Sept. 12, 1972 E. DURRWACHTER ET AL 3,691,026

PROCESS FOR A CONTINUOUS SELECTIVE ELECTROPLATING OF STRIP

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FIG. 1

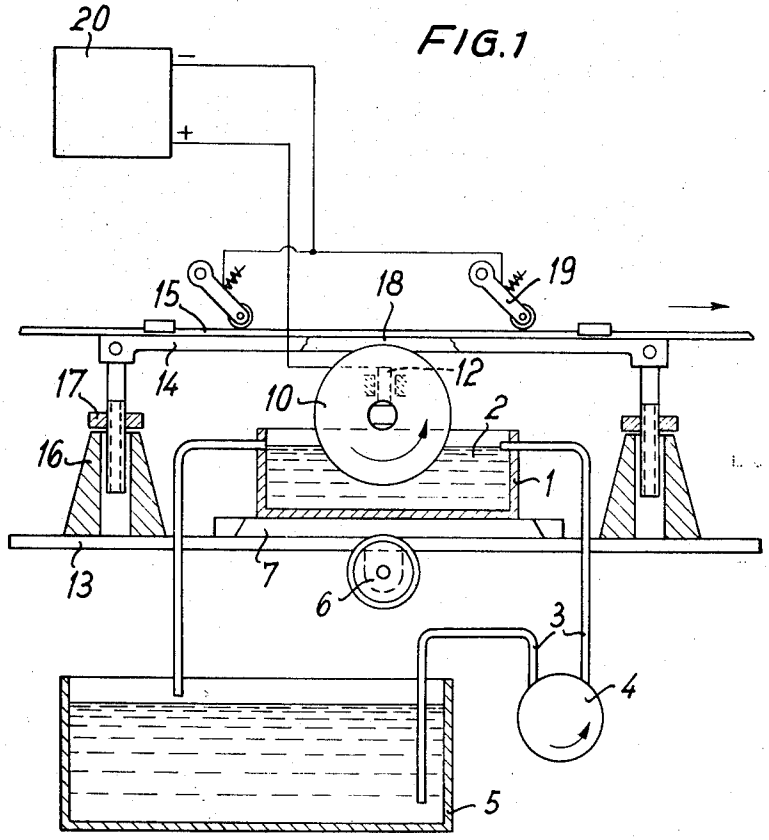

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FIG. 2

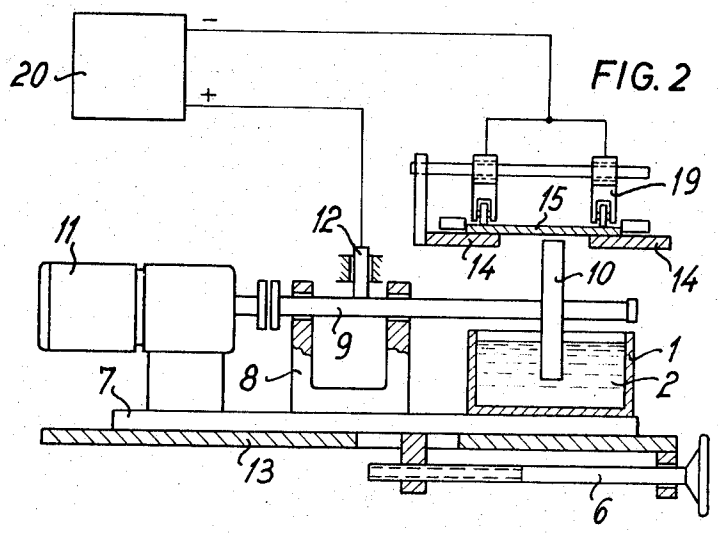

FIG. 3

