June 20, 1967 E. E. GOLDSTEIN 3,325,859

APPARATUS FOR MAKING RIGID MINERAL FIBER PANELS

Filed Dec. 4, 1961 2 Sheets-Sheet 1

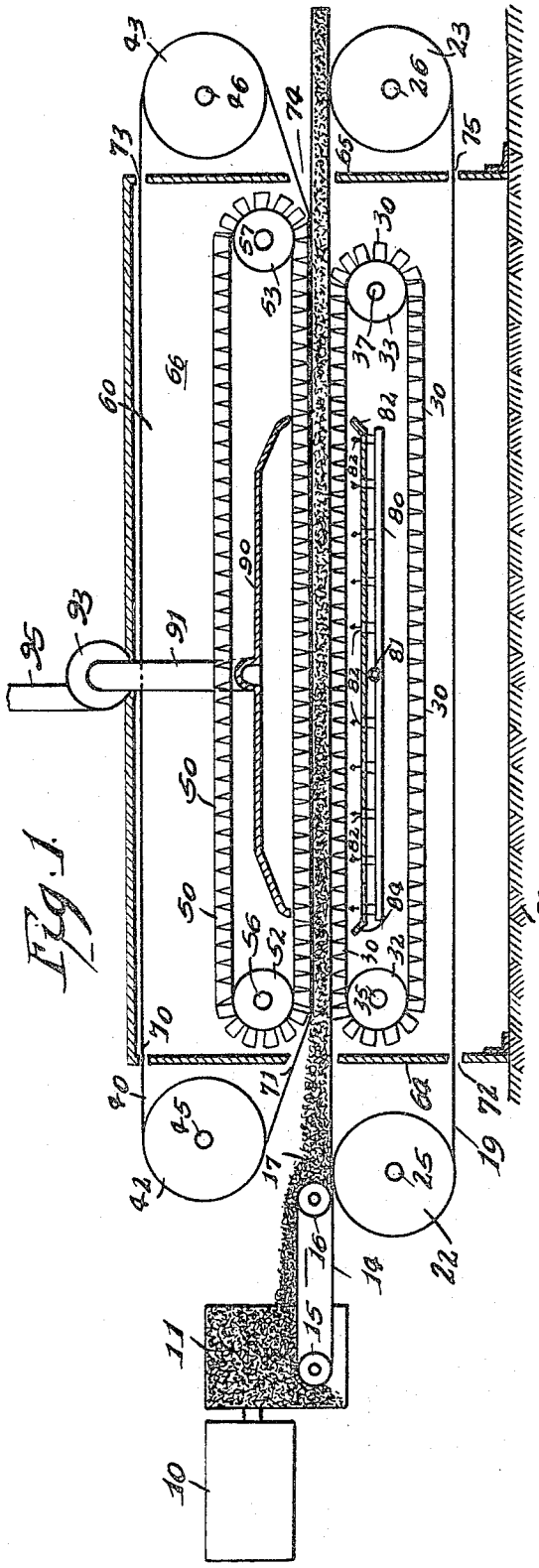


Fig. 1.

