Aug. 6, 1957 E. W. VAUGHN ET AL 2,801,671

MANUFACTURE OF X-RAY APPARATUS

Filed Aug. 29, 1955 2 Sheets-Sheet 1

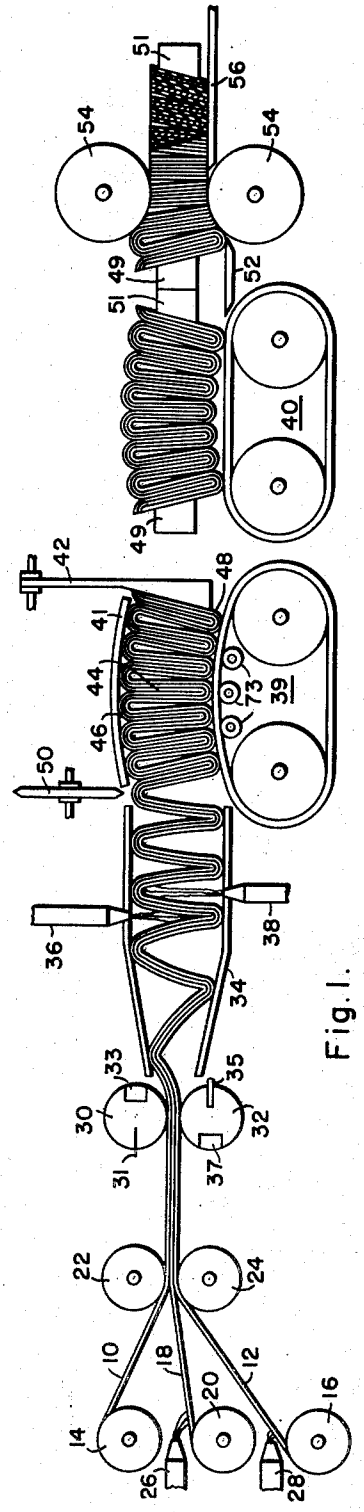


Fig. 1.

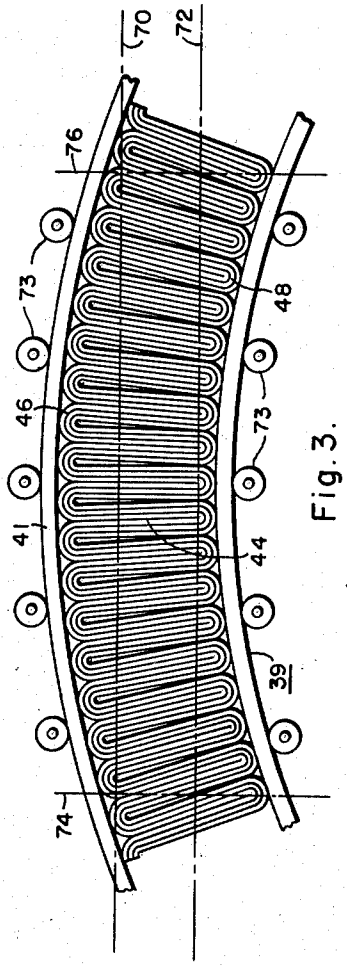


Fig. 3.

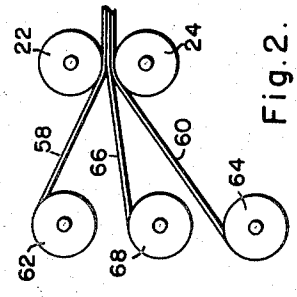


Fig. 2.

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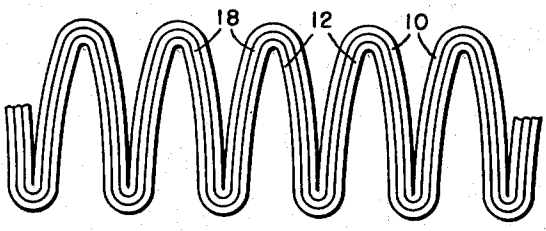


Fig.4.

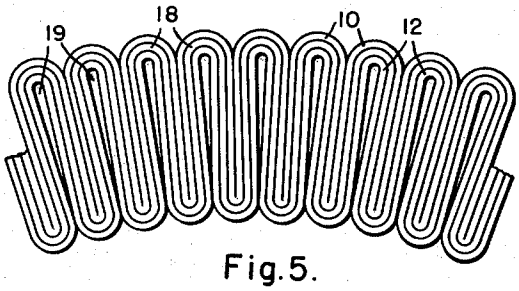


Fig.5.

