Aug. 26, 1969 H. JAMGOCHIAN 3,462,901

EMBOSSED CURTAINWALL WITH OVERLAPPED PORTIONS

Filed July 31, 1967 7 Sheets-Sheet 1

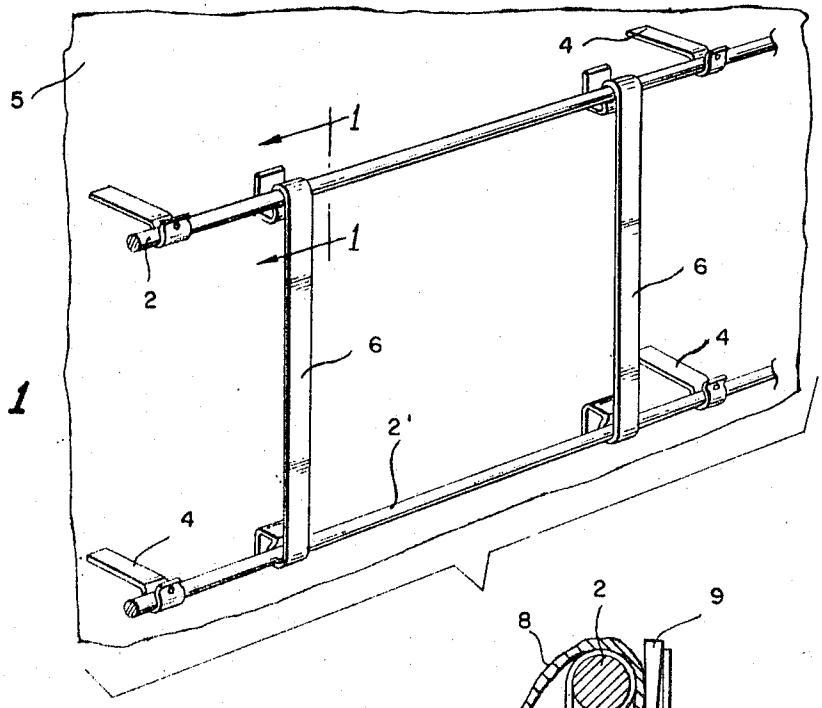


FIG. 1

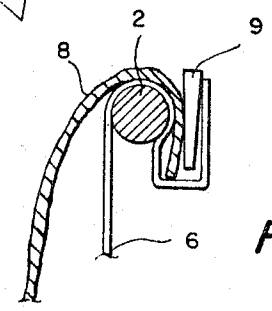
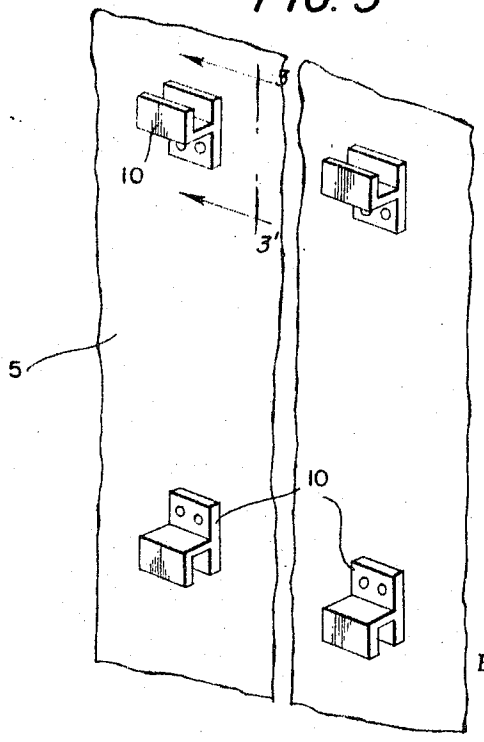


