

The invention relates to a coin made from a composite layered material and having an iron-containing core layer and austenitic chromium-nickel steel plated cover layers on both sides.

In the currency used during earlier times the value of the metal (gold, silver) substantially corresponded to the nominal value of the coins, so that their effective value always followed changes in the price of metals. From the middle of the 19th century onwards, the increasing demand for coins arising from industrialization and the intensification of trade and commerce was covered to an ever increasing extent by small change, in which generally the value of the metal represented only a fraction of the nominal or coining value. Since then, however, even small change made of gold or silver is no longer customary, since the value of metals has increased so considerably that the minting value of the coins was reached or exceeded, but at least is too high for economic minting.

Various attempts have therefore been made to replace the classical gold and silver with other materials in coins. Often the intention was to retain the original colour of the coin, nickel being substituted for silver and certain copper alloys for gold.

However, in the meantime even materials of nickel or alloys mainly containing nickel, which had been used on a large scale as substitutes for silver, have become regarded as too expensive for minting purposes and are to be replaced by cheaper materials. This is of course on the assumption that the substituted

materials have the same properties of use as nickel. For this reason aluminium, for example, cannot be considered because its specific density is too low, nor can standard iron materials, due to deficient resistance to corrosion.

However, the selection of a suitable substitution material is above all made difficult by the fact that the coins made from the new material must be used at least for some time in parallel with coins of nickel or nickel alloys having the same value, since technically it is hardly practicable and economically it is unjustifiable to change over to new coins on a predetermined fixed day. Merely for this reason the new coins must agree with the old coins with respect to all their properties relevant for automatic coin testers. However, even if it should be possible to decide on a changeover on a particular fixed date, the last-mentioned condition must be met, since it would in any case be quite impossible to re-equip or replace all coin testing machines with respect to the changed testing properties of the new coins.

In mechanical coin testing apparatuses, which are nowadays only used to a small extent, the sizes of the coins are tested and also their density and rebound behaviour following impingement on an anvil. In the course of time these relatively simple tests have been extended or replaced by the testing of the electrical and magnetic properties of the coins; the movement of the coins through the coin testing machine can be influenced to enable counterfeits to be effectively separated.

By means of built-in permanent magnets, electrically conductive but non-magnetizable coins can be slowed down by utilization of the eddy current braking effect, the main aspect being the relation between the specific density and the specific electrical conductivity of the material of the coin, for which a very narrow range of acceptance can be adjusted.

On the other hand, the movement of magnetizable coins can be directly influenced by magnets; a retardation, acceleration or lateral deflection usually results in a free flight path of the coin, so that only such coins arrive in the acceptance shaft as are made of the "correct" material.

Recently the testing of coins has been further improved by so-called electronic coin testers. Fig. 1 shows such a coin testing system in simplified form. It mainly consists of an a.c. measuring bridge (1) in one of whose arms a pair of measuring coils (2) is disposed, and also an electronic device (3) for the processing and evaluation of the measuring results. The a.c. current bridge (1) is so adjusted by means of balancing resistors (4) and a calibration coin that its diagonal voltage becomes zero when a "correct" coin (5) is situated between the measuring coils (2) - i.e., a coin whose dimensions and material properties correspond to those of the calibration coin. This zero balance is used as a test signal and evaluated for an acceptance decision. The electromagnetic coils can be adjusted to different frequencies, preferably in the range of 0.1 to 100 kHz. Testing reliability can be appreciably enhanced by multiple testing at different frequencies. Generally at least a double test is

needed to enable the influence of the dimensions of the coin to be determined as well as the properties of the material.

For the replacement of nickel by some other material this means that at the usual testing frequencies the substituted material must produce test results substantially corresponding to those of nickel.

Fig. 2 shows the locus curves of complex impedance for different materials and different testing frequencies, the dimensions of the coins remaining the same; the real part is plotted in ohms on the abscissa, the imaginary part in μH on the ordinate. The numbers on the curves state the testing frequency in kHz. It can be seen immediately that the hitherto customary non-magnetic coin materials - i.e., copper and copper alloys with up to 25% nickel (hatched zone 1) - are out of the question for solving the problem of substitution, since at all frequencies their characteristic test values are remote from curve 2, applicable to nickel. Nor is it possible to use the weakly magnetizable composite layered material, known from DE-A 15 58 703, having a nickel core occupying 7% of the total thickness, with two cover layers, amounting to 47.5% of the total thickness, of a copper alloy containing 25% nickel (curve 3), since for this in the customary range of frequencies there is no point at which the complex impedance agrees with or comes anywhere near to that of nickel.

DE-A 15 58 703 also discloses coin materials having a magnetizable core of iron and cover layers of non-magnetizable

chromium-nickel steels, but these materials are disadvantageous, due to difficult workability and poor coinability.

The problem is therefore to suggest a coin material, all of whose properties of use show that it is suitable as a substitute for nickel or coin alloys mainly containing nickel and which moreover is not so different as regards testing properties from the material to be replaced that it would mean that existing coin testing machines would have to be changed or re-equipped.

To solve this problem, a coin is suggested which is formed by a composite layered material of the kind specified and has a core layer of a ferritic chromium steel. According to a further development of the invention the thickness of each plated-on layer amounts to 2 to 10% of the total thickness of the composite layered material. Preferably the thickness of each plated-on layer amounts to 5% of the total thickness of the composite layered material.

Another solution of the problem according to the invention is that the composite layered material has a core layer of an austenitic chromium-nickel steel which is plated with a layer of a ferritic chromium steel both sides. The thickness of each plated-on layer amounts to 20 to 40%, preferably 30% of the total thickness of the composite layered material.

