

PATENT SPECIFICATION

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(54) LAYERED METALLIC MATERIALS

(71) We, VEREINIGTE DEUTSCHE METALLWERKE AKTIENGESELLSCHAFT, a body corporate organised under the Laws of Germany of Hedderheim, Frankfurt (Main), Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This application relates to layered metallic materials from which may be made coins or tokens for use in place of coins which, although they have the same thickness and size, can be distinguished or separated from one another by means of methods which rely upon magnetic properties. The possibility of distinction by such methods which are, in themselves, known, is of importance for coin operated machines, such as vending machines, inasmuch as they prevent or make more difficult the fraudulent use of counterfeit or lower-value foreign coins.

Coin operated machines are normally set for the acceptance of a certain coin, the acceptance of different coins being prevented as far as possible by various checking devices. Primarily these include purely mechanical devices which check the coin for size and weight. However, these characteristics can be easily imitated by using inferior materials. Owing to the fact that coins mostly consist of non-magnetisable materials, almost any coin operated machine therefore includes a device which, with the aid of a permanent magnet, rejects any magnetic materials. However, this still does not make it possible to reject inferior imitations from the range of non-magnetic materials. For this purpose devices are used in the

majority of vending machines, which carry out an eddy current test.

The eddy current test is based on the well-known principle that electric current is generated in a conductor as it is passed through a magnetic field. During this process, the generated current flows inside a disc-shaped electric conductor in small circular paths in the form of an eddy current. The important effect of this eddy current in respect of the said test is to form a second magnetic field which impedes the movement of the conductor through the first magnetic field. The result is that the disc slows down as it passes the magnetic field. Coin or token operated machines almost invariably employ the eddy current test, the metal coin or token rolling along an inclined guide path on which a magnetic field is arranged in such a manner that, towards the end of the said path, the coins or tokens intersect the magnetic lines of force and, according to their speed, are guided into the intake or reject channel by means of deflector pins, baffles or rebound pads. The final speed of the metal coin or token depends on the eddy current braking effect and its weight. For coins or tokens having an identical shape, the weight is proportional to the specific gravity of the material and the eddy current braking is proportional to its conductivity or inversely proportional to its specific electric resistance, the braking force being counteracted by the weight. With an identical runner channel position and inclination, the quotient of the weight and the braking force, i.e., the product of specific gravity and specific electric resistance, is a direct measure of the final speed, seeing that both the magnetic field and the entry speed are always

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identical in one and the same machine.

A satisfactory separation of coins or tokens made of materials other than those intended for the operation of the machine would be possible if, for the coins or tokens to be accepted by the machine, a material is used in which the product of specific gravity and electric resistance differs distinctly from this product of the other materials more suitable in respect of the other conditions. Up to now, however, it has not been possible to find such material which cannot be replaced by any other material. The solution of this problem is made even more difficult by the fact that the majority of vending machines are designed for operation by means of coins and have to comply with requirements in addition to being able to reject counterfeit or lower value coins.

Thus, for example, coins made of "coin silver", i.e., alloys of silver and copper in various proportions are not "vending machine proof", the electric resistances depending only to a slight degree upon the composition (proportion between silver and copper). It is, therefore, quite possible to use foreign coins of very different values in vending machines designed for operation by silver coins. Even when such foreign coins have an identical composition to that of the coins with which the machine is intended to operate, such foreign coins may have very different electric resistances and, consequently, different running times as a result of the heat treatment to which they have been subjected during the manufacturing process before minting. In the case of vending machines designed for accepting coin silver it is therefore necessary to employ rather wide acceptance ranges. The use of inferior copper/silver alloys or even industrial copper is therefore quite possible in the case described.

For materials having relatively high specific electric resistances, a separation of only slightly differing materials is very difficult with the available magnetic fields which can be produced by permanent magnets, separation requiring a highly sensitive setting of the coin checking unit. In addition, easily available materials may still be accepted, from which counterfeits can be produced. This applies, for example, to nickel chrome steels, copper/nickel alloys, brasses, bronzes and silver/copper alloys containing an addition of zinc and/or nickel.

