May 26, 1936. U. C. TAINTON 2,042,030

LAMINATED ARTICLE

Filed July 8, 1932 2 Sheets-Sheet 1

Fig. 1.

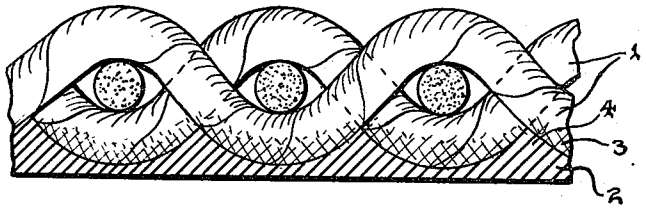


Fig. 2.

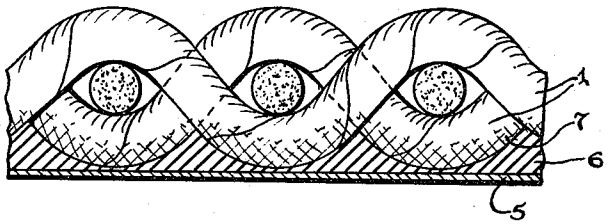
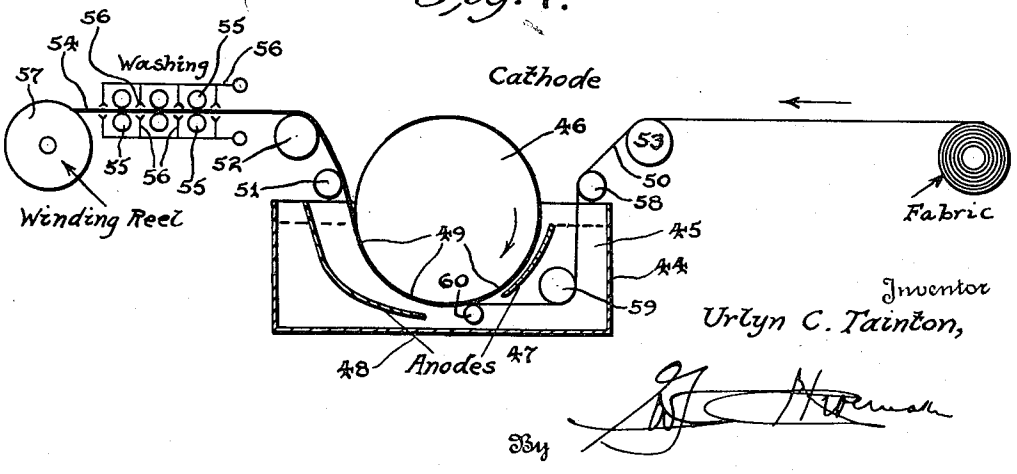


Fig. 3.



Fig. 7.



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Fig. 4.

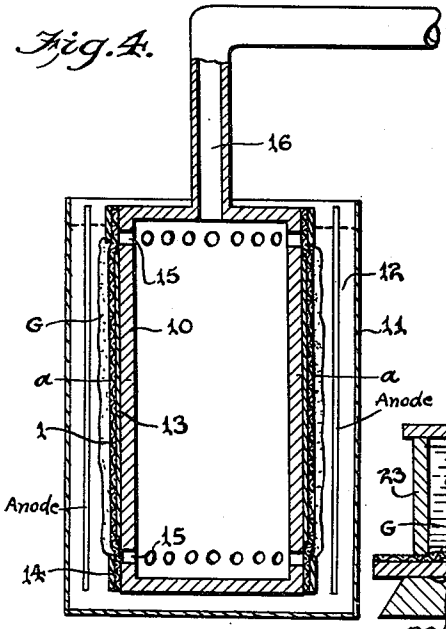


Fig. 4a.

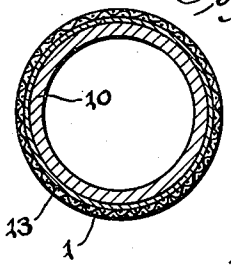


Fig. 4b.

