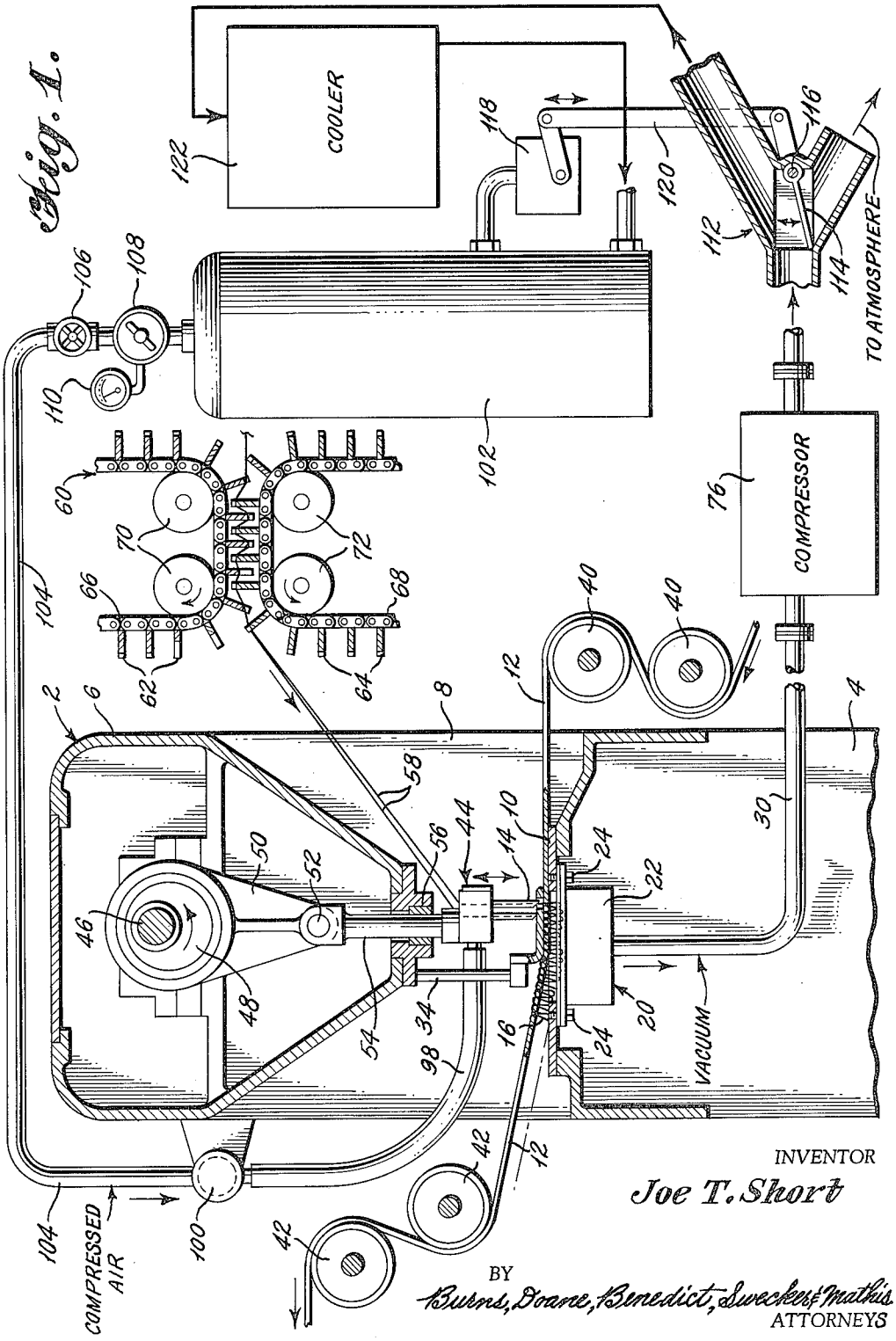
Nov. 16, 1965 J. T. SHORT 3,217,675

METHOD AND APPARATUS FOR THE PRODUCTION OF PILE FABRIC

Filed Nov. 7, 1962 3 Sheets-Sheet 1

Fig. 1.




