United States Patent [19]

Hayford, Jr. et al.

[11] **3,811,242**

[45] **May 21, 1974**

[54] **METHOD AND APPARATUS FOR COMPRESSING FOAM BLOCKS FOR STORAGE AND/OR SHIPMENT**

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[22] Filed: **Dec. 15, 1972**

[21] Appl. No.: **315,614**

[52] **U.S. Cl.** ..... **53/24**, 53/124 D, 53/124 TS, 100/42, 100/232

[51] **Int. Cl.** **B65b 63/02**

[58] **Field of Search** ..... 53/24, 124 D, 124 TS; 100/42, 232

[56] **References Cited**

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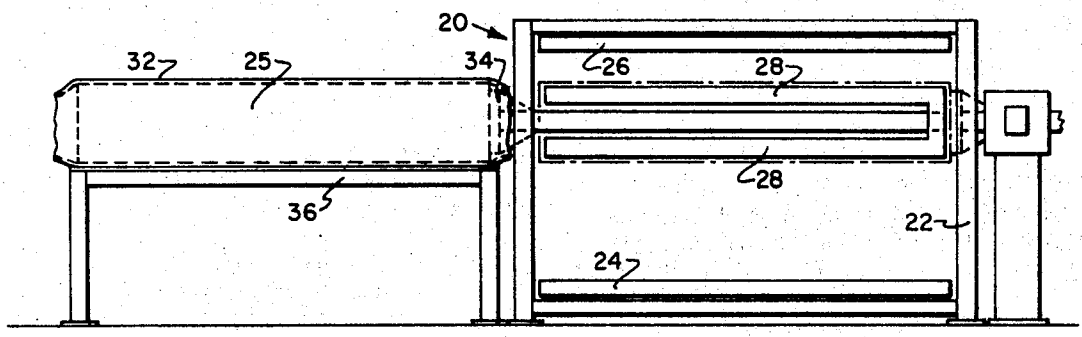
Primary Examiner—Travis S. McGehee

Attorney, Agent, or Firm—Samuelson & Jacob

[57] **ABSTRACT**

Method and apparatus for the compression and restraint of blocks of polyurethane foam or similar material to a small percentage of their original volume to reduce shipping and storage space. The blocks are compressed initially in the direction of at least one of the axes and are restrained in the direction of one of the other axes. Then, a restraining sleeve or a plurality of restraining bands holds the block in the compressed condition in the direction of the compressed axis and also prevents rebound or expansion in all directions of compression.