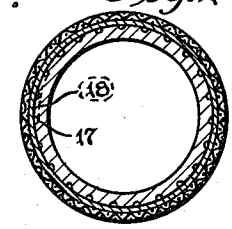
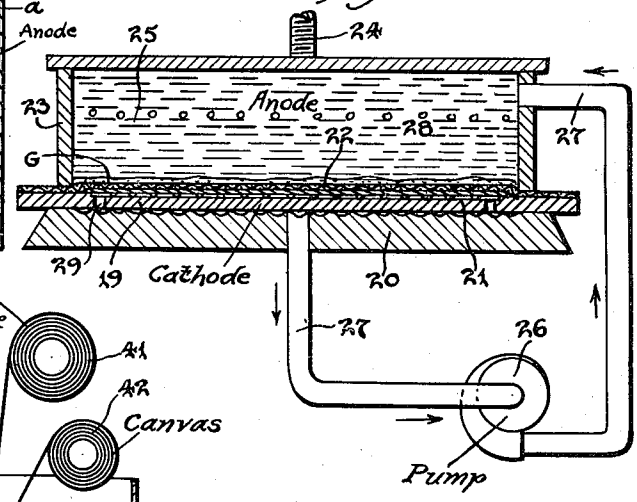


Fig. 5.



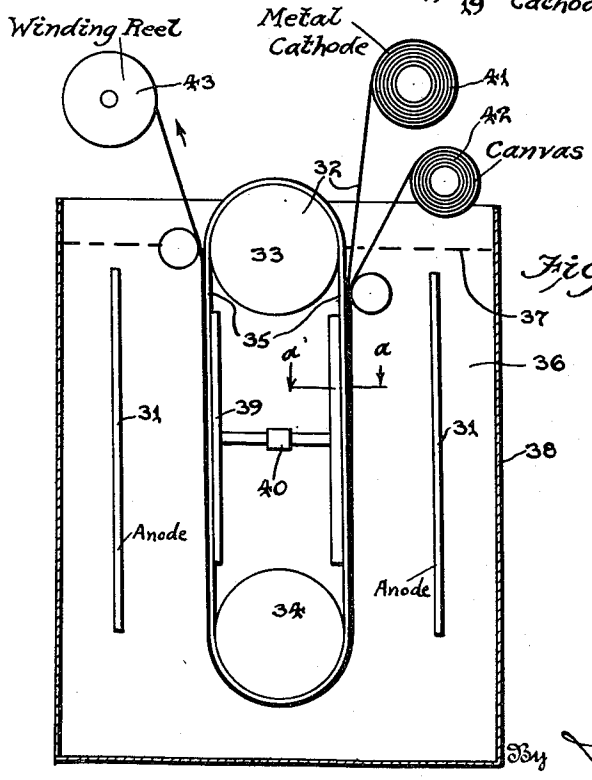
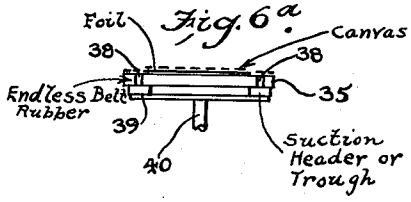


Fig. 6.

Fig. 6a.



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2,042,030

LAMINATED ARTICLE

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Application July 8, 1932, Serial No. 621,489

2 Claims. (Cl. 204—6)

The invention according to a broad aspect thereof relates to articles—including their production—comprising a metal portion to which there is attached, or which is attached to, a layer of porous or textile material such, for example, as an article having a thin metal face backed by a reinforcing body portion of porous or textile material.

According to a more specific aspect thereof, the invention particularly relates to a thin, flexible, laminated article in sheet formation which comprises a thin layer of metal providing a face portion thereof and a porous layer of sheet material or textile fabric that provides a body, back or reinforcing portion, dependent upon the manner in which the same may be used.