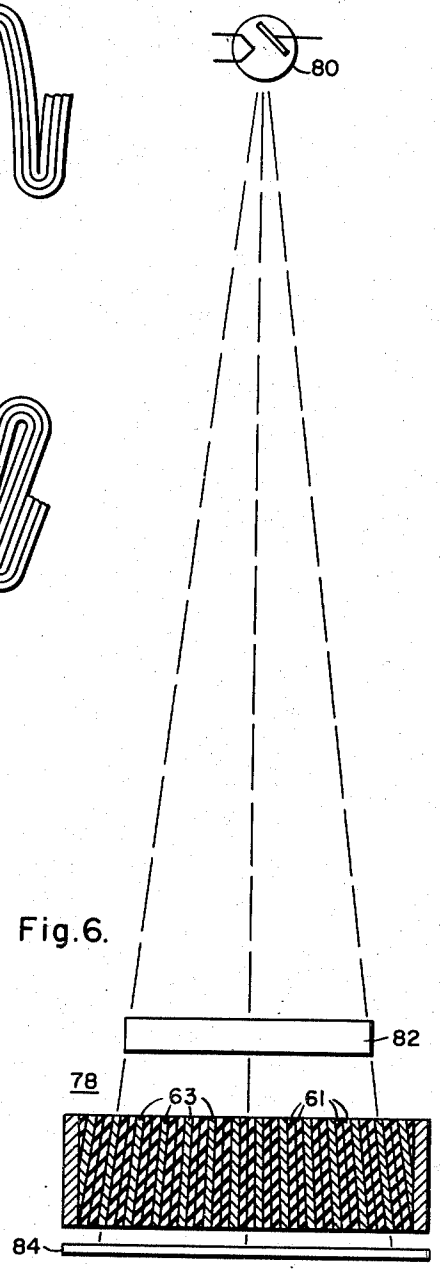


Fig.6.

WITNESSES

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MANUFACTURE OF X-RAY APPARATUS

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The present invention relates to the manufacture of X-ray apparatus and more particularly relates to the method and apparatus for the manufacture of focused X-ray diaphragms or Bucky grid.

It is an object of the present invention to provide improved X-ray diaphragms, and an improved method and apparatus for manufacturing such X-ray diaphragms.

It is another object of this invention to provide improved focused X-ray diaphragms or Bucky grids.

It is a further object to provide an improved method of making X-ray diaphragms using the inherent characteristics of the material employed to make the diaphragms to facilitate their manufacture.

It is a different object to provide an improved method for making X-ray diaphragms such that by differential treatment of the materials employed better spacing and alignment of the diphragm elements or portions will result.

It is an additional object to provide an improved focused X-ray grid or diaphragm, with the focal length of the grid being predetermined as desired.

These and other objects of the present invention will be apparent upon reading the following description taken in connection with the drawings in which:

Figure 1 is a schematic diagram showing the method and apparatus employed in accordance with the present invention;

Fig. 2 is a modification of a portion of Fig. 1;

Fig. 3 illustrates in more detail a portion of Fig. 1;

Fig. 4 illustrates the shaping or folding of the strips of X-ray pervious and impervious materials in accordance with the invention;

Fig. 5 illustrates the compressed sandwich structure including the folds of X-ray pervious and X-ray impervious materials; and

Fig. 6 shows a completed X-ray diaphragm and its manner of operation in accordance with the present invention.

In Fig. 1 there is shown the method and apparatus for the manufacture of focused X-ray diaphragms or Bucky grids. Initially, continuous strips or sheets **10** and **12** of X-ray transparent or pervious material such as paper are supplied by a pair of rolls **14** and **16**. An intermediate sheet **18** of X-ray opaque or impervious material such as lead is supplied from a roll **20** which is positioned between the other rolls **14** and **16**. The strips or X-ray transparent material **10** and **12** and the strip of X-ray opaque material **18** shown in Fig. 1 are supplied to positioning means comprising a pair of compression rollers **22** and **24** which compress the outer sheets of transparent material **10** and **12** against the inner sheet **18** such that these sheets or strips are contiguous to each other. Adhesive material may be provided between the first sheet **10** of transparent material and the sheet **18** of X-ray opaque material by means of a suitably positioned adhesive supply member **26**. Similarly, adhesive material may be provided between the sheet **18** of X-ray opaque material and the sheet **12** of X-ray transparent material by a second adhesive supply member **28**. The positioning rollers **22** and **24** position the sheets of X-ray opaque material and X-ray transparent material such that they are substantially contiguous in position. The latter contiguous sheets are then passed between a pair of shaping or forming members **30** and **32** which corrugate or pleat the contiguous sheets of X-ray opaque material and X-ray transparent material to form a multiple number of pleated folds which are doubled back as shown in Fig. 1. The shaping wheel **30** includes a shaping member **31** and a resilient insert member **33**. The shaping wheel **32** includes a shaping member **35** and a resilient insert section **37**. The shaping member **31** is illustrated as being smaller in size than the shaping member **35** such that it effectively folds the sheets of X-ray opaque material and X-ray transparent material on a fold having a smaller radius than do the folds formed by the shaping member **35**. In accordance with the present invention, the shaping members **31** and **35** may be given any desired predetermined form to provide the desired folding or pleating operation of the contiguous sheets or strips of X-ray opaque and X-ray transparent material which are passed between the shaping wheels **30** and **32**.