In respect of vending machine proofness, copper/nickel plated copper has been suggested and, for the purpose of increasing this vending machine proofness, an established value for the product of specific gravity and specific electric resistance and an established minimum thickness of the plating has been specified. Certain industrial

copper grades, however, can be imitated, so that no adequate vending machine proofness is guaranteed. In addition, plating of the harder copper/nickel component on the soft copper core involves difficulties.

Magnetisable materials can not be tested by the eddy current method because they are attracted to the permanent magnet, and the coin checking units of vending machines are normally designed for the rejection of such materials. It has already been proposed to use a nickel coin with 5% silicon as a non-magnetisable material with a magnetisable core of a nickel/iron/molybdenum alloy with approximately 80% nickel. This was based on the consideration that a lightweight magnetic coin will be attracted to the magnet as it rolls past the magnet of an eddy current checking unit, but will not stick to it. As the face of the coin contacts the magnet, the resulting speed reduction caused by friction will slow down the movement of the coin in the same manner as if it were retained by the eddy current mechanism. It was believed that through the use of this principle, the correct behaviour of the coin could be obtained only by a very carefully regulated magnetism, and it was therefore also believed that an appropriate special alloy was essential, the magnetism of which could be very accurately adjusted. Also it was considered essential for this purpose, to create a uniform friction surface for all coins thus designed and for the magnetic poles of the coin checker — in the latter case, for example, by applying a special band. The vending machine proofness, however, is still not guaranteed with such a coin in that, on the one hand, it could be replaced by any body having the same friction effect and, on the other hand, any non-magnetic material could be provided with an eddy current behaviour equivalent to the friction effect.

The present invention is based on the consideration that with such coins or metal discs made of non-magnetisable materials having a magnetisable layer, not only an eddy current braking effect but also braking by magnetic attraction occurs which depends on the thickness of the magnetisable layer without the friction forces playing any important part if the magnetic attraction is so adjusted that the coins do not actually stick to the braking magnet and that such adjustment of the magnetic attraction forces can be effected by regulating the magnetic field and/or the thickness of the magnetisable layer and is therefore not solely dependent upon the material.

According to the invention, there is provided a metallic material having two constituents arranged alternately in at least three layers, the one constituent being nickel

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and the other being a copper-nickel alloy having 5 to 60% nickel.

The invention also comprehends coins, or tokens for use in place of coins, made from metallic material according to the invention.

The factors affecting the present invention are shown, for example, by the following experiment which was carried out with copper/nickel 25 with nickel cores of 2.6%, 4%, 6%, 8.5% and 12% total thickness in and eddy current brake. The magnetic field, in this experiment, was established by alternately fitting 4 to 13 weak magnets. With

four of these magnets, the 12% nickel core disc was retained, the 8.5% core was passed through in a readily separable manner, whilst those having thinner nickel cores and those made of industrial copper as well as an American quarter coin made of coin silver passed through very much more quickly. With a slight

weakening of the magnetic field by removing two magnets or by introducing an air gap the 12% nickel disc was passed through and was readily separable. On fitting six magnets, the 8.5% nickel disc was retained, the 6% nickel disc moved at the same speed as, for example, the industrial copper and American quarter coins. With nine mag-

nets, the disc plated on 4% nickel was in the range of the coin silver, and the disc plated on 2.6% nickel was in the range between the non-silver materials and the coin silver. With thirteen weak magnets it was possible to arrange the 2.6% nickel disc during its running period in such a manner that it was not within the range overlapped by the other materials. It is thus possible,

by appropriately adjusting the magnetisable layer thickness which, from a manufacturing point of view, can be maintained at a relatively accurate level, and by a suitable choice of field strength of the braking magnet and the distance of the braking magnet from the coin running channel, to set acceptance ranges not overlapped by any other material. The lesser core thicknesses up to approximately 6% nickel can be imi-

