

Nov. 7, 1950

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2,528,540

METHOD OF ORNAMENTING SHEET METAL

Filed Feb. 25, 1946

2 Sheets-Sheet 1

Fig. 1.

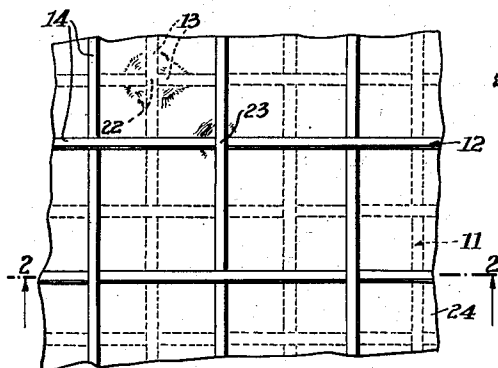


Fig. 5.

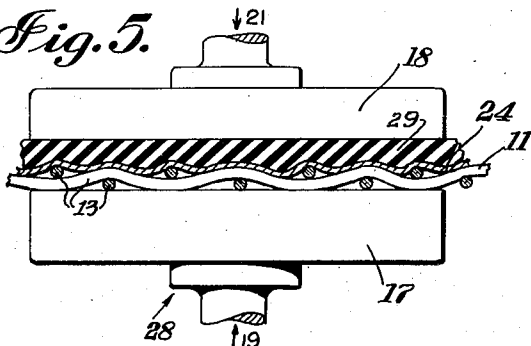


Fig. 6.

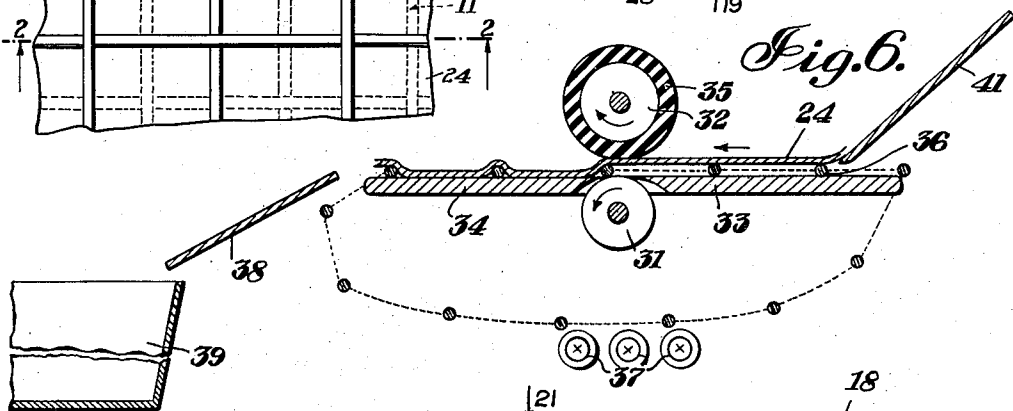


Fig. 2.

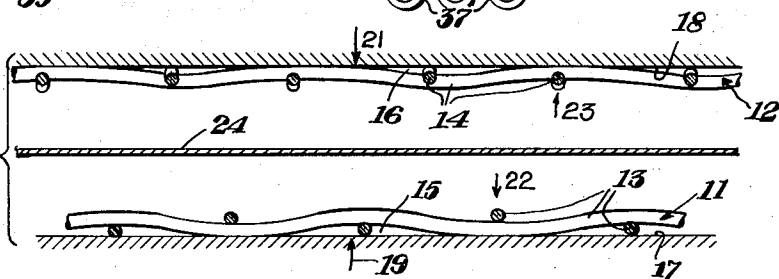


Fig. 3.

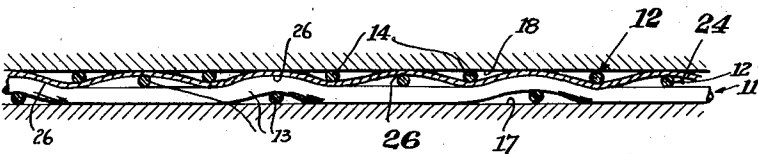
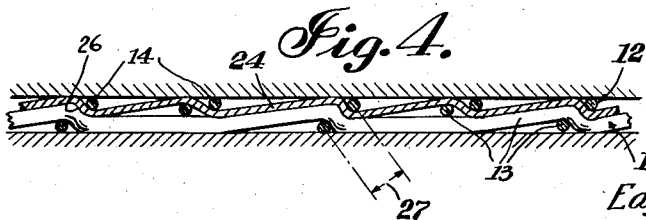


Fig. 4.



