June 19, 1962 A. E. CLENARD ETAL 3,039,951

ELECTROPLATING FIXTURE

Filed Jan. 2, 1958 2 Sheets-Sheet 1

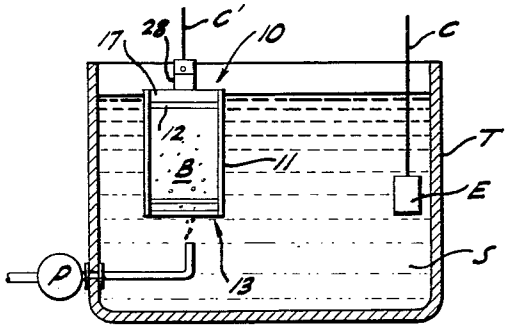


FIG. 1.

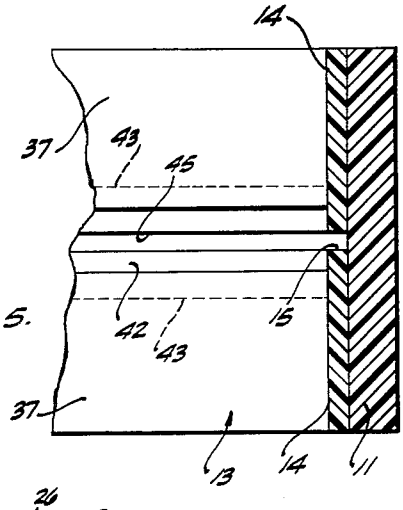
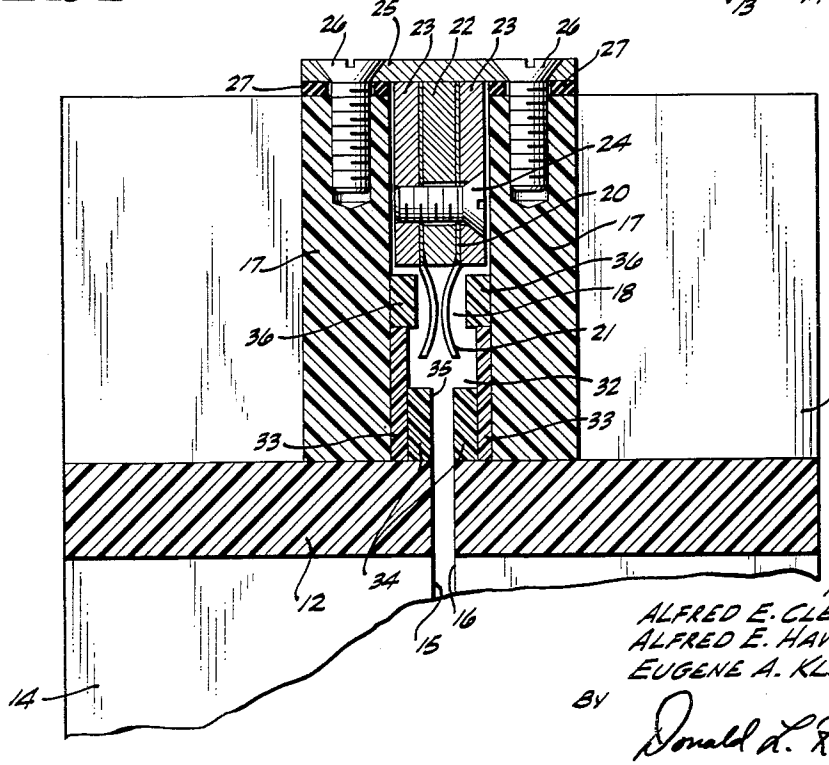


FIG. 5.

FIG. 4.



