July 7, 1942. R. MILLENAAR 2,288,972

METHOD AND APPARATUS FOR THE MANUFACTURE OF X-RAY GRIDS AND KINDRED DEVICES

Filed Feb. 8, 1938 3 Sheets-Sheet 1

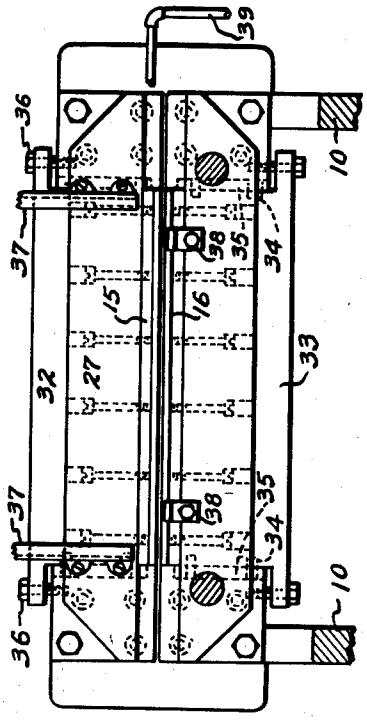

FIG. 2.

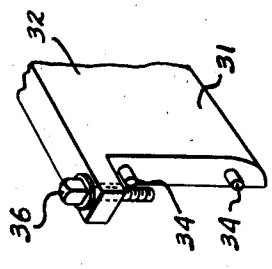

FIG. 3.

FIG. 1.

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Filed Feb. 8, 1938 3 Sheets-Sheet 2