tated by materials having lower specific electric resistances. Because of the difficulties involved, however, any imitation would be worthwhile only in the case of higher value coins. Owing to the fact that the invention makes available coins or tokens of the same thickness and size which can be distinguished or separated from one another by means of physical methods responding to magnetic properties and are of suitable materials having a magnetisable core and are characterised by the fact that the metal coins or tokens to be distinguished or separated from one another have a magnetisable core of varying thickness and the various thicknesses of the core are established

within a range of stages differentiable by the said methods, it is possible to manufacture a vending machine proof coin which is difficult to imitate, or an entire coin system having these properties which have, so far, not been obtainable. This possibility exists not only for national mints or a world-wide coinage system, but also, in the event of the national mint not being able to decide on the influence of such a system, also for the individual manufacturer of vending machine or vending machine checking units. He can easily adjust his checking units for the acceptance of a token made available by the present invention and sell such tokens to his customers for the price which would normally have to be inserted into the machine. As it is, these materials have the advantage that commercial materials, including non-magnetisable materials widely used for coins, can be safely separated from one another because of the different magnetic properties if the vending machine has been properly graded for the differential core thickness. Correct grading can be carried out, having regard to the technical manufacturing facilities and the separating capacity of the combined test, by magnetic attraction and eddy current braking at core thicknesses of 1 to 50%. For this reason it is advantageous to provide the coins or metal discs according to the invention with cores the thicknesses of which lie within this range.

It has also been established that the manufacturer of coins or coin blanks can make them particularly easily separable by producing coins with cores graded as to thickness within the abovementioned thickness range in such a manner that with each of the said thickness stages the core is at least 30% thicker than the core of the preceding grade. Whilst for vending machine proof metal tokens in private use any metal combination can be used within the scope of the invention, any official coins, as already mentioned, have to meet a number of additional requirements such as sound, certain colours which are not easy to imitate, high density and good rolling, punching and minting properties as well as resistance to corrosion and wear after the coin has been minted. The non-magnetisable copper/nickel alloys with a nickel content of 5 to 60% by weight, preferably 15 to 30%, not only meet all of these requirements in respect of a coin alloy but, together with nickel cores represent fully vending machine proof or, within the specified abovementioned core thickness ranges of up to 6%, represent at least satisfactorily vending machine proof coins. If necessary the said non-magnetisable alloys may contain additional elements such as, for example, zinc, manganese, iron, silicon and the like which do not affect their plateability and do not

within a range of stages differentiable by the said methods, it is possible to manufacture a vending machine proof coin which is difficult to imitate, or an entire coin system having these properties which have, so far, not been obtainable. This possibility exists not only for national mints or a world-wide coinage system, but also, in the event of the national mint not being able to decide on the influence of such a system, also for the individual manufacturer of vending machine or vending machine checking units. He can easily adjust his checking units for the acceptance of a token made available by the present invention and sell such tokens to his customers for the price which would normally have to be inserted into the machine. As it is, these materials have the advantage that commercial materials, including non-magnetisable materials widely used for coins, can be safely separated from one another because of the different magnetic properties if the vending machine has been properly graded for the differential core thickness. Correct grading can be carried out, having regard to the technical manufacturing facilities and the separating capacity of the combined test, by magnetic attraction and eddy current braking at core thicknesses of 1 to 50%. For this reason it is advantageous to provide the coins or metal discs according to the invention with cores the thicknesses of which lie within this range.

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render the alloys magnetic. When using copper/nickel alloys containing 5 to 60, preferably 15 to 30% nickel and having nickel cores in thicknesses of 2.6%, 4.0%, 6.0%, 8.5%, 12% and 17%, reckoned on the total thickness of the discs, a set of six coins respectively having these thicknesses may be provided which will meet any additional requirements and will have a degree of vending machine proofness so far unattained.

