

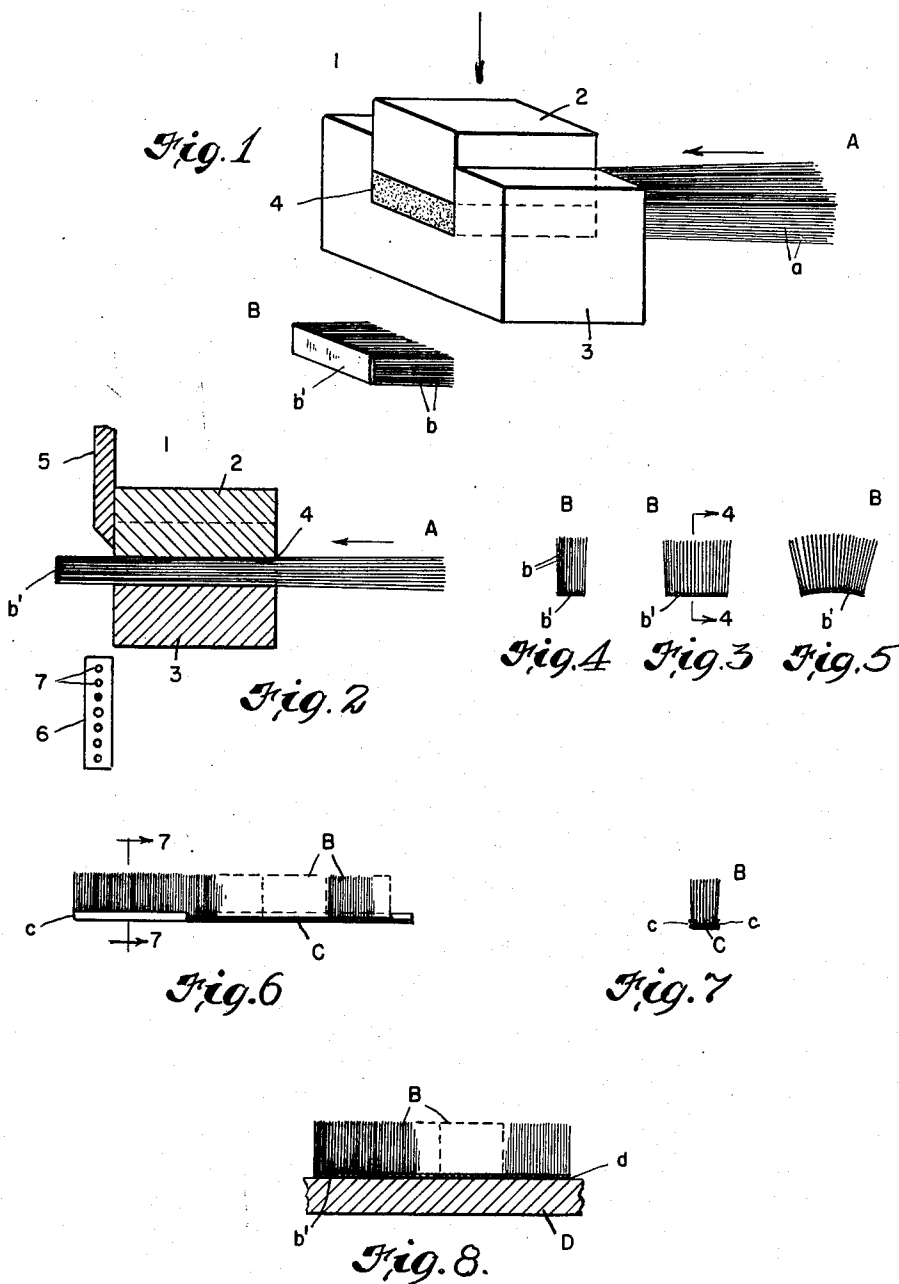
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R. O. PETERSON ET AL  
BRUSH AND METHOD OF MAKING SAME

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INVENTORS  
RUBEN O. PETERSON and  
FLETCHER C. MILES