FIG. 2

FIG. 3



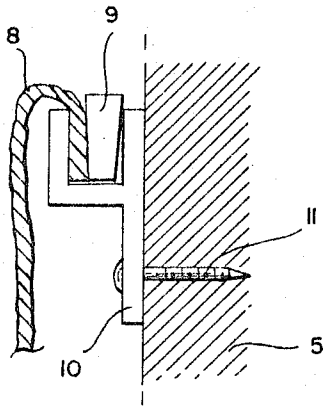


FIG. 4

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EMBOSSED CURTAINWALL WITH OVERLAPPED PORTIONS

Filed July 31, 1967 7 Sheets-Sheet 2

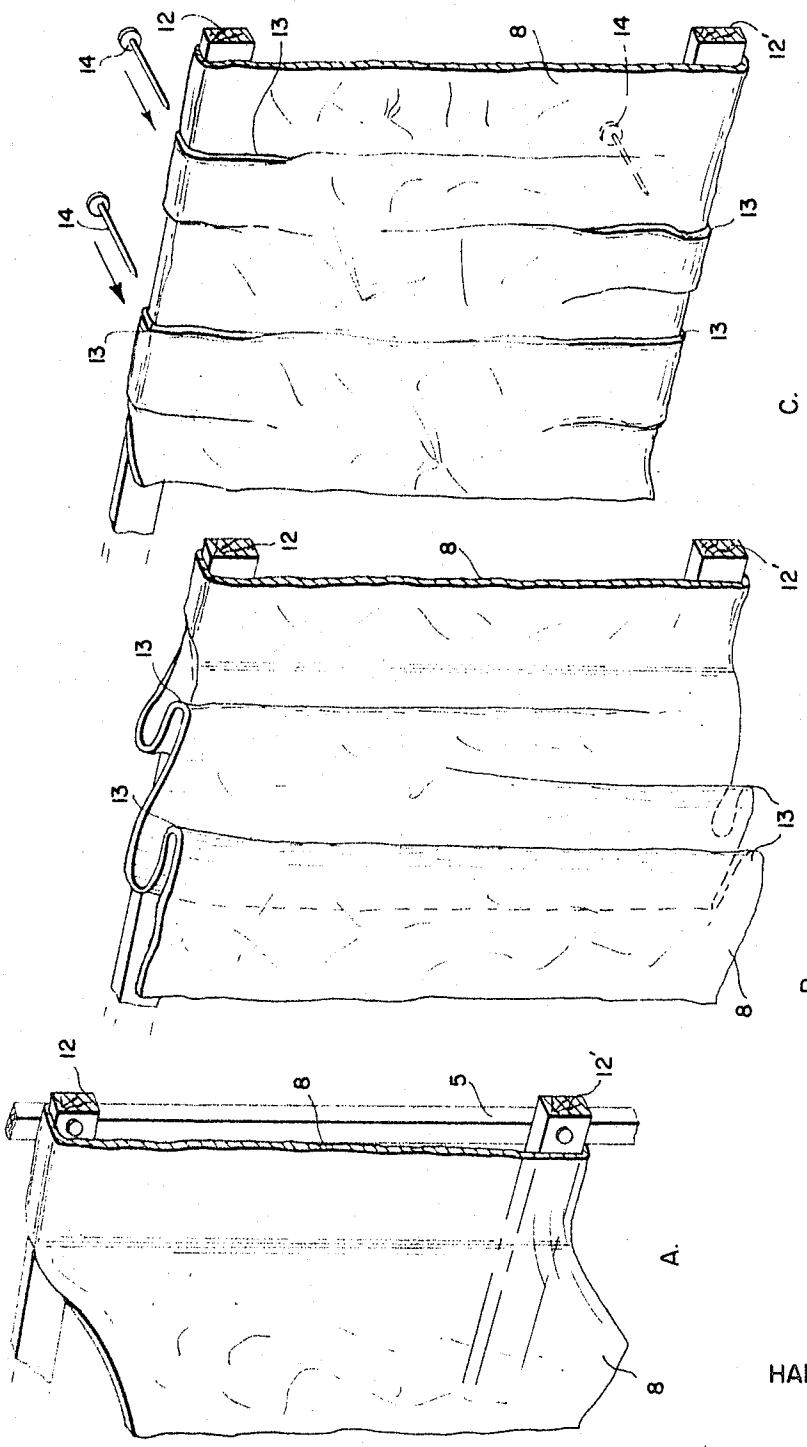


FIG. 5

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EMBOSSED CURTAINWALL WITH OVERLAPPED PORTIONS

Filed July 31, 1967 7 Sheets-Sheet 3

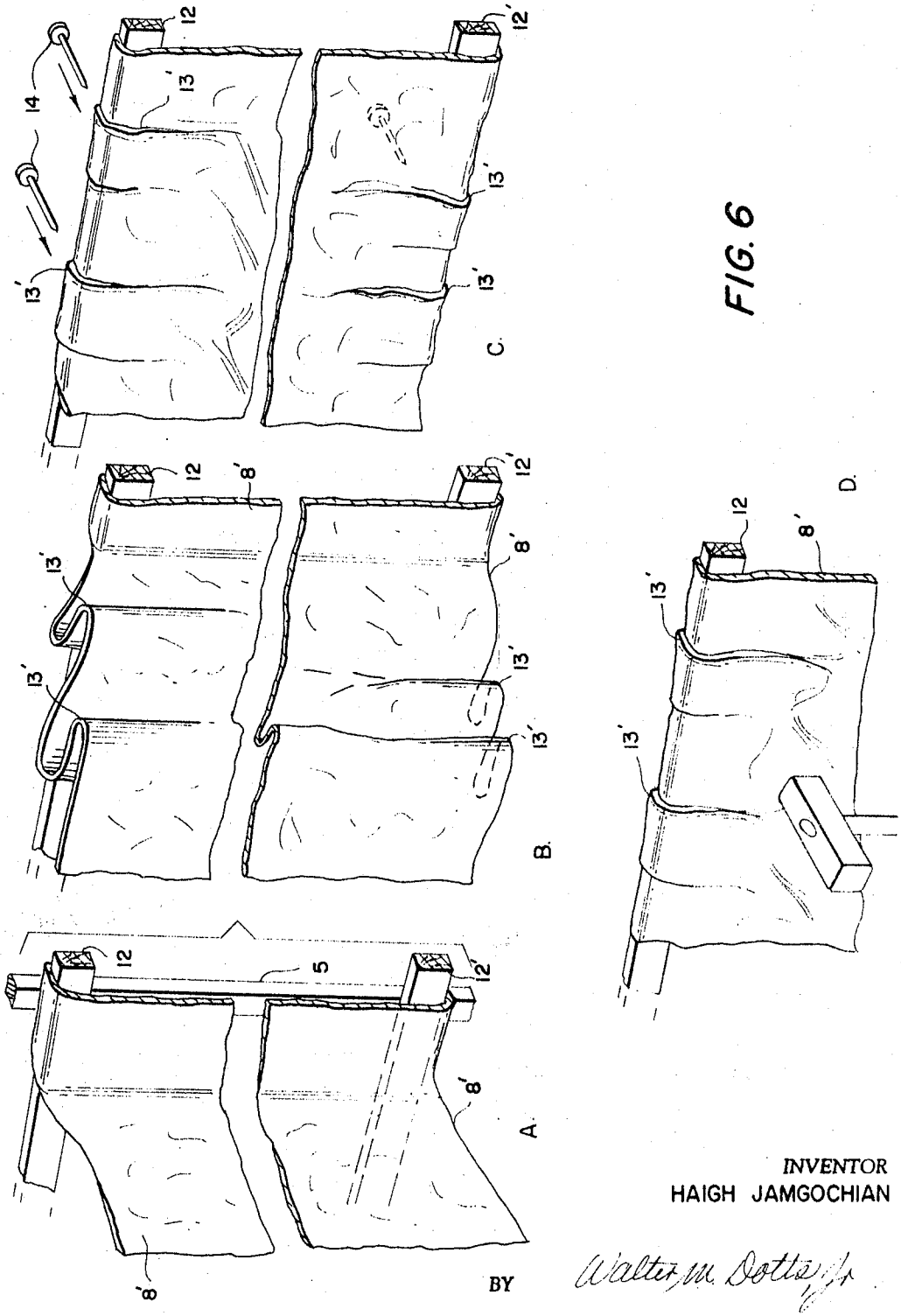


FIG. 6

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EMBOSSED CURTAINWALL WITH OVERLAPPED PORTIONS

Filed July 31, 1967 7 Sheets-Sheet 4

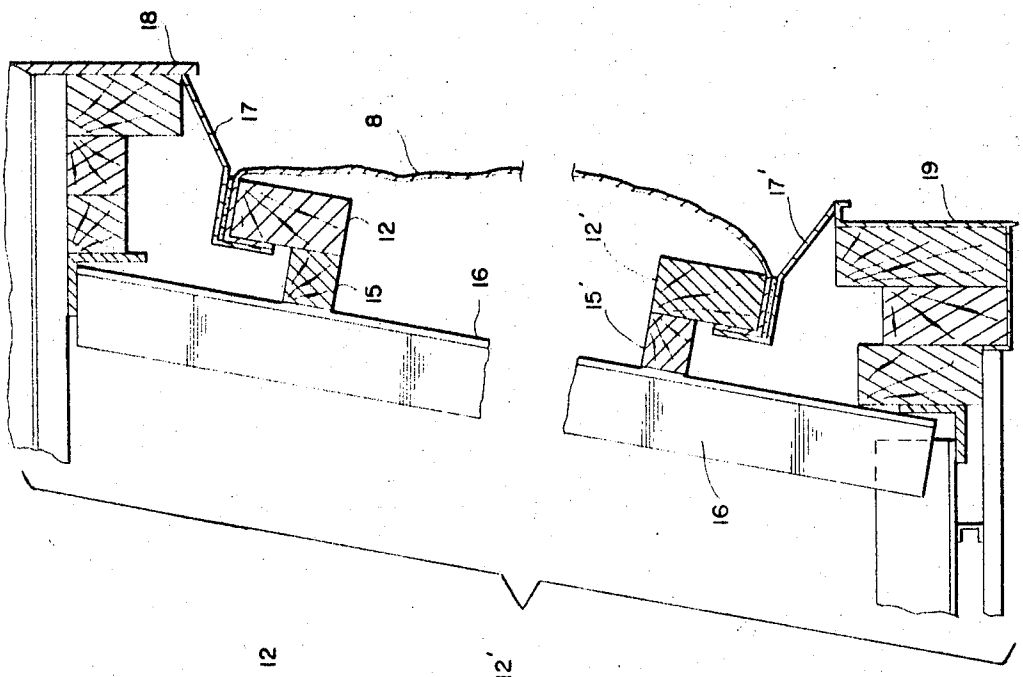


FIG. 8

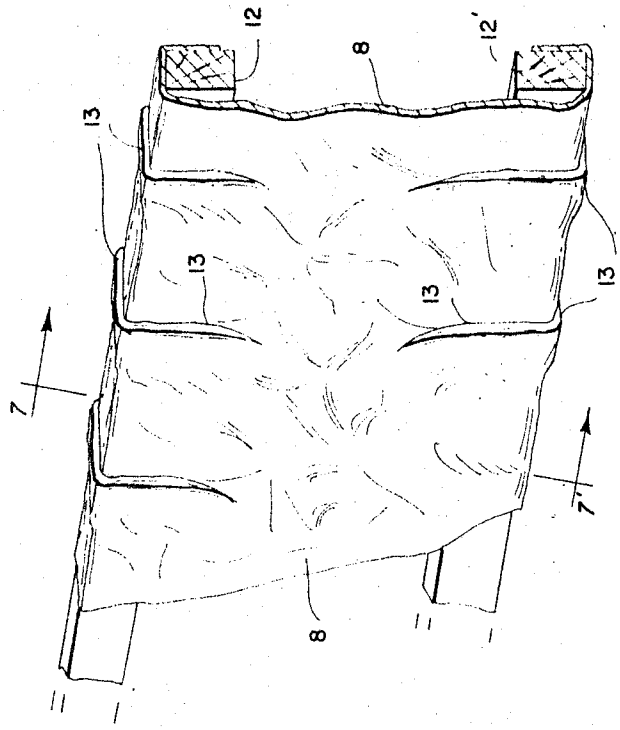


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EMBOSSED CURTAINWALL WITH OVERLAPPED PORTIONS

Filed July 31, 1967 7 Sheets-Sheet 5

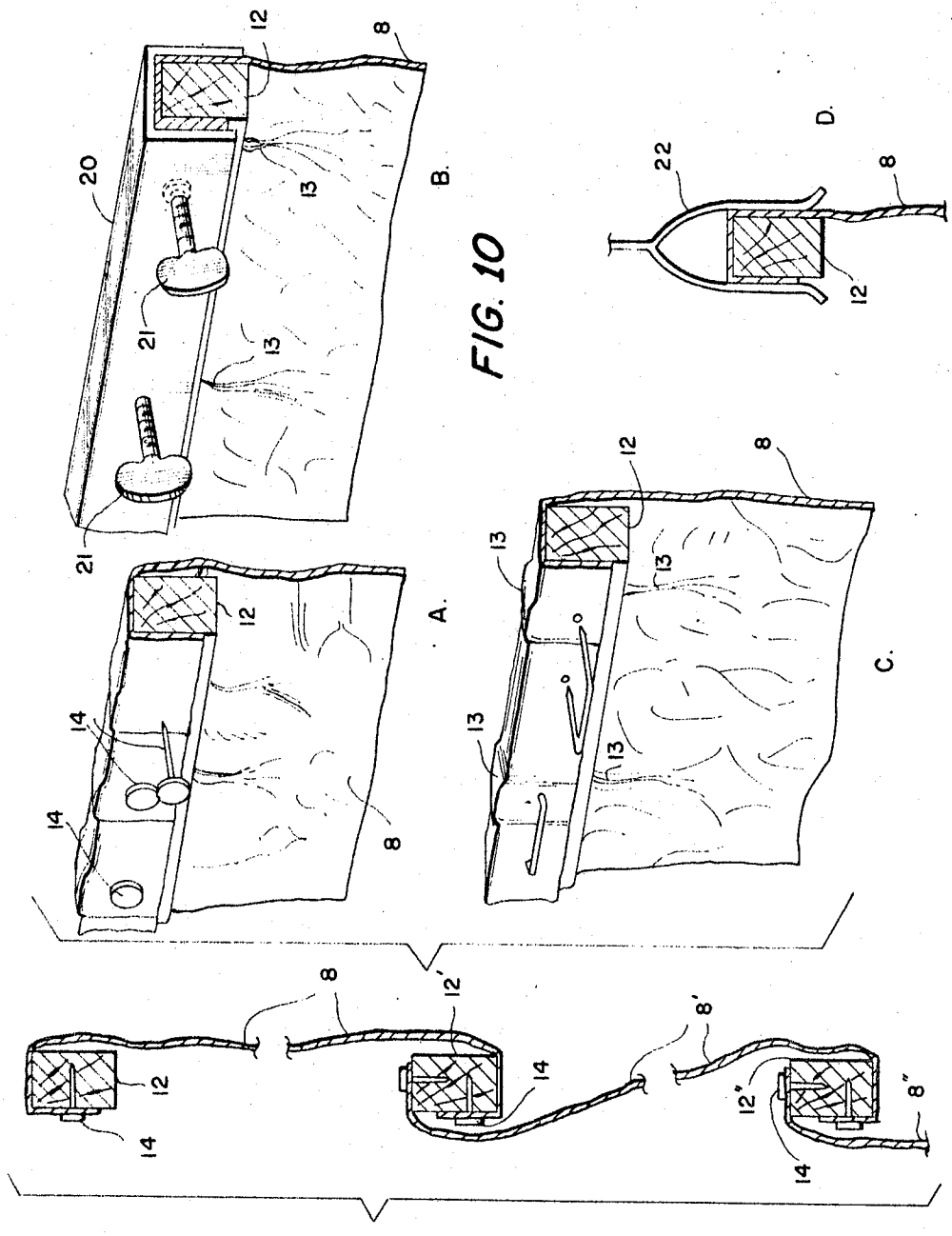


FIG. 10

FIG. 9

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EMBOSSED CURTAINWALL WITH OVERLAPPED PORTIONS

