Aug. 29, 1944. R. L. MELTON ET AL 2,356,866

MANUFACTURE OF ABRASIVE DISK MATERIALS

Filed Oct. 6, 1941 2 Sheets-Sheet 1

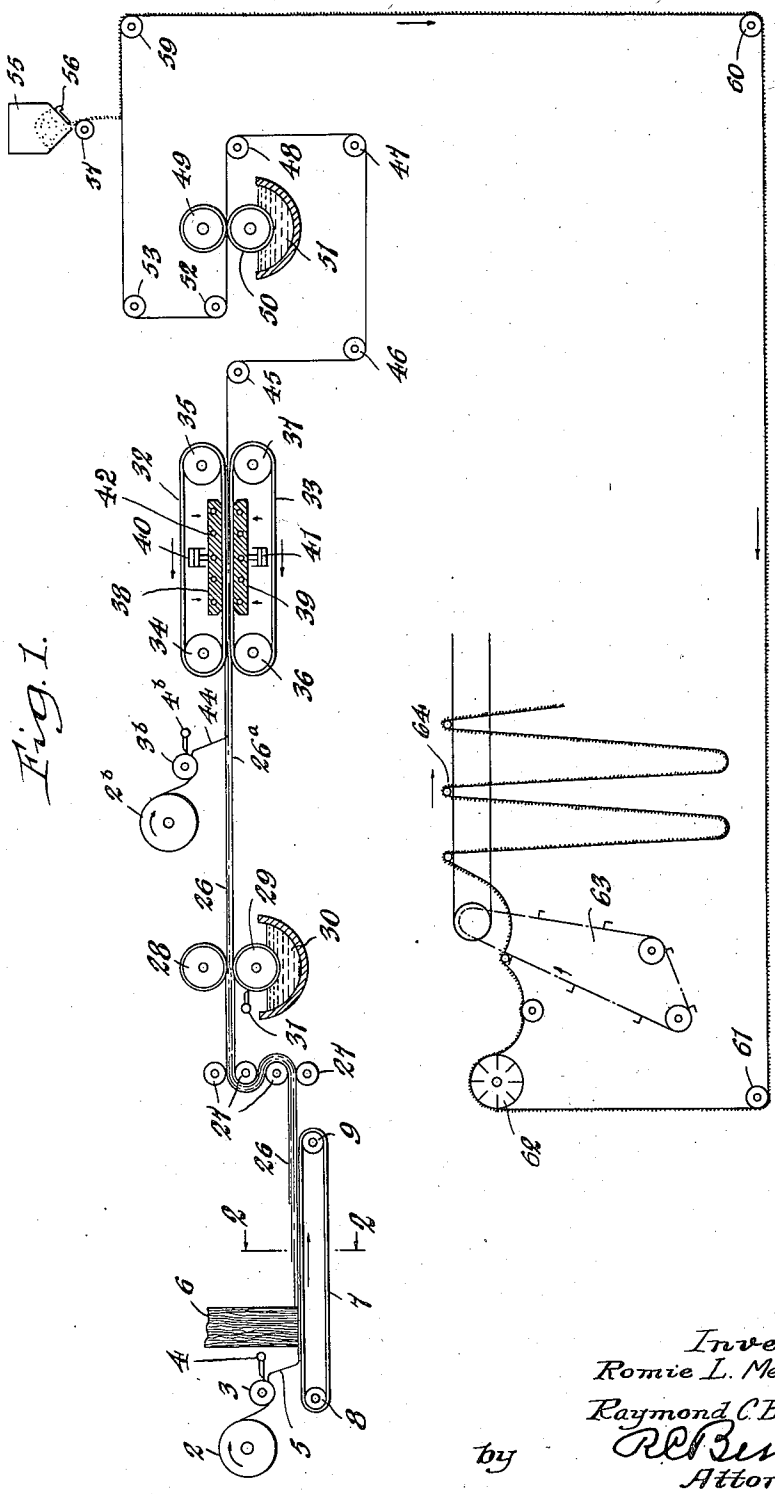


Fig. 1.

