May 14, 1963 W. A. MEIER 3,089,233

LIGATURE JOINING

Filed Dec. 28, 1959

Fig. 1

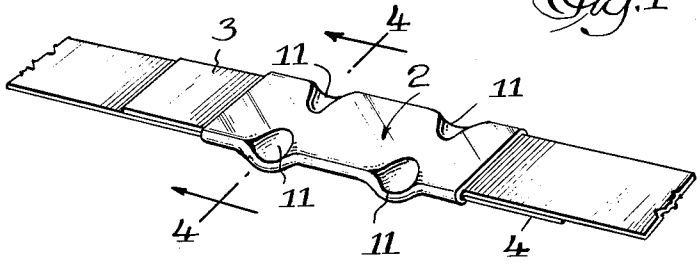
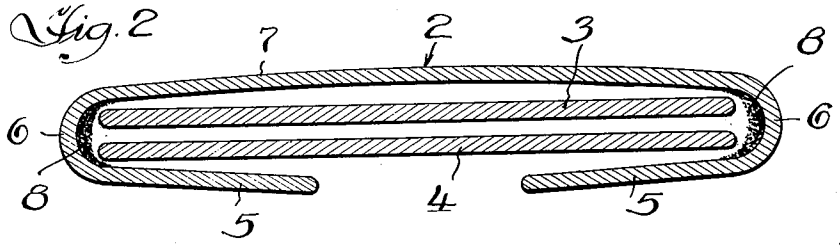


Fig. 2



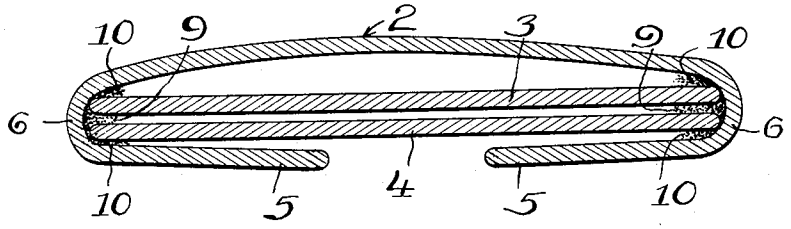


Fig. 3

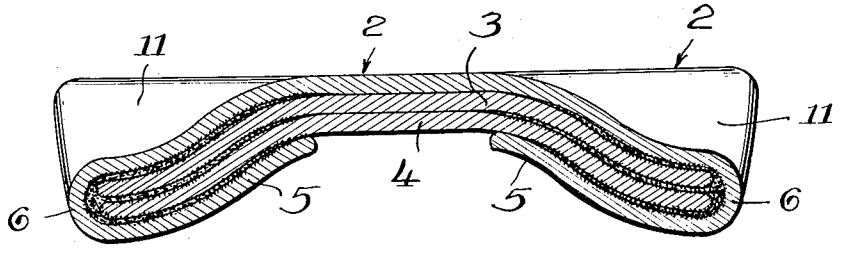


Fig. 4

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3,089,233
LIGATURE JOINING

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This invention relates to improvements in joining ligatures such as straps and wires and is particularly concerned with a method of forming joints between overlapped end portions of the ligatures to form a secure joint therebetween and to prevent relative movement of the end portions of the ligature.

Ligatures of the type with which the present invention is concerned are used in many diverse fields. Their most common use, however, is in the field of packaging and securing. In the usual packaging situation, the package or bundle is encircled with the ligature until the ligature overlaps upon itself. The ligature is then tensioned or "stretched" and the overlapped portions are secured together to form a joint.

Many forms of ligatures of the type under consideration are in common use. By and large, the most common forms are aluminum, iron and steel wire and strap. The present invention has general utility with respect to all of the aforementioned types of ligatures although most of the descriptions of this specification are with respect to steel strap. Steel strap is used for descriptive purposes herein, by way of example, and not with any intention to place any limitations upon the scope of the invention.

Ordinarily, when a joint is formed between the ends of strap, a seal, which is usually a metal member, is disposed over the overlapped portions and is crimped in place with the overlapped portions as a part of the joint structure.

When the strap is taken from a long length thereof, such as from a coil, the necessary amount is usually cut from the length after the package or bundle is encircled and the strap is stretched. Thus the seal overlies the overlapped end portions of the strap and only a minimum amount of strap is used. Similarly, when pre-cut lengths of strap are used, the seal overlies the overlapped end portions and is crimped in place to secure the end portions together after the strap is stretched.