BY

Oberlin + Limbach  
ATTORNEYS

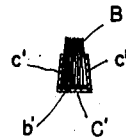
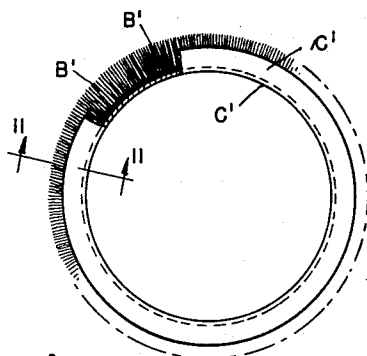
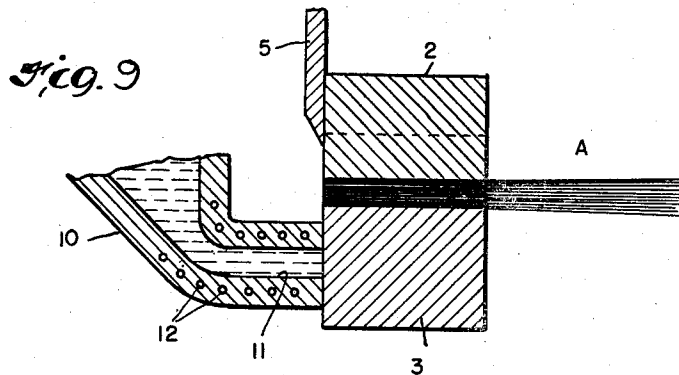
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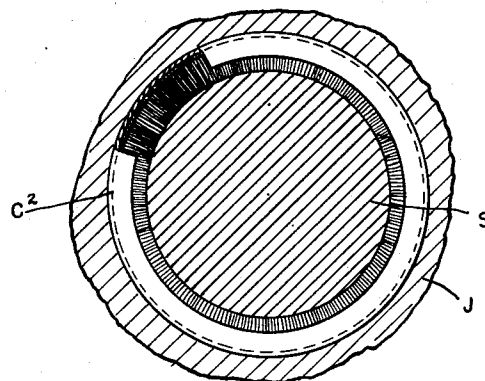
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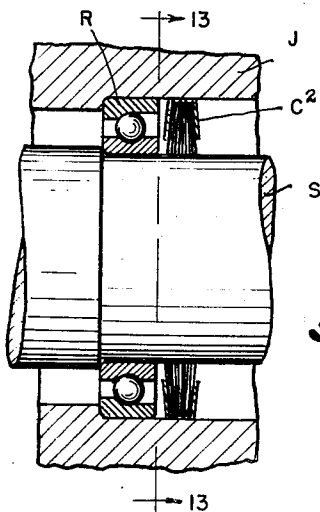
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*Fig. 10*



*Fig. 13*



*Fig. 12*

INVENTORS  
RUBEN O. PETERSON and  
FLETCHER C. MILES  
BY

*Oberlin & Limbach*  
ATTORNEYS

## UNITED STATES PATENT OFFICE

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## BRUSH AND METHOD OF MAKING SAME

Ruben O. Peterson, University Heights, and  
Fletcher C. Miles, Cleveland, Ohio, assignors  
to The Osborn Manufacturing Company, Cleve-  
land, Ohio, a corporation of Ohio

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6 Claims. (Cl. 15—160)

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The present improvements, relating to brush manufacture generally, have more particular regard to the manufacture of closely packed brushes of fine stranded or filamental material. However, as will appear, such improvements are not necessarily limited in their application to such or any particular type of brush, although the stranded material whereof the brush is made will require to be selected with a view to its adaptability to the novel method of manufacture involved.

Heretofore in the manufacture of closely packed brushes of fine stranded or filamental material one or the other of two well known methods has been employed. One such method involves folding over the brush material, the doubled strands then being held by some mechanical means such as a staple, retaining wire, or the like, with or without the assistance of an auxiliary binder or adhesive. The other method involves the setting of the ends of such stranded or filamental brush material assembled into desired form in a suitable binder such as an adhesive or cement which will harden upon drying or upon being subjected to other appropriate treatment.