The chromium steel on conveniently used is the rustproof ferritic steel X8Cr17 (Material No. 1.4016), the chromium-nickel steel

used being the rustproof austenitic steel X5CrNi1911 (Material No. 1.4303).

Further details of the invention will be explained with reference to the test results obtained.

Coin blanks having a thickness of 2 mm and made of the first-mentioned substitution material were moved between two measuring coils (Fig. 1), and the impedance of the coil/coin arrangement was measured at 0.1 kHz and 100 kHz as regards the real part (loss resistance R in ohms) and the imaginary part (inductive resistance L in henrys). Similar investigations were carried out on coin blanks of pure nickel, on the rustproof ferritic steel X8Cr17 (Material No. 1.4016) and on the rustproof austenitic steel X5CrNi1911 (Material No. 1.4303). The results are given in Table 1.

In the case of the inductive resistance L , at the frequency of 0.1 kHz a very good agreement is found between nickel (first line) and the composite layered material according to the invention (fourth line). The difference is only 1.2%, this not being very large in comparison with an acceptance range of a few per cent to be adjusted in the testing apparatuses. At the measuring frequency of 100 kHz, nickel and the composite layered material according to the invention are further apart, although a better approximation is possible via a fine adjustment of the selected layer thicknesses, if the test must absolutely be performed at 100 kHz and with a narrow zone of acceptance, and not at 0.1 kHz, where very good agreement is reached. As can be

seen, the steels (lines 2 and 3) participating in the composite layered material according to the invention are each clearly respectively above or below the values for nickel as regards inductive resistance, so that in practice it is always possible, within the framework of the given or technically practicable layer thickness ratios, to obtain adequate agreement between the composite layered material and nickel at the given testing frequencies.

Similar considerations apply to the loss resistance R , whose values are relatively close to one another for all the four samples at a measuring frequency of 0.1 kHz, so that a corresponding range of acceptance can be adjusted. With a measuring frequency of 100 kHz, the steels participating in the composite materials are again clearly respectively above and below the value for nickel, so that in this case also an approximation to the nickel value can be obtained via a fine adjustment of the proportions of the layer.

The last column gives the price ratios at present levels. According to this the price of the ferritic steel X8Cr17 (line 2) is only about $1/4$ that of nickel, the price of the rustproof austenitic steel X5CrNi1911 (line 3) is only about $1/3$ and the composite layered material (line 4) is only about half; in the last-mentioned case the higher processing costs due to the plating have already been taken into account.

To sum up: the aforementioned problem of substitution can be solved as regards all demands by the first-mentioned composite

layered material.

The second-mentioned composite layered material according to the invention can be used for coin testing systems in which the electrical damping of the sample is used for detecting and separating counterfeits. Table 2 shows the damping values for the four different coin materials, obtained at a testing frequency of 50 kHz. Surprisingly, the damping of the composite layered material according to line 4 does not lie between the values for the individual materials according to lines 2 and 3, but clearly above the higher value for X8Cr17 (line 2) and so close to the value for nickel that no different width of acceptance must be adjusted if it is substituted for nickel. In this case also a better agreement with the damping value for nickel can be obtained by precision adjustment of the layer thickness ratios.

Using the two composite materials according to the invention made from the same starting materials, a substitute for nickel can therefore be obtained which is in no way inferior as regards all the usual properties of use and which can be so designed with respect to all the relevant properties for the most modern coin testing devices that only a slight alteration, if any, must be made to the ranges of acceptance for nickel adjusted on the coin testing machine.

Wording on Fig. 2: Ordinate = inductivity in μH ; abscissa = resistance in Ω .

Top centre of drawing: CuNi 25 with 7% Ni core.

TABLE 1

		L in μH		R in ohms		Price ratio
		0.1 kHz	100 kHz	0.1 kHz	100 kHz	
1	nickel	4.840	610	4.7	132	1
2	X8Cr17	9.300	1.350	4.2	491	0.25
3	X5CrNi1911	930	560	3.6	83	0.33
4	2 x 5% (3) plated-on (2)	4.780	870	3.8	397	0.5

TABLE 2

		Damping in dB
1	nickel	65.3
2	X8Cr17	58.4
3	X5CrNi1911	19.1
4	2 x 30% (2) plated-on (3)	66.9



CLAIMS

1. A coin made from a composite layered material and having an iron-containing core layer and austenitic chromium-nickel steel plated cover layers on both sides, characterized in that the core layer consists of a ferritic chromium steel.
2. A coin according to claim 1, characterized in that the thickness of each plated-on layer amounts to 2 to 10% of the total thickness of the composite layered material.
3. A coin according to claim 2, characterized in that the thickness of each plated-on layer amounts to 5% of the total thickness of the composite layered material.
4. A coin made from a composite layered material and having an iron-containing core layer and plated cover layers of chromium-containing steel on both sides characterized in that the coin has a core layer of an austenitic chromium-nickel steel which is plated on both sides with a layer of a ferritic chromium steel.
5. A coin according to claim 4, characterized in that the thickness of each plated-on layer amounts to 20 to 40% of the total thickness of the composite layered material.
6. A coin according to claim 5, characterized in that the thickness of each plated-on layer amounts to 30% of the total thickness of the composite layered material.



7. A coin according to one of claims 1 to 6, characterized in that the chromium steel used is the rustproof ferritic steel X8Cr17 (Material No. 1.4016).

8. A coin according to one of claims 1 to 6, characterized in that the chromium-nickel steel used is the rustproof austenitic steel X5CrNi1911 (Material No. 1.4303).