One object of the invention is to provide a composite or laminated article such as above referred to in which the face portion and the body portion are firmly united or bound together through the medium of metal electrolytically deposited upon the back of the face portion through the pores or interstices of the layer of the porous sheet metal or textile fabric providing the body portion.

According to one aspect of the invention, the laminated article may be considered as a fabric provided with a metal face or, from another aspect, the laminated article may be considered as primarily a thin sheet of metal which is reinforced or backed by a porous or textile sheet serving as a body portion or as a back portion or as a reinforcing portion, dependent largely upon the manner in which it is viewed.

Another object of the invention is to provide an article of the type herein referred to in which the metal face and the flexible body portion are firmly united by metal electrolytically deposited through the fabric upon the back of the metal face portion whereby a firm adhering bond exists between the metal providing the face portion and the metal thus deposited and which metal, thus deposited, is built up until it extends into the pores or interstices of the flexible body or back portion until there is effected a firm bond between the metal thus built up and deposited and the flexible body.

Another object of the invention is to provide a thin, laminated, flexible sheet that comprises a thin, flexible sheet of metal providing a face or surfacing portion and a flexible sheet of material as, for example, leather or textile material made of and by weaving cotton, wool, silk, asbestos, or the like, as a body portion and which front and body portions are firmly secured through the medium of metal electrolytically deposited through the pores or interstices of the body portion when the face member and the body portion are held in close contact so that the face and back members are firmly bound together through the medium of the said metal.

The invention relates not only to the articles such as herein referred to and described, but also to the method whereby such articles are produced or from which said articles resulted.

The invention according to one aspect thereof relates to an improved form of electrolytic metal deposit in sheet form having associated with it a porous or textile material such as fabric, leather, et cetera, and this aspect of the invention is characterized in and distinguished by the fact that the metal is deposited in the pores or interstices of the porous material and between the fibers or strands thereof and which porous or textile material acts as a reinforcement to and for the metal deposit. The metal or articles produced as herein described possess a combination of very desirable properties of both the metal and the fabric. Such laminated or composite articles may be used for such purposes as airplanes, automobile tops, airplane wings, tents, awnings, or the like.

With these and other objects in view, the invention consists in the novel construction, combination and arrangement of parts hereinafter fully described, illustrated in the accompanying drawings, and pointed out in the claims hereto appended, it being understood that various changes in the form, proportion, and minor details of construction, within the scope of the claims, may be resorted to without departing from the spirit or sacrificing any of the advantages of the invention.

The invention also relates to the apparatus and composite features thereof wherein and/or whereby the process or processes is or are carried out for producing the article or articles herein described.

According to one mode of realizing the invention, metal is deposited upon a cathode from which it may be readily detached after a sufficient layer or thickness of metal deposit has been formed. The fabric, leather or other material is brought closely into contact with the active face of the cathode and the electrolysis is continued so that the metal grows on through the fibers or interstices of the material applied. After deposition in this manner of a sufficient quantity of metal, the fabric is pulled away from the cathode, bringing with it the deposit which has been formed initially and leaving the cathode in condition to repeat the process. In this way, a continuous metal surface is obtained on one side of the fabric or other material, and if the process is properly carried out, the metal is so intimately intergrown with the fabric as to be practically impossible of separation.

Where heavy materials are involved, it is advisable or frequently advantageous to apply a suc-

tion or pressure so as to keep the fabric in close contact with the cathode or in other words, in close contact with the metal face which is on or provides a part of the cathode. This may readily be done, as for example, by making a cathode cylinder hollow and by applying to it a suction from an air pump or similar device. It is feasible, however, to use means other than the suction pump for creating the pressure. The employment of the suction pump not only holds the fabric close to the cathode but may also replenish the electrolyte in the pores of the fabric as the metal is deposited. For very light or porous materials such as muslin, it is not desirable to employ the suction as the electrolyte can percolate freely enough into the fabric to supply the metal deposited from the solution.