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2 Sheets-Sheet 2

Fig. 7.

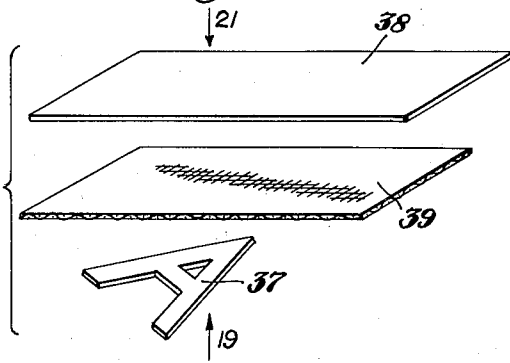


Fig. 11.

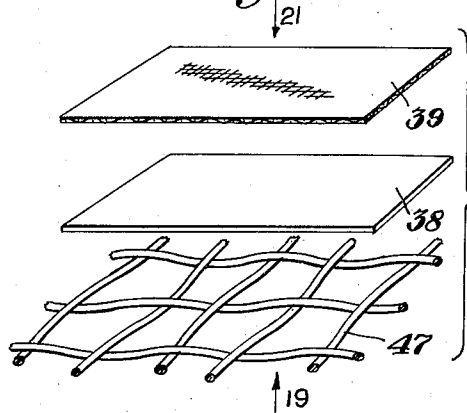


Fig. 8.

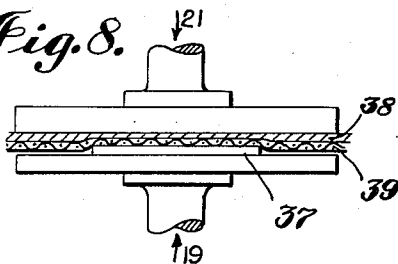


Fig. 12.

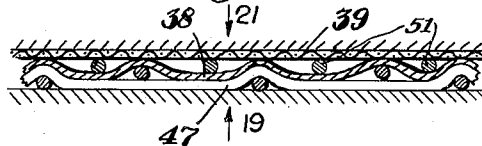


Fig. 9.

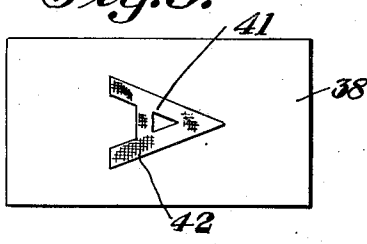


Fig. 13.

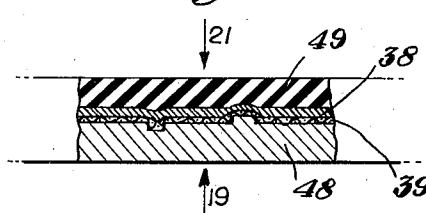
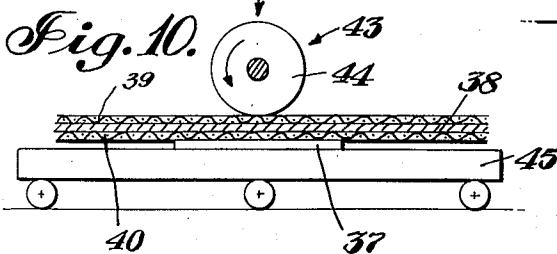


Fig. 10.



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METHOD OF ORNAMENTING SHEET METAL

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2 Claims. (Cl. 101—32)

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The invention relates to methods of forming sheet material and to articles of manufacture made thereby, and relates more particularly to methods of imparting ornamental patterns into sheet material by forming and to products made thereby.