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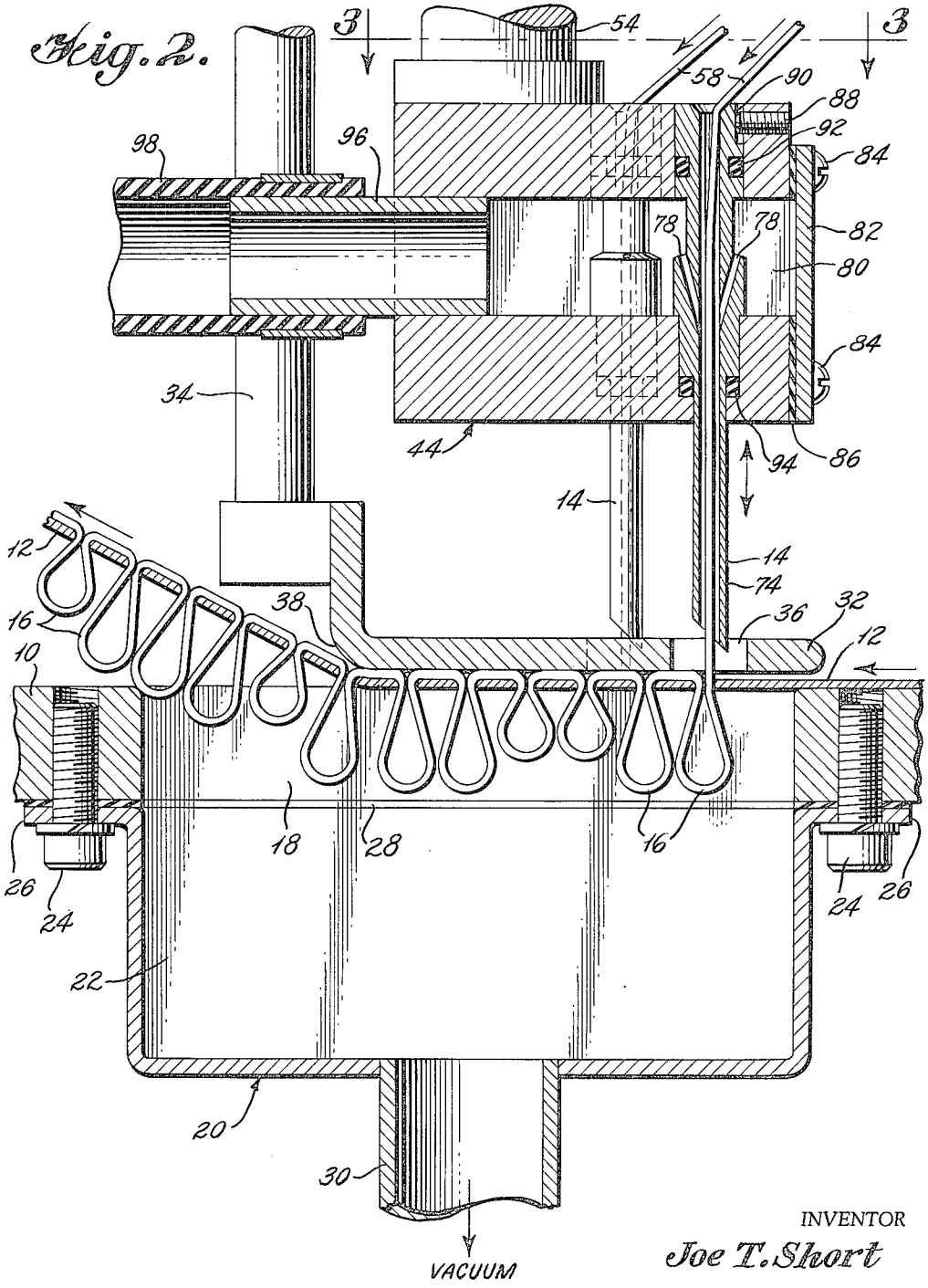
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METHOD AND APPARATUS FOR THE PRODUCTION OF PILE FABRIC

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Fig. 2.




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METHOD AND APPARATUS FOR THE PRODUCTION OF PILE FABRIC

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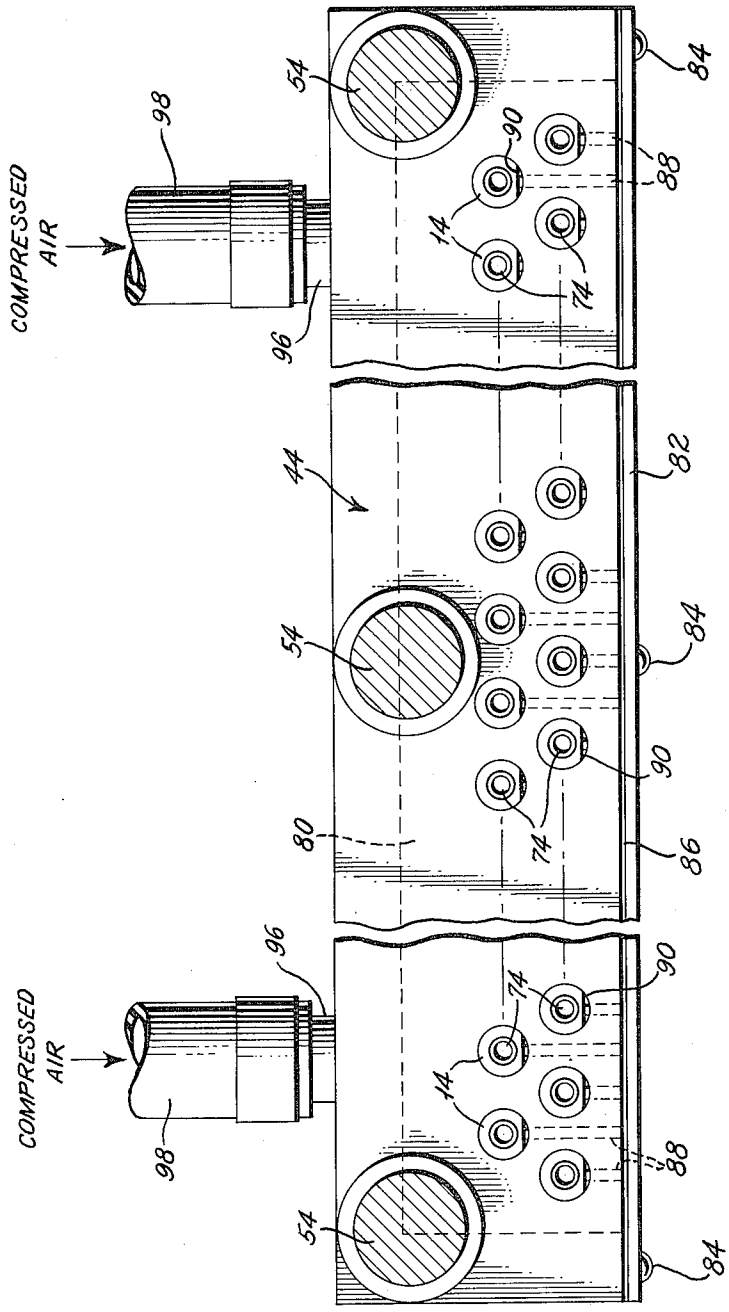