INVENTORS.
ALFRED E. CLENARD,
ALFRED E. HAWLEY,
EUGENE A. KLEIN,
BY
Donald A. Rogers
AGENT

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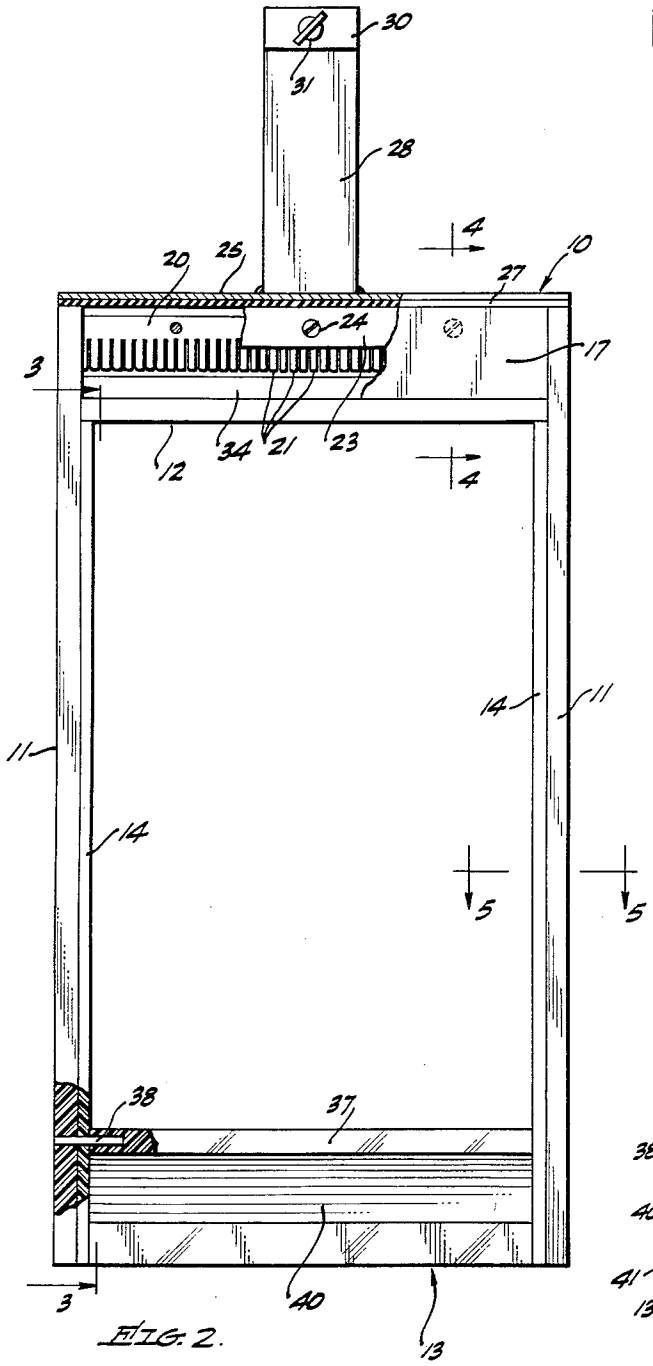


FIG. 2.

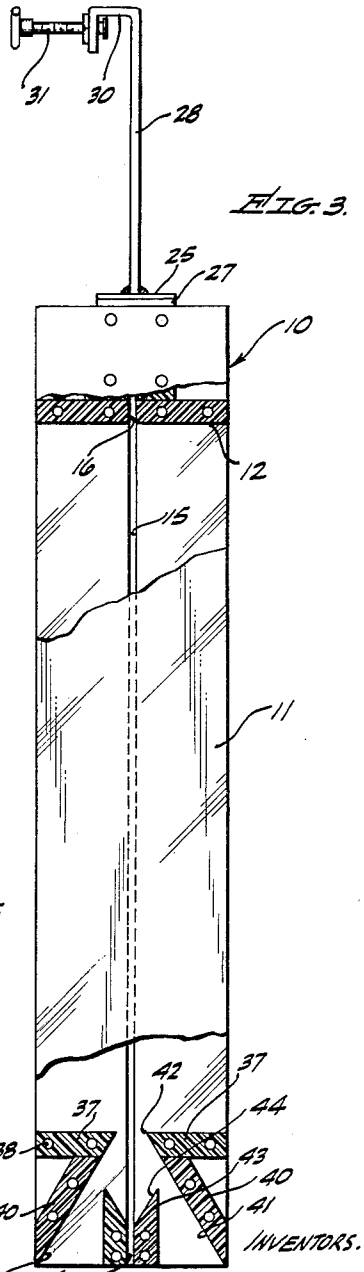


FIG. 3.

