

July 10, 1973

L. N. KOSOWSKY ET AL

3,745,105

APPARATUS FOR SELECTIVE ELECTROPLATING OF SHEETS

Filed Nov. 18, 1970

2 Sheets-Sheet 1

Fig. 1

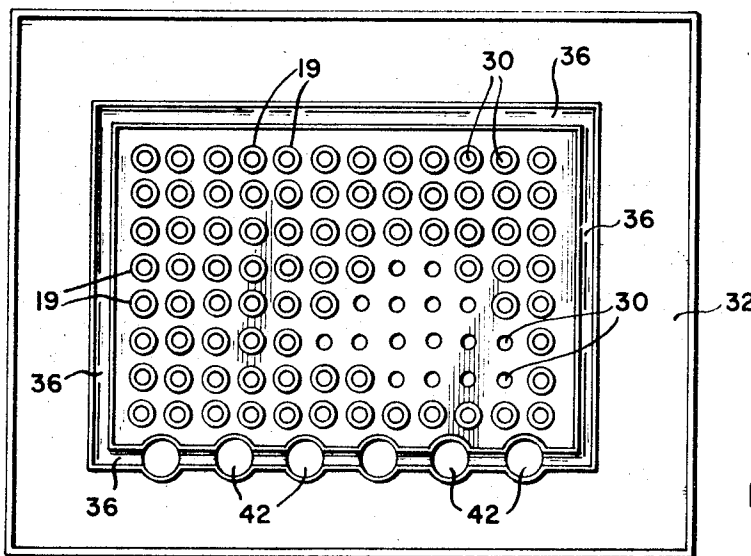
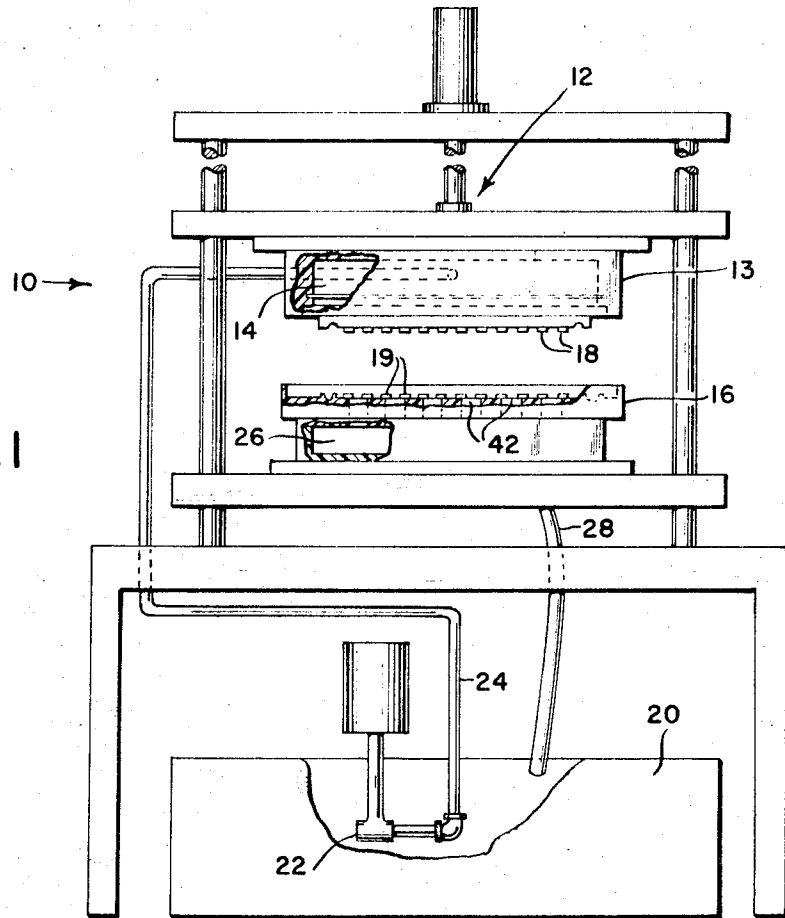