Desirable features for methods of forming sheet material are economy, simplicity and efficiency of machinery used, and ease of maintenance of the equipment. These features are generally obtained with practical limitations in such production methods now in use. However, almost all commercially used methods of forming sheet material are characterized by high initial cost of the required male and female dies, substantial weight of the same, and such dies are furthermore deficient in adaptability to any change of the patterns to be imparted to the sheet material. Practically all forming processes known to the present art utilize male and female dies which are, due to their expensiveness, economical only when employed in highly repetitive production.

It is therefore one of the principal objects of my invention to reduce the cost of forming sheet material.

Another object of my invention is to employ dies that are inexpensive, expendable and economical to use in short production runs.

Another object of my invention is to provide methods in which each step is simple and may be performed by unskilled persons.

Another object is to employ equipment the movable parts of which are light in weight.

A further object of my invention is to provide methods in which the same dies may be used for a wide variety of overall patterns to be imparted to sheet material.

A still further object of my invention is to provide a method utilizing dies which may easily be interchanged and which may be shipped, cleaned, repaired and otherwise maintained, without difficulty.

A still further object is to provide inexpensive and diversified articles of formed sheet material.

Further objects and advantages of the invention will be set forth in part in the following specification and in part will be obvious therefrom without being specifically referred to, the same being realized and attained as pointed out in the claims hereof.

The foregoing and other objects of the invention will be best understood from the following description of exemplifications thereof illustrated in the accompanying drawings, wherein

Fig. 1 is a plan view of a sheet material between two wire networks;

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Fig. 2 is an exploded view, in cross section, taken along line 2—2 of Fig. 1;

Fig. 3 is a sectional view similar to Fig. 2 showing the sheet material in close engagement with the two networks;

Fig. 4 is a sectional view similar to Fig. 2, but showing a modification;

Fig. 5 is a fragmentary view, partly in section, of a press and a wire network engaging a sheet material;

Fig. 6 is a fragmentary sectional view of a roller press engaging a sheet material and a network;

Fig. 7 is an exploded view, in perspective, of a wire mesh between a sheet material and a master die;

Fig. 8 is an elevational view, partly in section, of the articles shown in Fig. 7, in pressure engagement;

Fig. 9 is a plan view of a sheet material showing an impression and a pattern;

Fig. 10 is an elevational view, partly in section, of a sheet material between two wire fabrics over a master die, engaged by a roller press;

Fig. 11 is an exploded view, in perspective, of a sheet material between a network structure and a wire mesh;

Fig. 12 is a sectional view of the articles shown in Fig. 11, and a second network in pressure engagement; and

Fig. 13 is a sectional view of a die in pressure engagement with a sheet material carrying a rubber backing and separated from the die by a wire mesh.

Forming of sheet material, particularly the ornamenting and fashioning of metalwork, jewelry and related decorative products of handicraft, is frequently done by means of hand tools and by other hand-operated, simple means; although such manual working is tedious and time-consuming, and requires long experience, talent and mechanical skill of the artisan, this oldest form of shaping sheet material has been preserved through the times materially unchanged due to the continuing general appreciation of individual, different and artistic creations made in an endless variety by the craftsman's hand.

This hand tooling of articles made of sheet material therefore never could be entirely replaced by industrial production methods and, in all trades of metal jewelry manufacture, in the gold and silversmith's art as well as in costume jewelry and the decorative field, hand wrought, hand hammered and engraved articles enjoy a world wide demand often regardless of the fact that mass produced articles made by the stamping press are available at a mere fraction of their

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price, copying their appearance and pattern and made from the same or better material. Yet, these machine made articles are always distinctly different from those made by hand; all the hand made products show irregularities of the formed pattern itself and invariably are characterized by the basic fact that hand made duplicates never are exactly alike. These aberrations from the perfect pattern are often designedly provided, for artistic considerations: a minute deviation from the regular pattern, or a slight change in a line distinguishes one piece of hand made work from all other pieces of the same creation. The arts and crafts, the jewelry trade and discerning fashionable users always favor these slight irregularities and imperfections, the individualization and variety of original work, and attribute a definite charm and lasting value to the artisan's hand product even if it is one of many similar copies and not an original artwork.