Fig. 3.

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United States Patent Office 3,217,675 Patented Nov. 16, 1965



3,217,675

# METHOD AND APPARATUS FOR THE PRODUCTION OF PILE FABRIC

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17 Claims. (Cl. 112—79)

This invention relates to tufting methods and apparatus and more particularly, to methods and apparatus for forming tufted fabrics through the utilization of flowing fluids for bringing lengths of pile yarns into desired positional relationships with respect to a backing sheet.

For a number of years, tufting techniques have been used on a large scale in the production of pile fabrics. Floor covering materials, such as carpeting, provide an example of one type of product to which these techniques have been applied with considerable success. In a typical multiple needle tufting machine of the type used commercially prior to the present invention, the formation of pile loops or tufts is accomplished through the interaction of needle and looper elements disposed on opposite sides of a backing sheet. Both the needles and the loopers are arranged in long rows extending transversely of the backing sheet and the backing sheet is advanced longitudinally. Each of the needles has an eye near its free end through which a pile yarn is threaded. All of the needles move together toward and away from the backing sheet. As a needle moves toward the backing sheet, it carries with it a pile yarn and inserts a loop of this pile yarn through the backing sheet, and then the looper element moves into the pile loop to hold the loop as the needle is withdrawn from the backing sheet.

In the operation of such equipment, the pile yarns frequently are subjected to severe stresses that adversely affect the quality of the products produced and that tend to slow down production operations. Moreover the equipment iself is somewhat delicate, requiring close adjustments and frequent repairs.

The present invention relates to a new type of tufting process and apparatus in which the movements of the pile yarns relative to the backing sheet are brought about largely by the gentle action of fluid streams. In one embodiment of the invention, the backing sheet is fed over a vacuum chamber, and hollow needles mounted above the path of the backing are moved up and down to periodically project their discharge ends through the backing into the zone of subatmospheric pressure created by the vacuum chamber. As a result there is established within each of the hollow needles a downwardly directed fluid flow tending to deliver the pile yarn from the discharge end of the needle when the tip of the needle is disposed below the backing. Control over the amount of yarn actually discharged from the needle during a given cycle, and therefore over the height of the pile loop formed during that cycle, is exercised by means other than the needle itself. Such means, which may be pattern controlled, operates to release measured lengths of pile yarns to the needles, and the fluid streams discharge these measured lengths from the tips of the needles.

Although the yarn feeding action of the flow caused by the vacuum chamber beneath the backing sheet is satisfactory for many purposes, the overall performance characteristics of the system may in some instances be enhanced by placing portions of the hollow needle located above the backing in communication with a source of fluid under a pressure above atmospheric. In this embodiment a single compressor or pump may provide both the negative pressures required for the vacuum chamber and the positive pressures required by the fluid supply for the needles.



A more complete understanding of the invention will be gained from a consideration of a detailed description of the embodiment illustrated in the accompanying drawings in which:

FIGURE 1 is a diagrammatic view of a system embodying the principles of the invention;

FIGURE 2 is an enlarged vertical cross-sectional view illustrating the tufting zone of the system shown in FIGURE 1; and

FIGURE 3 is a horizontal cross-sectional view taken along the line 3—3 in FIGURE 2.

The installation depicted in FIGURE 1 includes a tufting machine 2 suitable for the production of wide yardage goods such as carpeting materials. The frame of the machine 2 includes a base portion 4 and an upper housing unit 6 which extends across the entire width of the machine and is supported at its ends by uprights 8. The base portion 4 carries a work support 10 over which a backing 12 is advanced in a manner to be described in greater detail below. As the backing 12 moves over the work support 10 it is penetrated periodically by hollow tufting needles 14, and pile loops or tufts 16 are inserted into the backing 12 through the needles 14.