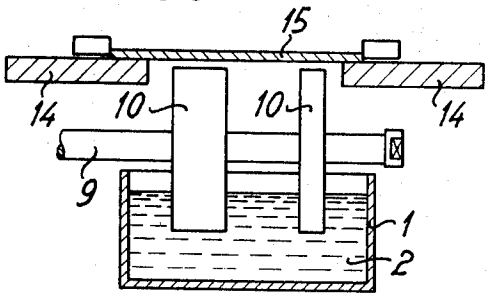

FIG. 4

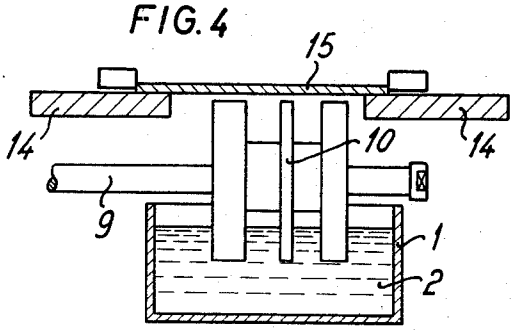

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FIG. 5

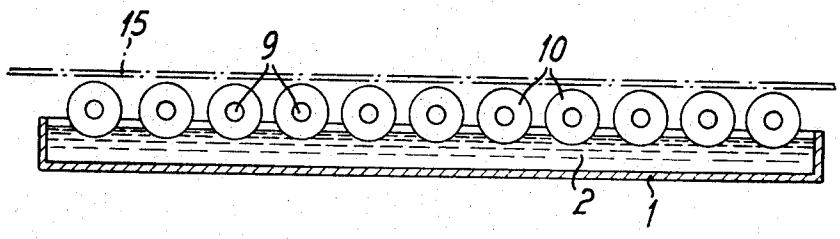

FIG. 6

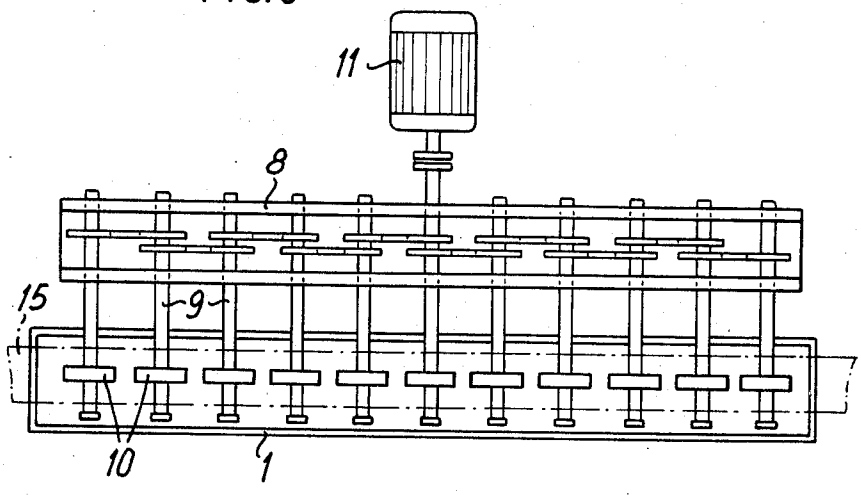

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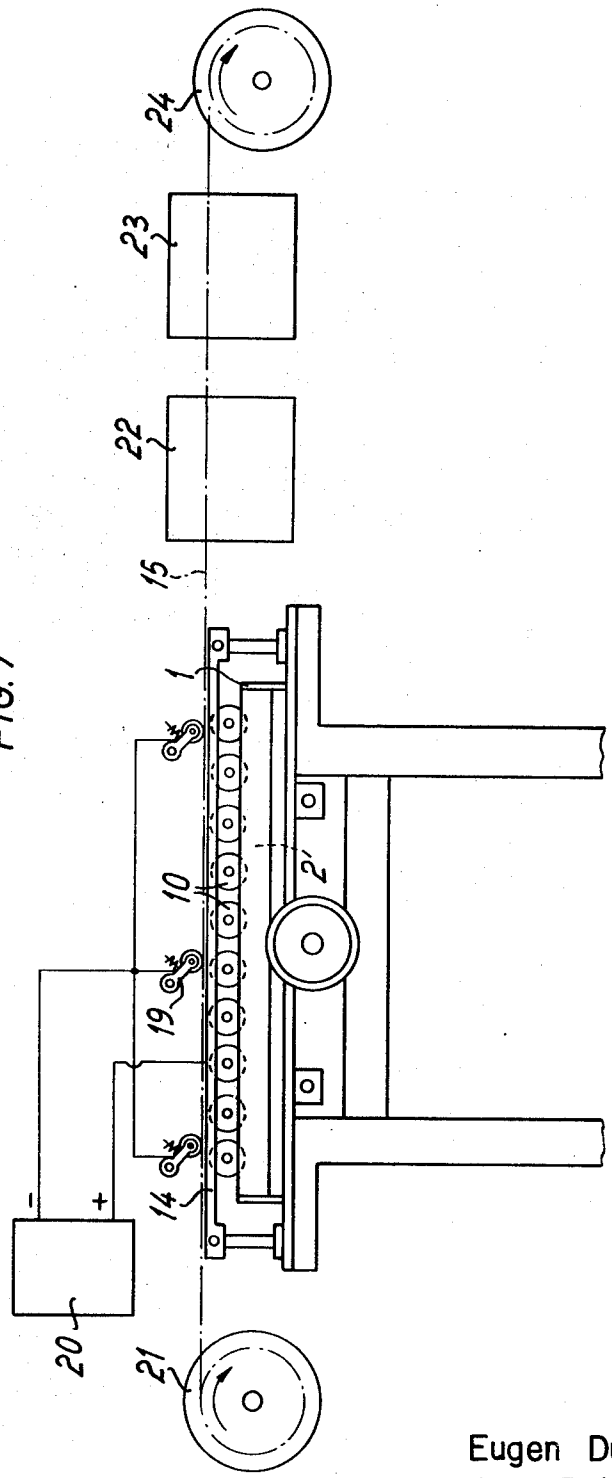
FIG. 7