It is evident from what has preceded, that the process may be adapted for continuous production of material in long lengths or rolls and in this instance, as is clear from what has preceded, the cathode is made cylindrical and caused to revolve in the electrolyte. Of course, if it is desired to apply suction during the electrolytic operation, the cathode should be made hollow and suitable ports should be provided that communicate with the central shaft of the cathode whereby suitable connections can be made to a suction pump. It is also evident that by suitable engraving of the cathode surface, any desired patterns may be obtained on the face portion of the metal.

It is also evident from the foregoing, that the process is of wide application and is susceptible of great variations. For example, any desired metal or combination of metals may be employed provided it or they can be electrolytically deposited from the solution at low temperature. Similarly, any porous metal may be provided as the body, back or reinforcing portion provided that such porous material will allow the passage of electricity through it. I have used effectively the following metals; alone, or in combination: copper, cadmium, nickel, gold, silver, tin, zinc, iron, chromium; and a great variety of textile fabrics and also leather, felt, et cetera.

The process herein described may also be used to attach fabric or similar material to thin sheets of metal or foil previously prepared. As previously indicated, in this way the metal foil is itself made the cathode surface and the fabric applied in an appropriate electrolyte. The passage of current then results in the plating of metal onto the foil and the growth of the deposited metal through and into the interstices of the fabric so that a very close bond is obtained between the foil on the one hand and the fabric material providing the interstices or the pores thereof on the other hand.

As illustrative of certain articles typical of the invention, of certain modes of producing said articles according to methods typical of the invention, and of apparatus wherein and whereby the invention may be realized, reference is made to the accompanying drawings forming a part of this specification, in which drawings:

Figure 1 is a sectional view—at an enlarged scale—of a piece of laminated sheet material composed of a layer or sheet of electrolytically deposited metal—as copper—and a backing or reinforcing layer or sheet of woven fabric or the like providing a flexible porous backing layer. According to this figure, the layer of facing material is secured to or firmly bonded to the layer or back of porous reinforcing fabric material through the medium of metal—as copper—electrolytically deposited through the pores or interstices of the fabric to and upon the back portion of the facing layer until the bonding material thus electrolytically deposited is built up and grows into the interstices of the backing layer in a manner to effect a firm bond or holding medium between the material providing the facing layer on the one hand and the backing layer of fabric or porous material on the other hand.

Fig. 2 is a sectional view—at an enlarged scale—of a piece of laminated sheet material similar in many respects to the laminated sheet of Figure 1, but in Figure 2 the sheet of facing material is provided by a layer of wrought metal in the form, for example, of a foil or thin sheet or strip and which facing sheet is united, as in the case of the sheet of electrolytically deposited material of Figure 1, through the medium of metal electrolytically deposited through the interstices or pores of the fabric or porous backing to and upon the back of the metal facing layer until there results the firm bond or union as between the facing sheet and the backing sheet.

Fig. 3 is a sectional view—at an enlarged scale—of a piece of laminated sheet material. In Figure 3, the backing material is illustrated as a porous piece of material such as leather or felt through the pores of which there is electrolytically deposited metal to and upon the back of a facing layer of metal until the metal thus deposited builds up and grows back into the pores of the interstices of the felt or leather and until there results a firm bond or union between the layer of metal facing material on the one hand and the porous backing material on the other hand.

Fig. 4 is illustrative of an apparatus or process in and according to which the article of Figure 1 may be produced. In this Figure 4, a simple apparatus is illustrated according to which a layer of fabric or similar backing material is stretched over a layer of metal previously deposited on a cathode and clamped in place on the cathode prior to the electrolytically depositing through the clamped-on fabric layer of the required amount of bonding material.

Fig. 4^a is a sectional view through the cathode of Figure 4, taken as on the plane indicated by the line *a*—*a* of Figure 4.