Filed July 31, 1967 7 Sheets-Sheet 6

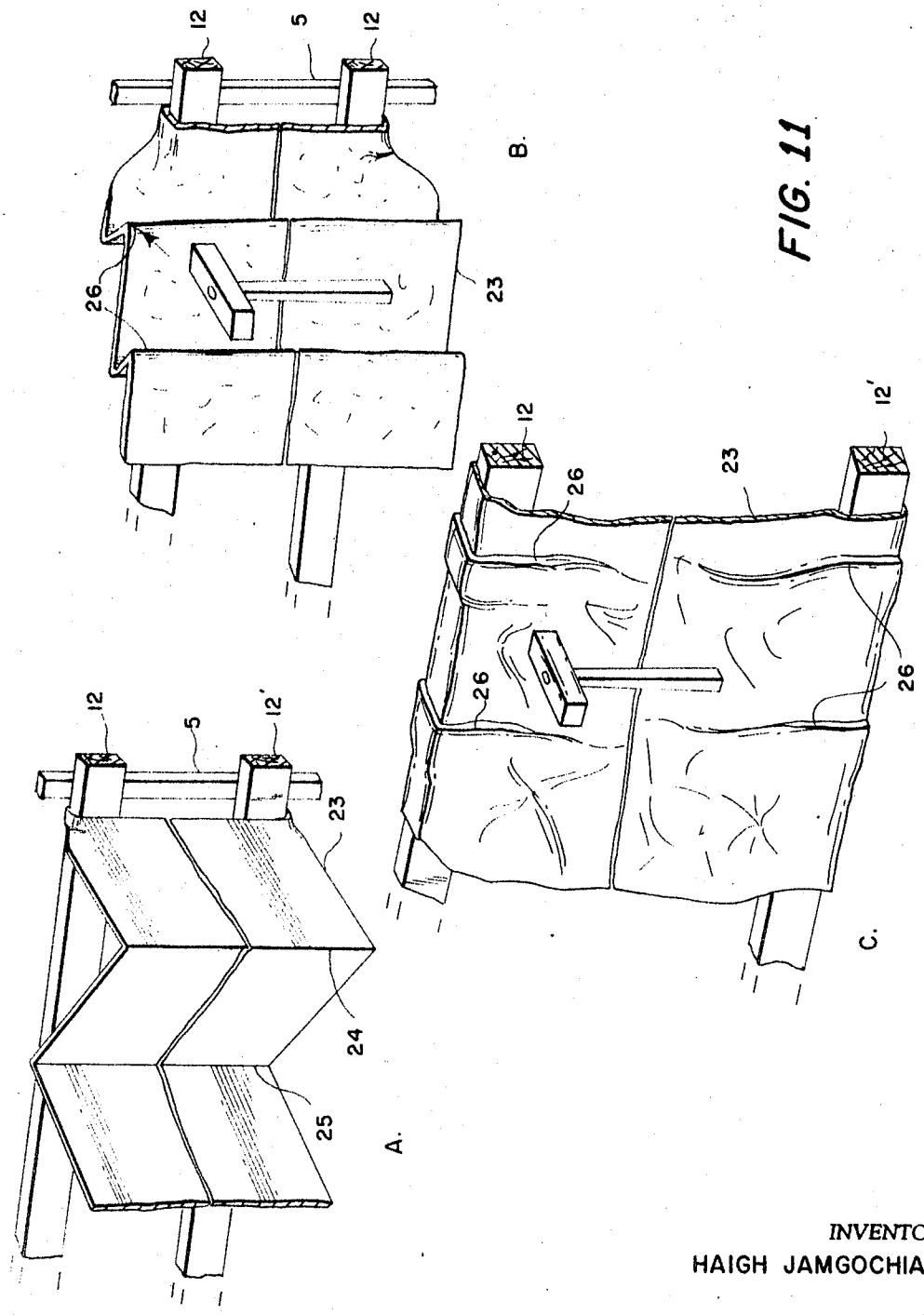


FIG. 11

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Aug. 26, 1969 H. JAMGOCHIAN 3,462,901

EMBOSSED CURTAINWALL WITH OVERLAPPED PORTIONS

Filed July 31, 1967 7 Sheets-Sheet 7

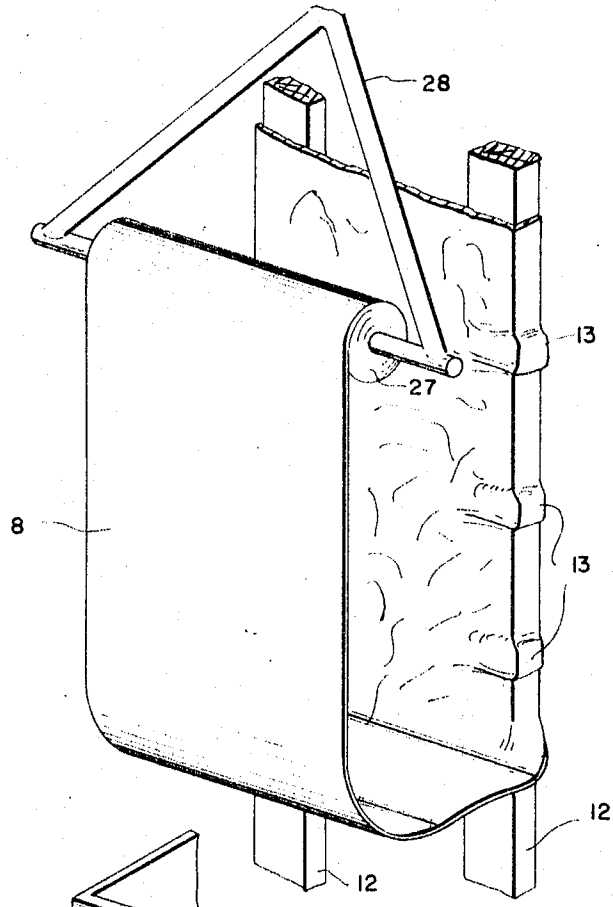


FIG. 12

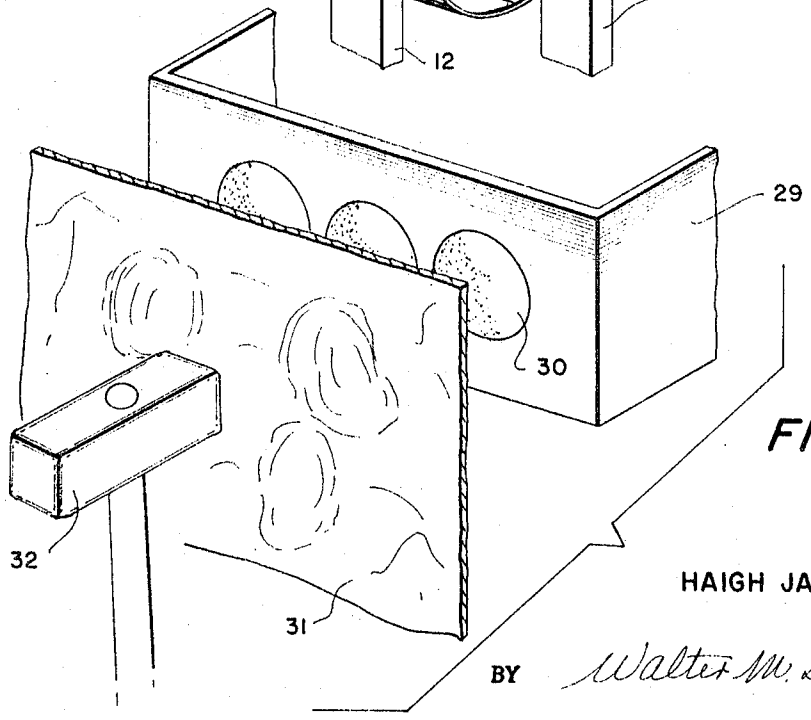


FIG. 13

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United States Patent Office 3,462,901
Patented Aug. 26, 1969

3,462,901

EMBOSSED CURTAINWALL WITH OVERLAPPED PORTIONS

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Filed July 31, 1967, Ser. No. 657,403
Int. Cl. E04c 1/64; E04b 2/00
U.S. Cl. 52—316 9 Claims

ABSTRACT OF THE DISCLOSURE

A long, seamless and jointless sheet metal strip is employed to fabricate a curtainwall by attaching two spaced-apart rows of supporting means to an underlying building structure and fastening the sheet metal strip across these rows of supporting means. Tucks are made by folding overlaps at intervals along both edges of the strip, thereby incorporating excess material in the curtainwall to accommodate expansion and contraction, while continuing to fasten the strip to the supporting means. Additionally, the sheet metal strip may be wrinkled purposely at many points between the rows of supporting means to increase the curtainwall's stiffness and mechanical stability while also providing a unique, artistic, textured appearance.

BACKGROUND OF THE INVENTION

Curtainwalls and the methods by which they are fabricated have many variations in conventional practice, but all prior art structures and erection methods known to this inventor have in common at least two basic similarities, namely: (1) That discrete structural panels and glazing components are employed, and (2) that expansion joints of some type must be provided between panels to accommodate thermal expansion and contraction.