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United States Patent Office 3,691,026 Patented Sept. 12, 1972

3,691,026

PROCESS FOR A CONTINUOUS SELECTIVE ELECTROPLATING OF STRIP

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Int. Cl. C23b 5/58, 6/68
U.S. Cl. 204—28 4 Claims

ABSTRACT OF THE DISCLOSURE

An anode potential is applied to roller means partly immersed in an electroplating bath of liquid electrolyte. The strip to be electroplated is arranged over the roller means so that the longitudinal direction of the strip is parallel to a tangent to the periphery of the roller means and the strip defines a gap with the periphery. A cathode potential is applied to the strip. The strip is moved in said longitudinal direction and the roller means are rotated at the same time to entrain electrolyte from the bath and maintain said gap filled with electrolyte.

This invention relates to a process and apparatus for a selective continuous electroplating of continuous strip of electroplatable material by means of a driven roller.

Electroplated metal strip has been known for a long time and used for various purposes (Handbuch der Galvanotechnik, vol. I, p. 414/1). Depending on the nature of the plant, the strip was moved horizontally or in a plurality of vertical loops through the electroplating bath for the electroplating operation proper (bulletin published by Dr. E. Dürrwächter Doduco KG, Pforzheim, Germany; Printed German Applications Nos. 1,046,435 and 1,163,-632 and German patent specification 1,046,978).

This invention relates to the electroplating of continuous strip of electroplatable material, including metal or electroplatable plastics materials, such as acrylonitrile-butadiene-styrene, in a process in which only one side of the strip is selectively coated in one stripe which is parallel to the longitudinal direction of the strip, or in a plurality of such stripes.

Metal strip provided with longitudinally extending layers of various other metals has been known for a long time. Such strip is described as bimetal strip and is made mechanically by weld-surfacing or roll-cladding. Such metal strip having one or more embedded or deposited weld layers consisting of metals or alloys, preferably of noble metals, and having various thicknesses and/or widths is used on a large scale in the electrical and electronic industries.

In the manufacture of, e.g., contact springs, from such bimetal strip the so-called contact surface can be coated with a layer of noble metal whereas the remaining portion of the spring consists of inexpensive base metal.

It has been found that bimetal strips having very thin metal layers in a thickness of only a few microns may be used in electric or electronic appliances, provided that the metal stripes are perfectly tight and free of pores.

The manufacture of bimetal strips having such thin metal layers by weld-surfacing or roll-cladding is impossible or very difficult, particularly because the heat which is applied during the weld-surfacing and rolling operations results in a considerable diffusion of one metal into the other so that the contact layer no longer consists of pure metal, such as a noble metal or zinc, although this is essential for a satisfactory electrical contact.

Numerous attempts have been made to provide a process in which a continuous strip of base metal is electroplated with a noble metal. For instance, the strip is moved around deflecting rollers so that it travels along a straight or helical path (German patent specification 1,046,078) through the bath containers. These processes result in strips which are entirely coated with noble metal on both sides.

The electroplating current is supplied in this case by means of wiping contacts, such as brushes (U.S. Pat. specification 3,328,281).

