United States Patent

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[54] **CARRIER FOR A SKIN GRAFT PATCH**
2 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **269/288,** 83/284, 83/678, 128/305.5, 269/131, 269/296
[51] **Int. Cl.** **A61g 13/00,** B23q 27/00
[50] **Field of Search** ..... 28/1; 81/418; 72/55, 471; 269/265, 296; 99/372, 373; 248/361 A, 350, 346; 156/347, 513, 535, 537, 589; 128/305.5; 269/131, 288; 83/284, 547, 678

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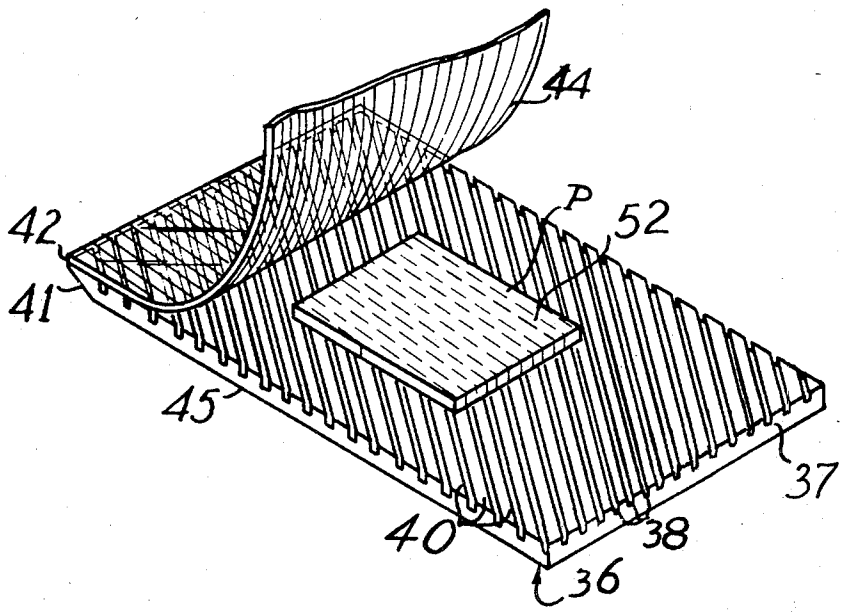
ABSTRACT: Carrier for a skin graft patch including a base member having parallel side edges and a plurality of grooves defining a plurality of spaced, substantially parallel and flattened lands, said grooves being obliquely disposed with respect to said side edges. The carrier also includes a cover sheet of thin material for retaining a patch of skin in a position across said lands.



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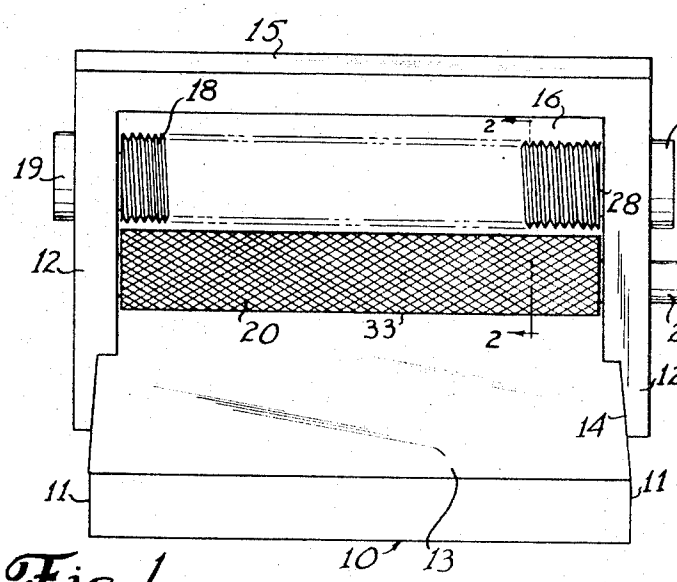