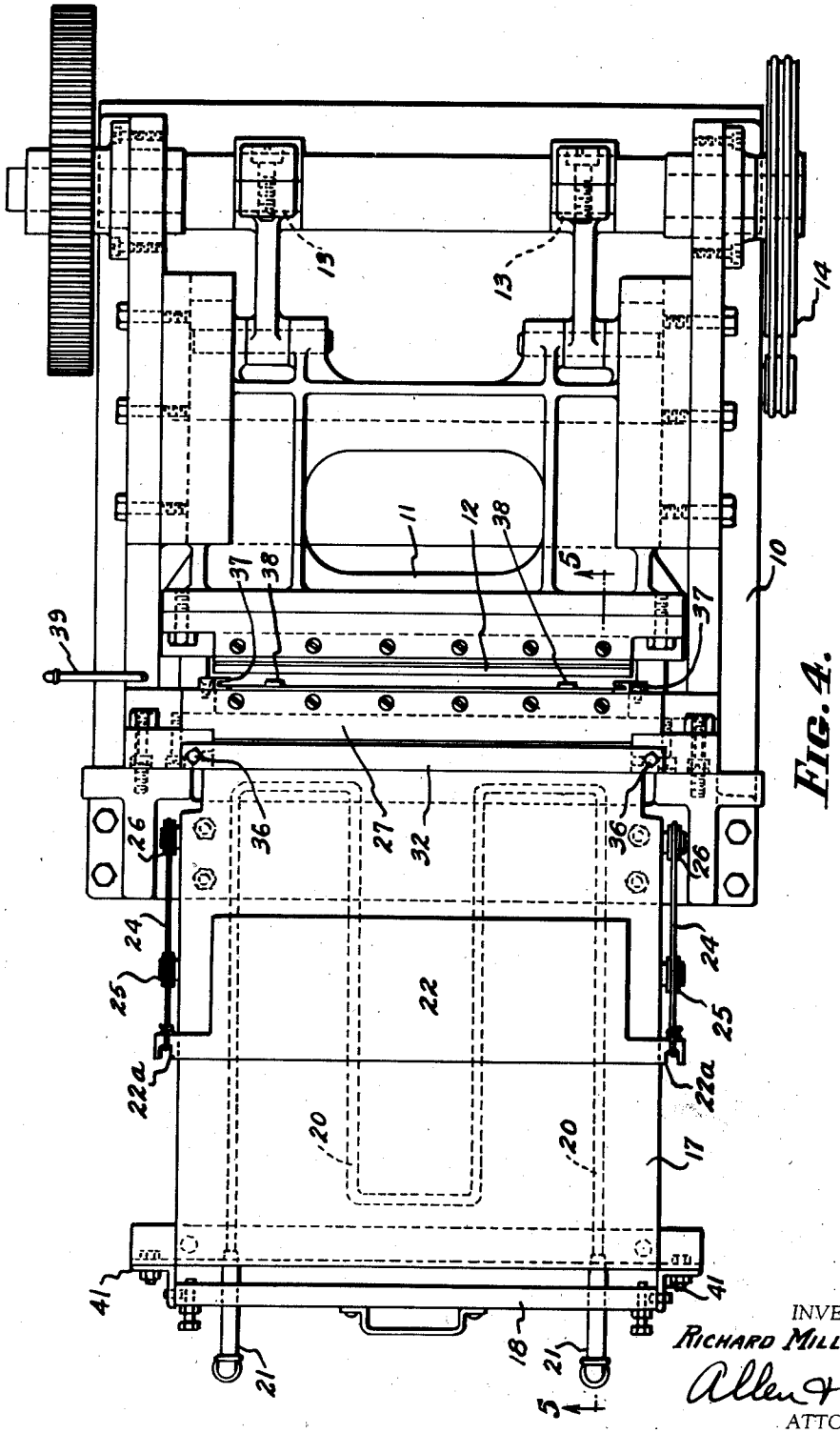

FIG. 4.

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Filed Feb. 8, 1938 3 Sheets-Sheet 3