Fig. 4^b indicates a form of cathode which can be employed in the apparatus of Figure 4.

Fig. 5 is illustrative of an apparatus or process according to which the articles of Figure 1, 2 or 3 can be produced. In Figure 5, the cathode is shown as a relatively straight, flat member and the woven fabric or layer of porous material is clamped in place by a box that completes the receptacle above the fabric into and through which box the electrolyte used in the process is circulated.

Fig. 6 is illustrative of a process and apparatus according to which a continuous method of making the articles of Figure 2 or 3 can be carried out.

Fig. 6^a is a sectional view through a portion of the apparatus of Figure 6.

Fig. 7 is illustrative of a process and apparatus according to which a continuous method of producing the article of Figure 1 can be carried out.

Reference will now be made to the drawings in detail. The enlarged sectional views typifying the articles to which this invention relates are shown in Figures 1, 2 and 3.

In Figure 1, a woven textile fabric 1 preferably of canvas, light or heavy according to the require-

ments desired, is faced with a layer of electrolytically deposited metal 2 that is bound or bonded to the fabric by means of metal, as at 3 and 4, electrolytically deposited through the fabric until it has filled the interstices and grown up into spaces in the fabric itself.

In Figure 2, a woven porous fabric 1 is metal faced as by a foil or thin sheet or strip of metal 5 that is bonded to the fabric through the medium of metal electrolytically deposited through the fabric such as metal at 6 and 7 and which is deposited until it has grown into the fabric as indicated at 7.

In Figure 3, a porous backing layer of felt or leather is provided at 8. This is faced by metal foil or a sheet of thin metal 9 which is secured to the backing through the medium of metal electrolytically deposited through the pores of the fabric upon the back of the facing member 9 until the metal thus electrolytically deposited has built up or grown into the pores of the backing material 8 to provide a firm bond or union between the metal face and the reinforcing material. Such metal growth is indicated at 9'. Each of the articles of Figures 1, 2 and 3 is in fact a laminated sheet product which is relatively flexible.

As to the apparatus of Figure 4 and Figure 4a, a cathode 10 is located in any suitable container or receptacle as 11 having suitable anodes therein, within which container or receptacle an electrolytic bath 12 is maintained. The electric current for maintaining the operation is applied in any suitable manner whereby metal will be electrolytically deposited from the bath to and upon the cathode or upon the metal in direct contact with the exterior of the cathode. In operating the apparatus of Figure 4, a layer of metal as 13 is electrolytically deposited upon the cathode. Thereafter, when the proper amount of metal has been deposited, the fabric as 1 is stretched about the deposited metal as shown in Figure 4a, and the electric current is applied until the metal has been deposited through the fabric and until it is built up in the interstices of the fabric whereby a firm bond or union is established between the original electrolytically deposited sheet and the fabric stretched about it. In carrying out this process, the ends of the fabric may be clamped in place as by bands 14 of rubber or other material and it will be noted the cathode is provided with openings 15 whereby suction can be applied through the tubular portion or member 16 of the cathode with the result that the fabric tends to be sucked toward and in close contact with the layer of deposited metal to which it is to be applied during the time that the bonding deposit is being applied through the fabric.

Figure 4b shows grooves as 17 and 18 which can extend both longitudinally and circumferentially of the outer face of the cathode. In short, the cathode can be given a desired configuration as by these grooves or otherwise so as to influence the desired appearance on the face of the resulting product.