INVENTORS.
ALFRED E. CLENARD,
ALFRED E. HAWLEY,
EUGENE A. KLEIN,
BY
Donald R. Ryan
AGENT

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3,039,951
ELECTROPLATING FIXTURE

Alfred E. Clenard, Malibu, Alfred E. Hawley, Lakewood, and Eugene A. Klein, West Los Angeles, Calif., assignors to Hughes Aircraft Company, Culver City, Calif., a corporation of Delaware

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3 Claims. (Cl. 204—297)

The present invention finds general utility in the field of electroplating, relates to electroplating devices and more specifically to a fixture for supporting a sheet of material in an appropriate position in an electroplating bath.

In the manufacture of printed circuits and like structures, it is common practice to utilize sheets of phenolic material having a copper clad surface bonded thereto. A pattern of holes is punched or otherwise provided in the sheet of material with this sheet being thereafter suitably plated with silver or the like whereby to effect electrical conductivity between the copper clad coatings on each side of the sheet. Following such application of silver, an over-all layer of copper is applied to each side of the sheet, and the silver coating, by means of electroforming, thus to deposit the copper over the surfaces of the sheet and through the holes therein. The printed circuit sheets must necessarily, in some instances, be relatively large and in the order of 10 by 20 inches. This large size, of sheet material as well as in smaller sizes, establishes many problems relative to the proper, accurate and efficient application of the copper coating thereto.

Heretofore, it has been common practice merely to suspend the sheets of material to be plated in an electroplating solution and to provide suitable agitation of the sheets and/or agitation of the specific plating solution. Due to variations in current density in the electroplating solution, such prior electroplating methods have tended to produce undesirable "burned" and/or "treed" edges on and areas in the sheets of material. In other words, there has been a build up of electroplating material adjacent the edges of the sheets or burned out surface areas, and a serious variation in the thickness of the copper coating over the area of the sheets, the central area of the sheets generally having a copper thickness that is considerably less than the thickness thereof adjacent the sheet edges. Accordingly, variable electrical conductivity is experienced across such sheets and in printed circuit patterns ultimately produced thereon. This "burning" and "treeing" occurs due to the very high current densities in the peripheral areas of the sheets and the reception of current from positions approximating a 270 degree arc thereabout. In order to correct and at least partially eliminate this problem, it has been the practice to employ so-called "robbers," in the form of metal bars disposed adjacent to the edges of the sheets, which serves to draw off stray current and prevent the flow of such variable current to the sheet surfaces. Such "robbers" are only a partial answer to the problem and are expensive to use, inasmuch as they consume electroplating rectifier capacity, receive copper from the solution and must be replaced at relatively short intervals due to the deposition of a heavy plating thereon.

In prior electroplating techniques for large sheets of material, other problems have existed relative to the means for making electrical contact with the board or sheet of material and distributing current flow equally over the entire sheet of material. Conducting strips have been employed along edges of the material to be plated; however, these strips have also become heavily plated thus requiring frequent and expensive replacement. In another instance, it has been found that the application of air through the plating solution to the surfaces of the

sheet of material serves to provide the desired agitation as between the plating solution and the surfaces to be plated; however, several problems have existed relative to a proper distribution of air flow over the surfaces of the board thus to insure substantially equal agitation over the entire surfaces. In the event such equal distribution of the agitating medium is not accounted for, additional "burning" and "treating" may occur thus to produce an unsatisfactory plating.

It may thus be seen that the ultimate end result desired in connection with the application of a copper or other metallic coating to a printed circuit board or like item resides in the provision of the plated sheet of material having the plated coating applied thereto in such a manner as to establish a constant, equal thickness coating that is free of "burned" or "treed" areas. This optimum end result cannot be accomplished by any one particular structure but is the combination of several allied elements arranged in a cooperative manner and each serving not only an individual but also an integrated purpose in connection with the desired end result. These elements include novel supporting structure for the sheet of material; means for protecting this sheet of material and conducting current thereto; means for eliminating the effects of "burning" or "treeing"; and means for establishing equally distributed agitation over the entire surface of the sheet. It should be clearly understood that all of these elements and the functional aspects thereof combine in their effects to produce the beforementioned desired end result.

It is accordingly one object of the present invention to provide an electroplating fixture and an electroplating technique whereby to establish and produce an even thickness plating over entire surfaces of sheet material or the like.