The use of the latter method has always involved certain unavoidable difficulties. The binder employed must necessarily adhere to the individual strands of the brush material and therefore wet them, at some stage of manufacture. However, particularly in the case of closely packed stranded material such binder is drawn up between the strands by capillarity so that if the binder is of such a nature that it will penetrate closely packed brush material there is a tendency for it to be drawn up far enough to render this method of manufacture unsatisfactory, particularly in the case of short-trimmed brushes, and in any event the brush material will be set in or retained by the binder to an uneven degree so that uniformity of product is difficult to attain. Also, the production of short-trimmed brushes in the past has involved the handling of short cuts of filamental material with attendant manufacturing difficulties which are avoided by use of our new method. When the strands or bristles are too short to be combed into parallel alignment it has been necessary to carefully cut, sort, and stack such short bristles by hand prior to insertion in the brush back. By our new method we are enabled to manufacture brushes with closely compacted but very short bristles in a substantially continuous process.

Within recent years a number of synthetic plastics capable of being drawn in monofilament

form have been made available for use as brush material. Such synthetic fiber forming products include polymeric amides having a protein-like chemical structure known under the trade name "nylon," vinyl resin fibers, vinylidene chloride fibers and various synthetic rubber-like plastics. From the foregoing and other compounds thus available in stranded form for use as brush material, those characterized as thermoplastic may be utilized in the present improved method of brush manufacture. Such method is based on the discovery that by simply applying heat in the proper manner to the base of an assembled group or bundle of strands of such thermoplastic synthetic filamental material the corresponding ends of the component strands are interfused and joined to form a secure bond for each such strand or filament. At the same time a more or less flexible base to which such strands or filaments are permanently attached is provided. A further important result is that the interfusion of such ends can be controlled so that the base thus formed is of uniform thickness (or thinness) throughout, with no consequential variation in the degree to which the component strands or filaments are bound together. In other words, the effect is entirely different from that where a binder such as referred to above is employed in that there is no excessive capillary action and in effect the resulting brush element is a unitary structure.

Our present improved method of making brushes is not limited to use to thermoplastic material such as described above for the stranded brush material, but may be utilized in the manufacture of dense brush-like structures capable of being circularized or similarly formed where the brush material consists of fine wire strands.

The present invention further comprehends the method of mounting brush-like structures produced as aforesaid, particularly when in circular or similar form so as to maintain the free ends of the stranded brush material in close relationship one to the other as is desirable where the brush is to be utilized not merely as a brush in the ordinary sense but as a seal and/or load-bearing device.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the steps and means hereinafter fully described and particularly pointed out in the claims.

The annexed drawing and the following description set forth in detail one method and one product exemplifying our invention, such disclosed procedure and product constituting, how-

ever, but one of various applications of the principle of our invention.

In said annexed drawing:

Fig. 1 is a perspective view, more or less diagrammatic in character, illustrating one way in which the present improved method of brush manufacture may be carried out, such figure including a perspective view of a brush element as formed by such method;

Fig. 2 is a central longitudinal section through an apparatus adapted to be used in carrying out the present method, several accessory parts being shown in addition to those appearing in Fig. 1;

Fig. 3 is a side elevation of a brush element as produced by the present improved method;

Fig. 4 is a transverse section of such element taken on the plane indicated by line 4—4, Fig. 3;

Fig. 5 is a side elevation of such element similar to that of Fig. 3 but showing the element with its base in flexed condition;

Fig. 6 illustrates a plurality of elements as assembled to form a so-called brush strip;

Fig. 7 is a transverse section of such brush strip as indicated by the line 7—7, Fig. 6;

Fig. 8 is a view similar to Fig. 6 but showing a different method of assembling such brush elements on a supporting base or brush back;

Fig. 9 is a central longitudinal section, similar to that of Fig. 2, through a modified form of apparatus, adapted to be used in carrying out the present method of manufacturing brush-like structures;

Fig. 10 is a side elevation with parts broken away to show the interior construction of a circular brush-like structure made in accordance with our improved method, adapted for use as a brush seal for a bearing;

Fig. 11 is a transverse section on the line 11—11, Fig. 10;

Fig. 12 is a central axial view of a typical bearing showing the manner in which such brush-like structure is applied thereto as a seal; and

Fig. 13 is a transverse sectional view of such bearing taken through said seal as indicated by the line 13—13, Fig. 12.

Referring to Figs. 1 and 2, the individual strands or filaments *a* utilized to form the present improved brush element will be drawn in closely compacted parallel relation from the skeins or reels in which filamental material of the character previously described is regularly supplied by the manufacturer. Such stranded or filamental material usually comes in the form of a multiple strand, the number of individual strands or filaments comprised therein varying with the diameter, i. e. fineness, of the individual strand.

