ABSTRACT OF THE DISCLOSURE

A reversible nonwoven fabric is made by interposing a fibrous interlay between two pre-bonded fibrous webs, needling into the fibres of one fibrous web to orient some of the interlay fibres through the opposite web in the form of tufts without appreciable orientation of the fibres in said web, repeating the needling from the other side of the three-layer structure, and then bonding the fibres of the interlay.

DISCLOSURE

This invention relates to nonwoven fabrics and to methods of making them and is particularly concerned with reversible nonwoven fabrics and to methods of making them involving, as an essential operation, the needle-punching of a composite fibrous structure.

According to this invention, in one of its aspects, there is provided a reversible nonwoven fabric which comprises a fibrous interlay interposed between two layers each constituted by a fibrous web wherein fibres are bonded together, with some fibres from the fibrous interlay oriented through a bonded fibrous web layer as fibre tufts and other fibres from the interlay oriented through the other bonded fibrous web layer as fibre tufts, said fibre tufts being set in position as a result of the bonding in the other of the fibres in the fibrous web interlay.

The constituent fibres of the fibre tufts may be substantially straight or they may be crimped. When the fibre tufts contain crimped fibres it is generally the case that fibres present in the fibrous interlay are also crimped. The presence, in the fibrous tufts, of crimped fibres is associated with advantages, for instance, more effective coverage of the underlying layers, and a superior resilience, compared with fibre tufts containing straight or substantially uncrimped fibres.

Preferably, the fibres present in the fibre tufts and which extend outwardly from the fibrous interlay, are orientated in planes normal or substantially so to the planar surfaces of the fabric.

The fibres oriented through the bonded fibrous web layers project beyond the planar surfaces of the layers as fibre tufts, and provided these tufts are well-defined, especially in relation to the length they project beyond the underlying layer, and sufficiently numerous, they form a definite layer of fibre tufts contiguous with the planar surface of each of the bonded fibrous web layers. In some instances the fibre tufts may lack the necessary definition, or be too few in number to provide a definite layer. It is possible to arrange that the fibre tufts on one surface of a fabric actually constitute that surface by forming a definite layer, while in the opposite surface the fibre tufts do not form a layer, and the surface is constituted both by fibre tufts and the underlying bonded fibrous web.

The arrangement of fibres from the fibrous interlay through the two fibrous web layers not only makes for a reversible nonwoven fabric, but further provides for the integration of the fibrous interlay with the two outer layers, between which it is sandwiched, so that the fabric exhibits an adequate dimensional stability and resistance to delamination.

The invention further includes in another of its aspects a method of making reversible nonwoven fabrics which comprises interposing a fibrous interlay between two bonded fibrous webs to form a composite structure, subjecting the composite structure to a needle-punching operation, wherein the needles enter from one surface of the composite structure and orient fibres in the fibrous interlay through a bonded fibrous web, and then to a further needle-punching operation wherein the needles enter from the opposite surface of the composite structure and fibres in the fibrous interlay are oriented through the other bonded fibrous web and then treating the needle-punched product to bond together fibres in the fibrous interlay.

When the fibrous interlay consists of, or contains a substantial proportion of fibres which possess a latent crimp, the development of this crimp provides a fabric with advantageous properties. The crimp development may be accomplished in the same treatment in which the needle-punched product is subjected for the purpose of bonding together fibres in the fibrous interlay, or in a separate treatment prior or subsequently thereto.

The expression "bonded fibrous web" as used herein means an assembly of relatively loosely associated fibres, which has been subjected to one or more treatments, to bond together fibres in an assembly thereby strengthening and stabilising it. The bonding together of fibres may, for instance, be based on the entanglement of contiguous fibres resulting from the needle-punching of the fibrous assembly, or on the adhesion union between fibres.

In one suitable treatment a bonding agent is incorporated in the assembly during its fabrication, or introduced into it so that individual fibres therein, through the agency of the bonding agent, are secured one to another. A treatment of the latter kind may be combined with a needle-punching operation in a conventional needle loom so that fibres in the fibrous web are bonded both mechanically and by means of a bonding agent.

In the needle-punching operation to which the composite structure, of which the bonded fibrous webs are part, is subjected, it is necessary that the bonded fibrous webs should permit the barb needles to pass therethrough without extensive disruption or reorientation of constituent fibres which would result if the barbs in the needles engaged fibres which lay in the path thereof.