Another object of the invention is to provide an electroplating fixture having means inherent therein for preventing "burning" or "treeing" of the plated layer adjacent peripheral areas of a sheet of material.

A further object of the invention is to provide an electroplating fixeure having a novel electrical contact arrangement carried thereby together with means for protecting the contact whereby to enable indefinite use thereof.

Still another object of the invention is to provide an electroplating fixture having construction characteristics enabling efficient use of air agitation in a plating solution.

A still further important object of the invention is to provide an electroplating fixture that may be constructed from readily available, machinable and inexpensive material.

Still another object of the invention is to provide a novel electroplating fixture for use with sheets of material and wherein means are provided for shielding portions of the sheets thereby providing means for eliminating the necessity of "robbers" in the electroplating solution.

Another object of the invention is to provide a novel electroplating fixture wherein high current density electroplating may be employed thus to reduce plating costs and time.

Other and further important objects of the invention will become apparent from the disclosures in the following detailed specification, appended claims and accompanying drawings, wherein:

FIGURE 1 is a partially diagrammatic sectional view of the present electroplating fixture disposed in conjunction with an electroplating solution and tank arrangement;

FIG. 2 is a front elevational view, partially in section, of the present electroplating fixture;

FIG. 3 is a side elevational view, partially in section,

showing the present electroplating fixture and taken substantially as indicated by line 3—3, FIG. 2;

FIG. 4 is an enlarged fragmentary sectional view showing details of the present electroplating fixture and contact finger arrangement therein, as taken substantially as indicated by line 4—4, FIG. 2; and

FIG. 5 is an enlarged fragmentary sectional view through one side portion of the present electroplating fixture as taken substantially as indicated by line 5—5, FIG. 2.

With reference to the drawings, the electroplating fixture of the present invention is shown as indicated generally at 10. The fixture 10, as shown in FIG. 1, is adapted for disposition in an electroplating tank T in which an electrode E is disposed. The tank T is adapted to retain a quantity of an electroplating solution S there being an air delivery pump P, associated with suitable conduits, for introducing air to the solution S and for effecting agitation of the solution over the surface of a printed circuit board B carried by the electroplating fixture 10. The electrode E and the fixture 10 are each connected to a source of electrical current by means of suitable conductors C and C'.

With reference to FIGS. 2 and 3, the electroplating fixture 10 comprises a frame structure that may be made from any suitable nonconductive, noncorrosive, acid resistant material such as a plastic material such as sheet Lucite, or the like. The various components of the frame of the electroplating fixture may be secured in respective positions by means of a plastic cement, or the like, and/or by means of dowels disposed in suitable aligned openings in the components.

The frame of the present fixture includes a pair of side members 11 that have upper ends that extend beyond a top plate member 12. The lower ends of the side members 11 are joined by means of an inverted funnel or trough structure 13, the purpose of which will be hereinafter more fully described. The side members 11 have a pair of strips 14 secured to the inside surfaces thereof and spaced laterally to define a groove 15 therebetween. As shown primarily in FIGS. 2 and 4, the top plate member 12 has a groove 16 disposed therethrough and aligned with upper ends of the groove 15 between the strips 14. Additionally, a pair of spacer members 17 are secured to an upper surface of the plate member 12 and extend laterally between the upwardly extending portions of the side members 11, the spacers 17 being spaced apart thus to define a housing for an electrical contact structure indicated generally at 18.

As shown, the electrical contact structure 18 includes a pair of contact strips 20 having a plurality of downwardly extending, integral, curved fingers 21. The strips 20 may be made from any suitable material; however, it has been found that thin flexible sheets or beryllium copper material are most satisfactory for this purpose. The strips 20 are retained in spaced relationship by means of a metallic plate 22 and metallic retaining members 23 that are in turn secured together by means of spaced screws 24 which threadably engage one of the retaining members 23. It may thus be seen that the contact members 20 are firmly clamped in position with the integral finger portions 21 thereof extending downwardly from the members 22 and 23 and within the space defined between the spacers 17. The plate and retaining members 22 and 23 are secured as by welding, or the like, to a metallic cover 25 that is in turn removably secured to the spacers 17 by means of screws 26 which threadably engage the spacers. Gaskets 27 are disposed between the cover 25 and the upper surfaces of the spacers thus to seal the upper end of the space defined between the spacers 17. The cover 25 also serves to support a mounting bracket 28 having a hook 30 on the free end thereof and being provided with a clamp screw 31 whereby to enable clamping of the present fixture to an upper edge of, or a mounting bar associated with, the electroplating tank T. The bracket 28 may be secured to the cover 25 as by welding or the like, and in accordance with customary practice, the cover 25 together with the bracket 28 may be coated with a suitable protective electroplating rack coating to prevent disposition of undesirable plating thereon.