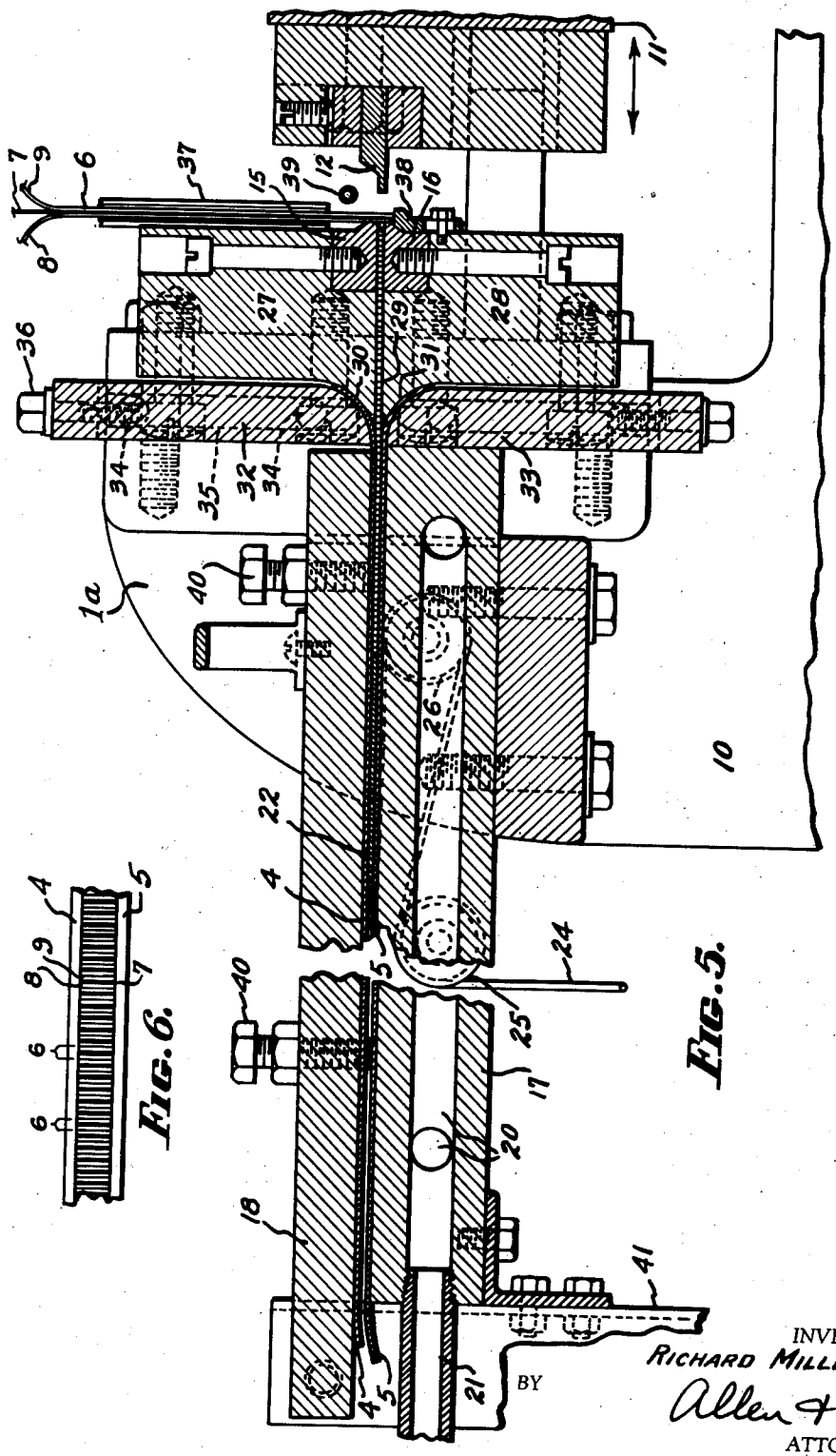

FIG. 5.

FIG. 6.

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Patented July 7, 1942

2,288,972

UNITED STATES PATENT OFFICE

2,288,972

METHOD AND APPARATUS FOR THE MANUFACTURE OF X-RAY GRIDS AND KINDRED DEVICES

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Application February 8, 1938, Serial No. 189,422

17 Claims. (Cl. 154—1)

I shall describe my invention in connection with the manufacture of what are known as X-ray grids, it being understood that the method and apparatus herein set forth are applicable to the manufacture of other articles presenting the same or similar problems.

In the taking of X-ray photographs, as is well known, an X-ray tube is located upon one side of the body to be photographed and the sensitized photographic film is located upon the other. The rays sent out by the X-ray tube travel as from a point source, and give on the photographic plate what may be termed a shadow image. While X-ray photographs have been made in this way with satisfaction for a large number of years, yet there is some apparent diffusion and deflection of the rays; and it has been ascertained that the clarity of the shadow image will be very greatly improved (so much so that in many instances details can be determined upon the film which otherwise would not be apparent) if there is interposed between the object and the film a grid structure consisting uniformly of alternate layers of material opaque to X-rays and material transparent to X-rays. The rays are caused to impinge upon the grid in a direction very nearly parallel to the plane of the said layers therein. X-ray grids have heretofore been manufactured of alternate thin laminations of lead foil or the like, and laminations of paper, the said laminations, on edge, being interposed between cover sheets of Celluloid or similar composition. Such grids, usually of foreign manufacture, have so far as is known been assembled by hand in a very laborious fashion, and are very costly.

The fundamental object of my invention is the provision of a means and method for the manufacture of X-ray grids or of similar products which are inexpensive and rapid while giving accurate and satisfactory results. The problem, in a sense, is one of the machine manufacture of structures of this class; and ancillary objects of my invention will be apparent in the ensuing discussion where the various problems are set forth.

By way of example, it is possible to assemble laminae of lead foil and the like, and laminae of paper or other fabric, saturated in an incompletely cured synthetic resin (e. g. a resin varnish consisting of the incompletely polymerized resin dissolved in a solvent such as water or alcohol). Before assembling, the saturated laminae are dried. In this way a block can be built up in which the layers are accurately formed and accurately spaced. If it were possible to shave this block into layers transversely of the planes of the laminae, theoretically quite excellent X-ray grids could be formed and there would be no essential limitation on their size. Such blocks can easily be produced, but it has not been found possible by any means or procedure of which I am aware to shave these blocks into grids. In any procedure by which the block is cut into layers, the relatively soft foil occurring between other laminae is mashed and distorted, and peened over the edges of adjacent laminae so as to give a structure in which the grid form is interrupted and non-uniform. Attempts to make X-ray grids in this fashion have, therefore, uniformly failed.

In the practice of my invention I produce X-ray grids or like articles by the rapid machine production and assembly of individual laminae, which are positioned between protective covering sheets in ways which I shall hereinafter set forth. The fundamental problems are the machine production of cleanly and accurately cut laminae without separation or displacement of the lead foil, mashing of the lead foil, or accumulation of lead dust or splinters between the laminae and the cover sheets; the rapid machine assembly of laminae on edge, between cover sheets without displacement thereof from the desired position; and the binding of the whole together into a substantially solid mass.

The several objects of my invention I accomplish by that method and in that structure and arrangement of parts of which I shall now set forth a particular exemplary embodiment. Reference is now made to the drawings wherein:

Figure 1 is an elevational view of my machine.

Fig. 2 is a sectional view thereof, taken along the lines 2—2 of Fig. 1.

Fig. 3 is a view of one of the locking members.