Fig. 2

INVENTORS
Leo N. Kosowsky
Curtis N. Lovejoy
John G. Cunniff
Robert T. Groom
BY *Cesari & McKenna*
ATTORNEYS

July 10, 1973

L. N. KOSOWSKY ET AL

3,745,105

APPARATUS FOR SELECTIVE ELECTROPLATING OF SHEETS

Filed Nov. 18, 1970

2 Sheets-Sheet 2

Fig. 3

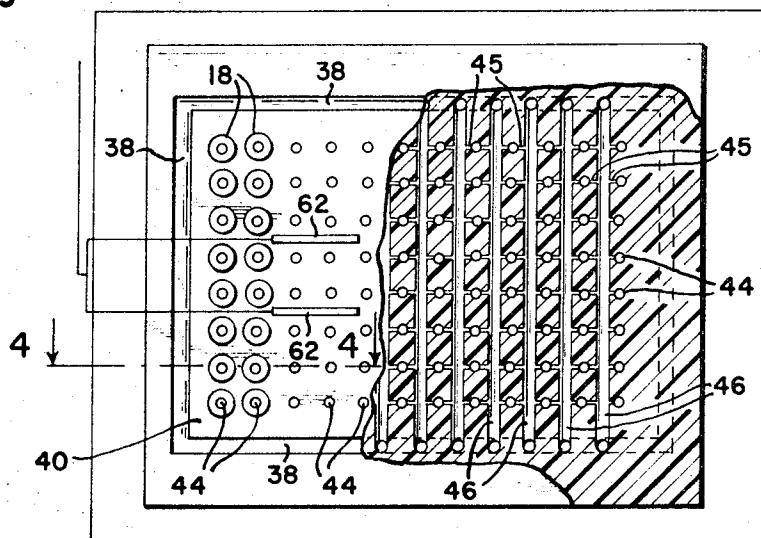


Fig. 4

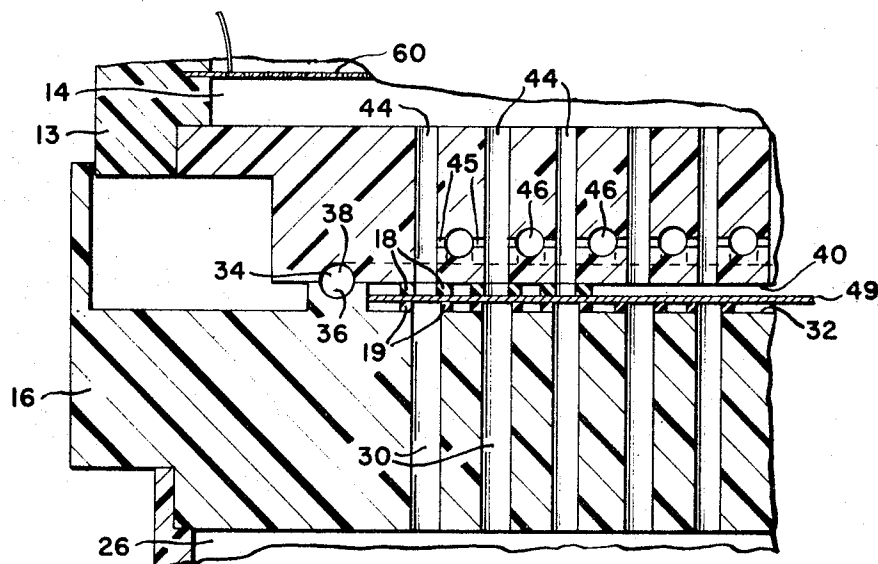


Fig. 5

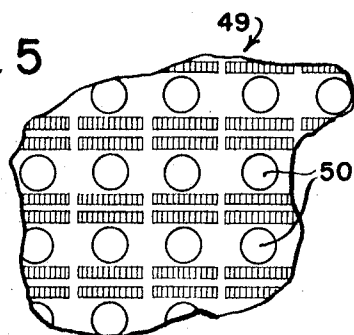
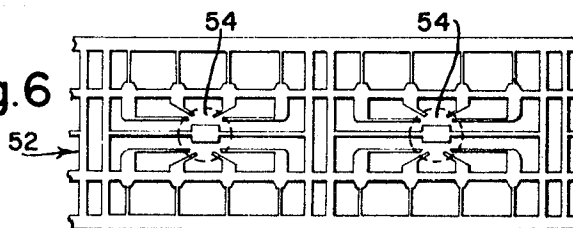