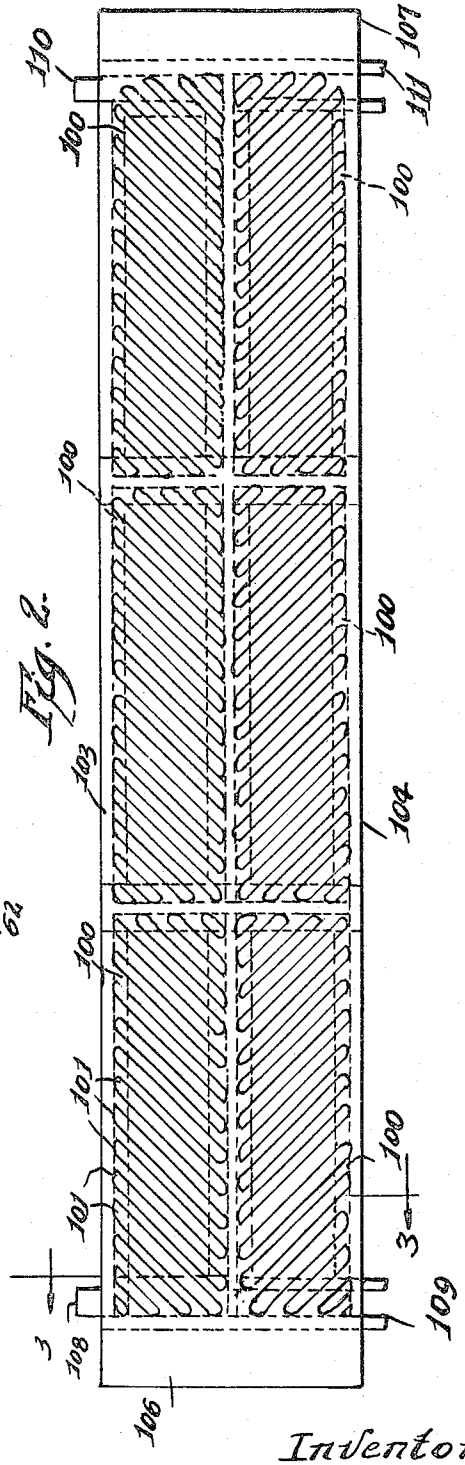


Fig. 2.

Inventor.
Eugene E. Goldstein.
By. James W Grace
Attorney.

June 20, 1967 E. E. GOLDSTEIN 3,325,859

APPARATUS FOR MAKING RIGID MINERAL FIBER PANELS

Filed Dec. 4, 1961 2 Sheets-Sheet 2

Fig. 3

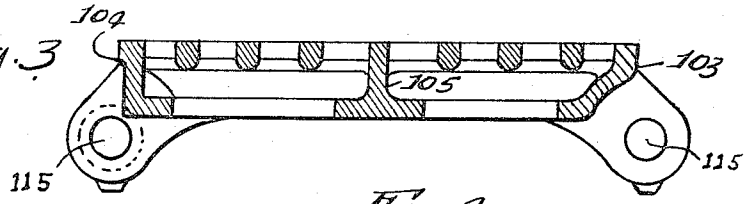


Fig. 4.

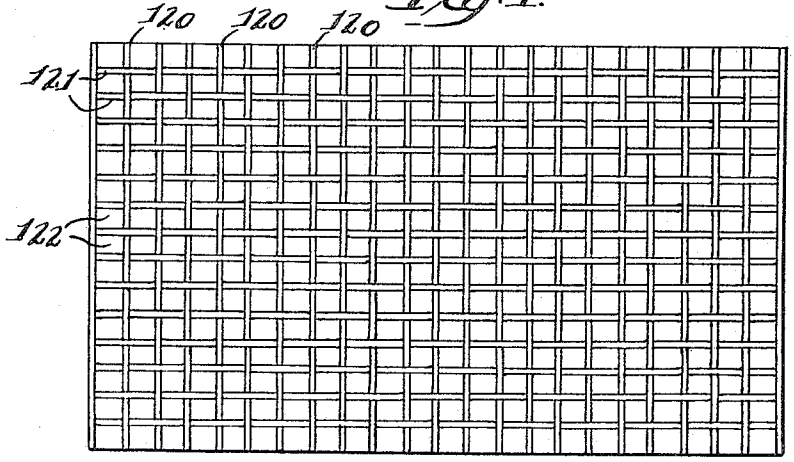


Fig. 5.

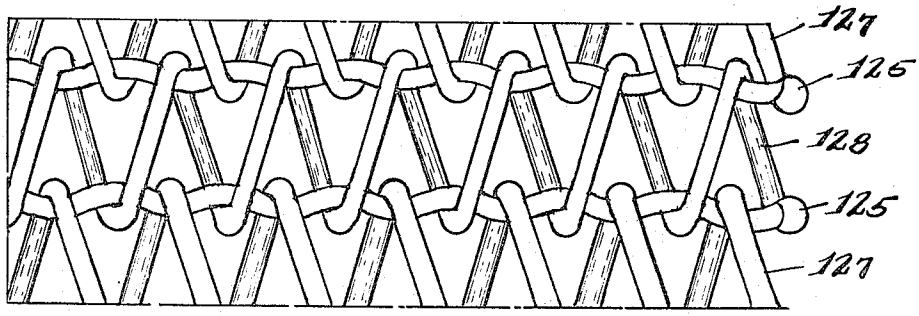
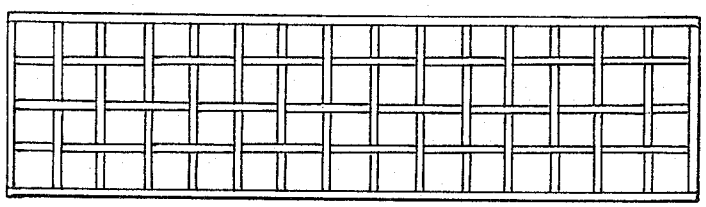