Mechanical mass production of formed sheet material, on the other hand, is based on quite contrary principles and requirements. Here, one pattern is selected and with great accuracy incorporated into a male and female die, at high initial cost, and therefore, to yield economical returns on the investment, huge quantities of reproductions have to be produced within a short period of time which, stamped from the same die by heavy precision presses, will all be exactly alike; in fact, the manufacturer has to regard any not perfectly uniform product as defective, since the dies are precision made to close tolerances. The same principles of mass production apply where rolling machinery is employed for the forming of sheet material, using engraved male and female rollers. Any alteration of the pattern, however slight, is uneconomical as it involves prohibitively expensive and time-consuming reshaping of both male and female dies or rollers, or the manufacture of a new different set of dies at a cost equal to the initial expense.

The present invention permits the machine production of articles almost indistinguishable from the hand made product and yet, the cost of the dies it provides is negligible and compares even favorably with the cost of the hand tools required by the manual worker. At the same time, it makes a multitude of variations of any basic ornamental pattern possible without any additional expense and it discloses means for producing articles in modern mechanical production methods at extremely low operating cost, without having two articles exactly alike unless so desired.

In carrying the invention into effect and referring now particularly to Figs. 1 and 2, I provide two substantially identical hard and flexible network structures 11 and 12, respectively, 11 designating a lower network and 12 an upper network. Each of these consists of a fabric or coarse mesh made of metal wire, thin interwoven metal rods or strips, plastic wire or similar material, or may also consist of a single piece of perforated sheet metal having large holes of circular or polygonal shape and regularly spaced from each other, for instance of the type commonly referred to as "expanded metal."

By way of exemplification the networks 11 and 12, shown in Figs. 1 and 2, disclose conventional fabrics made of intersecting wires 13 for the lower and 14 for the upper networks, surrounding openings 15 and 16, respectively. The wires are arranged crosswise and form intersections 22 at

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the lower network and intersections 23 at the upper network.

As shown in Fig. 2, the lower network 11 is resting on a table 17 of a conventional press (not shown in this figure) of the type shown in Fig. 5; the upper network 12 is shown below a plate 18 forming part of a plunger (not shown) of the press and, if desired, may be fastened thereto by any suitable manner. Pressure to be exerted by the press is indicated by vertical opposite arrows 19 and 21. A sheet of material 24 is shown between the upper and the lower networks and consists of comparably thin metal, such as rolled copper, aluminum, etc., or of other permanently cold deformable material.

In order to carry out the process successfully, my experimentation has shown that proportion is required between the thickness of the wire, the open areas between the wires, and the thickness of the sheet material; each opening of the network must cover a considerably greater area than the equivalent thickness of one wire; or, in other words, the area prescribed by the sum of all the openings of one network must be considerably larger than the area covered by all the individual wires of the same network. Furthermore, the wires should have a thickness at least equal to and preferably greater than that of the sheet material to be formed. And finally, the width of one opening must be at least equal to the sum of one wire thickness plus double the thickness of the sheet material. This last requirement applies only where, as shown in Figs. 1 to 4, two wire networks are used. As shown and described below, in certain instances a single wire network is used and then the last requirement does not apply. The reason for all these requirements is explained further below. The discovery that structures of the disclosed proportions are useable as means for attaining the disclosed effect, I consider to represent the nucleus of this invention. In my experimentation with wire fabrics of all types I have not been able to attain such three-dimensional effects until I used these open special network structures which embody proportions not found in wire mesh and similar standard products.

For the operation of my method, the two networks 11 and 12 with the sheet material 24 in between are placed between the table 17 and the plunger 18 of a press in such a manner that each wire intersection 23 of the upper network 12 is interlockingly located above and opposite an opening 15 of the lower network 11 and, correspondingly, each wire intersection 22 of the lower network 11 below and opposite an opening 16 of the upper network 12. Thereafter, the plunger is energized and pressure applied to the whole network-sheet material-assembly.

Under the impact of the pressure, each of the two networks 11 and 12, which are resilient and flexible, will be temporarily deformed and the sheet material 24 will undergo permanent deformation and be so formed to receive patterns of impression from the upper as well as from the lower networks.