12 Claims, 14 Drawing Figures



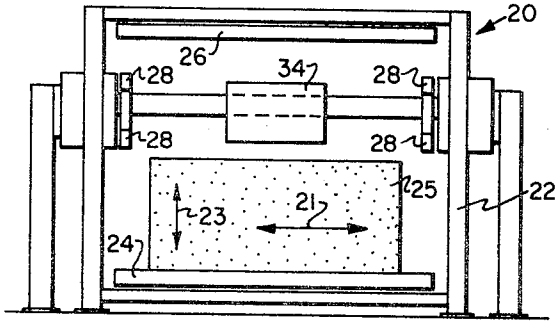


FIG. 1

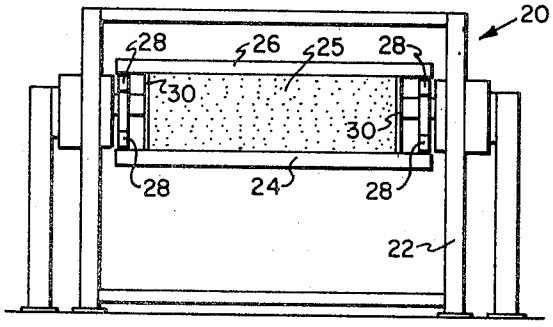


FIG. 2

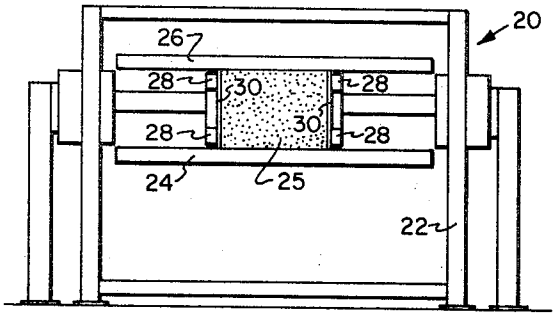


FIG. 3

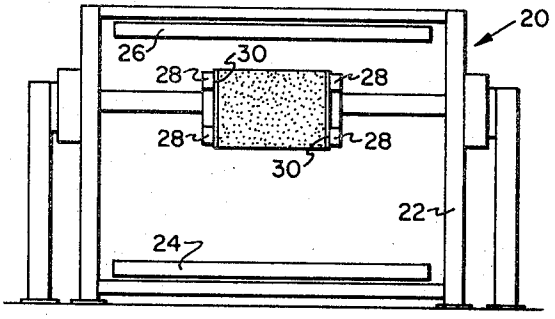


FIG. 4

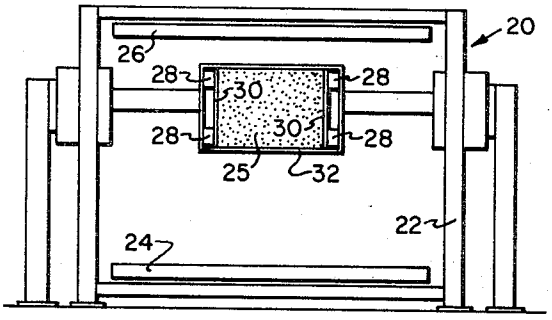


FIG. 5

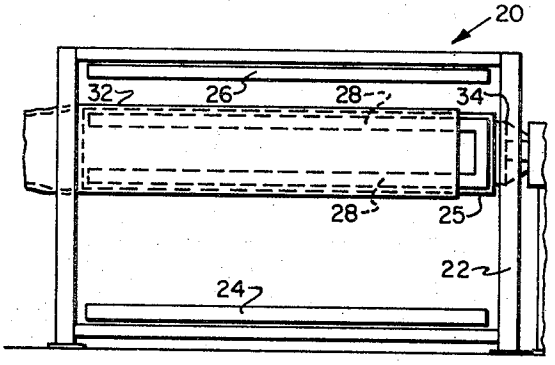


FIG. 6

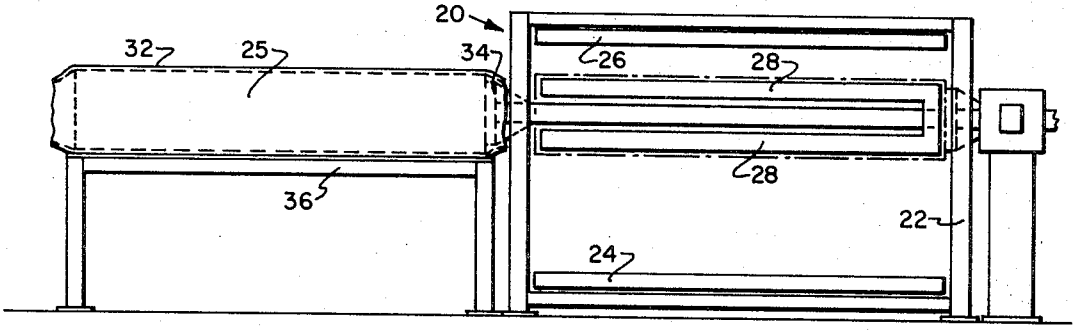


FIG. 7

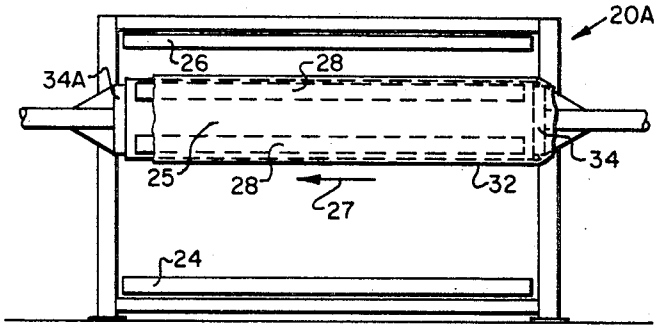


FIG. 8

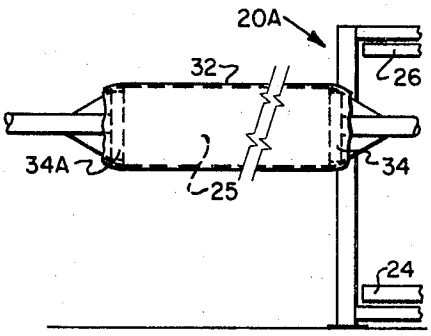


FIG. 9

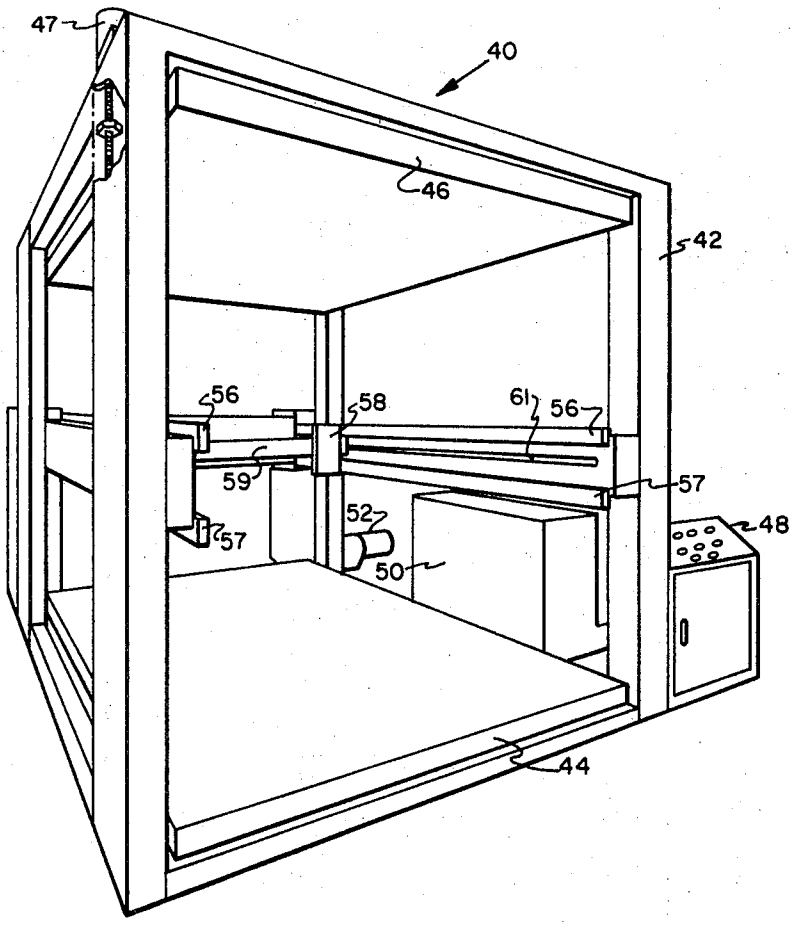


FIG. 10

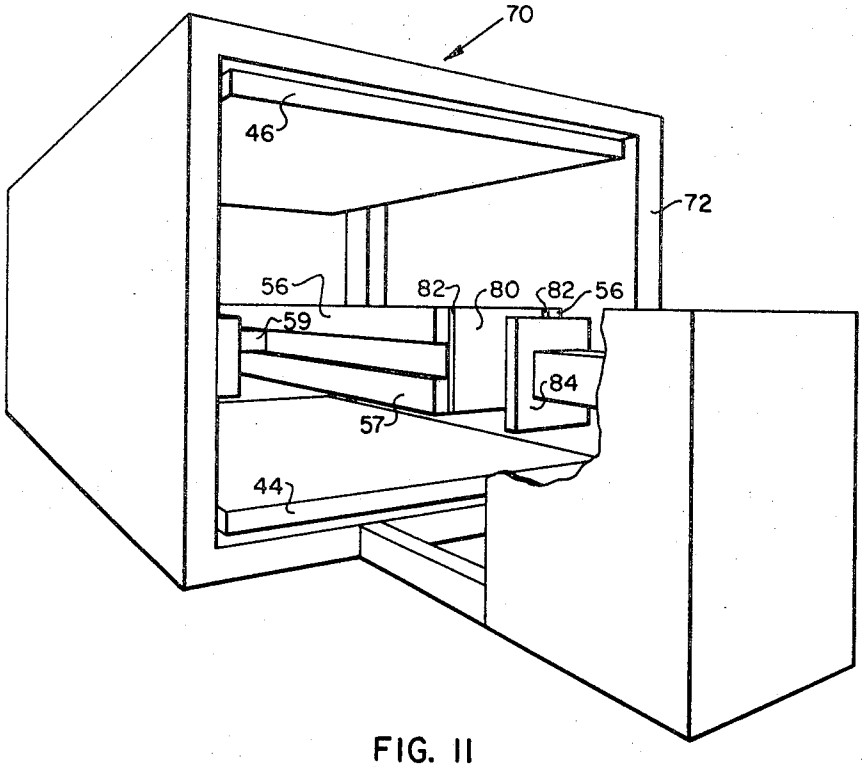


FIG. 11

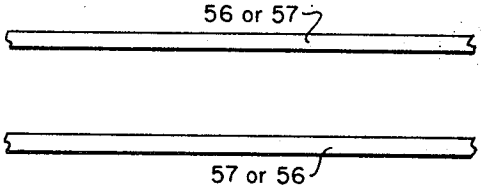