In the tuft forming zone, the work support 10 must be provided with openings into which the tips of the needles 14 and the pile loops 16 may be projected. A convenient construction is one in which the work support 10 includes a grate-like portion made up of a plurality of relatively thin strips 18. Only one of these strips 18 is shown in the drawings (FIGURE 2), but it will be understood that the machine 2 includes many of these elements. Ordinarily, it is preferred that one of the strips 18 be located on each side of each of the needles 14. The spaces between adjacent ones of the strips 18 provide elongated openings through which the pile loops 16 may be advanced freely.

Disposed immediately below the grate-like section of the work support 10 is a vacuum chamber 20. The casing 22 of the vacuum chamber 20 extends across the entire width of the tufting zone, and its side and end walls are secured to the work support 10 by suitable means such as screws 24. As illustrated, the screws 24 pass through horizontal flanges 26 at the upper end of the casing 22 and into threaded holes in the work support 10. Suitable gasket means 28 may be provided to minimize air leakage at the joint between the casing 22 and the work support 10.

Air is withdrawn from the vacuum chamber 20 through conduit means 30 communicating with the bottom thereof. In order to assure substantially uniform pressure distribution across the width of the machine 2, the outlet means should permit the withdrawal of air from a plurality of zones along the length of the chamber 20. As illustrated a plurality of the conduits 30 are located at spaced intervals along the vacuum chamber 20. However, a tapered hood would also serve this purpose.

A stationary presser foot 32 is spaced a short distance above the work support 10 in the zone of tuft formation. It is carried by support means 34 depending from the upper housing unit 6 of the machine frame. Openings 36 are formed in the presser foot 32 in vertical alignment with the needles 14, so that the needles 14 may penetrate the backing 12 while the latter is supported by the strips 18 that form the grate-like section of the work support 10.

The front end of the presser foot 32, that is the end past which the backing 12 moves in leaving the zone of tuft formation, is provided with a smoothly rounded, upwardly curved, surface 38 for guiding the tufted fabric away from the work support 10. As shown best in FIGURE 2, the fabric guiding surface 38 is located rear-

wardly of the front ends of the strips 18 so that the pile loops 16 may be removed from the spaces between the strips 18 without injuring them. However, the distance between the surface 38 and the front end of the grate-like section of the work support should not be so great as to leave a substantial portion of the top of the grate exposed when the fabric is in position.

The path of the backing 12 in moving toward and away from the zone of tuft formation may be established by a suitable arrangement of rollers. As illustrated in FIGURE 1, a pair of rollers 40 guides the backing toward the zone of tuft formation at about the level of the top of the work support 10, and an elevated pair of rollers 42 guides the fabric away from the zone of tuft formation along an upwardly inclined path. The installation includes suitable drive means, and the movements of the rollers are controlled to coordinate the advance of the backing with the operation of the needles 14.

The needles 14 are mounted on a needle carrier 44 which is moved up and down cyclically. A driven shaft 46 rotatably mounted within the upper housing unit 6 of the machine 2 serves to support and drive the needle carrier 44. A plurality of eccentrics 48, one of which is shown in FIGURE 1, are fixed to the driven shaft 46 at spaced intervals along its length. Cooperating with each of these eccentrics 48 is a bearing member 50 which is pivotally connected at 52 to the upper end of a push rod 54 mounted for vertical sliding movement within a bearing sleeve 56 carried by the upper housing unit 6. The lower ends of the push rods 54 are fixed to the needle carrier 44, so that the needles 14 will reciprocate vertically when the shaft 46 is rotated.

The pile yarns 58 forming the loops 16 may be supplied from any suitable source, such as a creel, not illustrated. In FIGURE 1, the pile yarns 58 are fed from the yarn source and released in a controlled manner to the needles 14 by a feed mechanism 60 of the notched bar type. In this feed mechanism 60, the pile yarns 58 are engaged by intermeshing pattern bars 62 and 64 mounted on endless carriers 66 and 68 that are guided through a yarn feeding zone by suitable means 70 and 72. The intermeshing pattern bars 62 and 64 cause the yarns 58 to assume undulating paths as they pass through the feeding zone. The individual pattern bars 62 are provided, with yarn-receiving notches in their edges, which notches may vary in depth so that the lengths of yarns stored in a row of these undulations may be different. When the endless carriers 66 and 68 move a pair of pattern bars 62 and 64 out of the zone of intermeshing, different amounts of yarn may be released to the different needles 14 in a manner well understood in the art.

The lower end portion of each of the needles 14 is cut away at an inclined angle to provide a pointed tip for penetrating the backing 12. The opening at the tip of each needle 14 communicates with a yarn passageway 74 through the needle. A length of yarn released to a needle 14 by the yarn feed mechanism 60 may pass freely through the interior of the needle and out of the tip portion thereof.