In Figure 5, the cathode is designated by 19. It extends horizontally and is supported upon a brace member 20. Anodes are located above the cathode. A layer of facing metal as 21 is supported on the cathode. This layer of metal 21 may be a layer of metal previously electrolytically deposited upon the cathode or it may be a layer of material in the form of foil or it may be a layer of wrought metal in a thin sheet formation. A layer or strip of porous backing material 22 is applied over the layer of metal 21. Thereafter, a box member 23 open at the bottom is clamped against the upper face of an extending peripheral portion of the backing material until a tight joint is secured as by clamping through the medium of screw 24. The joint provided by the lower end of the box and the fabric, et cetera, is sufficiently tight to hold the electrolytic bath 25. The box carries the anodes. A circulating pump as 26 is provided which sucks or draws the electrolyte from below the cathode through the medium of the pipe 27 and forcibly projects the electrolyte delivered by the pump through the pipe 27 into the chamber 28 within the box. By this construction, means is provided by which the electrolyte is positively pressed against the fabric and thus into and through the fabric with the result that the electrolyte passing through the fabric can pass outwardly through the openings 29 in or constituting a part of the cathode construction until the electrolyte passing through the openings 29 finally reaches the suction pipe 27.

It will be manifest that articles such as defined in Figures 1, 2, and 3 can be made by the apparatus and process of Figure 4 or by the apparatus or process of Figure 5.

The apparatus and process of Figure 6 employs any suitable tank or receptacle as 30 within which there is located anodes as 31 and a cathode-providing construction broadly defined as 32. This cathode construction 32 comprehends the employment of upper and lower guide members as 33 and 34 around which there passes an endless belt of rubber or other suitable material as 35. The electrolytic bath used in this apparatus is designated by 36 and may stand to such a height as indicated by the line 37. The endless belt 35 is in fact a supporting member of the cathode construction. It is shown in cross section in Figure 6a and it will be noted that it is provided with openings as 38 which are located over suction troughs as 39 which in turn are connected to any suitable suction apparatus through the medium of connector 40. At the right hand side of the apparatus of Figure 6, there are located the rolls of facing and backing materials which are to constitute the main portion of the final laminated product. The roll of metal facing material is designated as 41 while the roll of backing or reinforcing material of porous fabric or woven canvas is designated by 42. These rolls of material are located and arranged in such a manner that the metal directly engages the endless belt and the canvas is applied on the outer side of the metal when on the belt. The metal thus applied can and does constitute the cathode with the result that the metal from the electrolyte passes through the fabric to and upon the metal layer as the metal facing material and fabric backing material continuously and progressively pass through the electrolytic bath under the influence of the operation whereby the bonding metal is deposited through the fabric to and upon the back of the metal providing the face of the resulting laminated product. From the bath, the laminated product passes to and upon the winding reel 43. The apparatus of Figure 6 is shown as employing suitable guide rollers whereby the incoming strips are held in close contact with each other and against the endless belt construction and also whereby the resulting laminated product is held against the endless belt construction until substantially the time the laminated product leaves the electrolytic bath.

The apparatus and process of Figure 7 employ a suitable tank or receptacle as 44 in which there is a suitable electrolytic bath 45. The cathode is designated by 46 and is mounted in any suitable manner so that it revolves in the direction of the arrow. Anodes are provided at 47 and 48. Anode 47 is relied upon to cause the progressive formation of a thin layer of electrolytically deposited metal as layer 49—49—49. Anode 48 is relied upon to cause a deposit of binding metal to pass through the fabric 50 whereby the fabric and the previously formed layer of electrolytically deposited metal are united after having been brought together on the cathode. The resulting laminated product or fabric 50 passes over guide rollers 51 and 52 through a washing apparatus designated by 54 which includes several sets of squeezing rollers as 55 and valve-controlled washing sprays as 56, thence from the washing apparatus to and upon the winding reel 57.

At the intake side of the machine, suitable guiding-in rollers as 53, 58 and 59 may be employed. A roller 60 serves as means for guiding the incoming fabric and also in conjunction with roller 51 for causing the fabric to be pressed and to be held in contact with the deposited metal on the cathode during the time that the binding material is being deposited from the electrolytic bath through the fabric. The bond is made sufficiently strong whereby the facing material of the previously deposited electrolyte and the fabric backing are firmly bonded together and sufficiently strong to cause the metal on the cathode to be pulled or peeled from the cathode as the resulting laminated product leaves the cathode.