Fig. 3 discloses the position of the two networks and the sheet material after deformation, at the end of the pressure stroke of the plunger. As illustrated, each wire intersection of one network has pressed a portion of the sheet material into and caused it to protrude into and, at least partially, to pass through the opposite opening between the wires of the other network. Thus, the sheet material has permanently been deformed all over and has received depressions and

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elevations in alternating sequence on one surface and corresponding elevations and depressions on the opposite surface; furthermore, the sheet material has received crosswise grooves from impression by the wires and, since the wires of one network are laterally displaced with relation to those of the other network, the grooves on each surface of the sheet material are straight and are arranged intermittently to connect the centers of depression thereof and are laterally displaced with relation to the grooves in the other surface. The intermittence is brought about by the fact of alternation of overlapping of the wires in the networks at each succeeding intersection in any one direction and, thereby, an interruption of each groove occurs at every second depression. The grooves in the surfaces of the sheet material 24 are designated 26.

The fabric structure of each network will resiliently be deformed as the pressure is being applied and the networks, which are separated from each other by the sheet material, have begun to affect each other's structures, so that the wires between the points of intersection will appear straightened alongside the flat surface of the adjacent part of the press and the points of intersection will be accentuated and appear as spaced elevations protruding from a substantially flat wire structure. Before this deformation has taken place, all the wires 13 and 14 of the networks were substantially shaped like a sine-curve, as is the case with most types of meshes and fabrics, and after the pressure is relieved, the wires of each network will substantially resume their former shape. The slight and gradual, but continuous distortion and shifting of the structure described hereinabove accounts for the shaping of the finished article in a manner resembling hand work.

Naturally, where the network structure consists of perforated sheet metal, such as "expanded metal," though it will be deformed through the operation, the nature of this deformation will be different from that described above insofar as the intersections of the solid portions of such perforated sheet metal are in one plane and thus the distortion described above can not take place all over.

A different arrangement of the relative position of the two networks is shown in Fig. 4. The upper network 12 has been moved to an extreme position in which the intersections of each network, though still placed opposite the openings of the other network, have a place of greatest proximity to the wires of the opposite network; the wires of one network are only sufficiently laterally displaced with relation to the other to permit a deforming of the sheet material 24 between the two networks; such a minimum lateral displacement approximately equals the sum of two wire thicknesses plus one thickness of the sheet material. The minimum displacement is shown in Fig. 4 and designated 27. The deformation of the sheet material in this arrangement will be one that is characterized by sharp bends in one direction and slantwise surfaces in another direction, thus creating an irregular and interesting effect, resembling the "facettes" of precious jewelry.

As illustrated in Fig. 1, the wires of the two opposite networks may be parallel to each other. Yet, it is also possible to arrange the two opposite networks so that the wires of each will be in angular position relative to the wires of the other. I have found that the resulting deforma-

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tions of the sheet material formed therebetween show another type of a unique relief pattern artistic in appearance and distinctly resembling a hand-wrought or hammered article. Furthermore, each network, instead of having perpendicularly arranged crosswise wires, may be transformed to have wires intersecting at sharp angles forming a "diamond" shape. Any variation of the angular position of one network with relation to the other, or a minute change in lateral displacement of one network relative to the other, as well as the slightest change of angle of the wires within a single network, will form a finished article which is noticeably different from the article produced before. A practically unlimited variety of similar articles can thus be manufactured without entailing any separate expense or any appreciable amount of additional labor; these adaptations in the set-up of my dies may, of course, be introduced by hand. The basic rule to be observed is that the wire intersections of one network must face openings of the other. Otherwise, the resultant article will merely be provided with slight marks and indentations, but not show any deep elevations and depressions, as the wires will slightly penetrate into the surface of the material only and will not form the same three-dimensionally. Likewise, if the proportion of the openings to the gauge of the wire and the sheet material, as hereinabove disclosed, are not observed, at best a superficial embossing only results on soft material and not the three-dimensional forming attained by my process even on hard and heavy metal.

It may be observed on the illustration (see Fig. 3) that, in order to effect depressions in the sheet material, the intersections of one network force portions of the material through the openings of the opposite network; for that reason, the width of these openings in any direction must be at least equal to the diameter of one wire surrounded by sheet material, which therefore equals the thickness of one wire plus two thicknesses of the sheet material. Unless that requirement is met, the depressed portion of the sheet material would not be forced to enter into and pass through the opening of the network. In Fig. 3 it can also be seen that the thickness of one wire should equal at least the thickness of the sheet material, in order to effect an appreciable depth of depression of the same.