A process which has been used for a long time for electroplating articles on one side may be described as a swab process (Handbuch der Galvanotechnik 1966, Carl Hanser Verlag, pp. 673 et seq.; Metallwarenindustrie und Galvanotechnik, vol. 49, 1958, No. 11, p. 467; Materials and Methods, vol. 40, No. 6 (1954), pages 98–101). In that process a carbon anode is provided with a bibulous covering of textile or plastics material. The bibulous material is impregnated with highly concentrated electrolyte.

The Austrian patent specification 45,240 describes a process in which a roll covered with that bibulous material is in rolling contact with the strip while the covering is moistened with the electrolyte from above.

A high current density is employed. Relatively high voltages are required because the bibulous material is insulating. Nevertheless, only a relatively small amount of metal is available for deposition so that the process is relatively slow. Such movable anodes are often described as brush electrodes (Moderne Galvanotechnik, Machu, Verlag Chemie, 1954, p. 132) or as manual anodes or traveling anodes (Galvanotechnik, Pfanhauser, Akademieverlag, Leipzig, 1941, volume 1, 8th edition, p. 268). They may be used for a selective electroplating on various articles and in various forms.

A selective gold-plating of electric contacts and of strip by means of that Dalic process has also been described (Materials and Methods, vol. 40, no. 6, 1954, p. 101; Dalic News, February 1958; Electroplating and Metal Finishing, February 1958).

The Dalic process is highly satisfactory for electroplating round parts, such as the bearing portions of shafts for machines, as well as for reinforcing machine parts of all kinds and particularly for repairs and for a renewal of worn electroplated coatings. It has not been known so far to use that electroplating process for a selective electroplating of continuous strip so as to form stripes thereon. For a selective electroplating of continuous strip, other processes have been disclosed, in which those portions of a strip which should not be electroplated are covered with a layer of varnish or with an adhesive tape, which layer or tape is removed after the electroplating step.

A process which results in a highly accurate non-selective electroplated coating on one side of a strip has been described in the Printed German Application No. 1,163,-632.

A process and apparatus for the provision of a firmly bonded marginal coating on a continuous strip by vapor deposition in an evacuated vessel are also known. The German patent specification 1,199,097 describes an apparatus for coating wide metal strips by vapor deposition in a vacuum by means of electron beams. The German Patent Application S 10 529/48b of June 17, 1941 (see Fiat-Berichte) describes a continuous metallization of striplike substrates by vapor deposition.

The process according to the invention distinguishes from all these known processes by the manufacture of a strip in which a stripe coating is formed which has throughout the width of the stripe and throughout the length of the strip a uniformity that has not been attained before. Besides, the process results in a better edge sharpness and parallelism of the stripe than any other process and in a very small width tolerance. All these characteristics can be obtained with a process which is carried

out at very high speed. The apparatus provided to carry out the process according to the invention enables the formation of a single electroplated stripe on the strip or of a plurality of parallel longitudinal electroplated stripes having equal or different thicknesses and consisting of the same metal or different metals in a single operation.

These advantages are afforded by the process according to the invention by the use of an anode consisting of an inert roller, which is partly immersed into the electroplating bath and on its periphery entrains liquid electrolyte so that the gap defined between the periphery of the roller and the strip which moves over the roller along a path which is parallel to a tangent is filled with electrolyte.

The tub for holding the electroplating bath consists preferably of plastics material, such as polyvinylchloride, polypropylene or a metal container which is lined with plastics material, enamel, or rubber. This electrolyte tube is provided on top of a table, which is adjustable in a horizontal plane in a guide by an adjusting screw and carries a metal shaft, which is movably mounted in one or two bearings. A roller of V2A stainless steel, graphite or platinized titanium is carried by the shaft and axially held thereon in an adjusted position by spacing rings. From an electric motor or another drive means, the roller is rotated by the shaft at an infinitiely adjustable speed. The roller is immersed into the bath in the electrolyte tub. The shaft may be supported at one end or at both ends.

The strip-guiding means consist of plastics material and are electrically insulated from the remaining parts of the described installation and disposed over the bath container. The strip-guiding means are rigidly connected to the base frame by a guide means and vertically adjustable in said guide means by means of threaded nuts. The strip-guiding means serve to support a continuous strip of electroplatable material, such as brass, and to exactly guide said strip in a flat condition along a horizontal path. Before the strip is fed to the strip-guiding means, it is prepared for the electroplating operation in a usual manner, not described here.