The present coins and tokens have the additional advantage that they can be easily distinguished or separated also by means of other magnetic and electronic methods and from imitations made not only of non-magnetisable or highly magnetisable materials. All abovementioned properties and applications apply also in the event that the magnetisable component of the present metal coins or tokens is arranged in the form of mutually equally thick cover layers on the surfaces of the coin or token with the non-magnetisable component arranged as a core. Each of the cover layers will then, for the same purpose, be only half as thick as with metal coins or tokens in which the core consists of the magnetisable component. A metal coin or token having a magnetisable core of, for example, 2.6% of the total coin or token thickness, will then correspond to a metal coin or token having a thickness of each of the cover layers of each 1.3% of the total coin or token thickness; a metal coin or token having a magnetisable core of a thickness of 4.0% of the total thickness of the metal coin or token will then correspond to a metal coin or token having a magnetisable cover layer thickness of each 2.0% of the total thickness of the coin or token etc. For the rest, the conditions should be adjusted in exactly the same manner as described above in respect of coins or tokens having a magnetisable core. The advantage of a laminated material having an external magnetisable cover layer, or preferably, a magnetisable layer applied on both sides in the same thickness, lies in a considerable simplification of the manufacturing process and, consequently, in a reduction of manufacturing costs. The application of thinner layers to a thicker core can be carried out more easily, because of the different type of deformation for core and cover layer occurring during the plating process, than the application of thicker cover layers to a thinner core. In addition, the thinner cover layer — especially a layer made of magnetisable pure metals such as nickel, can be applied by means of an electrolytic thick nickel plating process. A nickel layer may also be applied by chemical

means. Subsequent cold rolling and diffusion annealing will compact the layer in such a manner that it is indistinguishable from a plating layer.

It is also possible, however, to apply the cover layers by a roll-on plating system. The layers may be bonded together at an elevated temperature and pressure, or at room temperature under pressure.

WHAT WE CLAIM IS:—

1. A metallic material having two constituents arranged alternately in at least three layers, the one constituent being nickel and the other being a copper-nickel alloy having 5 to 60% nickel.
2. A metallic material as claimed in Claim 1 wherein said other constituent is a copper-nickel alloy having 15 to 30% nickel.
3. A metallic material as claimed in Claim 1 or 2 wherein a layer of copper-nickel alloy is covered on each side by a layer of nickel.
4. A metallic material as claimed in any one of Claims 1 to 3 wherein a layer of nickel is covered on each side by a layer of copper-nickel alloy.
5. A metallic material as claimed in any one of Claims 1 to 4 wherein the thickness or total thickness of the layer or layers of nickel is from 1 to 50% of the total thickness of the material.
6. A metallic material as claimed in any one of Claims 1 to 5 wherein the layers have been bonded together at an elevated temperature and pressure.
7. A metallic material as claimed in any one of Claims 1 to 5 wherein the layers have been bonded together at room temperature under pressure.
8. A metallic material as claimed in any one of Claims 1 to 5 wherein the or each nickel layer has been applied by electrolytic or chemical means to the copper-nickel layer and the resulting structure has then been subjected to a cold shaping operation followed by diffusion annealing.
9. Coins, or tokens for use in place of coins, produced from a metallic material as claimed in any one of the preceding Claims.
10. A set of coins, or tokens for use in place of coins, produced from a metallic material as claimed in any one of Claims 1 to 8 wherein the thickness or total thickness of the nickel layer or layers in any one coin or token is at least 30% greater than that of the coin or token having the next smaller thickness or total thickness of the nickel layer or layers.
11. A set of six coins, or tokens for use in place of coins, produced from a



render the alloys magnetic. When using copper/nickel alloys containing 5 to 60, preferably 15 to 30% nickel and having nickel cores in thicknesses of 2.6%, 4.0%, 6.0%, 8.5%, 12% and 17%, reckoned on the total thickness of the discs, a set of six coins respectively having these thicknesses may be provided which will meet any additional requirements and will have a degree of vending machine proofness so far unattained.