In some instances, such as in securing a load in place in a railroad car, one end of each of a pair of lengths of strap are fastened, as with nails or staples, to the car. The other ends of the straps are then overlapped, stretched and sealed.

Throughout the specification and claims hereof, the expressions "overlapped end portions," "strap ends," "end portions" and similar terms are used to describe the overlapped portions of a ligature or ligatures which are secured together to form a joint, regardless of whether joining is effected at the ends or at intermediate areas of the ligature and regardless of whether one or two or more ligatures are secured together.

Several types of ligature material are available and are currently in commercial use. With regard to strap, there are untreated strap, coated strap, painted strap, waxed strap, heat treated strap and strap which has been treated in a plurality of different ways such as painted and waxed, etc. Coated, painted and/or waxed straps have grown in popularity in recent years due to their corrosion resistance and handling convenience. This type of strap has proved to be more convenient than untreated strap in packaging since it slips about the package more easily and permits more convenient and efficient tensioning of the strap. In addition, this type of strap is capable of sliding on itself while two strap portions are in face-to-face contact, whereby simpler and more efficient types of

tools may be used for stretching and tensioning the strap.

Painted and waxed strap, however, as opposed to untreated or "dry" strap has presented serious problems in forming joints of high strength and high efficiency. (Efficiency is expressed as a percent and is the ratio of the tensile strength of the joint to the tensile strength of the strap.)

A joint formed between the overlapped end portions of dry strap by a single seal having two pairs of crimps therein generally has an efficiency exceeding 90%. On the other hand, a joint of painted and/or waxed strap ends formed in substantially the same manner with substantially the same type of seal structure usually has an efficiency of about 30%.

The low efficiency and low tensile strength of sealed joints for painted and/or waxed strap has been the source of considerable concern in the strapping field. While a plurality of seals, each having a plurality of crimps therein, substantially improves the efficiency of the joint, the industry has not been satisfied with that solution and has spent considerable effort to attempt to improve joint efficiency and strength by other techniques.

The low efficiency of crimped joints in painted and/or waxed strap, it has been learned, is due to the capacity of the strap to slide on itself while in surface-to-surface engagement. This same difficulty also occurs with dry or untreated strap which is exposed to the elements and becomes wet, in which case the water seeping into the joint acts as a lubricant and permits the strap ends to slide or slip with respect to each other and with respect to the seal.

The problem of low joint efficiency and strength is particularly acute with crimped or pressure connected joint structures where the seal and the strap ends are not fractured or cut. Notched joints, which have tabs cut in the strap and seal, do not suffer the low efficiencies of crimped joints but are subject to low shock strength.

The present invention is particularly concerned with the problems of low joint strength and efficiency and provides a new method of joining, a new seal structure and a new composition for incorporation in a ligature joint whereby joints are provided with high efficiencies exceeding twice the efficiency of an ordinary joint and approaching 100%, and have high shock strength.

According to the present invention relatively hard, small grit particles are provided in the joint, preferably at least at the marginal edge areas of the overlapped end portions of the ligature and between the adjacent surfaces of the ligature end portions so that when the overlapped end portions are secured together, the particles will be embedded into the adjacent faces of the ligature ends and hold the same against relative longitudinal movement.

In an illustrative embodiment of the invention, and with particular reference to forming a joint in overlapped strap ends, as an example of a ligature joint, the grit is entrained in a carrier matrix formed of a thick, viscous substance which remains semifluid for a relatively long time. This grit-carrier mixture may be applied initially on the inside surface of the bight portions of the lips or flanges of the seal and in such quantities that when the seal is compressed or squeezed laterally of the strap and then crimped transversely of the strap, the mixture is first flowed into the space between the overlapped end portions of the strap and then keyed into the strap.

Also, some of the grit-carrier mix enters the space between each strap end and the opposed surface of the seal. The grit between the strap end and the seal further enhances the holding power of the seal by keying into those adjacent surfaces.

The presence of grit between the opposed surfaces of the sealed, overlapped strap ends, as described above, increases the tensile strength of the joint substantially in

excess of the tensile strength of joints made with seals of the same size and having the same number of crimps therein. Efficiencies more than twice as great as those resulting when sealing is effected without grit between the overlapped strap ends, are obtained with grit keyed into the strap ends.