The strip may be pulled through the strip-guiding means at any desired speed by a withdrawing device. By means of wiping brushes, the strip is connected as a cathode to the direct-current source of the installation. The electrolyte tub is filled with the electrolyte to about three-fourths of the height of the tub. To maintain a uniform concentration of ions in the electrolyte tub, the electrolyte is continuously circulated through a reservoir by means of a pump, which is provided with a filter.

The electrolyte which has been depleted by the discharge at the cathode is continuously replenished or regenerated in the reservoir because a uniform ion concentration must be maintained in the electrolyte forming the electro-plating bath.

Illustrative embodiments of apparatus according to the invention are shown diagrammatically and partly in section, in the drawing, in which

FIGS. 1 and 2 are, respectively, a longitudinal sectional view and a transverse sectional view showing a very simple apparatus according to the invention.

FIG. 3 is a transverse sectional view taken through the bath and two juxtaposed rollers.

FIG. 4 is a transverse sectional view which is similar to FIG. 3 and taken through three juxtaposed rollers.

FIG. 5 is a longitudinal sectional view taken through the bath and a plurality of successive rollers.

FIG. 6 is a top plan view showing the apparatus of FIG. 5.

FIG. 7 is a diagrammatic view showing the entire plant.

The drawing shows an electrolyte tub **1**, which contains an electrolyte **2**. The electrolyte can be circulated by means of a pipeline **3**, a pump **4**, which is provided with a filter, and a reservoir **5**. The capacity of the reservoir should be a multiple of the capacity, at least five times the capacity, of the electrolyte tub. The reservoir contains the sensors used to maintain the ion concentration of the electrolyte and to measure the pH-value, the means for supplying fresh electrolyte, and a discharge valve for the electrolyte. These means provided in the reservoir are not shown in the drawing.

A table **7** is horizontally adjustable along a track by an adjusting screw **6** and is provided with a bearing frame **8**, which is provided with one or two bearings, a shaft **9**, and a roller **10** connected to the shaft. The roller **10** may be arranged in any desired axial position on the shaft and is held in such position by spacing rings. The shaft is driven by a motor **11**. An anode potential is applied to the shaft by one or more wiping brushes **12**. The base frame **13** carries the strip-guiding means **14**, which is disposed over the electrolyte tub and receives the strip **15** to be electroplated. The strip is moved in its longitudinal direction in known manner by means of the withdrawing device, which is succeeded by an upcoiler. The vertical guide **16** provided for the strip-guiding means is adjustable by means of nuts **17** to enable an exact adjustment of the gap **18** defined between the periphery of the roller and the strip to be electroplated. Cathode potential is applied to the latter from the rectifier **20** by means of one or more wiping brushes or contact rollers **19**.

When it is desired to operate the appaartus, the electrolyte tub is filled with the electrolyte to about three-fourth of the height of the tub. By means of the vertical guide **16** for the strip-guiding means **14**, the gap is adjusted which is required between the periphery of the roller and the strip **15** to be electroplated. When the roller **10** is rotated, it is wetted by the electrolyte **2** so that liquid electrolyte fills the gap **18** between the roller and the strip **15**. As a result, the circuit is completed which is required for an electrodeposition of the metal which is contained in the electrolyte.

If the apparatus is properly adjusted, a supply of liquid electrolyte **2** will be maintained in the gap **18**. The roller **10** which delivers the electrolyte into contact with the strip should be as large as possible in diameter so that the area in which the strip is contacted by the liquid is as large as possible. Tests have shown that the roller **10** has preferably a diameter of about 100 millimeters and that the diameter may be within the range of 30–200 millimeters. Th width of the roller **10** will depend on the width of the electroplated stripe to be formed on the strip. Tests have surprisingly shown that the width of the electroplated coating is exactly the same as the width of the transfer roller **10** and the coating does not taper at its edges. This result has not been obtained in any known process for selective electroplating and will be obtained by the present process if a continuous metal strip is used which is dry and free of oxide and if the roller **10** has sharp edges. The adjusting screw **6** may be used to move the table **7** transversely to the longitudinal direction of the strip so that the roller **10** is disposed at a predetermined portion of the strip **15**.