FIG. 12

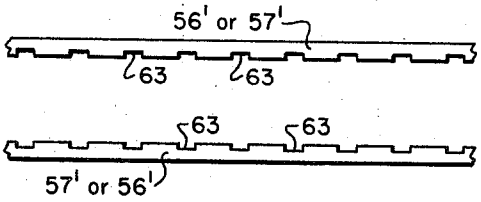


FIG. 13

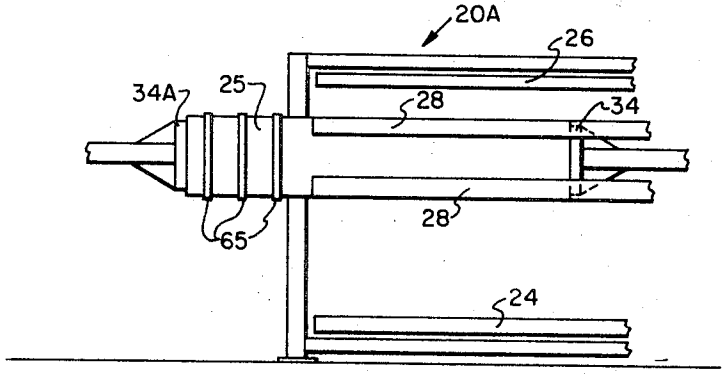


FIG. 14

METHOD AND APPARATUS FOR COMPRESSING FOAM BLOCKS FOR STORAGE AND/OR SHIPMENT

The invention relates to a method and apparatus for compressing blocks or buns of polyurethane foam or similar material to facilitate their economical shipment and/or storage.

Polyurethane foam, a low density, flexible material with open air cellular structure, is used in large quantities for the protection of fragile equipment during shipment and transportation. Maximum protection of such equipment is usually obtained when the foam is in its most expanded condition, namely, when the air cells within the material are largest. However, the user of the foam blocks for equipment protection is frequently located a long distance from the manufacturer of the foam blocks. Accordingly, it is desirable to be able to ship and store quantities of blocks or buns so that they will occupy the smallest posible volume. Ideally, one desires to compress the bun a maximum amount, to store it in the compressed and restrained condition and to obtain substantially full expansion to the original volume upon removal of the restraints.