Although the foregoing manner of applying the grit mix has been found to be very effective, a good joint can be obtained even though the grit mix is applied in a manner other than as described above. For example, but not by way of limitation, the grit can be applied directly to the area of the opposed, adjacent faces of the overlapped strap ends, at least at the margins thereof. Regardless of the specific manner in which the grit or granular material is disposed between the overlapped strap ends in accordance with this invention, it provides a keying action therebetween which greatly increases the efficiency and tensile strength of the joint.

During the process of making crimped joints wherein opposite edge portions of the seal and of the overlapped strap ends are deformed in the same direction, in a direction substantially normal to the surfaces of the strap ends and the seal, the straps are pressed together in surface-to-surface contact with substantial force. As a result, the grit between the strap ends is effectively keyed into the surfaces of the strap, and also into the inside surface of the seal, when the present invention is utilized in connection with making a joint of this type.

It is preferred, in order to obtain the greatest joint efficiency and strength, that the amount of granular material disposed between the overlapped strap ends be such that there is a thin layer thereof between the ends when crimping is effected. A thin layer permits each grit particle to be embedded and keyed into the adjacent faces of both strap ends. If after crimping is completed, the amount of grit between the strap ends is excessive, the individual granules will not effectively key into both straps. The grit, under these circumstances, will crush and/or roll and possibly reduce the efficiency of the joint. On the other hand, if the amount of grit employed is too small, insufficient keying will be effected and the efficiency of the joint will not be improved materially.

Any suitable abrasive grit material, such as, for example, aluminum oxide grit may be employed. The grit is preferably mixed with a binder or carrier of a type that dries to a tough, tenacious condition and yet remains plastic enough in consistency to permit easy flow of the grit during the sealing operation. For example, asphalt or asphalt-grease mixes perform in a satisfactory manner in that they permit suspension of the grit and thereby enable the grit to be squeezed between the straps and give high holding quality to the seal.

The carrier must be capable of anchoring the grit on the seal and yet must be sufficiently fluid and have proper flowing qualities to carry the grit into the space between the strap ends as the seal with the grit mix thereon is squeezed laterally in the initial step of lightly anchoring the seal. During the final crimping operation the excess grit-carrier mixture is squeezed out of the area between the straps, and the remaining grit is firmly keyed to the strap surfaces to hold the overlapped end portions against relative movement to provide the joint with a high efficiency.

Prior to the present invention, efforts had been made to use grit materials in ligature joint structures. All such efforts, however, were unsuccessful until, in accordance with the present invention, it was learned that (*a*) the overlapped ligature ends should be pressed together in intimate surface-to-surface engagement so that the grit will key into the surfaces, and (*b*) the grit should be carried by a matrix material having flowing qualities and providing easy flowing characteristics to the grit material whereby excess grit can flow from the joint during crimping.

The amount of grit and carrier mixture applied to the seal, as stated above, should be such that when the sealing operation is effected, there is a thin layer of grit between the overlapped strap ends. It has been found that the holding power, efficiency and tensile strength of the joint is dependent on the amount of grit present between the strap ends during the sealing and crimping operations. If small amounts of grit are employed, the efficency of the joint will be low. As the amount of grit is increased from a low value, the efficiency of the joint increases rapidly and quickly approaches a maximum value. Greater amounts of grit, after maximum holding power is reached, do not affect the joint efficiency until the amount of grit is so great that insufficient or improper keying is effected and/or crushing of the grit takes place during the crimping and sealing operations.

In accordance with the present invention, however, the problem of having too much grit or not enough grit between the adjacent surfaces of the overlapped strap ends is avoided. As a practical matter, it has been found most effective to apply a grit-carrier mixture to the bight portion of the lips or flanges of the seal so that, as described above, when the seal is squeezed laterally during the initial step of the crimping operation, the grit-carrier mixture will flow into the space between the overlapped strap ends. The carrier should have a proper viscosity, even after aging for a considerable period, to permit such flow of the grit-carrier mixture. When the seal and overlapped strap ends are crimped, some of the grit in the grit-carrier mixture will be keyed into the surfaces of the strap ends. The excess mixture, however, by virtue of the flowable characteristics of the carrier, including the excess grit in the mixture, will flow out of the space between the overlapped strap ends.