Fig. 6.



Inventor.
Eugene E. Goldstein.
By. James W Grace
Attorney.

United States Patent Office 3,325,859
Patented June 20, 1967

3,325,859
APPARATUS FOR MAKING RIGID MINERAL FIBER PANELS

Eugene E. Goldstein, Chicago, Ill., assignor to The Celotex Corporation, a corporation of Delaware

Filed Dec. 4, 1961, Ser. No. 156,773
2 Claims. (Cl. 18—4)

This invention pertains to an apparatus for making rigid mineral fiber panels and more particularly to an apparatus for making such panels comprising an inorganic fiber and a resin binder.

Rigid panels comprising inorganic fibers, such as interfelted mineral wool fibers, with a thermosetting or thermoplastic binder are desirable for installation in ceilings. These panels are preferably larger in size than the conventional 12" x 12" acoustical tile. Panels up to 4' x 8' or larger are preferred since they are more economical to install and require less handling than the smaller acoustical tiles. The appearance of such panels may be enhanced by laminating a thin sheet of glass mat to one surface and painting the mat. The lamination of a thin sheet of glass mat to the basic panel also increases its strength.

While such rigid panels may be made from a variety of inorganic fibers, such as textile glass fibers, mineral wool fibers, asbestos fibers, etc., for convenience, rigid panels manufactured from mineral wool fibers will be considered specifically.

One disadvantage of such large panels lies in achieving sufficient strength so that they have a high resistance to breakage and deflection. Deflection of the panel through lack of strength results in an unsightly ceiling having a wavy or undulating appearance. Large panels require a greater integrity and strength than smaller ones.

The large rigid panels are manufactured by incorporating a suitable resin binder with inorganic fibers, such as mineral wool fibers, and then curing the formed mat in an oven to set the resin. Improvements in the strength of such panels must be made by economical changes in the apparatus for their manufacture. It is also important that such improvements in the apparatus do not unduly complicate existing machinery and require additional maintenance.

It is an object of the present invention to provide a novel apparatus for manufacturing rigid panels.

It is another object of the present invention to provide an improved apparatus for manufacturing rigid panels without elaborate and costly modifications of existing equipment.

It is yet another object of the present invention to provide a novel, improved apparatus for manufacturing rigid panels which does not require undue maintenance time or expense.

These and other objects of the present invention will become more apparent to those skilled in the art when considered in relation to the preferred embodiments as set forth in the specification and shown in the drawings in which like numerals indicate like elements, and in which:

FIGURE 1 is an elevational view of the improved apparatus of the invention;

FIGURE 2 is a top plan view of a portion of the apparatus;

FIGURE 3 is a cross-sectional view of a portion of the apparatus taken along lines 3—3 of FIGURE 2;

FIGURES 4 and 5 are plan views of embodiments of a portion of the apparatus of FIGURE 1, and

FIGURE 6 is a plan view of a screen used in the apparatus of FIGURE 1.

Referring now to the drawings and particularly to

FIGURE 1 thereof, mineral wool is made by a fiberizing device **10**, herein shown as a box inasmuch as the specific apparatus for fiberizing the fibers may be of any conventional type. For example, it may comprise a rotor which divides a molten stream of slag into many fine streams which are then attenuated into long mineral wool fibers by means of a blast of steam.

During the fiberizing process, a suitable thermosetting resin is blown onto the mineral wool fibers. This may be done by spraying the resin through nozzles pointed at the fibers as they are formed. Alternatively, the resin may be introduced through a pipe in the rotor shaft and sprayed on the fiberized mineral wool as it is formed.