Fig. 4 is a plan view of the machine.

Fig. 5 is a longitudinal sectional view taken along the center line of Fig. 4.

Fig. 6 is an enlarged side elevation of an X-ray grid produced on my machine.

In my machine I provide an upper and a lower platen. Interspaced cover sheets are positioned with respect to these platens so that laminae may be assembled therebetween; and between the sheets there rides a compression member. For the laminae, I first make composite sheets by taking one or two layers of paper or the like, saturated in synthetic resin, a layer of lead foil and one or two additional layers of saturated stock, the lead foil being sandwiched between

the other layers. This composite sheet is pressed and cured in the ordinary way for laminated resinous products. The laminae for the X-ray grid are formed by a die-cutting operation of such nature that the die simultaneously cuts both longitudinal edges of the laminations. The laminations cut in this way are pushed through the die in side by side relationship and on edge, whereby they are accurately assembled together in the desired relationship and are pushed, against the resistance of the restraining or compression member, between the two cover sheets. By continued operations of the machine and the feeding to it of composite sheets, as hereinabove explained, the body of assembled laminae between the two cover sheets is produced. There is no essential limitation upon the length of X-ray grids which may be made in this way, nor is there any limitation on the width of the grid other than the maximum width for which the machine is constructed. The two cover sheets are previously coated with a thermoplastic cement which is hard at normal temperatures, but which, when the lower platen (and preferably the upper platen also) are heated, as with steam or the like, will fuse and bind the composite structure together. By the die-cutting operation to which I have referred, spalling and peening of the lead foil layer is prevented; and I keep my dies clean by means of air or other fluid, so that shavings or other pieces of the lead foil will not be incorporated in the grid structure.

Before proceeding to a description of the machine for this purpose, I will first describe an exemplary grid as illustrated in Fig. 6. This grid comprises interspaced cover sheets 4 and 5. Between the sheets there are laminations indicated generally at 6. Each lamination comprises a layer of lead or the like 7 sandwiched between layers 8 and 9 of material transparent to X-rays. In an exemplary embodiment, the over-all thickness of the article may be from .120 to .125 inch, whereas the space between the two cover sheets 4 and 5 may be one-sixteenth of an inch. The total thickness of each lamination may be .020 inch. Each lamination may contain a layer of lead .001 inch in thickness, the remainder of the thickness of the lamination being paper saturated in resin. With the dimensions just given, there will be fifty punchings or laminations per linear inch of the product. It will be understood that the dimensions which I have given are for the sake of a complete exemplary disclosure and do not constitute limitations, since these may be varied as desired. I have hereinabove discussed the matter of limitations as to size. With my particular machine I am currently making X-ray grids 17½ inches by 20½ inches; but larger or smaller ones can readily be made in accordance with my teachings.

In producing the stock for the laminations I ordinarily take two sheets of paper which has been saturated in a resin, as hereinabove set forth. Any of the synthetic resins may be used. Ordinarily I use a phenol formaldehyde resin of the Bakelite type. On these two layers I lay a layer of lead foil, and over this assemble two more layers of the saturated paper. The whole is placed between the usual polished plates in a press and the laminated structure is cured under heat and pressure, as is usual in synthetic resin practice. I do not desire, however, to be limited to laminae containing synthetic resin, since it will be perfectly apparent as the description proceeds that there are many ways of making the composite sheet for the laminations, and that material which is opaque to X-rays and material transparent to X-rays may be adhered together in a wide variety of ways for the uses of this invention.

The general details of the machine will best be appreciated from Fig. 1, where on a base 10 I mount a reciprocating ram 11 bearing a die member 12. This ram may be caused to move in suitable ways, as by an eccentric indicated at 13, having a drive indicated generally at 14. The details of this construction are illustrated, but do not form a limitation upon my invention; and various ways of actuating the ram or the die may be adopted in accordance with the skill and desire of the worker in the art. The machine has cooperating die members indicated generally at 15 and 16, forming together a female die part, the member 12 being a male die part. The die members 15 and 16 are suitably supported in the machine. On a level with the upper surface of the die member 16, the machine has a fixed platen member 17. A movable platen member 18 is hinged as shown at 19, and may be brought down over the fixed platen with a slight interspacing therebetween. The fixed platen may be perforated as at 20 and may have means 21 for the introduction therein of a heating medium, such as steam. While I have not shown the upper platen as heated, and while I have not found it necessary to heat it, yet it will be within the skill of the worker in the art to provide perforations in this platen also, together with flexible connections for the admission of heating fluid. It is well, also, to provide means for cooling the platens after the completion of the formation of the article; and the same or different fluid connections may be employed with suitable valves for the admission of a cooling fluid, such as water. Between the platens there is a compression member 22 which is urged toward the die by a weight 23, through the intermediary of a cable 24 which may be passed over sheaves 25 and 26. I preferably provide a weight 23 on each side of the machine.