Fig. 6



INVENTORS
 Leo N. Kosowsky
 Curtis N. Lovejoy
 John G. Cuniff
 Robert T. Groom
 BY *Cesari & McKenna*
 ATTORNEYS

1

3,745,105 APPARATUS FOR SELECTIVE ELECTROPLATING OF SHEETS

Leo N. Kosowsky, Sharon, and Curtis N. Lovejoy, Walpole, Mass., and John G. Cuniff, Foster, and Robert T. Groom, Warwick, R.I., assignors to Auric Corporation, Newark, N.J.

Filed Nov. 18, 1970, Ser. No. 90,632
Int. Cl. B23p 1/02; B01k 3/00

U.S. Cl. 204—224 R

13 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for selectively electroplating discrete areas on a sheet employs a plurality of dams to conduct plating solution to and from the sheet. A plurality of resilient seals bearing against the material to be plated seal preselected surface portions of the sheet into contact with the fluid zone and other portions out of such contact, the seals also forming a part of a conduit normal to the preselected portions. A pump pumps plating solution through the fluid zone so as to promote turbulence adjacent the preselected surface portions.

BACKGROUND OF THE INVENTION

(A) Field of the invention

This invention relates to apparatus and process for uniformly electroplating a plurality of discrete areas on a metallic substrate while maintaining the rest of the substrate out of contact with the electroplating bath.

(B) The prior art

In many electroplating operations, e.g. operations wherein microcircuits are electroplated with gold, there is a need to minimize the amount of expensive metal utilized by closely restricting its deposition to only those surface areas where its presence is essential. It is desirable, however, that such selective deposition of the metal be achieved without resorting to procedures which greatly restrict the production rate of an electroplating facility or which greatly increase the handling costs of the items being electroplated.

It has been known to use organic coatings to mask those areas of metallic substrates on which electroplating is not required and thereby avoid those areas being electroplated. After the electroplating step is finished, the masking material is removed, leaving the discrete electroplated zones. Obviously such a process requires expensive coating and stripping steps. Such steps add to the cost of the electroplating operation and also increase the probability that some of the work product will have to be scrapped because of damage incurred during the manufacturing operations.

Other suggestions have been made for electroplating small selected areas, but these suggestions have been limited to small-scale, repair-type operations wherein the rigorous requirements of high-rate or continuous manufacture need not be considered. Thus, for example, Ehrhart, in U.S. Pat. No. 3,071,521, discloses a single grommet-sealed chamber for use in repairing printed-circuits. Swanson, in U.S. Pat. No. 2,698,832, discloses a somewhat similar device utilizing a reservoir for an electroplating solution adapted to empty, by gravity flow, into a receptacle for receiving the solution. Neither of these inventions has suggested a way whereby a large number of discrete areas can be carried out at the same time and at optimum current densities. Indeed, neither inventor, in solving his own particular problem, has been faced with problems as complex as those involved in the electroplating of a plurality of discrete areas on the same electroplating apparatus.

2

All electrodeposited metals have crystalline structures which manifest themselves in the physical properties and appearance of the plated metal. In order to achieve plated deposits of suitable properties, it is necessary to control the current density at which the plating is carried out. Excessive current densities will result in deposits of poor quality. However, current densities which are too low will result in excessively long plating cycles and markedly reduce the production rate of the plating operations. It has been a particular problem in constructing apparatus suitable for electroplating of a large number of selected areas on a single extensive substrate to assure a suitably concentrated electroplating solution at each of the discrete areas being plated to enable plating at desired current densities.