Inventors,
Romie L. Melton,
Raymond C. Benner,
by R. C. Benner
Attorney.

Aug. 29, 1944. R. L. MELTON ET AL 2,356,866

MANUFACTURE OF ABRASIVE DISK MATERIALS

Filed Oct. 6, 1941 2 Sheets-Sheet 2

Fig. 2.

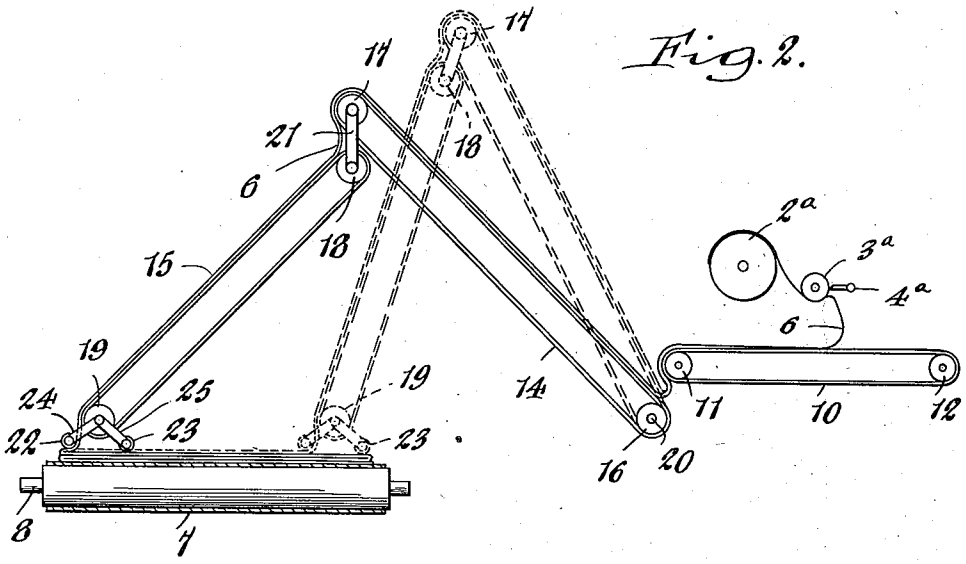


Fig. 3.

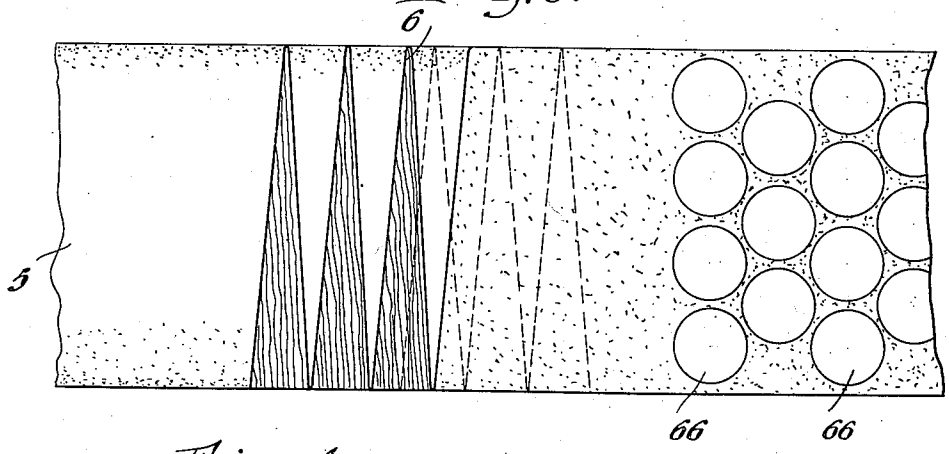
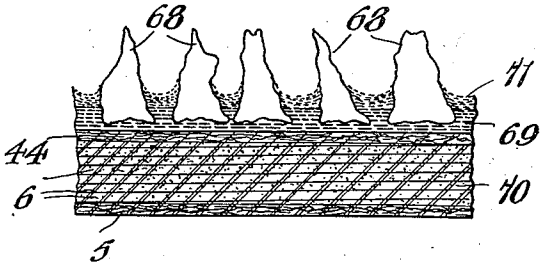


Fig. 4



Inventors,
Romie L. Melton,
Raymond C. Benner,
by R. C. Benner
Attorney.

