 11;

FIG. 14 is a cross sectional view of a further modification;

FIG. 15 is a cross section taken on the line K–K′; and

FIG. 16 is a sectional view taken on the line H–H′ of FIG. 15.

Other details of the invention will be understood from FIGS. 1 to 10. FIGS. 1 to 5 illustrate a polarized relay with a changeover contact. FIG. 1 is a section taken on the line A–A′ in FIG. 2; FIG. 2 is a view in the direction A in FIG. 5; FIG. 3 is a view in the direction Y in FIG. 4; FIG. 4 is a section taken on the line B–B′ in FIGS. 3 and 5; and FIG. 5 is a section taken on the line C–C′ in FIG. 4.

In the illustrated embodiment the holder **1** of the coil is a ceramic part. The surfaces **1***a*, **1***b*, **1***c*, **1***d*, **1***e*, **1***f* and **1***g* of the holder are metallized. Inside the hollow holder **1** is a contact blade **2** consisting of ferromagnetic material and electrically connected in conventional manner to a tag **3**. Located at the other end of the holder **1** are permanent magnets **4** and **5** which simultaneously function as contacts and which are therefore provided with an electroplated deposit of a noble metal, such as rhodium, and brazed, riveted or welded to contact members **6** and **7**. The two flat sides of the contact blade **2** are embraced by the blades of an adjustable spring **8**, the spring pressure of each blade being independently adjustable by a screw **9** and **10**, respectively. The adjustable spring **8** is secured to the root of the contact blade **2** preferably by a spot weld **8***a*.

It is a feature of the invention that the adjusting spring **8** serves not only for controlling the operational and release characteristics of the relay, but also for conducting the magnetic flux as well as the electric current. The adjusting spring **8** is therefore preferably made of a ferromagnetic material and electroplated with a metal that is a good electrical conductor, such as silver. A larger current conducting cross section is thus provided, capable of carrying and controlling a correspondingly higher current than conventional reed contacts can handle. The reduction in cross section of the contact blade **2** to provide flexibility and the thickness *h* of the blade admit of much greater manufacturing tolerances with respect to the properties of the blade as a spring than are allowable in reed contact blades lacking an adjusting spring. The contact making end **2***a* of the contact blade **2** between the two permanent magnets **4** and **5** preferably has a slit to ensure reliable contacting with two contacts. The contacting end **2***a* is provided with a noble metal deposit, such as rhodium or gold. The upper ends **6***a* and **7***a* of the contact members **6** and **7** are folded over towards each other to reduce the gap in the magnetic circuit as much as possible. The gap *g* in FIG. 1, electrically separates the two contact members **6** and **7**.

The winding **11** of the coil in the illustrated embodiment is provided with two tags **12** and **13** brazed to the metallized surfaces **1***c* and **1***d* of the holder **1**. The metallized surfaces **1***a* and **1***b* are available for making further connections. The tags **6** and **7** of the contacts as well as the tags **12** and **13** of the coil are provided with solder on their sides facing the holder **1** so that by pressing the tags against the cooperating surfaces of the holder **1** at solder fusion temperature an airtight soldered joint will be produced. After the contact tags **3**, **6**, **7** have been soldered to the holder **1** the interior **14** containing the contacts is evacuated and filled with a protective gas in conventional manner. The adjusting screws **9** and **10** are then inserted to prevent the protective gas from too quickly escaping. As soon as the relay has been adjusted the adjusting screws **9** and **10** as well as the point of attachment of the spring contact blade **2** are soldered to the contact tag **3** to make a tight joint.

An alternative embodiment is shown in FIGS. 6 to 10. This embodiment is an unpolarized relay in which the restoring force which keeps the contact blade **2** in rest position and thereby maintains the contact gap and determines the operational and release characteristics of the relay is adjustable. FIG. 6 is a view in the direction X in FIG. 7; FIG. 7 is a view in the direction W in FIG. 10, but without the embedding material **15**, FIG. 8 is a cross section taken on the line F–F′ in FIG. 9; FIG. 9 is a cross section taken on the line D–D′ in FIG. 10 and FIG. 10 is a cross section taken on the line E–E′ in FIG. 9. Instead of the two permanent magnets **4** and **5** in FIG. 5 the embodiment in FIG. 10 comprises one soft iron member **16** provided with a suitable surface for contact making, such as rhodium or gold.