Instead of using two network dies for forming a sheet material located therebetween, a single network may be used and a piece of sheet material placed face to face against one surface thereof, and a comparably soft backing, such as rubber or the like, applied to the opposite face of the sheet material, and then pressure applied to the whole. An arrangement of that type is illustrated in Fig. 5, where a network 11 is shown on the table 17 of a conventional press 28 (not shown in detail). The sheet material 24 is carried by the network 11, and a backing 29 consisting of a rubber mat is placed on top of the sheet material 24. When the press is energized, pressure will be applied between the plunger 19 and the table 17 (pressure is indicated by the arrows 19 and 21), and the backing 29 will force portions of the sheet material 24 through the openings of the network 11 and cause the sheet material to be formed and to receive a pattern corresponding to the shape and configuration of the particular network used. The resultant product will have grooves only on one surface. The pattern formed in the sheet material may be

varied by using different networks and by using backings of different degree of hardness, furthermore by changing the angles of wires within the network; but the variety, depth and beauty of patterns which may be imparted to a sheet material in this crude manner is much more limited than in the previously disclosed method based on interlocking networks.

For an accelerated production rate I provide a pair of power driven rollers 31 and 32, shown in Fig. 6, through which a network 36 carrying a piece of sheet material 24 may be fed from a feeding table 33 towards a discharge table 34. The upper rollers 32 is provided with a sleeve of network and/or with backing material 35, made of rubber or the like, to effect the forming of the sheet material as it passes together with the network 36 between the two rollers 31 and 32. In this arrangement a continuous production is possible as the network 36 may be endless and fed back to the feeding table below the lower roller 31 and supported on its return track by transport rollers 37, while the finished articles are deposited in a chute 38 located at the far end of the discharge table 34 from which they are expelled into a removable container 39. The feeding of the successive sheet materials to be processed may be accomplished through a gravity feed 41 which deposits succeeding strips of material on the upper surface of the endless network 36.

Instead of using open network structures of the type disclosed in the foregoing, having wide openings between the structural members or wires thereof, wire cloth or fabric of comparably thin wire and closely woven into a much finer mesh may be utilized to impart an ornamental, debossed or embossed effect to the surface of sheet material. Such wire fabrics I use in conjunction with either a conventional male die, or with a network structure employed as a die of the hereinbefore described type, or with a master which will be reproduced in the surface of sheet material and form a depression therein. The wire cloth or wire mesh is placed between the die, or the master, and the sheet material so that it will impart its inherent fabric pattern to the same surface which is subjected to impressions by the die or the master; or the wire mesh may be placed against the opposite surface of the sheet material with respect to the die; or, still further, a wire mesh may be placed on each surface of the sheet material so that the same rests therebetween and this layer arrangement subjected to impression by a die or a master.

Furthermore, it is also possible to use two network structures of the above described type (see Fig. 1) in connection with a die or a master. Thus, many variations are possible through the selection of network structures differing in thickness of wire and in mesh, where two networks are employed to form a sheet material. The wide-spaced network structure can thus be used either as a die in conjunction with a fine mesh wire fabric, or can be used with a punch die, for taking the place of the fine mesh wire fabric under certain conditions discussed below. The variation may be carried further by changing the angle of weaving of the two networks with respect to each other; many combinations of ornamentation on a sheet material may thus be created.

In Figs. 7 and 8, a master 37 is shown and a material 38 with a wire mesh 39 placed therebetween. When placed under pressure, indicated by opposite arrows 19 and 21, by means of a

press fragmentarily shown in Fig. 8, the master 37 will emboss the material 38. The embossing depression will substantially follow the contour of the master 37, and on the side of the depression the wire mesh 39 will have made impressions substantially in the form of its inherent fabric pattern in the depressed surface of the material 38.

The depression may be deepened by placing a soft backing on top of the material 38, if this is of soft character (compare Fig. 13). A sheet material so formed is shown in Fig. 9 and the depression area designated 41; impressions in form of a mesh pattern are also shown and designated 42.