As shown primarily in FIG. 4, a chamber 32 is formed between the spacers 17 and the cover 25, the bottom portion of the chamber 32 being open by means of the slot 16 in the top plate member 12. In order to limit the area within the chamber 32, a plurality of laterally extending members are disposed therein. As shown, a pair of filler members 33 are secured to each of the inner surfaces of the spacers 17 and elongated block members 34 are in turn secured to the filler members there being a space 35 defined between the block members 34. Additional sharp edged block members 36 are positioned adjacent upper ends of the filler members 33 outwardly from the contact fingers 21 and are secured to the inner surfaces of the spacers 17, the various components within the chamber 32, and forming walls thereof, being for a purpose to be hereafter more fully described.

With reference to FIGS. 2 and 3, the inverted funnel or trough means 13 comprises a pair of laterally extending generally horizontally disposed top portions 37 that are secured to the strips 14 of the side members 11 by means of a suitable cement and dowels 38. The top portions 37 form an upper end of an inverted funnel or trough, the lower portions being defined by trough side portions 40 that are also secured to the strips 14 forming a portion of the side members 11. It may thus be seen that a laterally extending inverted trough, defined by the surfaces 41, is provided in the lower portion of the electroplating fixture frame, there being a relatively narrow opening 42 defined between opposed edges of the portions 37.

In order to protect the lower end of a sheet of material to which plating is to be applied, a pair of laterally disposed shield or guard portions 43 are positioned within the confines of the trough 41. Upper edges of the guard portions 43 are bevelled to form substantially a V-shape therebetween, and as at 44, with the portions 43 being spaced apart to define a groove 45 that is contiguous with the groove 15 between the plate members 14 carried by the side members 11. The guard portions 43 are secured to the plate members 14 as by suitable dowels and/or a cement as described hereinbefore in connection with other components of the present frame.

In use, the present electroplating fixture is adapted to receive a sheet of material to which plating is to be applied by insertion of this sheet of material through the slot 45, between the guard portions 43, with the edges of the sheet being confined in the slot 15 between the plate members 14. The upper edge of the sheet is inserted through the slot 16, formed in the top plate 12, slot 35 between the elongated blocks 34 and thereafter between the plurality of curved contact fingers 21. Electrical current from the conductor C' is thereafter conducted through the bracket 28, cover 25, plate and retaining members 22 and 23 and contacts 20 to the surfaces of the sheet of material through the fingers 21.

With the sheet of material B in position within the confines of the present fixture, the fixture is disposed in the plating solution S and agitation of the solution is accomplished by means of air introduced to the solution from the pump P with the air thus introduced entering the trough 41 and being distributed along and confined against each side surface of the sheet of material B. It may be seen that the chamber 32 has an opening only in the lower end thereof and the plating solution will tend to enter this chamber. However, trapped air within the chamber serves to prevent the flow of solution therein whereby to protect the contact fingers 21 against contamination and plating. The sharp edges within the chamber 32 also serve to break any film of liquid entering the chamber to prevent contamination of the contacts by capillary action.

In the disposition of the present fixture in the plating solution S, care is exercised to insure a maintenance of a level condition of the fixture whereby further to prevent entry of the plating solution into the chamber **32**. It may thus be seen that the contact fingers **21** are protected and may be used for an indefinite period there being no undesirable build up of plating material thereon.