Fig 1

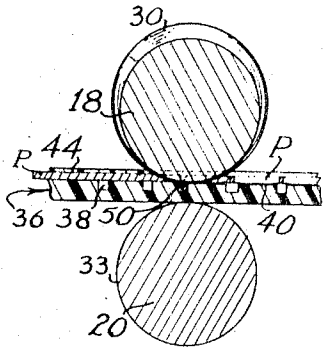

Fig 2

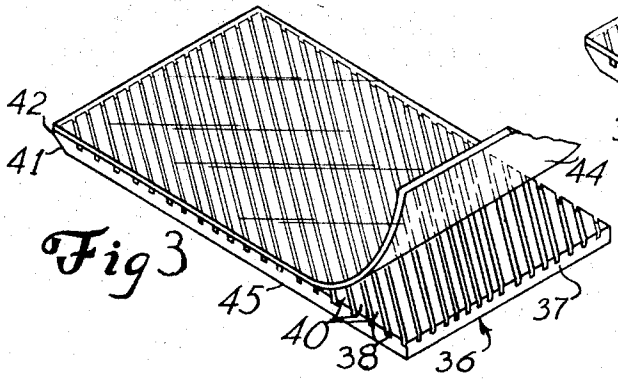

Fig 3

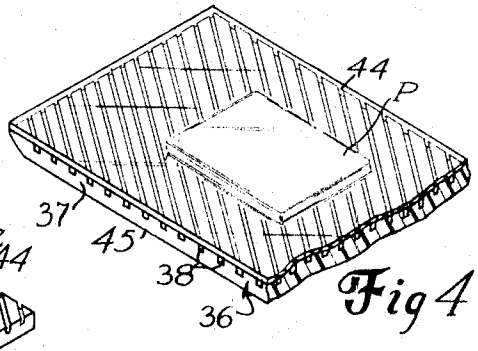

Fig 4

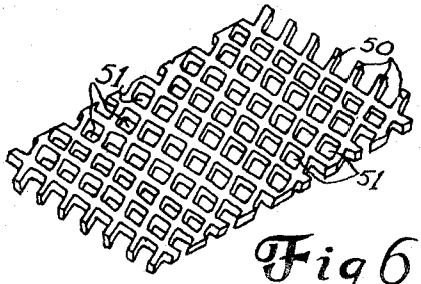

Fig 6

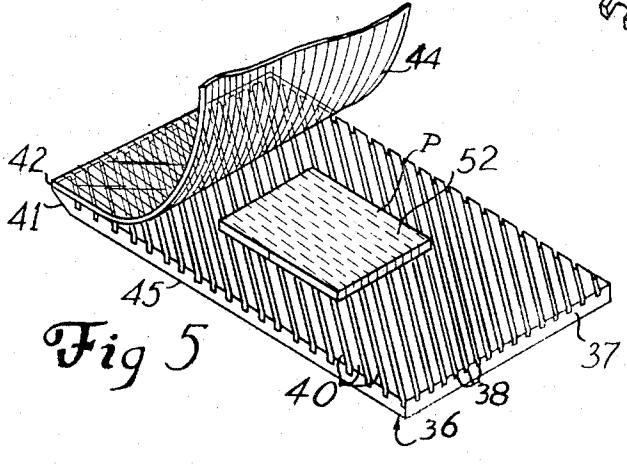

Fig 5

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CARRIER FOR A SKIN GRAFT PATCH

CROSS-REFERENCE TO RELATED APPLICATION

This application is a division of copending U.S. Pat. application Ser. No. 439,811, filed Mar. 15, 1965 now, U.S. Pat. No. 3,472,228 issued Oct. 14, 1969.

This invention relates to skin grafts and more particularly to a carrier for a skin graft patch which may be used in an apparatus for preparing skin from a donor area for grafting to a recipient area such as described in copending U.S. Ser. No. 439,811 and U.S. Pat. No. 3,358,688.