Patented Aug. 29, 1944 2,356,866

UNITED STATES PATENT OFFICE

2,356,866

MANUFACTURE OF ABRASIVE DISK MATERIALS

Romie L. Melton and Raymond C. Benner, Niagara Falls, N. Y., assignors to The Carborundum Company, Niagara Falls, N. Y., a corporation of Delaware

Application October 6, 1941, Serial No. 413,788

9 Claims. (Cl. 51—293)

This invention relates to flexible abrasive disks and to methods for their manufacture. More particularly it relates to the manufacture of abrasive disks in which a felted fibrous backing material is formed from a plurality of superposed carded fibrous membranes and consolidated to produce a disk backing characterized by a radial strength and toughness which is uniformly high in all directions. Such a fibrous disk backing material compares very favorably with the strength and toughness of vulcanized fiber backings and is much easier and far less expensive to manufacture. The invention further relates to a continuous process of forming such a felted fibrous backing material, adhesively securing abrasive grains to one surface thereof and cutting abrasive diks therefrom.

Heretofore the manufacture of abrasive disks, having the requisite strength and toughness for heavy duty grinding, has required the use of backing materials of vulcanized fiber. Such vulcanized fiber is expensive to manufacture because of the long drawn out chemical treatment required. Furthermore, abrasive disks cut from such materials are not uniform in strength in all directions due to the inherent characteristic of the fiber to be stronger in its longitudinal direction and weaker in its transverse direction. Efforts to overcome this difficulty included the application of a reinforcing web or cloth, paper, and other materials to produce a combination of two or more composite layers. Such combination backings have proven successful, even under severe grinding conditions, but are expensive to manufacture due to the number of operations involved.

The present invention provides a much simplified method of manufacturing abrasive coated disks which greatly reduces the number of steps required to go from the raw materials to the ultimate product and greatly lessens the time required to carry out such manufacture. The present invention further provides an abrasive disk having a backing which is uniformly tough and strong radially in all directions and will stand up under heavy duty grinding operations. This disk backing also retains the abrasive coating with tenacity and has a highly satisfactory resilience and flexibility as well as being less expensive and easier to make. The present process has a further advantage in that the abrasive disks can be manufactured as a continuous process from raw materials to finished product with a saving of both time and space.

In accordance with the present invention a felted fibrous web of the desired thickness is formed by building up on a moving endless support a plurality of layers of thin carded fibrous membranes to form a loosely felted structure which is then treated with a suitable adhesive binder and consolidated to the desired density. High strength of the web material in all directions is obtained by depositing one or more fibrous layers or membranes longitudinally of the moving conveyor and then depositing the succeeding layers of carded membranes in a criss-cross direction obliquely transverse to the length of the initially deposited web, with the direction of successively deposited layers changing, whereby the final web backing has a plurality of carded laps running in all directions. A binder adhesive is then applied into the web and distributed therethrough after which the formed web is consolidated and then subjected to heat and pressure to produce a dense backing material of the requisite strength and rigidity. An additional carded fibrous membrane or other woven fibrous material may be applied to the upper surface of the formed web backing immediately prior to the step of maturing the binder adhesive. The top surface of this layer of fibrous material will be starved of adhesive and thus provide greater adhesion and improved anchorage for the subsequently applied base coating of adhesive and abrasive granules. The abrasive coated web is then passed to a zone where the adhesive is matured to secure the granules to the backing after which the material is cut up into abrasive disks of desired size.