FIG. 3 is an elevation showing a modification. Two rollers **10** having different widths are secured to the shaft **9** in the manner described hereinbefore and serve to apply two stripes having different widths to the strip which is to be electroplated. Additional rollers having the same widths or different widths may be used in parallel on one and the same shaft. The number of such rollers will depend on the width of the strip and on the requirements.

FIG. 4 shows the use of a profiled roller **10** which instead of a number of individual rollers is used to apply, e.g., three stripes having different widths.

The speed of the strip to be electroplated will mainly depend on the desired thickness of the electroplated layer. Instead of controlling the thickness of the layer by the selection of a predetermined speed of the strip, a plurality of rollers fed from the same bath may be arranged in succession.

FIG. 5 is an elevation showing an apparatus which comprises, e.g., ten shafts **8**, which are arranged in succession and each of which carries eleven similar rollers **10** so that the surface on which the electrolyte contacts the strip is increased and the speed of the strip can be increased. All shafts are driven from a common motor **11** by the transmission **8**.

FIG. 7 is an elevation showing a plant which is provided with apparatus according to the invention having eleven rollers. A direct-current source **18**, a preceding uncoiler **21**, a succeeding brushing machine **22**, a drying oven **23** and an upcoiler **24** are generally known and are not claimed as parts of the invention but supplement the apparatus for carrying out the process for a selective electroplating of continuous strip in a complete plant.

The process which has been described may be used, for instance, to provide on base metal strips one or more electroplated stripes which consist of other metals and extend in the longitudinal direction of the strip and to provide a plurality of parallel stripes consisting of different metals if rollers **10** distributed over the width of the strip are immersed in different baths. The noble metals gold, silver and platinum, as well as alloys thereof with each other and/or with small amounts of non-ferrous metals such as nickel, cobalt, copper and zinc, have been found particularly suitable for a selective electrodeposition. The process according to the invention may also be used for a selective electrodeposition of other non-ferrous metals on base metals. Metals which are particularly suitable for use in the electroplating process are zinc, tin and lead as electrodeposited metals on base metals such as copper, nickel or alloys thereof with other non-ferrous metals. Plastics materials which can be electroplated may also be selectively coated. The electrolytes may consist of electroplating baths which contain potassium cyanide as well as acid baths.

The rollers connected as an anode consist preferably of stainless steels, which must have such a composition that they are not dissolved by the bath liquid. Rollers of graphite or platinized titanium have also proved satisfactory. The periphery of the roller has sharp edges and is polished. The use of peripheral surfaces having other surface finishes and profiles has not resulted in special advantages.

What is claimed is:

1. A process for producing a continuous, selective electroplating of strip, comprising the steps of:

(a) providing an electroplating bath of liquid electrolyte and a roller partly immersed in the bath;

(b) applying an anode potential to the roler;

(c) arranging a strip over the roller so that the longitudinal direction of said strip is parallel to a tangent to the periphery of the roller, and spacing the strip from the periphery of the roller to define a gap therebetween so that no direct physical contact exists between the periphery of the roller and the strip;

(d) applying a cathode potential to the strip; and

(e) moving the strip in the longitudinal direction while rotating the roller in the opposite direction to entrain electrolyte from the electroplating bath on the peripheral surface of the roller and maintain the entire area of the gap filled with the liquid electrolyte, whereby a stripe of metal whose width is substantially equal to the width of the roller is electroplated on the strip.

2. A process as defined in claim **1**, wherein the step of providing a bath and a roller includes the step of providing a plurality of rollers immersed in the bath for forming a plurality of parallel stripes.

3. A process as defined in claim **2**, wherein the step of providing a bath and a roller includes the step of providing a plurality of baths consisting of different electrolytes and each having at least one roller partially immersed therein, so that the plurality of stripes formed consist of different materials.

4. A process as defined in claim **1** wherein the roller has a polished peripheral surface with sharp lateral edges.

References Cited

UNITED STATES PATENTS

936,472	10/1909	Pfanhauser	204—26
3,008,892	11/1961	Owen	204—207
3,178,305	4/1965	Ward	117—8
3,305,459	5/1967	Smith et al.	204—18

F. C. EDMUNDSON, Primary Examiner

U.S. Cl. X.R.

204—15, 45 R, 53 R, 54 R, 55 R, 206