Sheet grafts, spaced patch grafts, and spray grafts are well known and have been frequently used in the past to graft skin from one area of a patient's body to another. However, these previous types of skin grafts have serious limitations and disadvantages. For example, sheet grafts using sheets of skin removed from donor areas are limited in usefulness because the recipient areas covered must be substantially the same size as the donor areas from which the sheets of skin are obtained.

Since many recipient areas are relatively large in relation to the possible donor areas from which sheets of skin may be obtained, several sheet grafts are frequently required to cover a single recipient area. This is highly undesirable from the standpoint of the patient. Thus, a sheet graft is useful only where the recipient area to be covered is relatively small and easily covered by a single sheet of skin obtained from a readily available donor area.

Moreover, sheet grafts tend to be characterized by undesirable accumulations of fluid under the sheet of skin covering the recipient area. These accumulations of fluid under the sheet of skin prevent the initial growing of the sheet of skin to the recipient area and as a result, a sheet graft often requires repeated draining of fluid from under the sheet of skin in order to be successful. This repeated draining of fluid is troublesome and unpleasant to the patient and when accomplished by holes made through the sheet of skin results in a loss of skin which retards healing.

Spaced patch grafts utilize a sheet of skin removed from a donor area and cut into small patches. These small patches of skin are evenly spaced over a recipient area using a carrier sheet and are held in position on the recipient area with the carrier sheet. The spacing between patches of skin permits a larger recipient area to be covered by skin from a donor area than is possible with a sheet graft. Moreover, the relatively small size of the patches of skin and the spacing between the patches of skin avoids the accumulations of fluid often encountered with sheet grafts.

However, the carrier sheet provides very little support to the patches of skin, and a spaced patch graft is very susceptible to trauma and breakdown since the slightest blow is generally sufficient to tear a patch of skin from the recipient area. In addition, since the small patches of skin are simply held against the recipient area by the carrier sheet, no means is provided for holding the patches of skin in tension and they tend to undergo elastic shrinkage. This shrinkage reduces the amount of recipient areas covered by the patches of skin and once the patches of skin have started to grow to the recipient area, the shrinkage of the patches of skin tends to tear the skin patches from the recipient area. Thus, the spaced patch graft is a relatively unsatisfactory means for avoiding the limitations of sheet grafts.

Spray grafts utilize skin removed from a donor area in microscopic skin particles. These skin particles are suspended in a suitable liquid and sprayed onto the recipient area. A spray graft allows the recipient area to be of any contour and to be relatively large in comparison to the size of the donor area from which the particles are obtained. A difficulty with the spray graft is that the graft is very susceptible to trauma since any blow is sufficient to tear the skin particles from the recipient area.

Another difficulty encountered with spray grafts is that it is practically impossible to spray the skin particles over the

recipient area with a uniform thickness. Moreover, the equipment necessary to obtain the skin particles for a spray graft and to apply the skin particles to a recipient area is complicated and relatively expensive to manufacture. The equipment is also relatively difficult to maintain if sterile conditions are to be achieved and to use if a graft approaching uniform thickness over the recipient area is to be obtained.

Thus, it is an object of the present invention to provide a carrier for a skin graft patch such that the patch may be intermittently slit in a plurality of offset rows while being maintained in a sterile condition. These and other objects, features and advantages of the present invention will become apparent from a consideration of the following specification in conjunction with a review of the accompanying drawings in which:

FIG. 1 is a front perspective view of an apparatus for perforating skin patches;

FIG. 2 is a detailed section view taken along the lines 2–2 of FIG. 1 which is taken from the valley between two cutting edges at the top of the cutter and extends through an adjacent cutting edge at the bottom of the cutter and including the skin graft patch carrier and its donor skin patch during the perforating operation;

FIG. 3 is a perspective view illustrating the carrier with its retaining sheet partially raised to receive a donor patch;

FIG. 4 is a fragmentary perspective view similar to FIG. 3 showing a donor sheet in position under the retainer sheet of the carrier;

FIG. 5 is a perspective view illustrating the carrier and sheet after perforation, with the cover sheet raised; and

FIG. 6 is a view of one type of expanded donor skin patch as formed with the present invention.