The construction of the cooperating parts of the machine will be best understood from Fig. 5, where like parts have been given like index numerals. In this figure the female die members 15 and 16 are shown affixed to blocks 27 and 28, extending across the machine between head members 1a. The blocks 27 and 28 are interspaced as at 29 by approximately the width of the laminae or punchings. The cover sheets 4 and 5 are shown lying respectively against the platen members 18 and 17, and the compression member 22 is shown lying between the cover sheets. The blocks 27 and 28 have curved noses 30 and 31, and the forward ends of the cover sheets 4 and 5 are shown as following the curvature of these noses and being interspaced thereby. The cover sheets are firmly held in position against these noses by locking members 32 and 33. One of these members is shown in detail in Fig. 3. It has a curved edge following generally the contour of the nose, and is slidably mounted in ways in the heads 1a on pins 34. The ways are indicated in dotted lines at 35. A bolt 36, rotatably mounted in the locking member at each end, may be threaded into a threaded perforation in the heads 1a; and the bolts in question may be caused to draw the locking members tight. Fig. 2 may also be referred to for a better understanding of the relationship of these parts. By the locking means aforesaid, the ends of the cover sheets 4

and 5 are firmly held so that these sheets cannot move with the laminations to the left.

I provide vertically extending guide means indicated at 37, for the lamination sheet 6. These guide means serve to carry the lamination sheet downwardly past the female die members 15, 16. Ordinarily I rely on gravity for this; but it does not constitute a departure from the spirit of my invention to provide positive feeding means for the lamination sheet 6, if desired, such as pinch rolls or the like. Below the level of the top surface of the die member 16 I provide a stop 38. It will be noticed that the action of this stop is such as to cause the lamination sheet to cover completely the opening of the female die 15, 16. When the male die 12 is actuated, therefore, it forms a punching by cutting both longitudinal edges thereof. The punching thus formed is forced into the space between the two members 15 and 16; and at each stroke of the male die a portion of the material is lost. I have found that by forming my laminae of punchings which are simultaneously cut on both longitudinal edges, I obviate the difficulties hitherto encountered with spalling or speening of the lead foil, or separation of layers and the like. The loss of the waste material is relatively unimportant. In order to keep the dies clean, I provide fluid means 39 through which a continuous or intermittent blast of air is caused to blow from the die surfaces any splinters or fragments of material adhering thereto. By the successive operation of the male die 12 and the continuous feeding of the lamination sheet 6, a succession of laminae builds up in the space between the blocks 27 and 28 in the desired order, and correctly assembled on edge. As the assembly grows it passes out between the noses 30 and 31 of the blocks and enters the space between the cover sheets 4 and 5, displacing the compression member 22. The operation which I have just described is continued until the desired space between the cover sheets 4 and 5 is filled up with the correctly assembled laminae, the laminae moving progressively to the left. The actual space between the cutting edges of the die members 15 and 16 is slightly less than the space between these members elsewhere and between the blocks 27 and 28. This is to say that beyond their cutting edges the members 15 and 16 and the blocks referred to are slightly relieved. As is well known, a punching is laterally compressed as it passes through the die and slightly expands thereafter. The space between the dies 15 and 16 between the block is such as to keep the laminae in assembled relationship; but the laminae cannot pass to the right and come out through the female die construction, for reasons which are now apparent.

Previous to placing the cover sheets 4 and 5 in my machine I have coated the surfaces thereof with a thermoplastic cement. I am not limited to any particular material for the cover sheets, and may use any desired fabric web or sheet including, but without limitation, Celluloid or any molded clear plastic. However, I have been using in practice cover sheets made up of a series of laminations of paper saturated in an incompletely polymerized resin, for example, Bakelite, or one of the urea resins, and pressed and cured in the usual way. The thermoplastic cement which I have been employing is a so-called Bakelite cement or other similar product available on the market and believed to consist largely of a rubber resin dissolved in a suitable volatile organic solvent. Such a cement dries hard, but retains, for very long periods at least, its thermoplasticity and can be softened by heat. The nature of the thermoplastic cement is, however, not a limitation on my invention.