Suitable support or holder members **34** are positioned to receive the corrugated or pleated strips of material as they are fed away from the pair of shaping wheels **30** and **32**. Suitable adhesive supplying nozzles **36** and **38** may be provided to apply adhesive between the respective folds of the corrugated sheets. In this respect the nozzle **38** or an additionally provided nozzle may be operative to supply a filler material between the larger radius folds of the corrugated or pleated strips. A conveyor or like member **39** is provided to support and form a sandwich or compressed structure having the arcuate shape of the conveyor member **39**. The conveyor or like member **39** compresses the corrugated or pleated strips against a stop member **42**. The compressed sandwich structure may be thought of as having an intermediate portion **44** where the strip sections are substantially radial relative to each other and having outer fold portions **46** and **48** where the strip sections are folded over or bent back on themselves as shown. The outer fold portions **46** may have a smaller or larger fold radius than the outer fold portions **48** due to the difference in the shape of the shaping members **31** and **35** on the respective shaping wheels **30** and **32**.

A suitable cutting member **50** may be provided to cut the compressed sandwich structure into a finite diaphragm structure or section after which the stop member **42** may be removed from the path of the diaphragm section such that it can move along to another conveyor member **40**. The diaphragm section may be held between end support or compression members **49** and **51**, and passed through any necessary subsequent treatment operations such as between a pair of machining or grinding members **54** to remove the outer fold portions **46** and **48** from the intermediate portion **44** or any other desired portions of the diaphragm section to form a finite sandwich section having predetermined dimensions as desired. Additional support or conveyor members **52** and **56** may be provided, if desired.

It is to be understood that additional cutting members similar to cutting member **50** may be provided to determine the width of the diaphragm section as desired or the sheets or strips of X-ray opaque and X-ray transparent material as employed may have a predetermined width corresponding to the desired width of the diaphragm section.

In Fig. 2 there is shown a modification of the supply rollers for supplying sheets of X-ray transparent and X-ray opaque material to the combination rollers **22** and **24**. In Fig. 2 there is illustrated two strips of X-ray opaque material **58** and **60** which are supplied from supply rolls **62** and **64**. An intermediate sheet of X-ray trans-

parent material 66 is supplied from roller 68. The method of manufacture and apparatus following the compression rollers 22 and 24 would be similar to that shown in Fig. 1 following the corresponding combination rollers.

In Fig. 3 there is shown the compressed sandwich structure having an arcuate shape corresponding to the arcuate shape of the conveyor member 39 as shown in Fig. 1. Since the corrugated or pleated strips have been compressed between the curved or arcuate shaped conveyor 39 and the form 41, the strip sections between the folds are substantially radial in position relative to each other with a focal length corresponding to the radius of curvature of the conveyor 39. It is within the teachings of the present invention to vary or change the curvature of the conveyor 39 and associated form 41 to provide any desired focal length focussed X-ray grid section, and the support rollers 73 have been provided in this respect.

If a planar or flat focused diaphragm is desired, the arcuate shaped sandwich structure can be machined or formed along suitable lines 70 and 72, such that the outer fold portions 46 and 48 respectively are removed. The resultant sandwich structure can be cut along the lines 74 and 76 to provide a finite diaphragm section having predetermined dimensions and which is flat in shape and focused as desirable for a focused X-ray diaphragm or grid. In addition, the latter finite diaphragm section can be sawed or cut into a plurality of thinner planar sections to make a plurality of such grids, if desired.