A perforating apparatus suitable for use with the present carrier is a simple, practical, effective and efficient structure readily designed to meet the demands of economic manufacture, and one easy to maintain in sterile condition. That form of the apparatus here shown by way of example comprises a generally rectangular base **10** which may be formed of aluminum, stainless steel or other appropriate composition capable of withstanding conventional sterilization procedures and of sufficient weight and dimension to insure stable support for the device. Vertically mounted at suitable parallel locations along the sides **11** of the base **10** are posts **12**, here shown as recessed as at **14** to receive sides **11**. Posts **12** are designed to be permanent and in rigid engagement with the base **10**, but may be releasably secured in rigid relation by separable fastening means of conventional form (not shown). The upper-ends of the posts **12** are preferably joined by a transverse head beam **15** here shown as formed integrally with the upper-ends of posts **12**. The inner faces of the posts **12** and bottom surface of the head beam **15** define, with the top surface **13** of the base **10**, a generally rectangular opening **16** in a plane normal to the top flat surface **13** of the base **10**.

Located within the opening **16**, approximately midway between the top surface **13** of the base **10** and the lower face of the head beam **15** and extending transversely thereof between the posts **12**, there is provided a pair of parallel rollers comprising a knife roll **18** rotatably mounted by end pintles (not shown) which extend into the posts **12** and are secured thereto by end head nuts **19**. The posts **12** rotatably mount therebetween a driving, knurled friction roll **20** spaced from the knife roll **18**. Each support for the driving friction roll **20** within the standards **12** (not shown) provides for relative vertical adjustment between the rolls **18** and **20**. Various types of rotatable and adjustable bearings are, of course, conventionally available and form in themselves no part of the present invention. On a projecting drive shaft **22** of the driving friction roll **20** is a manual operating handle **24**.

The knife roll **18** may be provided with a wide variety of cutting blades by which a donor skin graft patch may be cut as desired. In this respect, it is to be noted that the cutting apparatus here presented may, by simple modification and/or selection of knife roll design and configuration, lend itself to donor skin graft patch formation and application techniques

other than the specific expanded patch here shown. In the present apparatus the roll **18** is provided with helical cutting means exemplified here by a screw thread blade **28**, preferably of sharp V-shaped cross section to provide a helical cutting edge. In one presently successful embodiment of the apparatus, the blade edges are spaced approximately 0.050 inches apart. The pitch of the blades is, of course, uniform, each having 10 threads per inch. The pitch here shown is in a right-hand direction looking from the right, and the base roll diameter is approximately 1 inch. Other blade contours and configurations may, of course, be used to conform with varying techniques, skin thicknesses, elasticities, patch sizes and area expansions.

As above referred to, the friction drive roll **20** is knurled or otherwise provided with a friction surface **33**, and the adjustment of spacing between the rolls **18** and **20** is such as to provide a clearance therebetween to receive the present grooved skin graft patch carrier **36** as it is fed between the rolls by frictional engagement as the feed roll **20** is rotated. The carrier **36** is formed, as shown in FIGS. **3**, **4** and **5**, with a body **37** and side edges **45**. Body **37** defines in its upper surface a plurality of parallel grooves **38** which create intermediate parallel inclined lands **40**. The grooves and lands are obliquely disposed with respect to side edges **45** and extend across the entire upper surface of body **37**. The carrier body **37** is preferably formed of a substantially rigid, but slightly flexible, plastic material, such as polypropylene, polyetheylene, polyvinyl chloride and the like. A rectangle of polypropylene of approximately 3 by 12 inches has been successfully employed, the leading or top edge of which is preferably beveled as at **41** to receive thereover a return folded end edge **42** of a thin flexible and easily cut cover sheet **44**, the cover sheet being coextensive with the grooved upper face of the carrier body **37**.