In order that the invention may be more clearly set forth and better understood, reference is made to the accompanying drawings, in which:

Figure 1 is a diagrammatic side elevation, partly in section, showing one form of apparatus for making abrasive-coated disk material according to the present invention;

Figure 2 is a side elevation, partly in section, taken along the line 2—2 and depicts that part of the apparatus not generally shown in Figure 1, for depositing the fibrous membranes making up the greater part of the body structure of the disk backing material;

Figure 3 is a plan view of the abrasive coated disc material made by the present process and shows this material in various stages of its manufacture so as to better illustrate the body structure of the backing material and the manner in which abrasive discs are cut from the material; and

Figure 4 is a greatly enlarged vertical cross-

section through a fragment of an abrasive disk embodying and made in accordance with the teachings of the present invention.

Referring further to the drawings, Figures 1 and 2 illustrate one form of apparatus which may be employed in manufacturing abrasive-coated web material suitable for the production of abrading disks in accordance with the present invention. The particular apparatus shown comprises a carding machine consisting of a carding cylinder 2, a doffer roll 3 and a comb 4, adapted to form and deliver an initial carded fibrous membrane or lap 5 to a moving conveyor belt 7. Another carding machine assembly consisting of a similar carding cylinder 2*a*, doffer roll 3*a*, and comb 4*a* (see Figure 2) is positioned further along the path of travel of the moving conveyor 7 and adapted to deposit a carded fibrous membrane 6 in a criss-cross direction obliquely transverse to the direction of movement of the initially deposited membrane 5. Either or both of the carding assemblies shown may be supplemented by additional carding machines for the deposition of a greater number of fibrous webs in any direction, in which case the moving conveyor 7 would be extended in length sufficiently to take care of the number of carding machines employed.

The carded membranes or laps are delivered from the carding machines as flimsy webs of independent fibers generally parallel and loosely adhering together. These membranes may consist of any fibrous material capable of being carded into web form or separable into individual fibers. Such materials include natural fibers, such as cotton, wool, jute, flax and asbestos, as well as the various synthetic fibers, such as glass wool, resinous and rubber-like fibrous substances. Any one of these fibrous materials may be used singly or two or more may be mixed in any desired proportion. Cotton fibers are inexpensive and readily available in quantity and have been found to be highly satisfactory in the present process and consequently will be used as a specific example in connection with the detailed description of the apparatus and method of manufacture.

The initial fibrous membrane 5 is deposited upon the conveyor 7 in the direction of travel of the conveyor to form a continuous bottom layer of fibrous material for reception of the additional fibrous membranes and to provide the necessary strength to the final fibrous web in its machine or lengthwise direction. The conveyor belt 7 is provided with a smooth outer surface and is supported at the opposite ends thereof by rolls 8 and 9, which are driven by suitable means (not shown). The speed of the belt is synchronized with the rate of feed of the longitudinally deposited fibrous lap or laps 5 so as to prevent any appreciable strain or pull on the flimsy membranes during their deposition.

The membrane 6 and any additional membranes supplementary thereto, which are deposited by carding machines illustrated in Figure 2, are deposited upon the moving conveyor in a cross-cross manner so that this fibrous membrane lies transversely in an oblique direction to the movement of the traveling belt or conveyor 7. The direction of each membrane varies from that of the adjacent membranes so that the composite structure of the built-up fibrous web consists of a plurality of fibrous membranes in which the general fiber direction varies with each individual lap. That part of the apparatus for accomplishing this transverse deposition of carded fibrous membranes is shown in Figure 2 and consists of a conventional carding machine and auxiliary web distributing device. The carded fibrous membrane 6 is fed onto a moving conveyor 10 which is supported at the opposite ends thereof by the rolls 11 and 12, and driven by suitable means (not shown). The speed of the conveyor belt 10 is synchronized with the rate of feed of the fibrous membrane 6 so as to prevent any appreciable strain or pull on the flimsy web. The carded membrane 6 is then fed from the moving belt 10 onto a "camel-back" structure, which comprises a pair of moving belts 14 and 15, supported at opposite ends thereof by rolls 16 and 17, and 18 and 19, respectively, and driven by suitable means (not shown). These rolls are supported in turn by a side frame structure comprising a pair of side frames or arms pivotally mounted at the axis 20 and also pivotally connected at their adjoining ends 21 to permit the camel-back to move back and forth to deposit superimposed layers of the fibrous membrane 6 transversely of the moving conveyor belt 7. The camel-back is provided at its free end with a pair of small finger rolls 22, 23 attached to the end of pivotally mounted arms 24 and 25. These finger rolls apply pressure to the membrane being deposited to produce intimate contact with the deposited layers and insures cohesion therebetween. The rate of feeding the fibrous material from the camel-back in relation to the speed of travel of the conveyor 7 will determine the exact angle of deposition of the membrane as well as govern the thickness of the resulting fibrous web. The number and arrangement of the carding assemblies and the auxiliary mechanism will depend upon the desired thickness and type of fibrous web to be produced.