Thus, the grit should be present between the overlapped strap ends in an amount equal to or greater than a minimum amount below which increases in efficiency will be insignificant. Also, the carrier should be sufficiently flowable to permit the grit-carrier mixture to flow into the space between the overlapped strap ends and permit the excess to flow out of the space between the overlapped strap ends. Of course, in seals embodying the present invention, the grit-carrier mixture should be so disposed on the seal that when the seal is initially squeezed, the mixture will be in position to flow into the space between the overlapped strap ends.

The Grit

Any appropriate type of grit material may be employed in the process of this invention and in seals embodying the invention. An effective grit is aluminum oxide. However, other grit materials such as silicon carbide, which are substantially harder than ligature materials, for example steel and aluminum, and which have relatively high compression strengths as well as resistance to crushing or plane fracture, may be employed.

The grit may have any desired usable size. One of the controlling factors in the selection of the size of grit is that the grit should be small enough to flow with the carrier into the space between the strap ends and out from the space between the strap ends during the dynamic sealing process. It has been found that grit which will pass a 120 mesh screen, hereinafter called "120 mesh grit," performs very well. A preferred range of grit sizes in accordance with this invention is from about 80 mesh to about 180 mesh. However, similar grits may be employed if the crimping pressure is high enough to permit effective keying and larger grit sizes may be employed if the crimping pressure is low enough to prevent crushing of the individual grit particles or granules.

The Carrier

The carrier matrix for the grit material, as previously pointed out, must be a substance having plastic, semifluid characteristics which will permit flow of the grit material into and out of the space between the adjacent faces of the overlapped strap ends. Moreover, when the grit-

carrier mixture is applied to the bight portions of the lips or flanges of a seal, the carrier should have sufficient holding power to prevent undesired dislodging of the mixture from the seal during placement of the seal on the overlapped strap ends or during threading of the strap through the seal prior to crimping. The carrier should also have enough adhesive strength to properly hold the grit-carrier mixture in place on the seal from the time of manufacture of the seal until its use. An additional requirement for the carrier is that it remain sufficiently viscous for proper operation over at least the anticipated storage life period for the seal. Such a storage life period may be as long as several months.

Several carrier compositions have been found to be effective for the purposes of the present invention. One such composition is a mixture of grease and an asphalt adhesive.

It has been found desirable to employ grease as a base material for the carrier matrix for the grit material. One exemplary form of grease which may be employed within the scope of this invention is Conoco Lifetime Grease, available from Continental Oil Company.

It has been found desirable also to add a stiffening and adhesive constituent to the grease which, when mixed with the grease, provides a mixture having high holding power to retain the same in the bight portion of the seals and prevent dislodgement of the grit-carrier mixture from the seals prior to the sealing operation, such as during threading, which stiffens the mixture, and which provides good flow characteristics to the mixture.

An exemplary form of adhesive material for the carrier and one which falls within the scope of the present invention is a cut-back asphalt adhesive known as Tile-Tex GF–8. This is a cement product produced by and available from the Flintkote Company of Chicago Heights, Illinois. It is commonly used as an adhesive with asphalt, vinyl-asbestos and grease-proof floor tiles.

When employed together, the asphalt base adhesive and the grease should be thoroughly mixed to provide a carrier of uniform consistency. While any desired proportions may be employed, excellent results have been obtained with a carrier consisting of one part by weight of grease and three and one-half parts by weight of asphalt adhesive. Other proportions have also been successfully employed. The important factors in determining the proportions to be used are holding power, flowability and shelf life, all of which can be readily determined. A preferred range of constituents in the carrier is from about three parts by weight of asphalt adhesive to about four parts by weight of asphalt adhesive per one part by weight of grease.

The above described grease-asphalt carrier has given good results when employed in the present invention and has demonstrated a lasting ability even when subjected to relatively high drying and aging temperatures for extended periods.