The total thickness of the carrier body **37** is somewhat greater than the spacing between the friction drive roll **20** and the knife roll **18**. Thus, as the carrier is fed between the rolls, the cutting edges will engage and cut into the lands **40**.

In operation, it will be seen that as a carrier **36** is passed between rolls **18** and **20** with a donor skin patch positioned across lands **40** and covered by securing sheet **44**, the edges **30** of the helical blades cut through the cover **44**, patch P and into the lands **40**. However, the blades will not cut fully through the lands. Hence, upon passage, the patch will be cut at the areas that lie across the lands. Those portions of the patch that are in registration with the grooves **38** will not be cut since they will be depressed into the groove shown in FIG. **2** to constitute the material **50** (shown in FIG. **6**) between the slits and later, upon expansion of the serrated patch, they become the ribbons of the mesh shown in FIG. **6** bounding the mesh apertures **51**. By varying the angles of the parallel grooves with respect to the side edges of the body **37**, a wider or narrower series of cutting surfaces (i.e., lands **40**) is presented for the blades to work against as they pass over the carrier in a direction parallel to the side edges of the carrier body. By varying the width of the cutting surfaces, the lengths of the individual slits within the patch are varied to produce different designs of expanded skin patches.

It is, of course, to be understood that the present invention is not limited nor confined to specific sizes, shapes, angularities, or dimensions. However, by way of example, and as a specific teaching of one successful apparatus for cutting and a carrier, the following dimensions have been found successful:

Base Knife Roll (18) Diameter	0.75 inch approx.
Cutting Thread	0.10 inch approx.
Friction Feed Roll (20) Max. Diameter	0.76 inch approx.
Spacing from Depth of Thread to Max. Diameter of Feed Roll	0.34 inch approx.
Maximum Thickness of Carrier	0.04 inch approx.
Depth of Carrier Grooves	0.02 inch approx.

By this relationship of dimensions it will be seen that as the carrier passes between the rolls, the patch will be cut to provide echelon arrangements of rectilinear slits or perforations spaced by the distance of material overlying each groove in the direction of groove to blade contact.

From the foregoing it is believed that the function and use of the present apparatus will be fully understood as well as the method steps in preparing the donor patch and the nature of the patch itself. The apparatus, the method, the carrier, and the expanded patch have been successfully employed in numerous instances. In practice, split-thickness donor patches are employed. By the use of the present apparatus and method, a 1-square inch donor patch may provide approximately 3 square inches of the mesh patch for application to a recipient surface. Sterile techniques are employed and the donor patch is placed on the lands **40** of the grooved carrier body **37**. The sheet **44** is placed over the patch to retain it in position during slitting and to exclude contamination from ambient atmosphere. A temperature below 90° F. should be maintained for carrier body, patch, and perforating apparatus during operation.

Assuming the original donor patch to be substantially rectangular, it is preferably laid on the grooved surface of the carrier body **37** generally in a central position with its sides and ends parallel with the sides and ends respectively of the carrier body. In practice, a set of three carriers is usually provided with each perforating apparatus. Each carrier of such a set will be characterized by parallel grooves **38** extending at a different angle across the upper face of the carrier body from the angularity of the grooves of the other platens. In the present drawings, a median internal angularity of 22.5° from the edges of the body is shown. In considering the operation of the present apparatus, it should be assumed that the feed of the carrier **36** under the cutter roll **18** is straight, and parallel to the sides of the base **10**, and hence in a direction normal to the axis of the rolls **18** and **20**. If desired, guides (not shown) may be provided for maintaining such direction of movement. It will, of course, be recognized that with a carrier moving accurately in a direction normal to the axis of the knife roll **18**, the helical blades will cut along parallel lines inclined from the direction of carrier travel at an angle commensurate with the pitch of the helix of the blades. If perforations accurately parallel with the sides of a donor patch are required, such angularity may be compensated for by ether a slight angularity equal to the pitch of the helix in the placement of the patch on the carrier and/or an angularity of the carrier itself.