After the fibrous web 26 has been built up to the required thickness, it is ready to be consolidated to a greater density for added strength. At the same time it is usually desirable to incorporate a liquid adhesive within said web to bond the consolidated fibers and produce a web having a strength comparable to vulcanized fiber and the like. The web 26 is initially consolidated and strengthened by passage back and forth through a series of synchronously driven rolls 27 which may be located near the terminus of the conveyor belt 7. These rolls 27 do not exert any appreciable pressure on the web and are preferably all driven at the same peripheral speed as the moving web in order to avoid tension on the web. The back and forth or alternate bending of the web by the rolls 27 serves to alternately lengthen and contract opposite sides of the web, and this action causes the loose ends of individual fibers of adjacent membranes to become interengaged.

Passing from the rolls 27, the web is delivered to the adhesive binder applying rolls 28 and 29. The liquid adhesive binder is contained in a pan 30, which may be water-jacketed or heated as required. Revolving roll 29 is partially immersed in the liquid adhesive and with each revolution transfers a quantity of adhesive binder into the fibrous web. An adjustable scraper bar 31 provides a means of regulating the amount of adhesive introduced into the web. Passage between the rolls 28, 29 serves to consolidate the loose fibrous web and causes the binder adhesive to permeate throughout the web structure. The surfaces of both rolls 28 and 29 are covered with a resilient layer of absorbing material. The adhesive binder applied by rolls 28, 29 herein re-

ferred to as the body binder, is preferably of a heat-hardenable nature, such as thermo-setting phenol-formaldehyde resins, as for example those sold under the trade name "Durite S–2143" and "Durite S–1902," or the like and which will mature with heat to a permanently tough, hard binder of high strength. Sufficient resin should be incorporated in the fibrous web so that the resin comprises from 20% to 50% by weight of the impregnated fibrous material.

After the fibrous web **26***a* has been consolidated and the proper amount of adhesive binder applied therethrough it is passed through a suitable mechanism for continuously curing the included adhesive by heat and pressure, thereby permanently retaining the fibrous layers in a dense consolidated condition. A suitable cure for the liquid phenolic resins specified above requires a platen temperature of 300° F. for a period of two minutes. Curing time and temperature depends upon the thickness of the web and the requirements of the particular adhesive binder employed. Also, partial cures can be carried out at this stage of the process with the final or complete cure being effected later in the process at the time of maturing the base adhesive coating. The continuously curing apparatus for so treating the web comprises two flexible endless, metal belt platens **32**, **33** mounted on end pulleys **34**, **35** and **36**, **37** respectively, and driven by means (not shown) at a speed synchronized with that of the moving web **26***a*. The belt platens are arranged with their adjacent outside faces substantially parallel and spaced apart by an amount approximately equivalent to or very slightly less than the thickness of the traveling web to be treated. Directly in back of equal portions of both adjacent faces of the traveling platens **32**, **33** are flat, plate shape fluid pressure transmitting members **38**, **39** equipped with pressure cylinders **40**, **41**. These flat members **38**, **39** are heated by steam ducts **42** and are positioned so that when steam or other fluid pressure is introduced to the pressure cylinders **40**, **41** the traveling platens will be thrust toward each other to exert a uniform heat and pressure against the traveling web to mature the included adhesive binder and permanently consolidate the fibrous structure.