In Fig. 10 another modification is shown. In a roller press 43 comprising a roller 44 and a moving table 45, there is placed under pressure a sheet material 38 between two wire meshes 39 and 40, respectively, and this assembly is placed on top of a master 37. One or both of these wire meshes 39 and 40 may be replaced by a network of the type shown in Fig. 1 and designated 11. In this arrangement, as the roller 44 pressurizes consecutive portions of the sheet material in its layer arrangement with the wire meshes and the master 37, both surfaces of the sheet material 38 will receive mesh pattern impressions from the wire meshes; in addition, the master 37 will bring about a permanent deformation of the sheet material by forming a depression therein.

As mentioned before, if one of the wire meshes is of the open mesh type made from heavy gauge wire and the other one of a fine mesh grade of thin wire, as shown in Fig. 11, the resulting formed sheet material 38 will have depressions and elevations and in addition on one side grooves and a pattern on the opposite side of these grooves. It is preferable, where a network structure is used as a die as shown in Fig. 11, to provide on top of the layer arrangement a soft backing, such as rubber or the like, similar to the backing disclosed in Fig. 13. In Fig. 12 two network structures 47 and 51 are used, similar to the arrangement of the networks 11 and 12 shown in Fig. 1, and, in addition, a fine wire mesh 39 is used on top. The resulting product will have again depressions and elevations and grooves on both sides and a mesh pattern on one surface, in addition.

However, in Fig. 13 an otherwise different arrangement is shown. There, a conventional punch die 48 is used instead of the network die 47 of Figs. 11 and 12, and the sheet material 38 is separated from the die surface by a wire mesh 39. A rubber backing 49 is provided for a purpose indicated above.

The wire mesh 39 is placed between the sheet material and the surface of the die for facilitating transmission of pressure therebetween, as disclosed in detail in the foregoing. As related before, it has been found that such use of wire mesh between a die surface and the material reduces the pressure requirement. The reason is believed to be that the mesh transmits pressure onto the material over a plurality of spaced elevations, each elevation acting like a wedge that reduces the resistance against impression of the material. In contrast thereto, a solid die surface has to be applied against the full strength of the material resisting such impression. The selection of the proper wire mesh 39 will depend on the intricacy of the die to be impressed in the sheet material 38: The finer detailed a sur-

face is to be reproduced, the finer the mesh and grade of wire used; however, where large and solid surfaces have to be reproduced, the mesh and wire gauge may be coarse, and a wire network structure can be used in place of the fine wire mesh 39. A coarse mesh imparts to the finished article an interesting screen texture, whereas very fine meshes have to be used when it is not desired to make a distinct pattern appear.

Certain of the advantages of the invention have already been herein referred to. It may be useful, however, particularly to allude at this point to the advantages of my methods which admit of producing articles of formed sheet material by machine and at the same time imparting thereon the variety and the characteristics of hand-made articles so that they will be almost indistinguishable from the latter. The cost of production as well as the initial outlay of capital is very small because the material used as die is inexpensive and easily available and the articles may be turned out at a high rate of production.

I do not limit myself to the particular details of construction set forth in the foregoing specification and illustrated in the accompanying drawings, as the same refer to and set forth only certain embodiments of the invention and it is obvious that the same may be modified, within the scope of the appended claims, without departing from the spirit and scope of the invention.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent, is as follows:

1. In a method of ornamenting sheet metal to impart thereto a relieve and intaglio effect, imitative in appearance to that of hand wrought ornamentation, the steps comprising, inserting said sheet between two wire networks of substan-

tially similar shape off-set against each other so that the intersections of one are opposite apertures of the other, and subjecting the whole to pressure sufficiently great to deform said sheet by pressing portions thereof into said apertures, whereby one side of said sheet will receive a relieve appearance and the other side an intaglio appearance.

2. In a method of ornamenting sheet metal to impart thereto a relieve and intaglio effect, imitative in appearance to that of hand wrought ornamentation, the steps comprising, inserting said sheet between two wire networks one having larger apertures and wire thickness than the other, said networks being so positioned relative to each other that the intersections of one are opposite apertures of the other, and subjecting the whole to pressure sufficiently great to deform said sheet by pressing portions thereof into said apertures, whereby one side of said sheet will receive a relieve appearance and the other side an intaglio appearance.

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