Prior art methods have been used to produce some compressed foam block packages. Since the foam block would buckle if only one of the longer axes were compressed, compression was usually carried out in the direction of the shortest axis. As a result, it was possible to obtain only a limited amount of compression with a relatively large compressive force. Moreover, because of the nature of the material, the restraints necessary to hold the compressed block during storage and shipment were bulky and expensive.

Broadly, the invention is directed toward both a method and apparatus for obtaining maximum block compression while utilizing a minimum of restraining packaging to maintain the block in its compressed condition. The foregoing is accomplished by compressing the lock in the direction of one of its axes by an amount of the order of about 1 percent to 70 percent and then, while holding the block so compressed, compressing the block in the direction of a second axis (usually the longest or next longest) by an amount of the order of 10 percent to 75 percent. Now, the first compressive force is removed and the block remains compressed, in the direction of the first axis without bulging.

The block is now wrapped in a sleeve or is tied with straps of wire, plastic or similar material so as to continue to restrain expansion in the direction of the second compressed axis. The block is now ready for shipment and/or storage. In the event that a particular space volume is required for the compressed bun or block, the third axis may be compressed and restrained by the sleeve applied to the second compressed axis.

It is an important object of the invention to provide a method and apparatus for producing a compressed package of foam blocks or buns to maximize economical storage and/or shipment of the blocks.

It is a further object of the invention to utilize the unique property of the foam material which has been discovered by applicants to provide such a method and apparatus.

Yet another object of the invention is to provide a highly efficient packaging method wherein a high degree of compression is achieved and which is suitable to a wide variety of initial and compressed sizes.

It is a still further object of the invention to take advantage of the discovered, unique property of the material, namely, the high internal friction between the material's cell walls which is developed by sequential compression in the direction of two axes of the block.

It is yet another object of the invention to provide a method and apparatus for compressing a foam block whereby maximum compression is obtained from the use of a minimum amount of compressive force.

These and other objects, advantages, features and uses will be apparent during the course of the following description when taken in conjunction with the accompanying drawing, wherein:

FIGS. 1–7 are diagrammatic views showing the steps of the invention utilizing compression in the direction of two axes of the block to achieve packaged compression thereof;

FIGS. 8 and 9 are views similar to those of FIGS. 1–7 and which, together with FIGS. 1–5 show the steps of the invention utilizing compression in the direction of three axes of the block to achieve packaged compression thereof;

FIG. 10 is a perspective view of a preferred embodiment of apparatus of the invention;

FIG. 11 is a view similar to that of FIG. 10 showing apparatus for compressing a block in the direction of all three axes;

FIG. 12 is a top plan view of a pair of compression bars for use in the machines of FIG. 10 or FIG. 11.

FIG. 13 is a view similar to that of FIG. 12 of an alternate form of compression bars for use in the machines of FIG. 10 and FIG. 11; and

FIG. 14 is a diagrammatic view similar to that of FIG. 9 showing the application of straps to keep the block of material compressed.

When compressing an unstable column (such as polyurethane foam), for example, in the direction of its major (longest axis), the column will buckle. However, if the column is restrained from buckling in the direction of either or both of the other axes by either limiting the outward buckling action or by applying a minor compressive force in the direction of either of these axes the major axes compression will take place uniformly.

When the major axis is so compressed to and beyond a critical degree at which internal collapse occurs, additional compression takes place upon the imposition of a relatively minor increase in the compressive forces. Thus, a high degree of compression is attained effectively without requiring a proportionate increase in the compressive forces.

Once compressed beyond the point of internal collapse, the restraining or compressive forces applied to the intermediate or minor axes may be reduced or eliminated without subsequent buckling of the column.