It will be apparent that, when a needle penetrates the backing 12, the lower end of its yarn passageway 74 will be exposed to the subatmospheric pressure of the vacuum chamber 20 and the upper end of its yarn passageway 74 will be exposed to the pressure prevailing in the surrounding atmosphere. This pressure differential causes a fluid flow downwardly through the yarn passageway 74. The gentle action of the fluid flow causes the pile yarn 58 to move into the desired positional relationship with respect to the backing 12 without the pile yarn being subjected to severe stresses.

The conduits 30 communicating with the lower end of the vacuum chamber 20 should be connected to a compressor 76 of substantial capacity. Although the backing 12 and the pile loops 16 impede the entrance



of air into the upper end of the vacuum chamber 20, a large volume of air must be removed from the vacuum chamber in order to maintain the desired pressure level.

If desired, the entire flow through the yarn passageway 74 in the needle 14 may be that caused by the subatmospheric pressures existing in the zone beneath the backing 12. Such an arrangement is entirely satisfactory in many operations. In the illustrated embodiment of the invention, however, provision is made for the recirculation of air from the compressor 76 to the yarn passageways 74 of the needles 14.

As shown best in FIGURE 2, each needle 14 is provided with a plurality of downwardly inclined air passages 78 leading from a pressure chamber 80 in the needle carrier 44 to the yarn passageway 74. Air issues from the outlet ends of the passages 78 in the form of high velocity jets which urge the pile yarn 58 downwardly through the yarn passageway 74, supplementing the flow attributable to the subatmospheric pressures existing below the backing sheet 12.

The air chamber 80 preferably extends the full length of the needle carrier 44. It may be formed, for example, by milling a slot in bar stock and then providing a suitable closure for the open end of the slot. The closure may be a plate 82 detachably held in position by screws 84. Gasket means 86 should be included in the assembly to prevent undesirable air leakage.

The individual needles 14 may be inserted through openings in the top of the needle carrier 44 and then held in their proper positions by set screws 88. It normally is preferred that the set screws 88 bear against flats 90 milled on the upper end portions of the needles 14 in order to provide positive control over the angular orientation of the tapered points of the needles. Protection against air leakage about the exterior wall surfaces of the needles 14 is provided by suitable O-ring seals 92 and 94.

Air passes into the chamber 80 in the needle carrier 44 through a plurality of nipples 96 communicating with flexible conduit means 98 leading to a long cylinder 100 which serves as a distributor. The distributor 100 is fixed into position on the frame on the machine 2, but the flexibility of the conduit means 98 is sufficient to accommodate the reciprocating motions of the needle carrier 44. From FIGURE 3, it will be observed that there are a plurality of the flexible conduits 98. These are spaced at intervals across the width of the machine to minimize variations in the air pressure along the length of the chamber 80. In this connection, it should be pointed out that the width of the machine 2 may be fifteen feet or more. It is usually desirable to provide a construction in which the flow through any one of the needles 14 will be substantially the same as the flow through the other needles 14.

Air is supplied to the distributor 100 from a storage tank 102 through conduit means 104. Suitable flow controlling components should be located in this portion of the system. For example, FIGURE 1 illustrates a shut-off valve 106 for stopping the flow of air to the distributor 100 when desired, and it also shows diagrammatically a throttle valve 108 for regulating the pressure supplied to the distributor 100. A gauge 110 associated with the downwstream side of the throttle valve 108 gives a visual indication of the pressure in the line to aid the operator of the equipment in setting up and maintaining the desired conditions.

The tank 102 is supplied with air from the output of the compressor 76. In the normal operation of the system, however, the amount of air that must pass through the compressor 76 in order to maintain the desired pressure level in the vacuum chamber 20 is greater than the amount required for supplying the air chamber 80 in the needle carrier 44. Hence, it is desirable to include in the flow path between the compressor 76 and the tank 102 a blow-off valve that will direct the air discharged

from the compressor 76 into the atmosphere when the tank 102 requires no additional air.

In FIGURE 1 this blow-off valve is illustrated diagrammatically and is designated by the numeral 112. Its flow controlling member 114 is pivotally mounted at 116 for movement to one or the other of two positions. In the position illustrated, the member 114 directs the flow of air from the compressor along a path that leads to the air tank 102. In the other position of the member 114, it directs the air from the compressor 76 along a path that leads to the atmosphere. Pressure responsive means 118 is associated with the tank 102 and is connected to the flow controlling member 114 by suitable linkage means 120 so as to move the member 114 between its operative positions as required.

During operation of a recirculating air system of the type depicted in FIGURE 1, there is a tendency for the temperature of the air to rise gradually. It is therefore desirable that a cooler 122 be provided to lower the temperature of the air passing to the storage tank 102. This component may be conventional in construction, and it need not be described here in detail.