During the operations aforesaid, the upper platen 18 is in the lowered position as shown in Fig. 5. This platen may be held down by its own weight and the bolts illustrated at 40 used to interspace it from the lower platen; or the bolts or other suitable means may be employed to clamp the upper platen to the lower platen. At the conclusion of the operations aforesaid and when the desired assembly of laminations has been made between the cover sheets 4 and 5, I apply heat to one or both of the platens so as to fuse the thermoplastic material and bind the whole structure into one integral mass. The compression member 22 serves to keep the laminae in proper assembled relationship. I have found it advisable, however, during the pressing and curing stage to wedge the compression member 22 to the right by inserting wedges between it and the standard 41 which supports the outer end of the fixed platen 17 and the ears 22*a* of the compression member. Also during the curing stage I prefer to bring the die 12 to rest in its forward position, i. e. in the position in which it lies between the members 15 and 16, in order to prevent any possibility of displacement of the laminae in this direction.

When the grid structure has been built up in the way described, and is cooled and solid, the edges are trimmed as may be desired. The whole may be placed in a suitable frame, or may be given a metal binding.

Modifications may be made in my invention without departing from the spirit of it.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A mechanism for the manufacture of X-ray grids or similar articles comprising upper and lower platens, means for anchoring cover sheets so that said sheets respectively lie against said platens with a space between, and punch means for cutting laminations and for directing said laminations on edge in assembled relationship between said cover sheets, and moving them on edge between the said stationary cover sheets as said assembly grows.

2. A mechanism for the manufacture of X-ray grids or similar articles comprising upper and lower platens, means for anchoring cover sheets so that said sheets respectively lie against said platens with a space between, and punch means for cutting laminations and for directing said laminations on edge in assembled relationship between said cover sheets and moving them on edge between the said stationary cover sheets as said assembly grows, and means for heating at least one of said platens whereby the composite article may be bound together by adhesive of thermoplastic character previously placed upon said cover sheets.

3. In a machine of the character described, a frame, a hollow die in said frame, a platen connected with said frame at the level of the hollow in said die, means in connection with said platen and said die for anchoring a cover sheet, a punch operable in connection with said die to form punchings and to cause said punchings to pass through said die in assembled relationship and to be led against said cover sheet, and means for operating said punch means.

4. In a machine of the character described, a

frame, a die in said frame consisting of spaced female members, mounting means for said die members, a male die, means for reciprocating said male die, means for feeding material in front of said male die, and stop means for causing said material at each feeding motion to be fed beyond the opening between said female die members, whereby during the punching operation a punching is made by simultaneously shearing both sides thereof.

5. In a machine of the character described, a frame, a die in said frame consisting of spaced female members, mounting means for said die members, a male die, means for reciprocating said male die, means for feeding material in front of said male die, stop means for causing said material at each feeding motion to be fed beyond the opening between said female die members, whereby during the punching operation a punching is made by simultaneously shearing both sides thereof, and fluid pressure means for keeping said die members clean during repeated punching operations.

6. In a mechanism of the character described, a male die for cutting laminations and moving them in a direction transverse to their planes, means for reciprocating said die, spaced female die members, blocks for supporting said members leaving a passageway between, a platen at the level of one of said die members, a curved nose on the block supporting said die member along the surface of which a cover sheet may be placed, and means for locking said cover sheet to said nose, whereby a series of punchings produced by said die means, may be caused to pass through said passageway in assembled relationship and to lie against said cover sheet on said platen.

7. In a mechanism of the character described, a male die for cutting laminations and moving them in a direction transverse to their planes, means for reciprocating said die, spaced female die members, blocks for supporting said members leaving a passageway between, a platen at the level of one of said die members, a curved nose on the block supporting said die member along the surface of which a cover sheet may be placed, means for locking said cover sheet to said nose, whereby a series of laminations produced by said die means, may be caused to pass through said passageway in assembled relationship and to lie against said cover sheet on said platen, a second platen adapted to be spaced from the first, a nose on the second block and locking means for fastening a cover sheet thereto as hereinabove set forth, and means between said platens and lying between said cover sheets for exerting pressure on said assembly of laminations against its direction of movement.