Due to these inescapable needs in prior art curtainwalls for the assembly of discrete modular panels and for the provision of expansion joints between them, every known curtainwall fabrication method is more expensive in terms of materials and hardware and on-site labor costs than is the method of this invention.

In conventional practice, a curtainwall is usually erected by forming individual frames from frame members which are attached to an exterior wall of a building or to the skeleton of a building which comprises vertical columns and horizontal beams. Each individual frame may be supported upon a building's exterior wall or upon its skeletal framework by slidable means in order to accommodate expansion and contraction. Any frame can receive structural panels, glazing, or other non-load-bearing elements of the curtainwall.

Expansion joints between curtainwall panels are usually made weatherproof by caulking, installation of compressed resilient elements and the like, and these exposed joints are finally covered by decorative mullions. Prior to finishing of the expansion joints, each structural panel must be individually fastened to the underlying framework.

Such assembly procedures require skilled labor and the rate in linear feet per minute at which a conventional curtainwall can be constructed is very low.

SUMMARY OF THE INVENTION

This invention relates to a pioneering advance in curtainwalls and in methods for employing extremely lightweight materials in their construction. The present method teaches how to construct an attractive, strong, and mechanically stable curtainwall using materials never previously employed for this purpose, namely, relatively thin gauge sheet metal of various types and of many widths which is available in long seamless and jointless strips

supplied in coils, or pre-creased into accordion folds and supplied in stacks.

The method of construction and the curtainwall of this invention comprehends the attachment of two spaced-apart rows of supporting means to an underlying framing or wall thereby defining the width, shape, position, and extent of a curtainwall. These spaced rows of supporting means can be arranged in two substantially parallel horizontal lines for a horizontal curtainwall or they can be arranged in vertical columns for a vertical curtainwall or in any desired shape or position including diverging or converging lines of alternating divergent and convergent shapes.

The underlying building structure to which the rows of supporting means are attached may be the skeletal framework of a building comprising horizontal beams and vertical columns or it may consist of studding only, or it may be an existing wall of a building.

After the width, shape, position, and extent of the curtainwall have been established by the attachment of two rows of supporting means to an underlying building structure, one end of a long sheet metal strip is fastened across said rows of supporting means with the major portion of the width of said strip spanning the distance between said rows.

Because the sheet metal employed in the practice of the method of this invention is thin enough and of the proper temper to be bendable and foldable, the problem of providing for thermal expansion and contraction as well as acoustical vibration is solved by bending and folding the sheet metal strip to form tucks by overlapping portions of the strip at intervals along each edge before it is fastened to the corresponding row of supporting means. It is entirely optional whether or not there is any regularity to the spacing of the tucks along either edge of the sheet metal strip. Thus, due to the incorporation of a sufficient amount of excess material in the curtainwall by virtue of the tucks or overlaps to accommodate expansion and contraction in any direction, no expansion joints are needed and consequently there is a great saving in cost of construction compared with conventional curtainwalls.

When the surface of a curtainwall is canted at an angle to the vertical, as when a wall is tapered, two horizontal rows of supporting means arranged to provide such a taper will not be the same length. For example, the circumference of a tapered wall will increase in the direction of the increasing taper. In such cases, the total number of overlaps or tucks or the aggregate amount of overlap in all tucks combined will have to be greater at the shorter edge of the sheet metal curtainwall than along the longer edge in order to use up the excess sheet metal along the shorter edge of the curtainwall.

When such overlaps or tucks are folded and bent into the seamless and jointless metal sheet, protection against inward or outward buckling or "oilcanning" of the sheet metal is obtained as a by-product of such bending and folding which necessitates hammering the surface of the sheet. Such hammering or beating of the sheet metal to form the tucks produces indentations in the sheet metal strip over a wide area. These indentations may be completely random or, alternately, may be artistically done to provide a more regular or intentional pattern. In both instances, whether the indentations caused in forming tucks are regular or irregular what has, in effect, been created is an irregular surface which lends great stiffness and resistance to movement or deformation to a curtainwall and also provides the possibility for orginality in texture effects.

When the tucks formed at intervals along each edge of the sheet metal strip are large enough to extend nearly to the midpoint of the width of the strip or farther, the irregularities in the surface of the strip produced by these

large tucks will be sufficient to impart great stiffness and stability as well as a desirable textured appearance to the strip.

However, when the tucks are small and do not extend very far toward the midpoint of the width of the strip, large areas near the midpoint line along the length of the strip will remain as a smooth metal surface which would "oilcan," meaning to deform inward or outward due to the effects of thermal expansion and contraction or wind loading. Such "oilcanning" is not desirable because it is noisy and may cause eventual destruction of portions of the curtainwall by tearing it loose from its supports.

Therefore, in the event an architects' design calls for small tucks which do not provide sufficient irregularities in the sheet metal strips surface to resist "oilcanning," deliberate wrinkling of the strip at a plurality of points intermediate said supports becomes necessary. Such wrinkling may be accomplished by hammering indentations into either side of the strip or by embossing a texture or a design into either surface of the strip or by other means which produce a sufficient number of irregularities so that expansion and contraction can occur in any direction while the overall shape of the curtainwall remains stable.

Accordingly, the method of this invention comprehends the carrying out of an additional step comprising hammering or otherwise wrinkling any large smooth area of the sheet metal strip which remains free of indentations after the steps of tuck formation and attachment of the strip to the supporting means have been completed.

The wrinkling of any smooth areas remaining then in the sheet metal strip may also be accomplished by embossing a design in either surface of the curtainwall. Thus, an embossing die, which may be a female die comprising a surface having depressions forming a design therein, may be held against one side of a curtainwall constructed according to the method of this invention and hammer blows may be directed against the corresponding portion of the opposite surface of the curtainwall, forcing the sheet metal into the depressions in the die, thereby forming a depressed replica of the design in the curtainwall.

Alternatively, other desirable artistic effects can be created in the surface of a curtainwall constructed according to the method of this invention by holding a male embossing die having protuberances thereon against one side of the sheet metal strip and directing hammer blows against the opposite side of the curtainwall to form a raised replica or relief corresponding to the design on the male embossing die.

A further alternative is to employ free-hand hammering to produce a textured appearance or any desired artistic effect in the surface of the curtainwall of this invention.

Thus, the exposed surface of the curtainwall of this invention can be decorated with a wide range of sculptural effects in either relief or intaglio and such effects can comprise symbols or written characters and words as well as likenesses of people or objects. The range of choice is infinite in terms of design possibilities which may render a building unique and endow it with the character of a highly individual work of art.

Practice of the method of this invention has also proved that when soft, zero temper, sheet metal strip is hammered both in forming tucks and in deliberate wrinkling of any remaining smooth areas of the strip, the temper of the metal is increased by such working and it becomes much harder, thereby improving the stiffness and mechanical stability of the curtainwall of this invention.

It should be noted that when the curtainwall of this invention is constructed on rows of supporting means framework of a building, the inner surface of the curtainwhich have previously been attached to the skeletal wall may be finished, for example, by spraying a thick coating of urethane foam insulation on it, or by packing fiberglass bats against it. Drywall or wetwall construction can then be carried out interiorally of such insulation against the inside of the studding or framework of the building.