The thermosetting resin, which may be a suitable phenolic or phenol formaldehyde type of resin, is partially set prior to application and its final set occurs in the oven, which will be described in detail hereinafter.

The mixture of mineral wool and resin is blown into a collection chamber **11** and is collected upon a conveyer belt **14**. Conveyer belt **14** is mounted on rollers **15** and **16** and is driven in the direction of the arrow to deposit the mixture of mineral wool and thermosetting resin in the form of a mat **17** on the top of screen **19**. Screen **19** is mounted on rollers or drums **22** and **23** which are journaled on shafts **25** and **26**, respectively. Motor means not shown are connected to journals **25** and **26** to provide for movement of screen **19**.

Screen **19** is supported in a horizontal plane over the major portion of its upper length by interlocking flights or platens **30**, shown in greater detail in FIGURES 2 and 3. The flights are driven by chains (not shown) connected to the outer lower ends of the flights **30**. The chains and flights are mounted on rollers **32** and **33**, which are journaled on shafts **35** and **37**, respectively. Any conventional sprockets and chain arrangement may be used for such mounting. A suitable drive means (not shown) is connected to shafts **35** and **37** to drive the rollers **32** and **33**.

Mounted above and spaced from the screen **19** and flights **30** is a second screen **40**, which is mounted for movement on rollers or drums **42** and **43**. Rollers **42** and **43** are mounted for rotation on shafts **45** and **46** which are driven by conventional drive means (not shown). To provide a non-resistant backing for screen **40**, a series of flights or platens **50**, similar to flight **30** are mounted above screen **40** around drums **52** and **53** which in turn are journaled on shafts **56** and **57**, respectively.

The combination of the screens **19** and **40** and their supporting flights **30** and **50** form a press in which the thickness of the mat **17** is reduced from a semi-controlled thickness to approximately its final thickness. For example, the thickness of mat **17** as it enters the nip of screens **19** and **40** may be about 6 inches. The spacing between the screens **19** and **40** may be adjusted to reduce the thickness of the mat to about ⅞". The relative spacing of flights **30** and **50** is adjustable so that any desired thickness of the final mat can be achieved.

To provide for setting the resin in the mat **17**, the press section is located within an oven **60** shown in cross section. The oven is mounted on a base **62** and comprises four sides, of which only sides **64**, **65** and **66** are shown. The sides of the oven **60** have suitable openings **70–75** for the introduction and egress of screens **19** and **40** and the mat **17**.

A manifold **80** having an inlet pipe **81** and outlet pipe **82** is mounted below flights **30**, which are slotted to permit flow of hot air therethrough. Hot air under a slight pressure from a suitable source (not shown) is introduced into inlet pipe **81**. A hood **90** connected to an exhaust pipe **91** overlies the manifold **80** to draw off

the excess air which has penetrated the mat and to provide for suction through flights **50**. A suitable fan or air pump **93** is provided in exhaust pipe **91**. Exhaust air is ejected to the atmosphere through stack **95**.

The operation of the apparatus thus far described is as follows:

The mat **17** is first formed by the fiberizing of mineral wool and the incorporation therein of partially cured thermosetting resin. As the mat **17** is conveyed into opening **71** by screen **19**, it may be about 6 inches thick. This mat **17** is then compressed between screen **19** and **40** to about its finally desired thickness which may, for example, be ⅞". As the mat **17** is further moved through the screen oven **60**, it is held in compression by the flights **30** and **50** and the screens **19** and **40**. While held in this state, hot air at a temperature of about 500° F. is introduced into the mat through manifold **80** and flights **30**. The mat is conveyed through the oven at a speed of about 10 feet per minute. The speed at which the mat is conveyed may be adjusted depending upon the curing rate of the resin and the density of the mat. Speeds up to 50 feet per minute can be achieved.

Following the setting of mat **17** in the oven, it is then fabricated by being cut to suitable size by conventional saws. It may then be painted and packed for shipment.