With this in mind, it may be advantageous to utilise as the bonded fibrous web structures in which the fibres undergo, on contact with the needles, local displacement or deformation whilst resisting disruption or gross displacement.

Bonded fibrous webs in which at least some of the individual fibres possess a three-dimensional crimped configuration are found to be particularly convenient, especially if the bonding agent, if such a treatment be used to confer stability on the fibrous web, be confined to discrete areas throughout the web. Such webs possess a relatively open, stereoreticulate structure with a multiplicity of intercommunicating voids which facilitate the uninterrupted passage through the web of the needles during the needle-punching operation. The fibrous webs described in application, Ser. No. 342,300, now abandoned, provide particularly convenient bonded fibrous webs for use in this invention, for the fibres in such webs are heterofilaments, that is to say, they contain two or more components arranged in an adherent relationship along the length of the fibre and, as a result, possess a latent crimp, as well as a built-in binding action, the latter attributable
to the presence in the fibres of a potentially adhesive component.

On activation, the potentially adhesive component serves as a bonding agent to secure together fibres in the web but, it does not readily migrate from its position in the fibre, so that even after activation it remains localised and not spread throughout the web in the manner, for example, of an adhesive introduced into the web by its passage through a bath of the adhesive. The restriction of the bonding agent to refined spot bonds is found to facilitate the needle-punching operation.

For more detailed information relating to the nature of the heterofilaments, their formation into a fibrous web and the bonding, and/or crimping of fibres therein reference should be made to the specification accompanying the aforementioned application.

The two bonded fibrous webs which constitutes the outer layers of the composite structure may have the same fibre composition or they may have a different fibre composition, and in both instances they may be bonded in a like or different manner.

The thickness of the bonded fibrous web has to be considered in relation to the length of the fibres in the fibrous interlaces, for the depth of needle-punching employed for it is an essential feature of this invention that fibres should extend from the fibrous interlay through a bonded fibrous web layer, at least to the surface thereof. Preferably, the bonded fibrous webs have a thickness i.e. the dimension between the surface in contact with the fibrous interlay and the outer surface of the web, which does not exceed half the average length of fibres (assumed to be staple) in the fibrous interlay.

The fibrous interlay may comprise any loose assemblage of natural or synthetic fibres and it may be obtained, for example, by carding or garnetting process, by air-deposition, fluid paper-making, and the like. The fibrous interlay may vary considerably in thickness although it should be borne in mind that it must have thickness adequate to provide fibres for reorientation in two directions and fibre tuft formation. Again, the length of fibres within the fibrous interlay must be such that on reorientation they are capable of passing through the bonded fibrous web layers and, where appropriate, to project beyond it, the desired amount.

In most instances, it is preferred to use fibres having a length in excess of two inches. Continuous filamentary structures, for example, those produced by melt-spun or freshly extruded continuous filaments by means of an aspirator jet onto a stationary or travelling surface, for example, a conveyor belt, may also be used as the fibrous interlay.

The fibrous interlay may have a similar fibre composition to one or both of the two bonded fibrous webs as the outer strata of the composite structure, or it may have a composition different from both those bonded fibrous webs. Interesting and useful effects can be obtained by constituting the fibrous interlay of fibres having different dye uptake characteristics from the bonded fibrous webs. In those instances where it is desired to have crimped fibres present in the fibre tufts, the fibrous interlay should contain crimped fibres or fibres with a latent crimp amenable to development, subsequently to the needle-punching operation, by an appropriate treatment.

A variety of filaments can be made in such a manner that they possess a latent crimp.

One type of filament which possesses latent crimp and which affords particularly useful reversible fabrics according to this invention is a heterofilament, that is to say, a uniaxial filament comprising two or more components arranged continuously along the length of the filament, and in which the latent crimp is a reflection of the different physical properties, for example, different shrinkage behaviour, possessed by the components of the heterofilaments. Among suitable heterofilaments, mention may be made of those based on the polyamide system, for example, a poly(hexamethylene adipamide)/poly(epsilon caprolactam) or poly(hexamethylene adipamide)/poly(hexamethylene adipamide)-poly(epsilon caprolactam) copolymer heterofilament, polyesteramide, polyester, polyurethanes, polyoxylen, polycaprolactone, and the polyvinylidene system. The components of the heterofilament may be arranged in an eccentric sheath and core or in a side-by-side relationship.