In the illustrated embodiment of the invention, air is withdrawn continuously from the vacuum chamber 20 and air is supplied continuously to the pressure chamber 80 in the needle carrier 44. However, it will be observed that the pile loops 16 are formed in response to the yarn feeding action that takes place during that portion of the machine cycle when the tips of the needles 14 penetrate the backing 12, and it will be apparent that an intermittent air flow suitably coordinated with the movements of the needles 14 is suitable. For example, valve means may be included in the system and operated so as to shut off the flow from the vacuum chamber 20 and/or the pressure chamber 80 during portions of the machine cycle when the needles 14 are disposed above the backing 12.

Although reference has been made herein to the use of air as the operative fluid in the feeding of the pile yarns 58, it will be understood that the invention is not limited to this particular fluid. Other fluids may be employed when desired.

Various other modifications and variations will suggest themselves to persons skilled in the art. It is intended therefore that the foregoing description be considered as exemplary only and that the scope of the invention be ascertained from the following claims:

I claim:

1. A multiple needle tufting machine comprising a work support having aperture means therein, means for advancing a backing across said work support, a plurality of hollow needles, means on the side of the backing opposite said work support mounting said needles in alignment with said aperture means in said work support, means for causing cyclical relative movement between said needles and said work support to periodically dispose the needles in penetrating relation to the backing with their end portions exposed to said aperture means, each of said needles having a yarn passageway therein extending to a portion of the needle that is periodically exposed to said aperture means, means for supplying lengths of yarn to the yarn passageways in said needles during each cycle of relative movement between said needles and said work support, and suction means operatively connected to said aperture means in said work support for urging the yarn out of said needles when said needles penetrate the backing.

2. A multiple needle tufting machine comprising a work support having aperture means therein, means for advancing a backing over said work support, a needle carrier disposed on the opposite side of said backing from said work support, a plurality of hollow needles mounted on said needle carrier in alignment with said aperture means in said work support, means for causing cyclical relative movement between said needle carrier and said work support to periodically dispose the needles in penetrating relation to the backing with their end portions exposed to said aperture means in said work support, each of said needles having a yarn passageway therethrough terminating in a yarn discharge opening located in a portion of the needle that is periodically exposed to said aperture means, a yarn source, means for positively feeding predetermined lengths of yarn from said yarn source toward the yarn passageways in said needles during each cycle of relative movement between said needle carrier and said work support, and suction means operatively connected to said aperture means in said work support for urging the yarns out of said needles after said needles have penetrated the backing and created a hole in said backing for such yarns.

3. A multiple needle tufting machine comprising a work support including a portion made up of a plurality of spaced apart strips, means for advancing a backing along said strips over said work support, a needle carrier disposed on the opposite side of said backing from said work support, a plurality of hollow needles mounted on said needle carrier in alignment with the spaces between said strips, means for causing cyclical relative movement between said needle carrier and said work support to periodically dispose the needles in penetrating relation to the backing with their end portions exposed to said spaces between said strips at a location intermediate the ends of said strips, each of said needles having a yarn passageway therethrough terminating in a yarn discharge opening located in a portion of the needle that is periodically exposed to one of said spaces between said strips, means for supplying lengths of yarn to the yarn passageways in said needles during each cycle of relative movement between said needle carrier and said work support, and suction means in communication with the spaces between said strips for drawing air and yarn through said yarn passageways after said needles have penetrated the backing to form pile loops extending from the backing into the spaces between said strips.

4. A multiple needle tufting machine comprising a needle carrier, a plurality of hollow needles mounted on said needle carrier, and having yarn passageways therethrough terminating in yarn discharge openings at the lower ends thereof, a stationary presser foot disposed beneath said needle carrier and having holes therein in alignment with said needles, said presser foot being provided with an upwardly sloping fabric guiding surface spaced from said holes, a work support spaced below said presser foot and having elongated openings therein in vertical alignment with said holes in said presser foot, said openings in said work support extending forwardly from the location of said holes beyond said fabric guiding surface, a vacuum chamber below said work support in communication with said openings, means for advancing a backing along a path extending through the space between said presser foot and said work support and then upwardly along said sloping surface of said presser foot, means for moving said needle carrier cyclically up and down to periodically project the lower end portions of said needles through the backing into said openings, and means for supplying lengths of yarn to the yarn passageways in said needles during each cycle of movement of said needle carrier.

5. A multiple needle tufting machine comprising a work support having aperture means therein, means for advancing a backing over said work support, a needle carrier disposed on the opposite side of said backing from said work support, a plurality of hollow needles mounted on said needle carrier in alignment with said aperture means in said work support, means for causing cyclical relative movement between said needle carrier and said work support to periodically dispose the needles in penetrating relation to the backing with their end portions exposed to said aperture means in said work support; each of said needles having a yarn passageway therethrough

terminating in a yarn discharge opening located in a portion of the needle that is periodically exposed to said aperture means, a source of fluid at a pressure above atmospheric pressure, means for admitting fluid from said source to said yarn passageways for aiding in urging the yarns out of said passageways, means for supplying lengths of yarn to the yarn passageways in said needles during each cycle of relative movement between said needle carrier and said work support, and suction means operatively connected to said aperture means in said work support for also aiding in urging the yarns out of said needles after said needles penetrate the backing.