The assembled body *A* of strands *a* thus provided is carried, using such supporting or guiding means as may be necessary, to a press 1 on the order of that illustrated in Figs. 1 and 2. As there shown, such press comprises simply two die members 2 and 3, the first of which is reciprocally movable within a slot 4 in the second so as to provide a rectangular die opening through which the assembled body *A* of strands is led. It will be understood that the particular shape of such die opening 4 may be varied depending upon the shape which it is desired the finish brush element should take. By alternately raising and lowering die member 2 the pressure on the stranded body *A* may be released to permit such body to be advanced any predetermined distance, desired and then tightly clamped within the die opening.

Associated with the forward face of the press

thus composed of die members 2 and 3 is a shearing blade 5 and a heated member 6, each of which is mounted so as to be capable of movement across and in close fitting contact with such face. Since member 6 is heated, as indicated, its range of movement will desirably be such that it will normally lie clear of the adjacent press member, as illustrated in Fig. 2. Said member 6 may be conveniently heated by electrical resistance wires 7 suitably imbedded therein or in any other manner as may be found desirable.

Since the ends of the component strands or filaments of body *A* as initially assembled will be difficult of alignment, the operation is initiated by advancing such body *A* through die opening 4 until all of the component strands or filaments project beyond the forward face of the press. Thereupon die member 2 is moved downwardly so as tightly to compress the portion of such body *A* lying within opening 4 and the shear blade or knife 5 is moved to sever the projecting ends of the component strands.

Next, heated member 6 is moved across such forward face of the die members and the exposed ends of the strands *a* comprised in the portion of body *A* thus held compressed in die opening 4. The temperature at which member 6 is maintained will, of course, vary with the particular synthetic plastic compound whereof strands *a* are formed, but such temperature will be sufficiently high so that as a result of the movement of member 6, as just described, across the exposed ends of the assembled body of strands the latter will be rendered sufficiently plastic to interfuse and form a thin layer of the material to which each individual strand composing the body is integrally joined. The effect is very much like a searing action except that the composition is unchanged, the ends of the brush material being sealed instantly and joined to form a secure bond for each component strand or filament. Moreover, the thickness of the bonding layer of material thus produced can be very accurately controlled, it being preferred that such thickness should not greatly exceed the diameter of the individual strands composing the brush material. As shown in Fig. 2, the heating member 6 is of substantial mass, containing a number of heating elements 7, whereby it may be maintained at a proper temperature sufficiently high thus to interfuse such ends of the strands without damage thereto during rapid travel thereacross. Thermoplastic materials are damaged if subjected to too high temperatures. The mass of such heating member 6 is sufficient to provide a substantial heat reservoir with consequent insignificant lowering of the temperature of such member during the fusing operation.

The next step in the operation will be to raise press member 2 so as to relieve the pressure on the body of brush material held in die opening 4. Thereupon such body is advanced so as to project beyond the forward face of the press a distance equal to that which it is desired the strands *b* which enter into the finished brush element *B* should have. The body of brush material is now again clamped in the press by downward movement of die member 2; following which shear blade 5 is actuated to cut off the projecting portion of the body, thus producing the brush element *B* as illustrated in Fig. 1 wherein the component strands *b* are individually unitarily and firmly attached to the base *b'* which is shown as a thin, sheet-like base having appreciable thickness.

The sequence of operations just described may thereupon be repeated indefinitely until the stranded body A derived from a particular source (group of skeins or reels) is exhausted. Since the action of the heating member 6 is practically instantaneous, the sequence of operations may be repeated quite rapidly to form and sever from the stranded body A successive brush elements B.

As indicated, the interfusion of the ends of the component strands *b* of such brush element can be very accurately controlled so as to provide a base *b'* of uniform thickness or thinness. Where the brush element, and thus its base, is of rectangular form, as illustrated in Fig. 1 (see also Figs. 3 and 4), the thickness of said base will desirably be such as to render the same relatively rigid transversely of the element but flexible longitudinally of the latter. In other words, the element may be readily given a curvilinear form in its longitudinal direction, as illustrated in Fig. 5. On the other hand, as illustrated in Figs. 6 and 7, such element is equally adaptable for assembly in a channel base C of the type used in the manufacture of so-called brush strip which as at present made usually consists of a metal channel within which stranded brush material doubled about a retaining wire is held by compressing the side walls of the channel inwardly. Due to its condition of relative inflexibility transversely of the fusion produced base *b'* the present improved brush elements B may be directly seated in such channel C and upon similarly bending in the side walls *c* the element will be securely attached to the channel base C, as best shown in Fig. 7. Accordingly, by closely juxtaposing a series of elements B in such a channel base C, as shown in Fig. 6, a brush strip of indefinite length may be produced, and since the elements B are flexible in a longitudinal line the resulting brush strip may be similarly bent, if required, to fit a curvilinear support.