Since the grooves **38** separating the lands **40** are at an angle to the direction of movement of the carrier **36** and hence at an equivalent angle to the cutter roll **18**, the action of the helical blades to perform successive spaced perforations of the donor patch P where the patch material is in contact with the lands. At the grooves, where the patch material has no support beneath the blade edge **30**, the material is depressed into the groove, as at **50** in FIG. **2** to form ribbon material bridges **51** between the longitudinal rows of perforations **52**. It will be noted that the length of each slit and the extent of each bridge **51**, are controlled by the angularity of the grooves **38**, assuming the carrier to be moving in a straight path in a direction normal to the axis of the rolls **18** and **20**. Thus, with a groove angularity of 22.5° as shown in the drawings, and groove spacings of 0.075 inches, the slits will be 0.085 inches long, even though the land is only 0.075 inches wide transversely between grooves. Greater angularity of the grooves will reduce the slit length with respect to the direction of travel, toward the minimum of 0.75 inches (the transverse land width) as the relationship of groove angle to blade helix approaches 90°. The lesser the angle, the greater the slit length and bridge width, hence the provision of multiple carriers of differing groove angularities. It is, of course, recognized that a similar selective length of slit and width of bridge may be achieved by a selected angularity of the carrier itself as it is passed between the rolls **18** and **20**. It is further pointed out that the invention is not limited nor confined to helical cutting

blades nor straight or uniform grooves and lands of any particular dimensions Such details are here suggested by way of examples of a particular operative apparatus and carrier of the present invention.

In preparing a donor skin patch for cutting and subsequent expansion into a skin graft patch, patch P is placed on the carrier body **37** as hereinbefore disclosed and covered by sheet **44** to retain it in its position The beveled edge **42** is then inserted between the rolls **18** and **20** and the crank **24** turned whereby the knurled roll **20** feeds the carrier under the cutter **18** whereby the perforations are performed in the manner stated. A temperature below 90° Fahrenheit is maintained during the entire procedure. After the perforating operation, the patch is expanded by stretching in a direction substantially transverse of the parallel rows of perforations. Of course, the patch can be stretched in a direction parallel to the slits to provide the same expansion. The patch would then be pulled in a transverse direction to open the now-expanded slits of the patch.

In this initial expansion of the perforated patch, the skin is stretched beyond its elastic limit so that a permanent expansion of the live skin is effected. Thus, a perforated patch may be initially expanded substantially beyond three times the transverse dimension of the original patch whereupon relation will permit the donor patch to retain a dimension about three times the original dimension, with a longitudinal diminution of somewhat less than 20 percent. It has been found that a type of perforation and a degree of expansion producing substantially square openings, as at **51** in FIG. **6**, will effect a maximum expanded area.

In use the expanded donor patch of split thickness graft is placed in a fresh, raw and granulating recipient area. The mesh may be sewn on with a running 0000 chromic cat gut suture to the borders of the wound or preferably fixed in place with a gluing technique. A mild compressive dressing is applied. The mesh has been found to take and grow as other grafts do, and epithelization of the open spaces is complete in approximately 10 days. Take is enhanced by the absence of fluid accumulation under the graft. Rapid epithelization is related to the huge increase in graft border surface produced by the numerous slits. This phenomenon explains the absence of graft constrictions. The fact that the skin adnexae are evenly distributed over the grafted area insures stability against trauma and breakdown.

While this invention has been described in detail with particular reference to preferred embodiments thereof, it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinbefore and as defined in the appended claims.

I. Carrier for a skin graft patch comprising:

a. A base member having side edges, end edges, and a plurality of substantially parallel grooves defining a plurality of spaced, substantially parallel and flattened lands, said grooves being obliquely disposed with respect to at least one of said side edges; and

b. A thin easily cut cover sheet attached to the base member along one of its end edges, said cover sheet being constructed and arranged to retain a patch of skin adjacent said base member and in a position across said lands.

2. Carrier of claim **1** wherein said side edges are substantially parallel and said grooves are obliquely disposed with respect to said side edges.