The particular construction of the inverted funnel or trough **13** enables a focus of the air and direction thereof relative to the surfaces being plated. The efficient solution agitation caused by the turbulence of the air rising past the surfaces of the sheet of material being plated enables a high current density in the order of 100 amps. per square foot of surface to be plated. Certain areas of the material B, in the final printed circuit, contain no circuit and in some instances may be discarded. These surfaces are those confined within the slots **15**, **16** and **35** and within the confines of the trough **41**. The guard portions **43** serve to protect the lower edge of the material being plated and the angle defined at **44** increases the protection of the board of this area, this angle of the guard portions, the current density and the amount of agitation all being related and balanced to obtain the desired end results. An angle of less than 90 degrees to the surfaces being plated insures disposition of less metal along the protected areas then adjacent the central area of the material and it has been found that an angle of approximately 30 degrees to the board surface is most satisfactory for both electrical protection and mechanical strength. Tests in connection with a guard structure forming an obtuse angle with respect to the surfaces have produced unsatisfactory results and "burned" areas in the surfaces of the material.

It may thus be seen that the desired agitation of the plating solution is distributed over the entire surfaces of the board B and without the undesirable thin areas of plating or the production of "burned" or "treed" edges as have been experienced with heretofore known plating techniques.

While a particular type and configuration of electroplating fixture has been shown and described herein, it is to be emphasized and understood that the particular proportions are by way of example only and that this frame structure may assume various configurations dependent upon the size and shape of the sheets of material to be plated. The binding of the edges of the material by means of the nonconductive frame structure serve to distribute current flow over the entire surfaces of the sheet of material thus effecting an even distribution of the copper thereover and in layers of constant thickness. In this connection, it is further to be understood that while the present fixture and sheet material has been described as being used with a copper electroplating solution, other solutions and different metals may be employed without departing from the spirit and scope of this invention.

Having thus described the invention and the present embodiment thereof, it is desired further to emphasize the fact that many additional modifications may be resorted to in a manner limited only by a just interpretation of the following claims.

We claim:

1. An electroplating fixture for use with generally rectangular sheet material and adapted for immersion in an electroplating solution, said fixture comprising, in combination: a generally rectangular frame structure adapted for reception of said sheet material; means for confining side portions of said sheet material by portions of said frame structure; means carried by said frame structure for making electrical contact between said sheet material and a source of electrical energy; enclosure means carried by said frame and surrounding said contact means for shielding an upper edge of said sheet of material and for preventing intrusion of said electroplating solution upon said electrical contact means; trough means carried by and forming a portion of said frame structure for receiving and distributing a solution agitating flow of air over said sheet of material; and guard means comprising a portion of said receiving and distributing means for limiting solution agitation effects adjacent a lower edge of said sheet of material.

2. An electroplating fixture for use with generally rectangular sheet material and adapted for immersion in an electroplating solution, said fixture comprising, in combination: a generally rectangular frame structure having top, bottom and side portions and adapted for reception of said sheet material; groove means in said side portions of said frame structure for confining side edge portions of said sheet material; multiple contact finger means carried by said top portion of said frame structure for making electrical contact between surfaces of said sheet material and a source of electrical energy; air confining means positioned in said top portion of said frame for preventing intrusion of said electroplating solution upon said electrical contact means and for shielding an upper edge of said sheet of material; downwardly directed trough means carried by and forming a portion of said bottom portion of said frame structure for receiving and distributing a solution agitating flow of air over said sheet of material; and physical guard means disposed within said trough means for limiting solution agitation effects adjacent a lower edge of said sheet of material.

3. An electroplating fixture for use with generally rectangular metal clad sheet material and adapted for immersion in an electroplating solution having a solution agitating air flow induced therein, said fixture comprising, in combination: a generally rectangular frame structure having top, bottom and side portions and adapted for reception and retention of said sheet material; elongated groove means in said side portion of said frame structure for confining limited areas of side edge portions of said sheet material; laterally disposed multiple contact finger means carried by said top portion of said frame structure for making electrical contact between said metal clad surfaces of said sheet material and a source of electrical energy; air confining means in the form of an enclosure formed in said top portion and disposed about said contact finger means for preventing intrusion of said electroplating solution upon said electrical contact means and for shielding an upper edge of said sheet of material; laterally disposed downwardly directed inverted trough means carried by and forming a portion of said bottom portion of said frame structure for receiving and distributing said solution agitating flow of air over said sheet of material confined in said frame structure; and physical guard means disposed within said trough means for limiting solution agitation effects adjacent a lower edge of said sheet of material, said guard means being disposed on each side of said lower edge of and having upwardly directed surfaces arranged at an acute angle relative to said sheet of material.

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