Another type of fibre possessing a latent crimp is derived from edge crimped yarns, for example, poly(hexamethylene adipamide) or poly(ethylene terephthalate) edge-crimped yarns, available commercially under the registered trade name Agilon, which have been heat-treated under tension so as temporarily to remove the crimp. The crimp in these fibres may be restored by heating them in a relaxed condition, at a temperature in excess of that at which the crimp was temporarily removed.

Fibres derived from yarns which have been subjected to a crimping operation may possess a latent crimp which can be developed by a suitable treatment.

The treatment by which fibres in the fibrous interlay are bonded together may take a variety of forms.

For example, the fibrous interlay may contain a thermoplastic polymer in the form of a softening point lower than that of fibres present in the needling structure and the bonding of fibres in the fibrous interlay may be accomplished by heating the needled structure to a temperature sufficient to melt the powdered resin but not sufficiently to affect the fibres. Instead of being present in powdered form, the thermoplastic material may be incorporated in the fibrous interlay in the form of a sheet which, in the needling operation, is disrupted by the needles and to a certain extent at least distributed throughout the interlay.

When the fibrous interlay consists of, or contains, heterofilaments of the kind previously mentioned, the bonding of fibres therein can conveniently be achieved by the activation, most commonly by heat, although a chemical medium may be suitable in some instances, of the potentially adhesive component thereof. Consequently, the utilisation in the fibrous interlay of fibres of this type obviates the necessity of providing the fibrous interlay with an extraneous bonding agent. Furthermore, on account of their construction, heterofilaments possess a latent crimp, the development of which is generally attained by an appropriate heat treatment, which may in suitable instances be the same heat treatment by which the fibre bonding is effected. The development of crimp is reflected in a bulking of the fibrous interlay so that the structure has an increased resilience and, in the deformation of the fibre tufts which adopt convoluted configurations and spread out in the plane of the fabric thereby providing, in those fabrics in which the fibre tufts are arranged in distinct strata, for enhanced coverage of the underlying fibrous web layer.

However achieved, the bonding of fibres in the fibrous interlay stabilises that layer and, through adhesive union, more effectively keys the fibre tufts in position which consequently (relative to comparable fabrics in which fibres in the fibrous interlay are not bonded together) are of improved definition and have a superior resistance to extraction, for example, when the fabric is vacuum-cleated.

The invention is further described in the following illustrative example and the accompanying drawings wherein:

FIGURE 1 is a diagrammatic view sequentially illustrating an embodiment of the method of this invention and showing the apparatus assembled employed;

FIGURE 2 is a cross-sectional view, somewhat diagrammatic, of the needle-punched product which is obtained by needle-punching fibres from the fibrous interlay through the two bonded fibrous web layers using the apparatus assembly shown in FIGURE 1; and

FIGURE 3 is a cross-sectional view of a reversible
nonwoven fabric according to this invention, resulting from the method described with reference to FIGURE 1, and using the apparatus shown therein.

Referring to the drawings, and more particularly to FIGURE 1 thereof, reference numeral 10 has been applied to indicate a supply roll of a bonded fibrous web which is unwound therefrom and moved, in the horizontal plane, from left to right, as a layer 11 upon the surface of a travelling conveyor belt 12. A fibrous web 13 which, in this instance, contains a substantial portion of staple fibres derived from heterofilaments having a latent crimp and a heat-activatable potentially adhesive component, is withdrawn from a supply roll 14 and continuously superimposed upon the layer 11 and moved at the same rate and in the same direction as that layer. There is a loose physical engagement between the two layers. Reference numeral 15 indicates another supply roll of a bonded fibrous web, which may be the same as the bonded fibrous web from supply roll 10, or it may be a different bonded fibrous web. This bonded fibrous web is deposited as a layer 16 upon the structure comprising fibrous web 13 and layer 11. The composite structure 17, in which the fibrous web 13 constitutes a fibrous interlay between the two bonded fibrous webs 11 and 16, is then fed to a single bed needle loom of conventional design, generally indicated by reference numeral 18. Layer 16 rises a horizontal surface 19 supporting the composite structure, and a needle-bed roll 20 adapted for reciprocation in the vertical plane, and containing conventional barb needles 31 which pass in and out of the composite structure 17.