The other contact member **17** has the form of a grub screw made of silver or rhodium-plated copper, held in threads provided in the tag **18**. The other tag **7** is brazed to the contact member **16**. The tag **19** carries the contact blade **2** and also serves as a magnetic yoke. An insulating foil **20** separates the limb **19***a* of the yoke from the tag **7**. A hole **24** (FIG. 6) and an opening **25** in the holder **1** permit the end of the coil to be taken to the tags **12** and **13** for connecting up the coil. The spring **21** is adjustable by two screws **22**, **23** which preferably work in tapped holes in the limbs **19***a* and **19***b* of the

yoke. The adjusting spring **21** spans the reduced section portion of the contact blade **2**. The thickness of the reduced portion is marked *h*. If the two contact members **16** and **17** are replaced by the permanent magnet contacts **4** and **5** in FIG. 5 the resultant relay will be a polarized relay. In such a case the adjusting spring **21** could likewise be biased without the aid of additional means to retain the spring contact blade **2** not only in the illustrated center position but also in one or two deflected positions of rest. In the embodiment according to FIGS. 6 to 10 the presence of the two limbs **19***a* and **19***b* provides a lateral magnetic shield, so that the magnetic efficiency of the relay is better than that in the system illustrated in FIGS. 1 to 5. Naturally the path of the magnetic flux provided by the two limbs **19***a* and **19***b* of the yoke is one that could be similarly provide in the embodiment in FIGS. 1 to 5. The embedding material **15** which may consist of a castable resin or a thermoplastic material protects the coil from mechanical damage and may also be regarded as constituting an additional or as the sole sealing means of the relay, for instance if for reasons of economy the holder **1** were made of a suitable plastic. In such a case to tags could be riveted or adhesively attached to the coil holder or bent over a projection on the holder, and the coil ends embedded in the material. Finally, an activated getter material could be used for the coil holder in order to protect the atmosphere in the contact chamber for a considerable period of time against ionization by arcing.

A third embodiment which also contains facilities for the compensation of temperature effects is illustrated in FIGS. 11, 12 and 13. FIG. 12 is a section taken on the line F–F′ in FIG. 11 and FIG. 13 is a section taken on the line G–G′ in FIG. 11.

It is well known that the impedance of the coil of a relay and hence the energy required for a response changes with temperature by about 0.39% per ° C. A relay used in an environment in which the ambient temperatures vary bewteen −65° C. and +125° C. and which generates enough heat to raise its own temperature by 60° C. under 100% operational conditions would require twice the power for initiating a response at the minimum permissible than at the maximum permissible temperature. This means that the operational and release lags often undesirably vary and it is usually necessary at considerable cost to adapt the energizing circuitry to such conditions. The provision of a magnet system which compensates the temperature coefficient of the coil of the relay therefore suggests itself as a solution. This is achieved in the proposed arrangement which comprises a ceramic magnet **26** having a coercitivity that varies with temperature roughly in the same way as the impedance of the coil **32** and matches the magnetic circuit of the coil at least in the region of the air gap. As will be readily understood from FIG. 13 the necessary requirements can be readily met. A metallic magnet **31** which has a field strength that does not substantially vary within the temperature range from −65° C. to +200° C. is provided adjacent the ceramic magnet **26**. Assuming that the coercitivity of the ceramic magnet changes 0.5% per ° C. and that of the metallic magnet 0.02% per ° C., it will be readily understood that by suitably choosing the respective lengths of the two magnets an appropriate compensation of the forces due to thermal effects can be achieved. Some compensation of the permanent magnet forces acting in the air gap may also be provided by suitably selecting the dimensions of the cross sections Q of the contact members **27**, **28** which consists of ferromagnetic material and of the likewise ferromagnetic adjusting screws **29**, **30**, since this cross section will be magnetically saturated at a particular temperature, say at +25° C. An arrangement of this kind will commend itself principally when the temperature range within which compensation is to be effected is not very considerable and when only one ceramic magnet in a system according to FIG. 13 and two like ceramic magnets **33***a*, **33***b* in a system according to FIG. 14 take the place of the two magnets **26** and **31**. The contact members **35**, **36** of ferromagnetic material are connected in this case to the end face of the coil holder **37** in a manner that is well understood. The ceramic magnets **33***a*, **33***b* are located outside the coil holder **37** adjacent the outer faces of the contact members **35**, **36** and they touch the ends of the yoke **34** to which the spring contact blade **2** is centrally butt welded, whereas the free end of the blade inside the coil holder **37** comes to lie between the contact members **35**, **36** and thus forms the contact as well as the air gap.