Brush elements B are of course likewise adapted for direct attachment by adhesion of their bases *b'* to any desired supporting base or back, as illustrated in Fig. 8, where a series of such elements is shown attached by means of a layer of cement *d* to a block D which may consist of wood, metal or any other suitable material. Inasmuch as the bases *b'* of the brush elements B constitute an integument for the corresponding ends of the component strands of brush material in such element, the cement or other adhesive thus used to attach the elements to support D will not penetrate between the filaments or even come in contact therewith. Accordingly, none of the hereinbefore mentioned difficulty attending the use of a cement or like binder is involved.

It should be pointed out that if desired the brush elements where assembled in a channel C to form a brush strip as illustrated in Figs. 6 and 7 may similarly have their bases cemented to the strip as an additional means of securing the elements to the latter.

While in Fig. 8 an aligned series of brush elements B is shown as attached by the cementitious layer *d* to the supporting base or back D, it will be obvious that such elements may be similarly attached in spaced relation both longitudinally and transversely of the back. Furthermore, by making the elements of appropriate form and size, e. g. in the form of round bundles instead of the rectangular shape illustrated, the effect of individual bristle tufts may be obtained by attaching elements of this type in spaced relation, as described, onto the supporting base or back.

The modified method of manufacture illustrated in Fig. 9 involves the use of a press 1 comprising two die members 2 and 3, the same as illustrated in Figs. 1 and 2, and the body A of stranded or filamental material will be advanced through such press in the same manner as before so that successive sections of the closely compressed material may be cut off by shearing blade 5. However, instead of utilizing a heated member 6, which upon movement across the exposed ends of such sheared body held between press members 2 and 3 will render such ends sufficiently plastic to interfuse and form a thin layer of the material to which each individual strand composing the body is integrally joined, a member 10 is mounted for similar movement. This member, as diagrammatically illustrated in Fig. 9, comprises a chamber adapted to contain a body of the plastic material in fluid condition, and, extending from the lower end of such heated chamber, a nozzle 11 mounted so as to be capable of movement across and in close fitting contact with the forward face of the press. The transverse extent of the opening in said nozzle will be slightly greater than that of the assembled body A of strands held in the press and the material in the nozzle will be maintained at the desired temperature by means of electrical resistance wires 12 imbedded in the nozzle, or other suitable means.

Movement of the nozzle is correlated with that of the shearing blade 5 so that following the severing of the projecting section of stranded body A the opening in the nozzle will be caused to pass across the exposed ends of the body held in the press. The temperature of the material in the nozzle will be sufficiently high so that as a result of the movement just described the exposed ends of such assembly body will be rendered sufficiently plastic to interfuse and form a thin layer of the material to which each individual strand composing the body is integrally joined, just as before. The base layer thus produced will also include of course some of the heated fluid material supplied through the nozzle, but the result will be the production of a brush element substantially as illustrated in Figs. 3, 4 and 5, when the body A of filamental brush material is next advanced and the projecting portion thereof sheared off, except that the base *b'* of such element may be made of somewhat greater thickness due to intrusion of such molten plastic from such nozzle.

As previously indicated, while our improved method of brush manufacture is particularly adapted for use in making brush elements as described from filamental material composed of plastic fibers, such method is also adapted to the manufacture of the elements in question from fine metal filaments or strands. Particularly where the element is to be made from the latter, the modified construction of apparatus illustrated in Fig. 9 will be desirably employed. In such case the molten material supplied from chamber 11 through nozzle 12 to the cut-off ends of the body of stranded material held in the press will be molten metal, preferably the same as that of which the strands are composed or one having a comparable temperature of fusion so that the ends of the strands thus held in the press will be interfused to provide a thin base capable of flexure in its longitudinal direction.