If a substantial compression of the intermediate or minor axes, or both, is achieved prior to or concurrent with initial compression of the major axis and the major axis is substantially compressed, a unique and high internal friction developes. This characteristic permits the decreased and complete removal of the compressive forces on the intermediate and minor axes without rebound of these axes until the major axis compression is reduced or removed. With materials, such as polyurethane, where the compressive and restraint force is a function of the exposed face to be compressed, rather than the direction or axis to be compressed, the eco-

nomics of the packaging system and restraints show that maximum compression in the direction of the major axis is the most desirable.

In the foregoing discussion, the longest axis has been denominated the major axis, the shortest axis has been referred to as the minor axis and the other axis has been called the intermediate axis. However, the teachings of the invention apply with equal force to cubes or to shapes other than parallelopipedons.

In the drawing, wherein, for the purpose of illustration there are shown perferred embodiments of the invention, and wherein like numerals designate like parts throughout the same, the numeral **20** designates a machine of the invention, generally. Machine **20** is shown diagrammatically in FIGS. **1–7.** Machine **20** is seen to comprise a frame **22,** a lower plate or table **24** and an upper plate **26.** A polyurethane foam block or bun **25** is placed on plate **24** (FIG. **1**) and in this particular illustration is a parallelopipedon having three axes differing in length. One axis extends in the direction of arrow **21** of FIG. **1** and another extends in the direction of arrow **23.**

FIG. **2** shows the next step in the method of the invention wherein a pair of liners **30** of plastic, paper board or similar material have been placed as shown and table **24** and plate **26** have moved to the position shown to thereby compress the block **25** in the direction of arrow **23.** The liners **30** serve to reduce friction and bulging in the direction of the restrained axis when packaging later in the process.

FIG. **3** shows the position of block **25** after the block was first compressed in the direction of arrow **23** and then was compressed in the direction of arrow **21** by the opposed pairs of compression bars **28.** Next, the compressive force in the direction of arrow **23** is removed (FIG. **4**). Because of the nature of the material and the property discovered by applicants, the block does not bulge in the direction of the axis of arrow **23** when the compressive force applied by plates **24** and **26** is removed.

Next, a sleeve **32** of polyethylene or similar material is placed around the block **25** and the bars **28** as shown in FIGS. **5** and **6.** Now, a ram **34** pushes the block **25** into the sleeve **32** while the compression in the direction of arrow **21** is maintained by bars **28.** As the ram **34** pushes the block **25,** the friction between the block **25** and the sleeve **32** causes the block to carry the sleeve with it. If liners **30** were not used, the block **25** would distort and tear as it was being pushed into sleeve **32** as the frictional forces would be too great.

Thus, the block **25** is held compressed by sleeve **32** as shown on the left of FIG. **7** where it has been delivered to a table **36.** The table **36** may be replaced by a conveyor system, if desired.

In the event that it becomes advisable to compress the block in the direction of at least two of its axes and restrain it in the direction of the third axis, it is best to use a machine **20A** such as is illustrated diagrammatically in FIGS. **8** and **9.**

Machine **20A** is the same as machine **20** with the addition of a compression ram **34A** which cooperates with ram **34** as will be described below. After the block **25** has been restrained and/or compressed in the direction of arrow **23** and compressed in the direction of arrow **21,** a sleeve **32** is placed over the block **25** as shown in FIG. **8.** Now the ram **34** moves forward in the direction of arrow **27** toward compression ram **34A.** Compression ram **34A** restrains the block from moving and in cooperation with ram **34,** compresses it as shown in FIG. **9.** The sleeve **32** now holds the block **25** compressed even though no additional restraint is applied to prevent expansion in the direction of arrow **27.**

Apparatus **40** (FIG. **10**) is seen to comprise a frame **42,** a lower plate or table **44,** an upper plate **46,** a pair of upper compression bars **56,** a pair of lower compression bars **57,** a control panel **48,** a hydraulic enclosure **50** and a drive motor **52.** A motor **47** moves plates **44** and **46** toward and away from each other to apply restraint and/or compression to a block in the direction of a first axis. Similarly, upper and lower compression bars are moved toward each other to compress the block by the direction of a second axis after the first axis force is applied. The force applied by plates **44** and **46** may now be removed and the block may be ejected into a sleeve while maintaining the compressive force by means of bars **56** and **57.** A pair of ram plates **58** is utilized to eject the block into the restraining sleeve.