The movement of the needles in and out of the composite structure is achieved without any marked occurrence of broken or reoriented fibres in bonded fibrous webs as layers 11 and 16 but, in passage through the fibrous interlay 13, the barbs in the needles pick up fibres therein and push them downwardly into the bottom layer 11. The depth of needle-punching, and the length of fibre in the fibrous interlay are so arranged that the reoriented fibres are carried by the needles, through the bottom layer, so that part of the reoriented fibres project beyond the surface of that layer as fibre tufts, generally indicated by reference numeral 21.

The composite structure on emergence from the needle loom 18 is carried around a roller 22 and then through a second needle loom 23. The various parts, and mode of operation of this needle-loom are similar to the first needle-loom but, in the needle-punching operation conducted in this needle-loom, the needles penetrate the opposite surface of the composite structure to that in the first needle-punching operation and consequently, fibres are carried, by the needles, from the fibrous interlay 13 through the layer 16 which is now the bottom layer of the structure and fibre tufts project beyond the surface of that layer.

The fibrous web 13 as the fibrous interlay, instead of being delivered from the supply roll 12 can be deposited upon the bonded fibrous web layer 11 from a garnetting, carding or air-laying machine, or indeed from any suitable means for depositing a relatively loose assemblage of fibres.

Instead of utilising two separate needle looms to effect the first and second needling operations, the composite structure, after the first needle-punching operation, may be inverted so that the layer 11 now constitutes the top layer of the composite structure which in that configuration is passed once again through the same needle loom. It is thus possible to effect two needle-punching operations, involving the initial penetration of needles into opposite surfaces of the composite structure, in a single pass through a double-bed needle loom.

As shown, the two layers 11 and 16 of bonded fibrous webs have retained their configuration and there are few broken fibres, and minimal reorientations thereof, as a result of the passage of needles therethrough. However, the fibres of the fibrous interlay 13 have been reoriented as a consequence of the needle-punching. The direction of the reorientation is dependent upon the direction of the needle-punching by which it was effected.

Thus, in the needle-punching operation wherein needles initially penetrated layer 16, those fibres in the fibrous interlay 13, which were engaged by the needle barbs and carried through the opposite layer 11, were reoriented into vertical planes. Those vertically disposed fibres comprise a part 25 embedded within the bonded fibrous web as layer 11 and a part which projects beyond the surface 26 of layer 11 as a fibre tuft 27. The part 25 embedded within the layer 11 may be likened both structurally and functionally to the roots of the tree and serves to anchor each of the fibre tufts in position. The fibre tufts in effect, form a new outermost surface which serves to hide layer 11 from visual discernment. Needle-punching in the reverse direction, that is to say, when the needles initially penetrated the surface of layer 11, reorients fibres from the fibrous interlay through layer 16 and the resulting vertically disposed fibres comprise a part 28 embedded within the layer 16 and a part which projects beyond the surface 29 of the layer 16 as a fibre tuft 30. The needle-punching in the two directions, opposite surfaces of the product are constituted by fibre tufts so that the two surfaces have a similar appearance.

The needle-punched product 33 with fibre tufts present on both surfaces, is then passed through an oven 34 in which it is exposed to a temperature which is so selected and controlled that it effects, without sensibly affecting fibres in the two bonded web fibrous layers;

(i) the development of crimp in fibres present in the fibrous interlay and fibre tufts; and
(ii) the activation of the potentially adhesive component present in the heterofilament fibres.

The fabric derived from the combined needle-punching and heat treatments, and which is wound-up on product reel 35 is illustrated in a cross-sectional view in FIGURE 3.

As a result of the crimp development the fibre tufts 27 and 30 have effloresced and spread out in the plane of the fabric to form mushroom-shaped structures 31 and 32. The efflorescence of the fibre tufts and the associated mushroom-shaped structures is reflected in an enhanced coverage of the underlying surface of the bonded fibrous web layers 11 and 16, and an improved resilience, which is reflected in an enhanced resistance of the fibre tufts constituting the plious surface to deformation, arising say from the application of a load thereto. Moreover, the fabric containing such tufts has a superior aesthetic appeal and a softer, more attractive handle compared with similar fabrics in which the tufts are straight, or substantially uncrimped.