In commercial work, preparation of surfaces for plating is often as important as the electroplating step itself. This is especially so in electroplating surfaces for use in micro-circuit components. Thus, special care should be exercised in the construction of apparatus to assure that the surfaces to be electroplated are processed without contacting machine parts or by an operator's hands. This requirement has increased the difficulty of providing suitable apparatus for the electroplating of a large number of selected areas on a single, but extensive, substrate.

Ramirez et al., in U.S. Pat. 2,974,097 disclose means for continuously plating areas along the edges of a continuous strip. It should be noted, however, that the area being electroplated is a continuous area, not a plurality of small areas. Thus, the problem of solution distribution is much simpler than the one encountered by the instant inventors.

SUMMARY OF THE INVENTION

Therefore it is an object of the instant invention to provide apparatus which can quickly and conveniently effect the uniform and simultaneous electroplating of a large number of pre-selected discrete surface zones of a sheet.

Still another object of the invention is to provide apparatus having compact means for maintaining the desired concentration of, and agitation of, the electroplating solution.

Another object of the invention is to provide a novel process for electroplating pre-selected discrete surfaces zones on a sheet.

Other objects of the invention will be obvious to those skilled in the art on reading the application.

The above objects have been economically and conveniently achieved by construction of electroplating apparatus which provides for the maintenance of suitably high cation contents in the immediate vicinity of all of the discrete surfaces being electroplated and which is sufficiently versatile that surfaces of various sizes and shapes can be selected for electroplating without major modification of the apparatus.

The high cation contents are maintained, even at current densities of 15–25 amps per foot² and above in acid gold plating, by providing such a high flow of fluid proximate the surfaces being plated that excellent agitation is achieved. The ability to use the apparatus at high current densities markedly reduces the time which would otherwise be required to obtain platings of good quality to be achieved.

Because the total flow of electroplating solution would be, in the practice of the present invention, much greater than that required to provide sufficient metal to the surface being plated, it is sometimes possible to include inert fluid-fillers (such as gases, immiscible liquids, and slurried solids) in the fluid pumped through the apparatus. However, fluid is most conveniently all electroplating solution.

A particular advantage of the invention is the fact that it can be utilized to plate surfaces which are perforated or surfaces which are not perforated. A turbulence-promoting fluid path is utilized to facilitate the plating of the latter surfaces with the turbulence-promoting means advantageously being a sudden enlargement, a sudden contraction, a change in direction in the fluid path, or a combination of these. In order that such a turbulence-promoting means have the desired effect at the surface being electroplated, it is desirable that it be a distance from the non-perforated surface being electroplated of less than about 0.5 diameter of the conduit leading from the turbulence-promoting means to the surface being electroplated.

When a perforated sheet is used so that the electroplating solution passes through the sheet to effect plating on both sides thereof, the sheet itself usually acts as an efficient turbulence-promoting device if the perforations or apertures therein generally extend over the entire area to be electroplated.

ILLUSTRATIVE EMBODIMENT OF THE INVENTION

In this application and accompanying drawings we have shown and described a preferred embodiment of our invention and have suggested various alternatives and modifications thereof, but it is to be understood that these are not intended to be exhaustive and that other changes and modifications can be made within the scope of the invention. These suggestions herein are selected and included for purposes of illustration in order that others skilled in the art will more fully understand the invention and the principles thereof and will be able to modify it and embody it in a variety of forms, each as may be best suited in the condition of a particular case.

In the drawings:

FIG. 1 is a schematic elevation showing the general configuration of the electroplating apparatus according to the invention.

FIG. 2 is a plan view of the support assembly on which objects to be electroplated rest.

FIG. 3 is a plan view, partly in section, of the flow-distributing chamber.

FIG. 4 is a section taken along lines 4—4 of FIG. 3.

FIG. 5 is a plan view segment of a workpiece which has been electroplated at selected, non-perforated portions of the surfaces thereof.

FIG. 6 is a plan view of a segment of a workpiece which has been electroplated at selected, perforated portions of the surface thereof.