The Grit-Carrier Mixture

The mixture of carrier material and grit material may be in any desired portions which will provide the requisite characteristics for the mixture, i.e., long shelf life, high holding power and adhesive strength on the seal and high lubricating qualities for ready flow into and out of the space between the adjacent faces of the overlapped strap ends. A mixture which has been found to be highly effective is one having portions, by weight, of about three and one-half parts asphalt-adhesive, one part grease and nine parts grit material. In terms of carrier and grit, the aforesaid mixture contains about two parts by weight of grit to about one part by weight of carrier. It should be appreciated, however, that these portions are exemplary and that other portions may be employed.

When applying the grit-carrier mixture to a seal, however, it may be desirable to thin the mixture for more convenient flow through the applying mechanism. For this purpose, a volatile thinner for the grease and/or for the cut-back asphalt cement may be added to the mixture. When a thinner is added, however, it should be volatilized from the mixture after the mixture is applied to a seal.

The amount of grit-carrier mixture applied to each seal, is significant in that it is undesirable to apply a great excess of material to the seal and it is ineffective to apply an insufficient amount of the mixture to a seal.

In an exemplary embodiment of the present invention, excellent results were obtained in a joint of overlapped ends of one and one-quarter inch strap utilizing two crimps in a seal about two and one-quarter inches long wherein grit-carrier mixture was deposited in the bight portions of the seal in a total weight in excess of about 0.1 gram per inch of seal, including both edges of the seal. In this example, the total deposited material, weighed after volatilization of solvent added to the mixture for convenience in depositing the same, was about 0.25 gram.

The surprising fact is that a plot of weight of deposited material versus joint strength for any single joint construction shows that as the weight of deposited material increases, the joint strength and efficiency increases very rapidly until a maximum value is reached, at which point the curve flattens almost immediately. Thereafter, further increases in the weight of material deposited on the seal have little, if any, effect on joint strength and efficiency, inasmuch as excess material flows out from between the overlapped strap ends during the crimping operation by virtue of the flowable characteristics of the grit-carrier mixture.

An illustrative embodiment of the present invention is described below in conjunction with the accompanying drawings which form a part of the present invention, in which like reference numerals refer to like parts, and in which:

FIGURE 1 is a perspective view of a strap joint embodying the invention;

FIGURE 2 is an enlarged transverse sectional view of the seal and strap end portions prior to crimping;

FIGURE 3 is a sectional view similar to FIGURE 2, but showing the parts in positions assumed during initial squeezing; and

FIGURE 4 is a sectional view similar to FIGURES 2 and 3 showing the seal fully squeezed and crimped, and taken substantially along the line 4—4 of FIGURE 1.

An exemplary form of a seal **2** of a type which is threaded onto the strap, is shown in the drawings applied to the overlapped end portions **3** and **4** of a metal, usually steel, banding strap. It should be understood that any desired form or configuration of seal may be employed with the present invention and that the illustrations of the drawings and the descriptions herein contained of a threading type of seal are intended only to be illustrative and not to place any limitations on the scope of the invention.

The threading type seal **2** initially has a cross section substantially as illustrated in FIGURE 2, and is made of a single, substantially rectangular portion of steel sheet having its longitudinal margins or flanges **5** folded over inwardly toward each other, so as to overlie but be spaced from the intermediate portion **7** at one side thereof. The spaces between flanges or lips **5** and intermediate portion **7**, i.e., the width of the bight portions **6** of the folds, are sufficiently wide to enable the seal to be threaded over, or have threaded therethrough, the overlapped ends **3** and **4** of the strap. Also, the distance between the bight portions of the flanges or lips of the seal is sufficiently greater than the width of the strap to permit convenient threading of the strap through the seal.

In the embodiment of the invention shown in the drawings, a bead or layer **8** of the grit-carrier mixture is deposited on the inside surface of the bight portions **6** of the seal.

When the grit-carrier mixture is deposited on the seal, it is important that the mixture be deposited in an appropriate position on the seal so that as the seal is squeezed in the first stage of the sealing operation, at least a substantial portion of the mixture will be moved into the space between the overlapped strap ends. It is preferred that the mixture be deposited on the inside of the bight portion of the seal. It may be deposited on the seal after the seal is bent to its desired configuration for application to the overlapped strap ends so that it will not be dislodged by later handling and manipulation of the seal.

When a threading type seal such as the one shown in the drawing is used, the strap is threaded through the seal, fed about the bundle or package and then the free end is again threaded through the seal so that the overlapped strap ends both extend through the seal and are arranged in surface-to-surface engagement with each other. With other forms of seals, the strap ends may be overlapped prior to tensioning or stretching and the seal may be disposed over the overlapped ends of the tensioned strap.