Finally FIGS. 15 and 16 represent a simple embodiment in which the coil holder **38** is a ceramic magnet that has been magnetized in the direction of the double-headed arrow. Otherwise, the description relating to FIG. 14 also applies to FIG. 16. FIG. 15 is a section taken on the line K–K' in FIG. 16 and FIG. 16 itself is a section taken on the line H–H' in FIG. 1,.

The contact blade **39** has two extensions **40**, **41** which pass through the yoke **42** which is formed with two flanges **43**, **44** to which the extensions **40**, **41** are welded or firmly connected in some other way. If the flanges **43**, **44** are bent one way or the other the contact blade changes position and can thus be adjusted in the contrary direction inside the coil holder, principally in relation to the two contact members **45**, **46**.

For controlling high frequency currents the fixed contacts should have the lowest possible capacitance in relation to the cooperating open contact. In the embodiments in FIGS. 1 to 14 the contacting surfaces are also pole faces. From the point of view of magnetic efficiency a certain minimum size of the pole faces is necessary, in excess of that required for making electrical contact. In order to satisfy both requirements, i.e., optimum pole faces and small contacting surfaces the pole faces F_1 which functions as an electrical contact is associated with a supplementary pole face F_2, which being an electrically insulating ceramics magnet, creates practically no capacitance in conjunction with electrical conductors.

Having described the invention, what is claimed is:

1. An electromagnetic changeover relay having a contact system protected against environmental effects, comprising a bobbin, a contact blade of ferromagnetic material extending through the interior of the bobbin, cooperating fixed magnet contacts attached directly to one end of the bobbin to form a protective tube, and said contact blade at the other end of the bobbin sealing tube.

2. An electromagnetic changeover relay according to claim **1** wherein the magnets are permanent magnets and the contact blade is exposed to their magnetic field.

3. An electromagnetic changeover relay according to claim **2** wherein the magnets are electrical contacts which cooperate with the contract blade.

4. An electromagnetic changeover relay according to claim **1**, wherein the contact blade is associated with adjusting springs which conduct the magnetic flux and electric current.

5. An electromagnetic changeover relay according to claim **1**, wherein the bobbin is made of ceramic material.

6. An electromagnetic changeover relay according to claim **1**, wherein the bobbin is made of thermoplastic material.

7. An electromagnet changeover relay according to claim **1**, which further comprises a chamber for the contacts filled with a protective gas.

8. An electromagnetic changeover relay according to claim **1**, wherein the contact blade is adjustable by means of bendable extensions thereof.

9. An electromagnetic changeover relay according to claim **1**, wherein the bobbin consists of a ceramic magnet.

10. An electromagnetic changeover relay according to claim **1**, wherein the bobbin is made of getter material.

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R. N. ENVALL, Jr., Assistant Examiner

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,477,045 Dated November 4, 1969

Inventor(s) HANS SAUER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading, lines 3 and 4, now reading:

"Hans Sauer, Munich, Germany, assignor to Matsushita Electric Works Ltd., Osaka, Japan"

should read:

--Hans Sauer, Munich, Germany, assignor to Matsushita Electric Works Ltd., Osaka, Japan and to said Hans Sauer

SIGNED AND SEALED
JUL 21 1970

(SEAL)
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