In Fig. 4 there is shown in greater detail the resultant shaping of the contiguous strips of X-ray opaque and X-ray transparent material due to the operation of the shaping wheels 30 and 32. The smaller radius which can be varied in shape practically from a sharp crease as illustrated to any desired dimension is provided by the shaping member 31 of the shaping wheel 30. The larger radius is provided by the shaping member 35.

In Fig. 5 there is shown the compressed sandwich structure including the filler material 19, if desired, positioned between the strip sections formed by the larger radius folds.

In Fig. 6 there is shown the completed X-ray grid or diaphragm 78 as manufactured in accordance with the method and apparatus shown in Fig. 1 with an X-ray tube 80 shown in operative position relative to the diaphragm 78 and between the object or patient 82 to be X-rayed and the film or like member 84 for responding to the X-rays.

In the operation of the apparatus shown in Fig. 1, the sheets 10 and 12 of X-ray transparent material are fed with the intermediate sheet 18 of X-ray opaque material between the pair of compression rollers 22 and 24 which position these sheets contiguous to each other. Subsequently, the contiguous sheets are passed between the shaping wheels 30 and 32 which corrugate or pleat the contiguously positioned sheets such that the shaping member 31 of the shaping wheel 30 in conjunction with the resilient section 37 of the shaping wheel 32 provides a first radius fold or bend in the contiguous strips and the shaping member 35 of the shaping wheel 32 in conjunction with the resilient section 33 of the shaping wheel 30 provides a second and larger radius fold or bend in the contiguous strip material. The shaping wheels 30 and 32 operating in conjunction with the conveyor member 39 compress the corrugated or pleated strips into a compressed sandwich structure against the stop member 42. Then the cutting member 50 is operative to cut the compressed sandwich structure into a finite diaphragm section and the stop member 42 is removed to allow this finite diaphragm section to pass on to the second conveyor member 40 and through any additional treatment operations such as between the pair of machining or sanding rollers 54. The final product as placed on the support member 56 is an X-ray diaphragm or Bucky grid having predetermined dimensions as desired and made up of alternate strip sections of X-ray impervious material 53 and X-ray pervious material 51. This X-ray diaphragm is focused in nature and is operative with an X-ray source as shown in Fig. 6 which is preferably positioned at substantially the radial center of the arcuate shape of the conveyor 39 as shown in Fig. 1.

Fig. 2 illustrates the modifications of the strip material arrangement which may be provided as desired. Fig. 4 illustrates the shaping operation of the shaping wheels 30 and 32 and Figs. 3 and 5 illustrate the operation of the conveyor member 39 and its associated form member 41 in combination with the stop member 42 to provide a compressed sandwich structure having an arcuate shape with a curvature radius corresponding to the desired focal length of the final X-ray diaphragm or grid.

Although specific embodiments of the present invention have been shown and described, it is to be understood that still further modifications thereof may be made without departing from the spirit and scope of the invention. In this respect the final X-ray diaphragm or grid for practical use may require a support frame to protect it from damage and distortion, and further may require face sheets of X-ray transparent material such as a suitable plastic or aluminum.

We claim as our invention:

1. In a method of making an X-ray diaphragm comprising alternate strip sections of X-ray transparent material and X-ray opaque material, the steps of positioning a strip of the first material contiguous to a strip of the second material, corrugating the contiguous strips of said first and second materials to form a pleated first structure having alternate first and second folds, with said first fold having a smaller radius than said second fold, and compressing said pleated structure into a sandwich structure having an arcuate shape.

2. The method of making an X-ray diaphragm including alternate sections of X-ray transparent material and X-ray opaque material comprising the steps of positioning a strip of the first material contiguous to a strip of the second material, pleating said contiguous strips to form a pleated first structure having alternate first and second folds, with each of said first folds having a smaller radius than each of the second folds, and compressing said pleated structure into a second sandwich structure having an arcuate shape.

3. The method of claim 1 characterized by the step of inserting a filler material into each of the second folds.

4. In apparatus for making an X-ray diaphragm including alternate strip sections of X-ray pervious first material and X-ray impervious second material, the combination of a positioning member for positioning a strip of the first material contiguous to a strip of the second material, a pleating member for forming the contiguous strips of the said first and second material into a pleated first structure having first folds and second folds, each of the first and second folds having a radius, with the radius of the first folds being smaller than the radius of the second folds, and a compression member for compressing the pleated first structure into a sandwiched second structure, with the pleating member being positioned between the positioning member and the compression member.

5. The apparatus as claimed in claim 4, with a filler supply member positioned between the pleating member and the compression member for supplying a filler material into each of the second folds.

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