Either surface of the fabric can be used as the functional surface in those applications which call for a pilous-surface material. Quite apart from their role in providing the fabric with surfaces comprising fibre tufts, the re-oriented fibres interlock the fibrous interlay to the outer layers thereby providing an integrated needled fabric having a degree of dimensional stability and a resistance to delamination.

The adhesive union between the fibre tuft "roots" located in the fibrous interlay and the heterofilament fibres present in the interlay keyed the fibre tufts in position and improves their definition as well as their resistance to extraction. Moreover, the bonding of fibres in the interlay itself stabilises and strengthens that layer.

The content of fibre tufts is dependent upon the needle-punching density, and consequently can readily
be varied. When there are insufficient fibre tufts, or if, because of the low depth of needle-punching, they project only a very short distance beyond the underlying bonded fibrous web, they may not form a definite layer but rather part of the surface of the bonded fibrous web.

The bonding of fibres in the fibrous interlay may be accomplished by means other than through the heat activation of a potentially adhesive component of heterofilament fibres, these other means, which include the activation of a thermoplastic resin present in the interlay in the form, for example, of a powder or a film, are useful in the absence, from the fibrous interlay, of suitable heterofilament fibres.

EXAMPLE

A quantity of 6 denier, three inch staple fibres formed from heterofilaments comprising equal proportions by weight of poly(hexamethylene adipamide) as one component and an 80/20 random copolymer of poly(hexamethylene adipamide)-poly(epsilon caprolactam) as the other component, the two components being arranged in a side-by-side relationship, was laid into a random or isotropic fibrous web leaving a weight of approximately 3 ounces per square yard by means of a Proctor and Schwarz Duoflorm air-laying machine. The web was then passed through a single bed needle loom supplied by William Bywaters Limited of Leeds, equipped with 36 gauge regular barb needles. The needle penetration was adjusted to penetrate 1/4 inch and the rate of needleing was controlled to effect 200 punches per square inch. As a result of this needleing operation fibres in the fibrous web were bonded together through the fibre entanglement and the associated frictional forces. Fibre bonding was further developed by passage of the needle fibrous web through an Efco conveyerised oven operating at a throughput of ten feet per minute and a temperature of approximately 230°C. The effect of this heat treatment was two-fold; in the first place, it resulted in the development of fibre crimp, and secondly it activated the copolymer component, as the potentially adhesive component of the heterofilaments, which became adhesive and, in that condition, bonded contiguous fibres together. The resulting bonded fibrous web had a relatively bulky stéréotactically organized structure containing a multiplicity of intercommunicating voids.

Another bonded fibrous web was made in a manner identical to that previously described.

The two bonded fibrous webs, each 3/8 inch thick, were brought together with an interleaving carded layer, half an inch thick, of 6 denier, three inch, heterofilament staple fibres comprising equal proportions by weight of poly(hexamethylene adipamide) as one component and an 80/20 random copolymer of poly(hexamethylene adipamide) and poly(epsilon caprolactam) as the other component, the two components being arranged in a side-by-side relationship, having a weight of 5 to 6 ounces per square yard, on a traveling belt and using the method described with reference to FIGURE 1 of the accompanying drawings.

The composite structure so formed was passed once through the single bed needle loom equipped with 36 gauge regular barb needles, the speed of the structure fibres in the loom being adjusted to effect 250 punches per square inch and the needle penetration adjusted to penetrate a short distance through the bottom bonded fibrous web whereby the first few barbs of each needle passed therethrough. The needles passed through both of the outer strata without any excessive breaking of fibres in the bonded fibrous webs which constituted these layers, but the barbs on the needles caught fibres in the fibrous interlay and dragged them through the bottom bonded fibrous web. As a result, fibres from the interlay were reoriented into planes normal to the planar surfaces of the composite structure. A length (approximately ¼ inch) of each of the reoriented fibres projected beyond the surface of the bottom layer as part of a fibre tuft (each of which was composed of many fibre ends), and all the fibre tufts provided the structure with a new surface which had the appearance of a conventional pilous surface. The structure was then inverted and passed once again through the same needle loom equipped with identical needles and adjusted to effect the same needleing density and needle penetration.