A series of brush elements B' thus produced is shown in Fig. 10 as arranged in a circular channel-form base C' which differs from the base C

of the construction illustrated in Figs. 6 and 7 in that the side walls  $c'$  thereof extend a substantial distance beyond the base  $b^2$  of the brush element and are bent inwardly toward the median plane of the latter. As a result the outer face of the brush element or assembled series of such elements may be laterally compacted to such degree as may be found desirable for the use to which the elements in such assembled form are to be put, or, conversely, as illustrated in Fig. 12, such outer face may be allowed to spread so that the outer width of the member is greater than that of the base.

One such use, viz. as a brush seal for a bearing, is illustrated in Figs. 12 and 13. As there shown, the circular base  $C^2$  is press fitted or otherwise closely held within the journal  $J$  of the bearing adjacent the ball race  $R$  which forms the bearing proper for the shaft  $S$  rotatably supported in such journal. The laterally compacted outer face of the filamentous brush material held in base  $C^2$  will closely and yet yieldingly contact with the cylindrical surface of the shaft and provide a most effective form of seal against the entrance of dust or even objectionable gases into the bearing proper or any mechanism lying beyond such bearing. When the brush element is conformed and secured to the inner periphery of an annular support as thus shown in Figs. 12 and 13 with the strands extending generally radially inwardly there is a resultant spreading of the already compact material at the brush face, laterally confined and supported by the radially inwardly flaring side members  $c'$ . On the other hand, when the brush element is circularized as shown in Fig. 10 or similarly deformed to conform to a convex mounting there is naturally a resultant lessening of the density of the brush face since such face lies at the outer periphery. The side walls  $c'$  of the channel-form base  $C'$  may accordingly be inclined toward one another as shown in Fig. 11 to compact such brush face, the latter now being narrower than any other portion of the stranded body.

We are aware that it has heretofore been proposed, as in Patent No. 885,032 to De Ferranti, to use a filamentous element on the order of a brush as a seal or packing in conjunction with a bearing. However, so far as we are aware, no commercial use has ever been made of such a seal because of the failure to provide a construction of brush adapted to this particular kind of service. This it is believed is due to failure to appreciate the fact that forming a brush convexly, as by circularizing the base thereof about the external surface of a cylinder, causes the free ends of the filaments to separate and form undesirable spacing and passageways through the seal. In the present construction, in the first place, not only is the circularizing of the brush elements greatly facilitated by their unique construction, but the objectionable feature just referred to is eliminated by laterally compressing the body of filamentous material in such a manner that the free ends remain in close proximity, one to another, after they have been formed to the required shape.

Furthermore, by introducing between the strands of filamentous material of a member such as illustrated in Figs. 10, 11 and 12, a resilient, rubber-like material, such member may be adapted for use as a resilient load-bearing and abrasion-resisting device. To transform the member to this use, after being formed in the circular shape illustrated, it will be placed in a

mold along with the requisite quantity of rubber-like material in fluid or plastic condition and then the latter will be cured in the usual manner.

From the foregoing it will be seen that the present improved construction of brush element not only lends itself to rapid and economical manufacture, but is adapted for use in a variety of ways in the construction of brushes of different types. Thus the brush strip, as illustrated in Figs. 6 and 7, may be used to form either a flat, circular or cylindrical brush by attaching the channel base  $C$  to a suitable support. Furthermore, the component element  $B$ , where designed for use in the making of such brush strip, may be made considerably longer than illustrated by assembling a correspondingly larger body  $A$  of the stranded or filamentous material and spreading the same out flatwise to fill a correspondingly wider die space 4 in the press composed of die members 2 and 3. It should be stated that the herein described short-trimmed form of brush element composed of relatively fine filamentous material, in addition to the above described use in bearing seals, has been found to serve with a high degree of satisfaction as a seal around openable windows and doors in conveyances and buildings. A brush suitable for such use is currently in demand for sealing purposes in aircraft gun turrets where the gunner must be protected from the high velocity stream of very cold air that would otherwise interfere with his efficiency. Rubber seals have been found entirely unsuitable for this purpose and in this and other fields a brush element such as described, particularly where mounted in a suitable channel base to form a brush strip, presents marked advantages. Similarly there may be other fields of use for the present improved brush element where its function is not precisely that of a brush in the ordinary sense of the term.