To facilitate the functioning of the electrolytically depositing of metal in an even and uniform manner, applicant feels it advantageous to use a layer of diatomaceous earth or silica gel on the outer surface of the backing fabric during the time that the bonding metal is being electrolytically deposited through the fabric. This layer of diatomaceous earth or silica gel is indicated in Figure 4 and also in Figure 5 by the letter G and it serves to equalize the flow of the electrolytic bath through the fabric by forming an obstructing cake where the flow is the greatest. This layer of diatomaceous earth or silica gel could be used in all forms of the apparatus herein shown and the invention hereof contemplates such use although it is not necessary to use diatomaceous earth or silica gel for the purposes herein pointed out.

In each form of apparatus shown in the drawings, there is illustrated the combining of a layer or sheet of copper—or other suitable metal—as the face or facing material, and canvas or woven duck—or other porous flexible material—as the back or backing material. The electrolyte used consists, for example, of a standard copper plating solution such as copper sulphate, containing free sulphuric acid. In such case, the anodes are of copper and the cathode is either a cylinder or a plate preferably made of aluminum. If another metal is employed, such as copper, for the cathode, it should be treated with oil or graphite to prevent the deposit from adhering too tightly.

According to one form of the invention, and particularly the form illustrated in Figures 4 and 4^a, the cathode is placed in the electrolyte and a thin coating of copper deposited on it, after which it is withdrawn and the duck or canvas is stretched tightly around it, and in such a method the cathode is returned to the electrolyte and the deposition continued for a suitable period. The action is preferably stopped as soon as the metal begins to come through on the outside of the fabric.

By then pulling the material away from the cathode, the metal piece is also detached from the cathode and will be found to be intimately bonded or bound to the fabric whereby the desired laminated article results. This process may be referred to as a batch or piece process because of the fact that one operation is practically completed upon and for one piece or laminated article before the operation is carried out upon the same cathode for the production of another piece or laminated article.

The process of Figure 5 may also be considered as a batch or piece process.

In contrast to the batch or piece method, it is feasible, as has been pointed out, to employ what may be termed the continuous process, to wit, one in which there is employed a relatively continuous and progressive feed of a strip of facing material and a corresponding relatively continuous and progressive feed of a strip of fabric under conditions whereby the fabric and the facing material are progressively brought together along successive portions of their lengths and whereby they are intimately bonded together by the electrolytic deposition of metal progressively effected through successive portions of the fabric to and upon the successive portions of the metal facing material associated with the fabric. Such a continuous method or process is carried out in the apparatus of Figure 6.

It is also within the contemplation and purview of this invention, as previously indicated, to progressively and continuously form a facing sheet of metal by electrolytically depositing the same according to a continuous and progressive method and to progressively and continuously secure such facing sheet of metal to a layer of progressively fed fabric by electrolytically depositing metal through the fabric in a manner whereby the sheet of facing material thus formed and the fabric thus fed are progressively united. Such a continuous method or process is carried out in the apparatus of Figure 7.

The invention contemplates the construction of apparatus employing an electrolytic cell, the arrangement of parts of the apparatus which cooperatively function with respect to the electrolytic cell and particularly with the cathode of the electrolytic cell, and the employment of the apparatus and parts thereof for and in a manner whereby the laminated articles herein described can be produced and whereby the processes for producing the laminated articles can be carried out.

What is claimed is:

1. The method which comprises holding porous organic sheet material in close contact with a thin uniform sheet metal face providing member and at the same time electrolytically depositing metal through the pores of the sheet while thus placed and maintaining a pressure upon said porous sheet and said metal face sufficient to prevent their separation during electrolytic deposition and flowing the electrolyte under pressure through the fabric to replenish the metal content of the liquid adjacent the metal face and withdrawing the liquid in the direction of the plane of the fabric.

2. A laminated article of manufacture resulting from the method defined in claim 1.

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