6. Tufting apparatus comprising a work support having aperture means therein, means for advancing a backing over said work support with one side of said backing exposed to one side of said work support, a vacuum chamber disposed on the opposite side of said work support and communicating with said aperture means, a needle carrier disposed on the opposite side of said backing and having a high pressure air chamber therein, a plurality of hollow needles mounted on and extending through said needle carrier and projecting toward said aperture means in said work support, each of said needles having a longitudinally extending yarn passageway therein terminating in an outlet opening at the end of the needle adjacent the backing and having a yarn inlet opening at the end thereof opposite said outlet opening, each of said needles being provided with an air inlet connecting said high pressure air chamber in said needle carrier and with said yarn passageway in the needle for aiding in urging the yarn out of said yarn passageway, means for causing cyclical relative movement between said needle carrier and said work support to periodically cause said needles to extend through the backing into said aperture means in said work support to dispose said outlet openings of said needles in fluid communication with said vacuum chamber, means for supplying predetermined lengths of yarn to the yarn inlet openings of said needles during each cycle of relative movement between said needle carrier and said work support and compressor means having its intake operatively connected to said vacuum chamber and its discharge operatively connected to said high pressure air chamber in said needle carrier for also aiding in urging yarn out of said needles after said needles penetrate the backing.

7. Tufting apparatus comprising a work support having aperture means therein, means for advancing a backing over said work support with one side of said backing exposed to one side of said work support, a vacuum chamber disposed on the opposite side of said work support and communicating with said aperture means, a needle carrier disposed on the opposite side of said backing and having a high pressure air chamber therein, a plurality of hollow needles mounted on and extending through said needle carrier and projecting toward said aperture means in said work support, each of said needles having a longitudinally extending yarn passageway therein terminating in an outlet opening at the end of the needle adjacent the backing and having a yarn inlet opening at the end thereof opposite said outlet opening, each of said needles being provided with air inlet passages intermediate the length thereof communicating with said high pressure air chamber in said needle carrier and with said yarn passageway in the needle for admitting air to said yarn passageway to aid in urging the yarn out of the needle, means for causing cyclical relative movement between said needle carrier and said work support to periodically cause said needles to extend through the backing into said aperture means in said work support to dispose said outlet openings of said needles in fluid communication with said vacuum chamber, means for supplying predetermined lengths of yarn to the yarn inlet openings of said needles during each cycle of relative movement between said needle carrier and said work support, compressor means having its intake operatively connected to said vacuum chamber for producing a vacuum to cooperate with said high pressure air in urging the yarns out of said needles when said needles penetrate the backing, an air tank operatively connected to said high pressure air chamber in said needle carrier, conduit means connecting said tank to the discharge of the compressor, and means responsive to the pressure in said tank to interrupt the flow of air to said tank when the pressure in said tank reaches a predetermined level and divert the flow of air from the discharge of said compressor.

8. Tufting apparatus comprising a work support having a plurality of apertures therein, means for advancing a backing over said work support with one side of said backing exposed to one side of said work support, a vacuum chamber disposed on the opposite side of said work support and communicating with said apertures, a needle carrier disposed on the opposite side of said backing and having a high pressure air chamber therein, a plurality of hollow needles mounted on and extending through said needle carrier and projecting toward said apertures in said work support, each of said needles having a longitudinally extending yarn passageway therein terminating in an outlet opening at the end of the needle adjacent the backing and having a yarn inlet opening at the end thereof opposite said outlet opening, each of said needles being provided with air inlet passages intermediate the length thereof communicating with said high pressure air chamber in said needle carrier and with said yarn passageway in the needle for admitting air to said yarn passageway to aid in urging the yarn out of the needle, means for causing cyclical relative movement between said needle carrier and said work support to periodically cause said needles to extend through the backing into said apertures in said work support to dispose said outlet openings of said needles in fluid communication with said vacuum chamber, means for supplying predetermined lengths of yarn to the yarn inlet openings of said needles during each cycle of relative movement between said needle carrier and said work support, compressor means having its intake operatively connected to said vacuum chamber for producing a vacuum to cooperate with said high pressure air in urging the yarns out of said needles when said needles penetrate the backing and its discharge operatively connected to said high pressure air chamber in said needle carrier, and means for cooling the air between said compressor and said high pressure air chamber in said needle.

9. In a method of tufting in which cyclical relative movement between a backing and a plurality of hollow needles carrying pile yarns causes the needles to extend through the backing periodically with their end portions exposed on the face side of the backing, the improvement which comprises establishing a zone of subatmospheric pressure below the pressure of the ambient air on the face side of the backing to cause the pile yarns to feed through the needles, and controlling the length of pile yarn made available to each needle during each cycle.

10. In a method of tufting in which cyclical relative movement between a backing and a plurality of hollow needles carrying pile yarns causes the needles to extend through the backing periodically with their end portions exposed on the face side of the backing, the improvement which comprises establishing a zone of subatmospheric pressure below the pressure of the ambient air on the face side of the backing to cause the pile yarns to feed through the needles, and supplying during at least certain cycles different lengths of pile yarns to different ones of said needles to form pile tufts of different lengths on the face side of the backing.