While in the foregoing description the stranded or filamental brush material is composed either of a thermoplastic compound on the order of those specifically identified, or of wire strands, it is also possible to utilize the present improved method for fabricating brushes out of other materials such as natural fibers or metal strands by first applying to the latter a coating of such thermoplastic material. Such coating may then be fused and the individual strands united to the resulting integumental base in the same manner as where the strands are composed wholly of thermoplastic material.

It will be understood that the term "thermoplastic material" as used herein is intended to apply equally to synthetic fiber forming products such as described as well as the various metals which are available in stranded form and suitable for use in brushes.

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the product and method herein disclosed, provided the step or steps stated by any of the following claims or the equivalent of such stated step or steps be employed.

We therefore particularly point out and distinctly claim as our invention:

1. In a method of making brush elements and the like from strands composed at least in part of a thermoplastic material, the steps which comprise retaining a body of such strands disposed in substantially parallel relationship in desired cross-sectional shape with aligned ends exposed, and then interfusing such ends with addi-

tion of further molten material to form a thin, flexible sheet base for such element wherewith the individual strands are united.

2. The combination with a brush element comprising a closely compacted body of thermoplastic stranded material, the component strands thereof being joined by fusion at their base ends to form a thin flexible sheet; of a concave support for said element to which such flexible sheet is conformed, and means laterally confining and supporting said stranded material with the latter forming a brush face of greater width than the width of said body of thermoplastic stranded material where joined to said sheet.

3. As a new article of manufacture, a narrow elongated channelform support and an elongated flexible, deformable brush element clamped therein by the sides of such channel, said brush element comprising a body of stranded thermoplastic material joined by fusion at the base ends of such strands into a narrow sheet of sufficient transverse inflexibility relative to the compressibility of said body of strands to be thus securely laterally clamped by such channel sides and of sufficient longitudinal flexibility to readily conform to circularization and like deformation of said channelform support.

4. In a method of making brush elements from strands composed at least in part of a thermoplastic material, the steps which comprise laterally compressing a body of such strands disposed in substantially parallel relationship in a die, such strands being drawn from a continuous source of supply of indefinite length, passing a substantial body of molten thermoplastic material across the assembled ends of such strands under pressure in contact therewith, thereby momentarily fusing the end portions thereof and also intruding such molten material to form a thin, quickly solidifying film of such thermoplastic material including such fused ends, thereby forming a unitary thin flexible sheet base, releasing such pressure, advancing such body of strands a predetermined distance beyond such die, again compressing such body of strands, severing such body between such die and such

integral unitary base portion to produce a brush element, and thereafter repeating such cycle.

5. The combination with a brush element comprising a closely compacted body of thermoplastic stranded material, the component strands thereof being joined by fusion at their base ends to a thin flexible sheet; of an annular support for said element to the inner periphery of which such flexible sheet is conformed and secured with such strands extending generally radially inwardly therefrom, and radially inwardly flaring supporting means laterally confining and supporting such stranded material, the brush face of such element being of correspondingly greater width than the base portion thereof.

6. In a method of moving brush elements from strands composed at least in part of a thermoplastic material, the steps which comprise compressing a body of such strands disposed in substantially parallel relationship in desired cross-sectional shape in a corresponding die opening, shearing off the portion of such body projecting beyond such opening, and then interfusing short but appreciable lengths of the end portions of such strands held thus compressed in such die by heating the same by intrusion of additional molten thermoplastic material to form a thin, flexible, sheet base for such element wherewith the individual strands are united.

RUBEN O. PETERSON.  
FLETCHER C. MILES.

#### References Cited in the file of this patent

#### UNITED STATES PATENTS

Number	Name	Date
764,898	Mumford	July 12, 1904
1,037,830	McMillan	Sept. 3, 1912
1,118,156	Schoepe	Nov. 24, 1914
2,100,138	Heldt	Nov. 23, 1937
2,171,591	Minich	Sept. 5, 1939
2,303,800	Swann	Dec. 1, 1942
2,310,186	Abrams	Feb. 2, 1943
2,329,222	Schlegel	Sept. 14, 1943
2,341,823	Smith	Feb. 15, 1944
2,438,156	Dodge	Mar. 23, 1948