The steps which must be taken in combination to give the method of this invention and which are reflected in the curtainwall which is claimed herein, are:

(A) attaching two spaced-apart rows of supporting means to an underlying building structure;

(B) fastening a portion of a long sheet metal strip across said rows of supporting means with the major portion of said strip spanning the distance between said rows;

(C) forming tucks by overlapping portions of said strip at intervals along each edge of said strip, while

(D) continuing to fasten said strip across said rows of supporting means at a plurality of points near each edge of and along the length of said strip.

An additional method step may be necessary in cases where, for a variety of reasons, the tucks formed along both edges of the sheet metal strip and the concommitant hammering which is usually necessary in bending and folding these overlaps do nat eliminate all large smooth undisturbed areas from the surface of the curtainwall. In such cases, deliberate wrinkling of such large smooth areas becomes necessary, as previously described, or, as an alternative procedure, embossing of a design in the curtainwall eliminates such smooth areas while creating desirable decorative effects, as has also been previously described.

Nevertheless, the broadest definition of the combination of this invention comprises the steps A through D given above, wherein provision is made for incorporating excess material into a curtainwall so that expansion and contraction can occur in any direction, thereby eliminating the need for expensive and time-consuming fabrication of expansion joints and permitting very rapid wall erection in a long, unbroken strip at speeds of several feet per minute.

Brief description of the drawing

FIGURE 1 is a perspective schematic view showing one alternative modification of the two spaced-apart rows of supporting means across which a sheet metal strip may be fastened according to the method of this invention.

FIGURE 2 is a partial sectional view on line **1—1** of FIG. 1.

FIGURE 3 is a perspective schematic view showing a second alternative modification of the two spaced-apart rows of supporting means across which a sheet metal strip may be fastened to form the curtainwall of this invention.

FIGURE 4 is a partial sectional view on line **3—3'** of FIGURE 3.

FIGURE 5 contains three perspective schematic views, A, B, and C, which illustrate a third alternative modification of the two spaced-apart rows of supporting means shown in other modifications in FIGS. 1 through 4, showing how a sheet metal strip may be applied thereto to form a curtainwall according to the method of this invention.

FIGURE 6 contains four perspective schematic views, A, B, C, and D, which illustrate the same modification of the two spaced-apart rows of supporting means illustrated in FIG. 5, showing a variation of the method by which a curtainwall may be constructed according to the method of this invention.

FIGURE 7 is a perspective schematic view illustrating a finished curtainwall constructed according to the method of this invention.

FIGURE 8 is a sectional elevation taken along line **7—7'** of FIG. 7 which also contains additional structural details illustrating one way in which flashing, roofing, studding, and associated structures relate to the two rows of supporting means across which the curtainwall of this invention is constructed.

FIGURE 9 is a partial sectional schematic elevation through a multi-tiered curtainwall constructed according to the method of this invention.

FIGURE 10, views A, B, and C illustrate in perspective schematic three alternative modifications of ways to fasten a sheet metal strip to one row of supporting means according to the method of this invention, and view D is a partial sectional schematic illustrating a fourth alternative way to fasten the sheet metal strip to a support.

FIGURE 11, contains perspective schematic views A, B, and C which illustrate how a pre-creased sheet metal strip, provided with pre-determined fold points, may be used to construct a curtainwall according to the method of this invention.

FIGURE 12 is a perspective schematic view illustrating a vertical curtainwall constructed according to the method of this invention across two vertically disposed rows of supporting means.

FIGURE 13 is an exploded schematic view illustrating a method for embossing a design in the curtainwall of this invention.

Referring now to FIG. 1, structures **2** and **2'** are spaced-apart wire cables held under tension and supported at intervals by clamps **4** which are attached to an underlying building structure **5**. Such attachment may comprise anchoring of clamps **5** to an exterior wall of a building undergoing renovation or, alternatively, may comprise bolting, welding, or riveting to the skeletal framework of a building under construction. In either case, the attachment of two rows of supporting means, represented here by cables **2** and **2'** to an underlying building structure **5** is a first step in constructing the curtainwall of this invention because the spacing of these two rows of supporting means defines the width of the curtainwall just as their length and inclination to the vertical define the curtainwall's length and taper. Brackets **6** snap over cables **2** and **2'** when these cables are bowed toward each other. Brackets **6** may be spaced every two feet along each cable **2** or **2'**, for example, and are employed to provide a simple and fast means of fastening portions of the edges of a sheet metal strip across cables **2** and **2'**.

Referring to FIG. 2, a portion of a bracket **6** is shown snapped over cable **2** and one edge of a sheet metal strip **8** is shown fastened securely in bracket **6** by driven wedge **9**. The portion of the edge of sheet metal strip **8** which is bent over cable **2** and wedged into bracket **6** may comprise a tuck or overlapped portion of one edge of strip **8** or may alternatively, consist only of a straight portion of one edge of strip **8**. The edges of strip **8** are folded back over cables **2** and **2'** and are crimped around them in the spaces between brackets **6**. It is even feasible to eliminate brackets **6** and to crimp both edges of strip **8** tightly over cables **2** and **2'** throughout their lengths.

In FIG. 3 an alternative modification is shown wherein the two spaced-apart rows of supporting means which are attached to an underlying building structure to define the length and width of the curtainwall of this invention, comprise brackets **10** which are anchored to the underlying building structure **5**, which may be a wall or, alternatively, may be the studding or framework of a building.

A typical bracket **10** is shown in FIG. 4 attached to wall **5** by bolt **11**, and sheet metal strip **8** is shown bent over the top of bracket **10** and secured within bracket **10** by wedge **9**.

The modification of the supporting means illustrated in FIGS. 3 and 4 is best suited to the construction of the curtainwall of this invention on the exterior wall of a building undergoing renovation because, in such a case, the brackets **10** in either row can be spaced at very close intervals on the wall, such as on one or two foot centers, to provide many closely spaced points at which each edge of sheet metal strip **8** can be fastened.

A still further modification of the two spaced-apart rows of supporting means is shown in view A of FIG. 5 wherein two spaced-apart rows of furring strips **12** and **12'** are attached to an underlying building structure **5**. These may be long rows of furring strips which are bolted to the studding comprising part of the skeletal framework of a building during construction, and the curtainwall of this invention will then comprise a portion of the outer skin of the building. The method step wherein these furring strips **12** and **12'** are first attached to an underlying building structure **5** defines the size and position of the curtainwall.

Subsequently, sheet metal strip **8** is fastened across the two rows of supporting means **12** and **12'**, as is also shown in view A of FIG. 5. The exact means employed to fasten strip **8** to supporting means **12** and **12'** is optional, and several modifications illustrating different ways this may be accomplished are shown in FIG. 10, views A, B, C, and D, which will be discussed in more detail below.

View B of FIG. 5 illustrates tucks **13** which have been formed in both edges of sheet metal strip **8** in order to incorporate excess material in the curtainwall to provide for thermal expansion and contraction.

While tucks **13** are being formed by bending and folding overlaps in sheet metal strip **8**, the fastening of strip **8** to supporting means **12** and **12'** is continued. Thus, both the tuck-forming step and the step of fastening the strip **8** across the two spaced-apart tows of supporting means are carried out more or less concommitantly since some of the construction crew members should be hammering and bending the sheet metal to form tucks while other crew members follow them and fasten both the overlapped and the straight portions of the strip **8** to the two rows of supporting means **12** and **12'**.