The present coins and tokens have the additional advantage that they can be easily distinguished or separated also by means of other magnetic and electronic methods and from imitations made not only of non-magnetisable or highly magnetisable materials. All abovementioned properties and applications apply also in the event that the magnetisable component of the present metal coins or tokens is arranged in the form of mutually equally thick cover layers on the surfaces of the coin or token with the non-magnetisable component arranged as a core. Each of the cover layers will then, for the same purpose, be only half as thick as with metal coins or tokens in which the core consists of the magnetisable component. A metal coin or token having a magnetisable core of, for example, 2.6% of the total coin or token thickness, will then correspond to a metal coin or token having a thickness of each of the cover layers of each 1.3% of the total coin or token thickness; a metal coin or token having a magnetisable core of a thickness of 4.0% of the total thickness of the metal coin or token will then correspond to a metal coin or token having a magnetisable cover layer thickness of each 2.0% of the total thickness of the coin or token etc. For the rest, the conditions should be adjusted in exactly the same manner as described above in respect of coins or tokens having a magnetisable core. The advantage of a laminated material having an external magnetisable cover layer, or preferably, a magnetisable layer applied on both sides in the same thickness, lies in a considerable simplification of the manufacturing process and, consequently, in a reduction of manufacturing costs. The application of thinner layers to a thicker core can be carried out more easily, because of the different type of deformation for core and cover layer occurring during the plating process, than the application of thicker cover layers to a thinner core. In addition, the thinner cover layer — especially a layer made of magnetisable pure metals such as nickel, can be applied by means of an electrolytic thick nickel plating process. A nickel layer may also be applied by chemical

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It is also possible, however, to apply the cover layers by a roll-on plating system. The layers may be bonded together at an elevated temperature and pressure, or at room temperature under pressure.

WHAT WE CLAIM IS:—

1. A metallic material having two constituents arranged alternately in at least three layers, the one constituent being nickel and the other being a copper-nickel alloy having 5 to 60% nickel.
2. A metallic material as claimed in Claim 1 wherein said other constituent is a copper-nickel alloy having 15 to 30% nickel.
3. A metallic material as claimed in Claim 1 or 2 wherein a layer of copper-nickel alloy is covered on each side by a layer of nickel.
4. A metallic material as claimed in any one of Claims 1 to 3 wherein a layer of nickel is covered on each side by a layer of copper-nickel alloy.
5. A metallic material as claimed in any one of Claims 1 to 4 wherein the thickness or total thickness of the layer or layers of nickel is from 1 to 50% of the total thickness of the material.
6. A metallic material as claimed in any one of Claims 1 to 5 wherein the layers have been bonded together at an elevated temperature and pressure.
7. A metallic material as claimed in any one of Claims 1 to 5 wherein the layers have been bonded together at room temperature under pressure.
8. A metallic material as claimed in any one of Claims 1 to 5 wherein the or each nickel layer has been applied by electrolytic or chemical means to the copper-nickel layer and the resulting structure has then been subjected to a cold shaping operation followed by diffusion annealing.
9. Coins, or tokens for use in place of coins, produced from a metallic material as claimed in any one of the preceding Claims.
10. A set of coins, or tokens for use in place of coins, produced from a metallic material as claimed in any one of Claims 1 to 8 wherein the thickness or total thickness of the nickel layer or layers in any one coin or token is at least 30% greater than that of the coin or token having the next smaller thickness or total thickness of the nickel layer or layers.
11. A set of six coins, or tokens for use in place of coins, produced from a

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metallic material as claimed in any one of
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thickness of the nickel layer or layers of the
coins or tokens in the set is 2.6%, 4.0%,
5 6.0%, 8.5%, 12% and 17% respectively of
the total thickness of each coin or token.

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