Each ram plate **58,** only one of which is shown in FIG. **10** is engaged with pusher bar **59** and between a bar **56** and a bar **57.** As the opposed bars **56** and **57** move toward each other in a direction across machine **40,** the plates **58** are moved toward each other. As pusher bar **59** is moved along drive members **61** toward the front of machine **40,** ram plates **58** push against the compressed block to eject it from the machine. Only one of the drive members **61** is shown in FIG. **10.** There is a second one located between the bars **56** and **57** at the left of the figure.

Thus it can be seen that the ram plates **58** are properly positioned laterally by means of the bars **56** and **57.** Once they are positioned behind the block or bun of foam plastic, they serve to eject the block from the machine as pusher bar **59** moves forward along drive members **61.**

Machine **70** is shown in perspective in FIG. **11.** It is similar to machine **40** and includes a compression ram to obtain compression of the order of about 2–10 percent in the direction of the third axis. The figure shows the machine with the bun compressed in the direction of two axes just prior to application of the restraining sleeve and further application of the third axis compression.

Machine **70** is seen to comprise a frame **72,** an upper compression plate **46** and a lower compression plate **44.** A plastic block **80** is shown compressed between the pairs of bars **56** and **57** (only one bar **57** is shown). Pusher bar **59** has pushed the ram plates (not shown) against the rear of the foam block **80.** Liners **82** are in position at the side of block **80.** Next the restraining sleeve is slipped over the compression bars to surround the block. Compression ram **84** is now moved against the front of block **80** and pusher **59** pushes the ram plates against the rear of block **80.** When the desired third axis compression is obtained, the block is held between the rear ram plates and front compression **84** which now move in the same direction to eject the block into the sleeve.

FIG. **12** is a top plan view of a pair of compression bars **56** or **57** which rest smoothly against the block and are used when a restraining sleeve is employed to hold the compressed block. FIG. **13** is a view similar to that of FIG. **12** of a pair of compression bars **56'** or **57'** which may be used in machines **40** or **70** when it is advisable to use restraining straps instead of a restraining

sleeve. The bars 56' or 57' are provided with a plurality of grooves 63 to facilitate the application of the straps to the block while the block is within the confines of the machine prior to ejection.

FIG. 14 is a diagrammatic view similar to FIG. 9 wherein the block is being ejected in steps to permit the application of straps 65. It is also possible to use the stepped ejection technique to apply straps to blocks which have been compressed by the machines 20, 40 and 70. When the stepping method is used, either smooth compression bars such as are illustrated in FIG. 12 or grooved compression bars such as are illustrated in FIG. 13 may be used.

It is noted that the open end of the restraining sleeve is in a plane transverse to that formed by the first axis and the second axis. Similarly, each of the straps lies in such a transverse plane.

Since the control system, electric motors and the hydraulic system do not form a part of the invention, details of these elements are not shown.

By way of illustration and not by way of limitation of the scope of the invention, following are examples of results attained with polyurethane foam blocks by utilizing the teachings of the invention:

Uncompressed block	Compressed to
12' × 7' × 4'	4' × 7' × 18"
7' × 9 ½' × 4'	7' × 4' × 18"
10' × 7' × 3'	5' × 7' × 30"
90" × 7' × 3'	90" × 42" × 30"

After the compressed blocks arrive at their destination and are ready for use, the restraining sleeve or bands are removed and the block expands to almost its original dimensions. The block may then be cut into the desired sizes and shapes. The amount that the block expands, upon removal of the restraints, varies with the creep and cure of the plastic under compression. Commercial polyurethane foam expands to about 98 percent of its original dimensions when compressed up to 50 percent of its original dimensions.

While various embodiments of the invention have been shown and described, it is apparent to those skilled in the art that modifications are possible without departing from the spirit of the invention or the scope of the subjoined claims.