View C of FIG. 5 shows the sheet metal strip **8** as it appears after tucks **13** have been formed at intervals along both edges, and after these edges of strip **8** have been hammered and bent over supporting means **12** and **12'** preparatory to fastening with nails **14** (as illustrated) or attachment by any suitable means such as the examples shown in views A, B, C. and D of FIG. 10.

The tucks **13** formed in one edge of strip **8** need not lie directly opposite the tucks formed in the opposite edge of strip **8**. The spacing of tucks can be irregular. Although the principal purpose of these tucks is to provide the essential function of incorporating needed excess material in the curtainwall to accomodate expansion and contraction, a subsidiary function of these tucks is to provide a way to shorten either edge of strip **8** when necessary to keep strip **8** following the two rows of supporting means **12** and **12'**. Even when these rows of supporting means **12** and **12'** are parallel, the difficulty in handling a large coil of wide sheet metal strip makes it nearly impossible in practice to keep strip **8** from cocking at an angle to the rows of supporting means. When this happens, strip **8** can be brought back into parallel relationship with the rows of supporting means by overlapping more material and thereby shortening the edge of strip **8** which is running farthest outside of the area defined by rows of supporting means **12** and **12'**. When one row of supporting means is shorter or longer than the other, as in a tapered wall, more material must be overlapped and incorporated in tucks along the edge of the sheet metal strip which follows the shorter row of supporting means.

It should be noted in view C of FIG. 5 that the hammering necessary to bend and form tucks **13** in both edges of strip **8** has resulted in the formation of wrinkles covering most of the surface of strip **8**, leaving no large smooth undisturbed areas which could give rise to "oilcanning." The reason for this is that tucks **13** are very large and extend from both edges nearly to the longitudinal mid-line of strip **8** or even farther. Thus, since the formation of these large tucks results in the elimination of substantially all large smooth areas from the sheet metal strip, no additional step of forming more wrinkles is necessary.

However, referring now to FIG. 6, there is illustrated the case where relatively small tucks which do not extend anywhere near the longitudinal midline of strip **8'**, are formed along both edges of a very wide sheet metal strip

8' as can best be seen in views C and D. In the construction of any curtainwall by the method of this invention, it is optional whether small or large tucks are employed. The essential criterion is that sufficient total overlap be provided to incorporate the required amount of excess material in the curtainwall to accommodate the maximum amount of thermal expansion and contraction which may occur in any direction. The total overlapping needed will vary for different materials, for various thicknesses of sheet metal strip, and for different dimensions of individual curtainwalls.

According to the architect's choice, the use of more excess material and, thus, more overlapping may be provided than is strictly necessary to accomodate expansion and contraction. Thus, relatively large tucks might be specified and no further wrinkling of the sheet metal strip would be required to eliminate smooth areas of the sheet metal strip after its edges had been fastened to the rows of supporting means.

On the other hand, another architect might specify that the minimum amount of material should be used, therefore calling for less overlapping and smaller tucks which might not extend very far from the edges of the sheet metal strip toward its longitudinal mid-line.

This is the situation illustrated in FIG. 6, of which view A shows two rows of supporting means **12** and **12'** fastened to an underlying building structure **5** and shows strip **8'** fastened across these rows of supporting means **12** and **12'**. In view B of FIG. 6, small tucks **13'** have been formed at intervals along both edges of strip **8'**. View C of FIG. 6 shows how small tucks **13'** as well as straight portions of the edges of strip **8'** have been bent over rows of supporting means **12** and **12'** so that the edges of strip **8'** can be fastened thereto by nails **14**.

Referring still to FIG. 6, view D illustrates an additional step comprising wrinkling of smooth areas of strip **8'** which remain undisturbed after the small tucks shown in view B have been fastened down as shown in view C. Such wrinkling may be accomplished by hammering (as illustrated) or by other means such as embossing a design into the surface of strip **8'** as shown in FIG. 13.

It should be noted that views A–C in FIG. 5 and views A–D in FIG. 6 do not directly correspond to the similarly lettered method steps appearing in some of the claims. In fact, view A of FIG. 5 as well as view A of FIG. 6 combine two distinct method steps, namely: (A) attaching two spaced-apart rows of supporting means to an underlying building structure, and (B) fastening a portion of a long sheet metal strip across said rows of supporting means with the major portion of the width of said strip spanning the distance between said rows.

Turning now to FIG. 7, a curtainwall constructed according to the method of this invention is illustrated as it appears when completed, showing sufficient wrinkling of the sheet metal strip **8** to eliminate all large smooth areas.

FIGURE 8 illustrates how the curtainwall of this invention may be integrated with other elements of a building structure. Here sheet metal strip **8** is shown fastened to supporting means **12** and **12'** which are furring strips and are attached to a building stud or column **16** via purlins **15** and **15'**. Flashings **17** and **17'** provide the weatherproofing necessary to integrate the curtainwall with the overhang **18** from a built-up roof and with the fascia **19**.

A useful method for combining two or more curtainwall spandrels constructed according to the method of this invention is illustrated in FIG. 9. Here are shown three rows of supporting means, **12**, **12'**, and **12''** arranged directly above one another to support a composite vertical curtainwall.

Two sheet metal strips **8** and **8'** are shown fastened to these three rows of supporting means, and the top of a third strip **8''** is also shown to illustrate how each component sheet metal strip below the top strip is fastened in the form of the letter "S" (as viewed when a vertical section is taken across the composite curtainwall).

For example, the upper edge of strip **8** runs first behind supporting means **12'** before being fastened behind it and on top of it by nails **14**, while the lower edge of strip **8'** runs in front of strip **12''** before being fastened beneath and behind it by nails **14**. Similarly, the upper edge of sheet metal strip **8''** is shown running behind supporting means **12''**. In like manner, curtain-wall spandrels can be combined to produce a composite curtainwall of any desired height using sheet metal strip of standard available widths. Caulking should be inserted in the space between each row of supporting means and the upper edge of each sheet metal strip which runs behind any row of supporting means. Similarly, caulking should be inserted between the upper edge of strip **8** and flashing **17** and between the lower edge of strip **8** and fascia **19** in FIG. 8 to complete the weatherproofing.

Referring to FIG. 10, views A, B, C, and D illustrate alternative modifications of means for fastening sheet metal strip **8** to a row of supporting means **12**. In view A, fastening is by means of nails **14** which are driven through the sheet metal strip **8** near its edge and into the rear of the supporting means **12** which in this case is a furring strip. It is advantageous to bend a portion of strip **8** over the top of a furring strip and to nail it to the rear side. In this way, almost all of the weight of the curtainwall and the effects of pulling, tugging, hammering, and tuck formation during the construction steps are distributed over a large area of the supporting means **12** instead of pulling directly against nails **14** which might tear through the sheet metal if the strip were nailed to the front side of a furring strip. Nevertheless, where desirable for other reasons, it is entirely within the scope of this invention to nail or otherwise fasten the edge of a sheet metal strip directly to the front of a furring strip or other supporting means.