In this pass through the loom, the needles entered the structure from the surface of fibre tufts resulting from the first needle-punching (and between the actual tufts) so that the direction of needle-punching with reference to the arrangement of layers making up the composite structure, was the opposite of the direction in the previous needle-punching operations. The needles entered the structure between the fibre tufts without any significant destruction of the tufts, and they reoriented fibres from the fibrous interlay through the other bonded fibrous web, beyond the surface of which fibre tufts projected.

The two opposite surfaces of the needle-punched product were composed of fibre tufts, standing proud above an underlying bonded fibrous web, and they had a similar appearance, simulating the surfaces of a conventional pilous surface material.

The needle-punched product was then passed on a conveyor belt through an air oven operating at a throughput of ten feet per minute and a temperature of approximately 240°C. The effect of this heat treatment was two-fold. In the first place, it developed potential crimp in the heterofilament fibres in the fibrous interlay and those of the fibre tufts. As a consequence of the development of crimp, the fibre tufts underwent an efflorescence, and spread-out in the plane of the fabric to form mushroom-shaped structures, and a bulking effect was manifest in the fibrous interlay itself. Secondly, it activated the copolymer component of the heterofilaments throughout the structure and so bonded together fibres in the fibrous interlay. The bonding of fibres in the fibrous interlay provided for the enhanced anchorage of the fibre tufts, as did the coalescence between the part of each of the fibre tuft roots and heterofilament fibres in the bonded cellent permanence of form. They were much more securely held in position than fibre tufts in a similar fabric in which fibres in the fibrous interlay were not bonded together.

What I claim is:

1. A reversible nonwoven fabric which comprises a nonwoven fibrous interlay interposed between two layers each constituted by a nonwoven fibrous web wherein fibres are bonded together, with some fibres from the fibrous interlay oriented through a bonded fibrous web layer as fibre tufts and other fibres from the interlay oriented through the other bonded fibrous web layer as fibre tufts, said fibre tufts being set in position as a result of the bonding together of fibres in the fibrous interlay, and said tufts consisting essentially of fibres from said fibrous interlay.

2. A reversible nonwoven fabric as claimed in claim 1 wherein the fibre tufts contain crimped fibres.

3. A reversible nonwoven fabric as claimed in claim 1 wherein constituent fibres of the fibre tufts are heterofilaments.

4. A reversible nonwoven fabric as claimed in claim 1 wherein the fibre tufts on one or both of two opposite surfaces of the fabric constitute a definite layer contiguous with the planar surface of the underlying bonded fibrous web layer.

5. A reversible nonwoven fabric as claimed in claim 1 wherein the fibre tufts on at least one of two opposite surfaces of the fabric do not constitute a definite layer so that the surface is constituted both by fibre tufts and the bonded fibrous web layer.

6. A reversible nonwoven fabric as claimed in claim 1
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wherein the bonded fibrous web contains fibres which are adhesively united.

7. A reversible nonwoven fabric as claimed in claim 6 wherein the bonded fibrous web contains crimped fibres.

8. A method of making reversible nonwoven fabrics which comprise interposing a nonwoven fibrous interlay between two pre-bonded nonwoven fibrous webs to form a composite structure, subjecting the composite structure to a needle-punching operation, wherein the needles enter from one surface of the composite structure and orient fibres in the fibrous interlay through a bonded fibrous web without any appreciable orientation of the fibres of the fibrous web, and then to a further needle-punching operation wherein the needles enter from the opposite surface of the composite structure, and fibres in the fibrous interlay are oriented through the other bonded fibrous web without any appreciable orientation of the fibres of said other fibrous web, and then treating the needle-punched product to bond together fibres in the fibrous interlay.

9. A method of making reversible nonwoven fabrics as claimed in claim 8 wherein the fibrous interlay contains a substantial proportion of fibres which possess a latent crimp, which is developed in the same treatment as that used to bond together fibres in the fibrous interlay.

10. A method of making reversible nonwoven fabrics as claimed in claim 9 wherein fibres in the fibrous interlay are bonded by heating the needle-punched product.

11. A method of making reversible nonwoven fabrics as claimed in claim 8 wherein fibres in the fibrous interlay are bonded by exposing the needle punched product to the action of a chemical medium.

References Cited

UNITED STATES PATENTS

1,722,764  7/1929  Rasch  156—148 XR
1,722,140  2/1964  Crowe  156—148 XR
3,122,142  2/1964  Crowe  156—148 XR

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U.S. Cl. X.R.
28—72.2; 156—148; 161—154