The individual flights **30** and **50** are identical and are shown in greater detail in FIGURES 2 and 3. A typical flight may be of cast iron or other suitable metal capable of resisting distortion. The flight **30** has a rectangular upper cast face having sets **100** of slots **101** cut therethrough at an angle of about 45° with respect to the length of the flight. Slots **101** provide for movement of hot air through the flight **30**. For strength, the flight **30** has two depending flanges **103** and **104** and a central rib **105**. The major under surface of the flight is open to receive hot air from manifold **80**. End plates **106** and **107** are cast integrally to the flanges **103** and **104** to complete the cast frame and surface of the flights. Lugs **108–111** are cast integrally with the flanges **103** and **104** and extend downwardly and outwardly. Lugs **108–111** are drilled as at **115** to provide a means of locking of successive flights to keep the flights in adjacency and move the flights in unison. The locking arrangement also keeps the upper faces of adjacent flights in the same horizontal plane. Lugs **108** and **110** are in the form of single fingers. Lugs **109** and **111** are in the form of two spaced fingers. The single fingers of one flight are inserted between the space fingers of the next adjacent flight and a pin is inserted in holes **115** to secure the flights in uniform fit.

With reference to the screens **19** and **40**, various types of such screens are shown in FIGURES 4–6. FIGURE 6 shows a short section of a screen having a mesh of 4 x 4. The term "mesh" means the number of holes or interstices per linear inch. Thus, a screen having a mesh of 4 x 4 means that the screen has four interstices per inch in each direction. A screen having a mesh of 4 x 6 means that the screen has four interstices per linear inch in a direction and six interstices per linear inch in the other direction. In the ensuing discussion of the effect produced by different screens on the strength of the cured mat, the screen having a mesh of 4 x 4 will be considered to be a coarse screen.

The screen shown in FIGURE 4 is an enlarged view of a screen having a mesh of 14 x 16. The wires **120** and **121** are interwoven to provide interstices **122** which permit the flow of hot air through the screen. A screen of this type uniformly compresses the mineral wool fibers and leaves a rather uniform pattern of small bosses, corresponding to the interstices of the screen, on the surface of the mat after its cure.

An alternative type of screen is shown in FIGURE 5. This screen is referred to as having a balanced weave design in which spaced sinuous wires **125** extend across the screen to lock together the adjacent loops of helically wound wires **127** and **128**. Thus the loops of helically

wound wire **127** alternate with the loops of helically wound wire **128**. The term "mesh" is not directly applicable to this design, so a different system of mesh designation is used. In this system of mesh designation, the letter "B," to indicate balanced weave design, precedes a code number. The first numerals of the code number designate the number of loops of helical wires **127** and **128** in twelve inches of belt width. The second indicates the number of sinuous wires **125** in twelve inches of belt length. The last numeral indicates the wire gauge. For example, a screen of this type manufactured by the Ashworth Brothers, Inc., of Winchester, Va., designated B–84–84–17, is one which has eighty-four loops of helical wires **127** and **128** across twelve inches of belt with eighty-four sinuous wires **125** in twelve inches of belt length. The wire is 17 gauge, or its diameter is 0.054 inch. A screen having the designation B–84–84–17 was used in making a rigid panel.

The strength of the rigid panel is dependent upon the amount of resin and the degree to which the resin in the mat is cured. The latter factor is in turn dependent upon the air flow through the mat. With regard to the use of a screen through which hot air is forced to cure the resin, there is a minimum amount of open area of the screen which is practicable. If the screen is too closely woven, hot air cannot flow in sufficient volume to cure the resin completely. Obviously, uncured resin in the mat does not contribute efficiently to the strength of the panel.

On the other hand, as the open area of the screen increases, the strength of the board diminishes. The full reason for this phenomenon is not completely understood; however, it has been found that a surprising increase in panel strength is achieved as the open area of the screen is reduced.

It is believed that as the open area of the screen diminishes, the mineral wool fibers are more uniformly compressed, and the cured resin can more effectively hold them in confinement. This is particularly true with respect to those fibers which are on or near the surface of the mat. Thus, the closer the mesh, the more uniformly the mineral wool fibers in the mat are compressed and held in place by the resin binder.

From another viewpoint, as the mesh of the screen increases, the number of wires which press upon the surface of the board increases and the spacing between the wires diminishes. Hence, the individual fibers of the mat are held in place more uniformly with a fine mesh screen than with a coarse screen.