The embodiment of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. The method of compressing a block of foam material to effectively reduce its volume for shipment and/or storage which comprises:
compressing the block in the direction of one of its axes (first axis) an amount of the order between 1 percent and 70 percent;
compressing the block in the direction of another of its axes (second axis) an amount of the order between 10 percent and 75 percent while maintaining the compressive force in the direction of the first axis;
removing the compressive force in the direction of the first axis;
applying restaining means around the block so as to confine the block in the directions of both compressed axes;
removing the compressive force in the direction of the second axis; and
placing a liner along each face of the block normal to the second axis before compressing the block in the direction of the second axis.

2. The invention of claim 1 wherein the step of applying the restraining means comprises:
ejecting the compressed block into a sleeve whose open end is transverse to the plane formed by the first axis and the second axis.

3. The invention of claim 1 wherein the step of applying the restraining means comprises:
placing a plurality of straps around the compressed block;
each of the straps being in a plane transverse to that formed by the first axis and the second axis.

4. The invention of claim 1 including:
the step of compressing the block in the direction of its third axis an amount of the order of 2% to 10%.

5. The invention of claim 4 wherein:
the step of compressing the block in the direction of its third axis is carried out while applying the restraining means.

6. The invention of claim 1 wherein:
the step of applying the restraining means comprises ejecting the compressed block into a sleeve whose open end is transverse to the plane of the first axis and the second axis; and
the block is compressed in the direction of its third axis an amount of the order of 2% to 10% concurrent with the applying of the restraining means.

7. The invention of claim 1 wherein:
the step of applying the restraining means comprises placing a plurality of straps around the compressed block, each of the straps being in a plane transverse to that formed by the first axis and the second axis; and
the block is compressed in the direction of its third axis an amount of the order of 2% to 10% concurrent with the applying of the restraining means.

8. Apparatus for compressing a block of foam material to effectively reduce its volume and to apply restraining means to hold it in said compressed state for shipment and/or storage which comprises:
first compressing means for compressing the block in the direction of a first axis thereof;
second compressing means for compressing the block in the direction of a second axis thereof;
a sleeve;
a ram for ejecting the compressed block into the sleeve such that the second compressing means and the sleeve serve to prevent the block from expanding while the block is being fully ejected into the sleeve; and
a plate opposed to the ram such that the block is compressed in the direction of its third axis while being ejected into the sleeve.

9. The invention of claim 8 including:
third compressing means for compressing the block in the direction of its third axis.

10. The invention of claim 9 wherein:
the first compressing means comprises a pair of opposed horizontal plates movable toward and away from each other; and
the second compressing means comprises a pair of opposed upper bars and a pair of opposed lower bars, each upper bar being coupled to a lower bar, the coupled bars being movable toward and away

from each other in a direction transverse to the movement of the pair of opposed horizontal plates.

11. The invention of claim **10** wherein:

the pairs of opposed bars carry a plurality of spaced grooves to permit the application of straps to the block in planes transverse to that formed by the first axis and the second axis.

12. The invention of claim **8** wherein:

the first compressing means comprises a pair of opposed horizontal plates movable toward and away from each other; and

the second compressing means comprises a pair of opposed upper bars and a pair of opposed lower bars, each upper bar being coupled to a lower bar, the coupled bars being movable toward and away from each other in a direction transverse to the movement of the pair of opposed horizontal plates.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,811,242 Dated May 21, 1974

Inventor(s) William H. Hayford, Jr., et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Address of "William H. Hayford, Jr., Summit Point, Ringwood, N.J. 07456;" should read --William H. Hayford, Jr., 44 Summit Point, Ringwood, N.J. 07456;--
Column 1, line 20, "posible" should read --possible--
Column 1, line 40, "lock" should read --block--
Column 2, line 29, "FIG. 11." should read --FIG. 11;--
Column 2, line 60, "developes" should read --develops--
Claim 1, line 14, "restaining" should read --restraining--

Signed and sealed this 29th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

USCOMM-DC 60376-P69
☆ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.