Referring to FIG. 1, it is seen that a selective electroplating apparatus 10 is mounted on a hydraulic press 12 so that an upper member 13 comprising flow-distributing chamber 14 can be moved into contact with lower support member 16. The press is shown in its open position. Each of upper member 13 and lower member 16 comprise a series of grommets 18 and 19 mounted, respectively, on the opposing faces thereof. These grommets, when in register with one another, are adapted to bear against a sheet to be electroplated and to form seal means to restrict the flow of electroplating solution to those surfaces of sheet which are defined by an aperture in the grommet.

When members 13 and 16 are brought together so that the upper grommets and lower grommets sealingly contact each other, electroplating solution of the type known in the art and stored in reservoir 20 is pumped via pump 22 and pipe 24 into flow-distributing chamber 14. The solution is then conducted (through a liquid zone defined by flow paths more clearly shown in FIGS. 2 through 5) back into a chamber 26 in lower member 16, thence through return conduit 28 and back to reservoir 20.

FIG. 2 illustrates the faceplate 32 of lower support member 16 and the placement of grommets 19 on the surface thereof. Some of grommets 19 are not shown to more clearly show apertures 30 in lower face plate 32.

Apertures 30 are vertical conduits leading into chamber 26.

Around the area of faceplate 32 on which grommets 19 are adhesively positioned, is a semicircular drain groove 36 which cooperates with a similar groove 38 in upper face plate 40 (see FIG. 3) to form a perimeter drain 34 most clearly shown in FIG. 4. This perimeter drain 34 provides a flow path whereby excess electroplating solution can be carried to large vertical conduits 42 and thence downwardly into chamber 26, conduit 28 and reservoir 20.

FIGS. 3 and 4 best illustrate the flow paths by which the flow of electroplating solution is distributed to the surfaces to be electroplated and continuously replenished in the vicinity of said surfaces.

FIG. 3 is a bottom view of the upper member 13 showing a face plate 40 on which are mounted grommets 18.

Grommets 18 surround vertical conduits 44 which, roughly, correspond to apertures 30 in lower face plate 32. These conduits 44 are connected via smaller lateral conduits 45 to transverse drain channels 46. Lateral conduits 45 and drain channels 46 provide means for a continuous high-rate flow of electroplating solution to be returned to upper drain groove 38 and perimeter drain 34.

FIG. 4 shows how lateral conduits 45 are positioned proximate the grommets 18 so that the flow there into creates sufficient turbulence and mixing in the terminal portion of conduits 44 to allow the proper concentration of electroplating solution to be maintained even when relatively high current densities are utilized. This factor is of particular importance when the selected portions of the sheet to be electroplated are not perforated to allow flow of solution therethrough.

Also seen in FIG. 4 is anode grid 60 which is mounted in upper member 13 just above upper face plate 40. The anode is submerged in electroplating solution during the plating operation. The cathode comprises two metallic strips in the form of spring 62 which are mounted on upper member 13 and positioned to contact (a conductive sheet, e.g., sheet 49 shown in FIG. 4 to be sealed between grommets 18 and 19) and thereby incorporate as a cathode the conductive sheet to be electroplated.

FIG. 5 shows a plan view of a portion of a typical metallic sheet 49 which is electroplated only in non-perforated areas 50 which correspond to the size of the aperture in the grommet which seals against area 50.

FIG. 6 shows a plan view of a portion of a typical metallic sheet 52 which is electroplated only in perforated areas 54.

In one typical operating procedure, a pump with a nominal capacity of 350 gallons per hour is used to supply fluid to the illustrated apparatus wherein the vertical conduit 44 is $\frac{3}{32}$ -inch in diameter, the conduits 45 are $\frac{3}{16}$ -inch in diameter, and the large drain holes 42 in bottom plate are $\frac{3}{4}$ -inch in diameter. The inside diameter of the lower grommet 19 and vertical conduit 30 therebeneath are $\frac{5}{32}$ -inch.