11. In a method of tufting in which cyclical relative

movement between a backing and a plurality of hollow needles carrying pile yarns causes the needles on one side of the backing to extend through the backing periodically with their end portions exposed on the other side of the backing, the improvement which comprises establishing a zone of subatmospheric pressure below the pressure of the ambient air on the other side of said backing and admitting to said needles above said backing, fluid from a zone of superatmospheric pressure to cause the pile yarns to feed through the needles, and controlling the length of pile yarn made available to each needle during each cycle.

12. A method of tufting which comprises inserting end portions of a plurality of hollow needles a predetermined distance through a backing to expose such end portions on the face side of the backing, establishing a zone of subatmospheric pressure on the face side of the backing to cause air to flow through said needles after said needles penetrate the backing, and supplying to said needles lengths of yarn sufficient for the formation of pile loops of greater length than the distance said needles are inserted through said backing.

13. In a method of tufting wherein hollow needles on one side of a backing penetrate a transverse area of the backing for inserting yarns fed to the needles through the transverse area of the backing upon relative movement between the needles and the backing toward and away from each other, the step of applying a vacuum to the other side of the backing along the transverse area through which the needles are passed, the vacuum being sufficient to pass air through the needles for urging the yarns out of the needles to the extent permitted by the feed of the yarns to the needles and sufficient to urge air through the backing.

14. In a method of tufting wherein hollow needles on one side of a backing penetrate the backing for inserting yarns fed to the needles through the backing upon relative movement between the needles and the backing, the step of reducing the air pressure on the other side of the backing appreciably below the pressure of the ambient air for urging yarns out of the needles to facilitate the formation by the yarns of loops having pile heights in excess of the depth of penetration of the needles.

15. In a method of tufting wherein a backing is fed along a prescribed longitudinal path through a tufting zone and wherein a plurality of hollow tufting needles are disposed adjacent the tufting zone on one side of the backing with the tufting ends of the needles protruding toward the backing, and wherein upon relative reciprocatory movement between the needles and the backing the tufting ends of the needles are inserted through successive transverse areas of the backing in the tufting zone to the extent that the tufting ends protrude on the other side of the backing for introducing increments of the yarns to the other side of the backing for forming loops, the step of reducing the pressure of atmospheric air on the other side of the backing throughout the transverse area of the backing in the tufting zone for urging the yarns out of the needles to the extent permitted by the feed of the yarn to the needles during that portion of each cycle in which the tufting ends of the needles protrude on said other side of the backing.

16. In a method of tufting wherein a backing is fed along a prescribed longitudinal path through a tufting zone and wherein a plurality of hollow tufting needles are disposed adjacent the tufting zone on one side of the backing with the tufting ends of the needles protruding toward the backing, and wherein upon relative reciprocatory movement between the needles and the backing the tufting ends of the needles are inserted through successive transverse areas of the backing in the tufting zone to the extent that the tufting ends protrude on the other side of the backing for introducing increments of the yarns to the other side of the backing for forming loops, the steps of reducing the pressure of atmospheric air on said other side of the backing throughout the transverse area of the backing in the tufting zone for urging the yarns out of the needles to the extent permitted by the feed of the yarn to the needles during that position of each cycle in which the tufting ends of the needles protrude on said other side of the backing, and applying a fluid under pressure above atmospheric pressure to the hollow portions of the needles and directing the fluid in the direction of said tufting ends of the needles for aiding in the discharge of the yarns from the tufting ends during that portion of each cycle in which the tufting ends of the needles protrude on said other side of the backing.

17. In a method of tufting wherein a backing is fed along a prescribed longitudinal path through a tufting zone and wherein a plurality of hollow tufting needles are disposed adjacent the tufting zone on one side of the backing with the tufting ends of the needles protruding toward the backing, and wherein upon relative reciprocatory movement between the needles and the backing the tufting ends of the needles are inserted through successive transverse areas of the backing in the tufting zone to the extent that the tufting ends protrude on the other side of the backing for introducing increments of the yarns to the other side of the backing for forming loops, the steps of reducing the pressure of atmospheric air on said other side of the backing throughout the transverse area of the backing in the tufting zone for urging the yarns out of the needles to the extent permitted by the feed of the yarn to the needles during that position of each cycle in which the tufting ends of the needles protrude on said other side of the backing, applying a fluid under pressure above atmospheric pressure to the hollow portions of the needles and directing the fluid in the direction of said tufting ends of the needles for aiding in the discharge of the yarns from the tufting ends during that portion of each cycle in which the tufting ends of the needles protrude on said other side of the backing, reducing the flow of fluid in the hollow portions of the needles during that portion of each cycle in which the needles no longer protrude through the backing, and raising the pressure of the atmospheric air on said other side of the backing during that portion of each cycle in which the needles no longer protrude through the backing.

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