Similarly, in view B of FIG. 10, one edge of sheet metal strip **8** is bent over supporting means **12** and is fastened between means **12** and channel clamp **20**, which is tightened down in compression against the edge of strip **8** and supporting means **12** by wing bolts **21**. Channel champs like the example illustrated in view B may be many feet long and are of value in cases where the curtainwall is not finished on the inside and will be subjected to sea spray or other corrosive conditions which may dictate replacement at frequent intervals. This modification of a fastening means is also useful for constructing temporary curtainwalls or windbreaks using very inexpensive thin gauge sheet metal.

View C of FIG. 10 shows still another modification of means for fastening a sheet metal strip **8** to supporting means **12**. This case lends itself to very high speed curtainwall construction and employs industrial staple guns to drive staples into a furring strip to which the sheet metal strip must be fastened. This is probably the least expensive and fastest means of fastening a sheet metal strip to a supporting mean.

View D of FIG. 10 shows a stirrup clamp **22** which exerts compression against opposite sides of a supporting means **12** such as the furring strip illustrated and holds the edge of a sheet metal strip tightly between itself and the furring strip.

Referring now to FIG. 11, view A illustrates two rows of spaced-apart supporting means **12** and **12'** which have been attached to an underlying building structure **5** and across which one end of a precreased sheet metal strip **23** has been fastened. Accordion folds **24** and **25** form predetermined starting points for overlapping portions of the sheet metal to form tucks **26** which may be seen in view B of FIG. 11. These tucks may comprise any desired amount of overlap using the preformed crease as a starting point. View C of FIG. 11 shows how the completed curtainwall made from precreased sheet metal looks like the curtainwall of FIG. 7. Again, according to

whether the architect called for small or large tucks, additional wrinkling to remove smooth areas of the surface of strip **23** which might remain undisturbed after tuck formation may or may not be necessary as previously discussed.

Referring now to FIG. 12, two vertical, spaced-apart supporting means **12** and **12'** are attached to an underlying building structure (not shown) and a strip of sheet metal **8** uncoiling from roll **27**, which is carried by hoisting truss **28**, has been employed to construct a curtainwall according to the method of this invention. Tucks **13** were formed as previously discussed while continuing the fastening of the edges of strip **8** to supporting means **12** and **12'**.

FIGURE 13 illustrates an embossing die **29** having a design **30** which may comprise either raised or depressed areas held behind a portion of the sheet metal surface **31** of the curtainwall of this invention while a hammer **32** is used to beat the design **30** into the surface **31** of the curtainwall.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In one example of a preferred embodiment of this invention, the sheet metal strip employed in constructing the curtainwalls comprising the outer skin of a large office building recently completed in Richmond, Va., was 0.032 inch thick natural aluminum sheet. This aluminum strip was supplied by the manufacturer in coils 9 feet wide by 700 feet long. This length was especially suited to the size of the building which was circular with a maximum circumference of about 700 feet. Thus, the 700 foot lengths supplied in the coils provided continuous circumferential spandrels needing no expansion joints or seams other than one at the starting (and finishing) point for each spandrel.

In order to provide natural, soft aluminum sheet which would be easy to fold and bend to make tucks, the sheet aluminum coils or rolls were annealed in an oven until zero temper was obtained. As has been previously discussed, the sheet metal gains in hardness and increasing temper during hammering and working. The aluminum sheet became quite stiff during the construction of the curtainwalls for the office building mentioned above.

Such aluminum strip in various widths is readily available in several thicknesses and forms a beautiful curtainwall which is very resistant to weathering and surface staining and which does not require any protective coating.

Many other types of sheet metal can be employed in strip form to construct curtainwalls according to the method of this invention. For example, a residence currently under construction in Richmond, Va., comprises a 3 foot wide exterior curtainwall made from thin 10 ounce copper sheet. This copper sheet will soon form an attractive green carbonate surface which resists further weathering and, in the wrinkled or rippled form of surface characteristic of curtainwalls made according to the method of this invention (when not embossed with specific designs) will soon resemble a mossy stone wall.

Soft stainless steel now sold by Crucible Steel Company under the trademark "Rezistal" can be bent and folded easily to form tucks and can be wrinkled, rippled, or embossed. This material is presently under consideration for the construction of the curtainwalls of this invention and probably will be adopted since its cost is about half as much as copper sheet in equivalent thicknesses.

In the example of a preferred embodiment of this invention mentioned above, where 0.032 inch thick aluminum strip 9 feet wide was used, the two spaced-apart rows of supporting means **12** and **12'** took the form of 2 inch by 4 inch wooden furring strips which were bolted to the steel framework of the building with a distance of 7 feet 9 inches, measured between their outer edges. Thus, 7 feet 9 inches was the width spanned by the aluminum strip. Tucks were made along both edges of this aluminum strip at irregular intervals following the general standard devised by the architect of about 1 inch of overlap per running foot of curtainwall. These were relatively small tucks, a typical example being a 4 inch overlap made after fastening 4 running feet of strip to a furring strip. Wrinkling of the surface of the aluminum strip was carried out concommitantly with tuck formation and fastening of the edges of the strip to the furring strips. No large smooth areas of the sheet metal surface remained unwrinkled after this process was completed. For purposes of illustration only, a smooth, undisturbed area of more than nine square feet would have been considered too large to leave unwrinkled or unindentated in the example of a preferred embodiment given, where the width of curtainwall was close to 8 feet.

Although applicant is the architect-inventor who conceived this method for fabricating light-weight jointless and seamless curtainwalls, the nature of his first project (the office building mentioned above) was still so experimental that cost savings available from this inexpensive method of curtainwall construction cannot be calculated precisely. The cost of the aluminum strip employed in the example given was 22 cents per square foot for the 0.032 inch thickness. Considering all other costs involved, and estimating that the present attainable construction rate per running foot of an 8 foot wide curtainwall would be double the 2 feet per minute speed already attained in practice, it appears that such curtainwalls can be built using the method of this invention at a cost total of approximately three times the cost of the sheet metal strip.

I claim:

1. A curtainwall comprising two spaced-apart rows of supporting means attached to an underlying building structure and sheet metal strip fastened across said rows of supporting means with the major portion of the width of said strip spanning the distance between said rows, with overlaps at a plurality of points along each edge of said strip where said strip is fastened across said rows of supporting means, thereby incorporating at least sufficient excess metal per linear foot of curtainwall to accommodate environmental expansion and contraction without the need for expansion joints in said curtainwall, and an embossed pattern in said strip intermediate said rows of supporting means.

2. The curtainwall of claim **1** wherein said supporting means are wire cables.

3. The curtainwall of claim **1** wherein said supporting means are furring strips.

4. The curtainwall of claim **1** wherein said supporting means are lines of spaced-apart brackets.

5. A composite curtainwall constructed in at least two tiers comprising at least first, second, and third spaced-apart rows of supporting means attached to an underlying building structure, with a sheet metal strip fastened across each consecutive pair of rows with the major portion of the width of each strip spanning the distance between a consecutive pair of rows, with overlaps at a plurality of points near each edge of and along the length of each strip where said strip is fastened to said supporting means, and with each consecutive edge of a strip lapped first in front of and then behind each row of supporting means in that order starting with said second row.

6. The curtainwall of claim **1** wherein said supporting means are wire cables.

7. The curtainwall of claim **1** wherein said supporting means are lines of spaced-apart brackets.

8. The curtainwall of claim **5** wherein said supporting means are furring strips.

9. The curtainwall of claim **5** wherein each sheet metal

strip is embossed intermediate a consecutive pair of rows of supporting means.

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