As the first step of the sealing and joining operation, the seal is subjected to a lateral squeezing pressure by the crimping tool. This initial squeeze tends to lightly anchor the seal. Moreover, it forces substantial quantities of the grit mix 8 between the strap ends 3 and 4, as indicated at 9 in FIGURE 3. Also, some of the grit-carrier mixture flows to a position between the outside surfaces of the strap ends and the inside surface of the seal, as indicated at 10.

Following the initial squeezing step, the seal and the overlapped strap ends are crimped and deformed under considerable force. FIGURE 4 illustrates the seal and strap ends when fully compressed and crimped, as indicated at 11. It will be noted that the semifluid grit mix has now been distributed substantially evenly in the form of a thin film between the surfaces of the strap end portions, at least at the marginal area thereof, and some of the mixture is between the outer surfaces of the strap ends and the inside surface of the seal. During this step of the sealing process, the excess grit mixture flows out of the crimped areas of the space between the strap ends. The remainder of the grit is keyed into both of the opposed surfaces of the strap ends by virtue of the crimping force applied to the seal. Similarly, some of the grit remaining between the strap ends and the seal is keyed into the surfaces thereof.

The presence of grit over substantial areas of and keyed into opposed surfaces of the tightly clamped and crimped joint assembly results in a joint that has greater holding power, high tensile strength and higher efficiency, and will withstand greater impact stress than similarly sealed joints lacking such grit. Thus, joint structures made in accordance with and embodying the present invention may be made with fewer pairs of crimps and therefore more easily and with less work effort and yet have higher efficiencies than heretofore known joint structures. Herein, "a pair of crimps" refers to opposed crimps, one at each side of the seal.

Although there is described a preferred embodiment of the invention in considerable detail, it will be understood that the description is intended to be illustrative, rather than restrictive, as many details of the structure shown and method described may be modified or changed without departing from the spirit or scope of the invention.

I claim:

1. The method of forming a joint between overlapped ends of a strap, comprising providing a seal member having a body portion and a pair of flanges thereon joined to the body portion by bight portions, depositing a thick, viscous grit-carrier mixture in the bight portions of the seal, disposing the seal about the overlapped strap ends with the bight portions of the seal adjacent to marginal edges of the overlapped strap ends, squeezing the seal laterally of the strap ends, flowing at least a portion of the grit-carrier mixture into the space between said overlapped strap ends, and crimping said seal and said overlapped strap ends under a pressure sufficient to key at least a portion of the grit in the grit-carrier mixture into adjacent faces of said overlapped strap ends at least at the marginal portions thereof.

2. The method of forming a joint between overlapped ends of a strap, comprising providing a seal member having a body portion and a pair of flanges thereon joined to the body portion by bight portions, depositing a grit-carrier mixture having hard, granular grit material of a size in the range of from about 80 mesh to 180 mesh therein, in the bight portions of the seal, disposing the seal about the overlapped strap ends with the bight portions of the seal adjacent to the marginal edges of the overlapped strap ends, squeezing the seal laterally of the strap ends, flowing at least a portion of the grit-carrier mixture into the space between said overlapped strap ends, and crimping said seal and said overlapped strap ends under a pressure sufficient to key at least a portion of the grit in the grit-carrier mixture into adjacent faces of said overlapped strap ends at least at the marginal portions thereof.

3. A seal for forming a joint between a pair of overlapped strap ends comprising, a seal body, flanges on opposite sides of said seal body bent out of the plane of the seal body, said flanges being connected to said seal body by bight portions, respectively, thick viscous grit-carrier mixture constituted by pressure-flowable adherent material having hard grit particles suspended therein adhered to the interior surfaces of said bight portions, said grit-carrier mixture being present in said bight portions in a total amount in excess of about 0.1 gram per inch along the length of the seal.

4. A seal as recited in claim 3 in which said grit-carrier mixture contains, by weight, about three and one-half parts asphalt adhesive, one part grease, and nine parts hard grit particles.

5. A seal as recited in claim 4 in which said grit particles are particles of aluminum oxide.

6. A seal as recited in claim 3 in which said grit particles have a particle size of from about 80 mesh to about 180 mesh.

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