To show the relationship of the mesh of the screen to the strength of the panel, the following tables may be considered. These tables set forth the Modulus of Rupture of the panel divided by the density of the panel for two types of screen. In this table, since the strength of the panel is a function of its density, the ratio of Modulus of Rupture of the panel to its density is a more meaningful figure.

TABLE I

	Density, lbs./cu. in.	M.O.R., lbs./sq. in.	$\frac{\text{M.O.R.}}{\text{Density}}$
Fine screen panel	13.3	89	6.7
Coarse screen panel	12.0	66	5.5

The fine screen panel was made with a screen which was a woven Fourdrinier wire screen, available as a 16 x 14 mesh screen. The coarse screen used was a 4 x 4 mesh woven wire screen.

Table I shows that as the mesh of the screen increases, the strength of the panel increases. In this case, there is a surprising increase in strength of about 22%.

Reference has been made to the deflection of the finished panel when installed. The resistance of the panel to deflection is a function of its Modulus of Elasticity, and a consideration of Table I, which sets forth the

Modulus of Rupture and the Modulus of Rupture divided by the density, shows that a panel made using a more closely woven screen has a much higher resistance to rupture than a panel made using a more coarsely woven screen.

TABLE II

	Density, lbs./sq. in.	M.O.E., lbs./sq. in.	M.O.E. / Density
Fine Screen Panel	13.3	8,600	601
Coarse Screen Panel	12.0	4,400	366

From Table II it can be seen that a fine screen imparts a surprising increase in strength in terms of M.O.E. divided by density to the panel. In fact, there is an increase in strength of the fine screen panel of about 64% compared to the coarse screen panel.

The precise reason for the unexpected increase in strength of the panel because of the fineness of the screen is not fully understood. However, in testing other screens, it has been found that screens up to mesh size of 30 x 30 to the inch have further increased the strength of the panel up to about 30% over that using a coarse mesh screen of about 4 x 4 mesh.

In summary, the use of a finely woven screen over the flights in an oven press wherein the binder of a mineral wool fiber acoustical panel is set, results in the production of a rigid panel having a surprising increase in strength.

While there is set forth herein the best known embodiments of the present invention, other changes and re-arrangements will occur to those skilled in the art, and it is intended to cover such changes and re-arrangements in the appended claims.

I claim:

1. An apparatus for manufacturing a rigid panel comprising an oven,

conveyer means extending into said oven for introducing a mat of inorganic fiber and thermosetting resin uniformly dispersed throughout said mat into said oven,

press means for compacting said mat to less than its original thickness,

said press means including a pair of groups of interlocked platens, said pair of groups being mounted and arranged so that the facing surfaces of said groups of platens are maintained in spaced parallel horizontal planes,

and a pair of wire screens forming a part of said conveyor means, each of said screens being mounted so as to overlie a respective one of said planes formed by said groups of platens, and in which each of said screens is coarser than 30 x 30 mesh and finer than 4 x 4 mesh.

2. An apparatus for manufacturing a rigid panel comprising an oven,

conveyer means extending into said oven for introducing a mat of inorganic fiber and thermosetting resin uniformly dispersed throughout said mat into said oven,

press means for compacting said mat to less than its original thickness,

said press means including a pair of groups of interlocked platens, said pair of groups being mounted and arranged so that the facing surfaces of said groups of platens are maintained in spaced parallel horizontal planes,

and a pair of wire screens forming a part of said conveyer means,

each of said screens being mounted so as to overlie a respective one of said planes formed by said groups of platens, and in which each of said screens comprises spaced sinuous wires running transversely across the screen and pairs of helically wound wires having loops of each wire of each pair of helically wound wires coupled to one of said sinuous wires in alternation with loops of the other of said pair of helically found wires and in which there are 84 of said sinuous wires per 12 inches of screen length and 84 of said loops per 12 inches across the screen.

References Cited

UNITED STATES PATENTS

1,851,949	3/1932	Dike.	
2,698,260	12/1954	Meauze et al.	117—102
2,826,236	3/1958	Meauze	156—324 X
2,975,470	3/1961	Snelson et al.	156—376

EARL M. BERGERT, *Primary Examiner.*

P. R. WYLIE, J. F. MATTHEWS, W. E. HOAG, *Assistant Examiners.*