An air-drying neoprene-based cement of the type known in the art provides a suitable adhesive for use in attaching the grommets to the face plates of the apparatus. The face plates themselves are suitably formed of metal or plastic materials. The effective area of the anode is usually at least twice the effective area of the cathode.

It will thus be seen that the objects set forth above among those made apparent from the preceding description are efficiently attained and, since certain changes may be made in the above product without departing from the scope of the invention, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense. It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. Apparatus for use in selectively and simultaneously electroplating a plurality of discrete areas on sheet material said apparatus comprising

(A) a fluid zone forming means to conduct electroplating solution to and from said sheet material;

(B) a sealing means adapted for bearing against a material to be electroplated and comprising a plurality of resilient seals adapted for sealing pre-selected surface portions of said sheet into contact with said fluid zone and other portions of said sheet out of contact with said fluid zone; said seals forming part of a conduit which is normal to said pre-selected portions;

(C) means for pumping electroplating solution through said fluid zone, said pumping means being of such capacity that it forms means to agitate electroplating solution on pumping said solution through turbulence-promoting means positioned proximate said seal means and adapted to promote turbulence adjacent said preselected portions of said sheet.

2. Apparatus as defined in claim 1 wherein said seal means are gaskets adhesively and removably, attached to said apparatus, hence forming interchangeable means to define the size and shape of said pre-selected areas.

3. Apparatus as defined in claim 1 wherein said fluid zone comprises a fluid path through apertures formed by said resilient seals adapted to seal pre-selected portions on opposing sides of said sheet.

4. Apparatus as defined in claim 1 wherein said fluid zone does not comprise a fluid path through each said preselected portion of said sheet.

5. Apparatus as defined in claim 1 (1) wherein said resilient seals are gaskets having apertures, the cross section of which are adapted to define said pre-selected portions of said sheet and (2) wherein a flow-distributing member comprising conduits leading to said apertures and a system of channels leading from each said conduit at a position adjacent said gaskets, said system of channels, forming means to assure flow-induced agitation of liquid in said gasket apertures.

6. Apparatus as defined in claim 5 wherein said channels leading from points in said conduit adjacent said gaskets terminate at a peripheral drain surrounding and defining the outer boundary of said fluid zone.

7. Apparatus as defined in claim 6 wherein said peripheral drain is formed by said flow-distributing member and a support member.

8. Apparatus as defined in claim 7 wherein said support member comprises conduit means to carry said fluid out of the apparatus.

9. Apparatus as defined in claim 5 wherein said gaskets on said flow-distributing member and gaskets on a support member are adapted to hold said sheet and the cross-section of an aperture in said gaskets forms means to define areas of said sheet to be electroplated.

10. Apparatus as defined in claim 4 wherein said sheet is a cathode and an anode is positioned in a chamber forming part of said fluid zone in said flow-distributing member.

11. Apparatus as defined in claim 5 comprising electrical connections to adapt said sheet as a cathode and (2) an anode positioned in a chamber forming part of said fluid zone in said flow-distributing member.

12. Apparatus as defined in claim 1 wherein said cathode contacts electrical contacts formed as springs which bias said flow-distributing member against said sheet and are positioned within the space defined by the exterior walls of the gaskets and outside said fluid zone.

13. Apparatus as defined in claim 5 wherein said channels branch from said conduit at a distance of less than about 0.5 diameter of said conduit from an edge of said gaskets adapted to bear against a sheet to be processed.

References Cited

UNITED STATES PATENTS

2,721,839	10/1955	Taylor	204—297	RX
3,644,181	2/1972	Donaldson	204—224	X
3,658,684	4/1972	Sickels	204—224	X
2,895,814	7/1959	Clark	204—224	X
3,317,410	5/1967	Croll et al.	204—239	X

FOREIGN PATENTS

1,098,182	1/1968	Great Britain	204—15
760,016	10/1956	Great Britain	204—224

JOHN H. MACK, Primary Examiner

D. R. VALENTINE, Assistant Examiner

U.S. Cl. X.R.

204—237, 275, 297 R