8. In a machine of the character described, a frame, a ram reciprocable in said frame, a male die on said ram for cutting laminations and moving them in a direction transverse to their planes, stationary blocks in said frame, spaced female die members having a passageway therebetween, means for anchoring cover sheets to said blocks, spaced platen means lying on the outer side of said cover sheets and means for feeding material to be sheared to said dies, whereby a series of laminations is made by punching, passing progressively through said passageway and being positioned between said cover sheets.

9. In a machine of the character described, a frame, a ram reciprocable in said frame, a male die on said ram for cutting laminations and moving them in a direction transverse to their planes, stationary blocks in said frame, spaced female die members having a passageway therebetween, means for anchoring cover sheets to said blocks, spaced platen means lying on the outer side of said cover sheets and means for feeding material to be sheared to said dies, whereby a series of laminations is made by punching, passing progressively through said passageway and being positioned between said cover sheets, said means for feeding comprising guideways for said material to be punched, said die means being adapted to punch said sheet material across the width thereof, and stop means adapted to cause said feeding means to feed material over and beyond the space between said female die members, whereby said punchings are made by the simultaneous shearing of both edges thereof.

10. In a machine of the character described, a frame, a ram reciprocable in said frame, a male die on said ram for cutting laminations and moving them in a direction transverse to their planes, stationary blocks in said frame, spaced female die members having a passageway therebetween, means for anchoring cover sheets to said blocks, spaced platen means lying on the outer side of said cover sheets and means for feeding material to be sheared to said dies, whereby a series of laminations is made by punching, passing progressively through said passageway and being positioned between said cover sheets, said means for feeding comprising guideways for said material to be punched, said die means being adapted to punch said sheet material across the width thereof, and stop means adapted to cause said feeding means to feed material over and beyond the space between said female die members, whereby said laminations are made by the simultaneous shearing of both edges thereof, and fluid pressure means for keeping said dies clean.

11. In a machine of the character described, a frame, a ram reciprocable in said frame, a male die on said ram for cutting laminations and moving them in a direction transverse to their planes, stationary blocks in said frame, spaced female die members having a passageway therebetween, means for anchoring cover sheets to said blocks, spaced platen means lying on the outer side of said cover sheets and means for feeding material to be sheared to said dies, whereby a series of laminations is made by punching, passing progressively through said passageway and being positioned between said cover sheets, said means for feeding comprising guideways for sheet material to be punched, said die means being adapted to punch said sheet material across the width thereof, and stop means adapted to cause said feeding means to feed material over and beyond the space between said female die members, whereby said laminations are made by the simultaneous shearing of both edges thereof, and compression means for restraining an assembly of laminations in the direction of their motion.

12. A process of making an X-ray grid which comprises joining a layer of X-ray impermeable material to at least one lamina of X-ray permeable material so as to produce a stiff, self-sustaining composite, capable of being punched into laminations, forming a series of punchings from said composite between female die members forming a throat, by the action of a male

die member whereby said punchings are cut singly and are moved through said throat in a growing assembly with the planes of the punchings transverse to their direction of motion in said throat, and as said assembly grows restraining the movement thereof so as to compress said assembly in the direction of its motion.

13. A process of claim 12 in which the X-ray permeable lamina of said composite material for punching is a sheet material saturated in a synthetic resin and pressed and cured in combination with said X-ray impermeable layer whereby to form a stiff composite.

14. The process of claim 12 in which prior to each punching operation said composite is passed across and beyond said female dies so that both edges of each punching are sheared in the same punching operation.

15. The process of claim 12 in which prior to each punching operation said composite is passed across and beyond said female dies so that both edges of each punching are sheared in the same punching operation and in which said composite comprises a layer of metal foil and at least one lamina of fibrous material treated with a synthetic resin and pressed and cured against said metal foil.

16. The process claimed in claim 12 involving the movement of said assembly between X-ray permeable cover sheets which are stationary during said movement, until a sufficient portion of said assembly has been moved between said cover sheets to form an X-ray grid, and involving the subsequent adhesion of said cover sheets to said assembly positioned therebetween.

17. The process claimed in claim 12 involving the movement of said assembly between X-ray permeable cover sheets which are stationary during said movement, until a sufficient portion of said assembly has been moved between said cover sheets to form an X-ray grid, and involving the subsequent adhesion of said cover sheets to said assembly positioned therebetween, said stationary cover sheets being coated with a non-tacky thermo-plastic adhesive during the movement of said assembly and said adhesion being accomplished by heat.

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