It has been found desirable to apply an additional carded fibrous layer **44** from the carding assembly **2***b*, **3***b*, **4***b* to the top surface of the consolidated fibrous web **26***a* after the body binder adhesive has been incorporated in the web and prior to the step of curing. As a result that portion of the web nearest the upper surface is starved of adhesive binder and is not as smooth and hard as otherwise might occur and therefore presents a better surface for the anchorage of a top coating of abrasive grain and adhesive binder. In other words, the application of an additional fibrous layer following the introduction of adhesive into the web serves to give a top surface which is simulative in effect to the use of a top cloth or fabric layer in the ordinary manufacture of combination backings but without the expense involved therewith. However, a cloth or fabric layer may be used at this point in the present process instead of the fibrous membrane if desired.

Passing from the curing apparatus the web is carried around idler rolls **45**, **46**, **47** and **48** to adhesive-applying rolls **49**, **50** for applying a surface or base coating of adhesive. The liquid adhesive is contained in a pan **51**, which may be water-jacketed or heated, as required. Revolving roll **50** is partially immersed in the adhesive and with each revolution transfers a measured amount of adhesive to the web. The adhesive binder applied may be glue, resin or any other suitable adhesive for the purpose.

The adhesively coated web is then moved over idler rolls **52**, **53** and under a grain hopper **55** where a layer of abrasive granules is deposited onto the freshly coated adhesive surface. The hopper **55** is provided with an adjustable feed gate **56** and grain distributing rolls **57** which permits a uniform shower of grain of desired density to be deposited. The abrasive coated web is then passed over supporting rolls **59**, **60**, **61** and suction drum **62** to a chamber where the adhesive is matured. This chamber may contain a festooning device **63** for festooning the coated material on to supporting sticks carried by the moving rack **64**.

After a preliminary set or cure has been imparted to the base adhesive coating, a second or sizing layer of adhesive may be applied over the abrasive layer to more firmly anchor the individual granules in position. Such a sizing coating may be applied by the conventional adhesive rolls and further details are not deemed necessary. The coated web is then passed to a final heating chamber or rack where it is fully matured. When the cured web is removed from the final curing chamber it is either cut into abrasive disks by dieing out the blanks with a punch press or the coated material rolled up and stored for future use as a disk material.

Figure 3 illustrates an abrasive coated fibrous disk material made according to the present invention and shows the material in various stages of its manufacture in order to bring out certain features of its structure. The obliquely transverse positioning of the fibrous membrane **6** is clearly shown as it is deposited on the initially deposited lengthwise web **5**. The transverse arrangement of the membrane or membranes **6** serve to increase the cross-ways strength of the final web so that when abrasive disks cut from the areas **66** are obtained they will have a uniformly high tensile strength in all directions across the disk.

Figure 4 is a greatly enlarged vertical section through a fragment of coated abrasive disk material. This view shows clearly the initial longitudinally deposited carded fibrous layer **5** and the transversely deposited membranes **6** forming the body structure of the backing. The fibrous top layer **44**, applied after the base has been adhesively impregnated and applied to promote the abrasive grain adherence, is also shown. The abrasive granules **68** are held in place by the base adhesive binder **69**, which has penetrated the fibrous structure to the limited degree permitted by use of the adhesive-starved fibrous top layer **44**, but which is sufficient to firmly grip the backing so as not to be dislodged therefrom in use. The lesser amount of adhesive in the fibrous layer **44** is shown by the lightness of the upper portions of the diagonal lines **70** representing the impregnating body adhesive. A further sizing coat **71** of adhesive further anchors the abrasive grain in place.

Abrasive coated disks as herein made exhibit numerous advantages accruing from the method of manufacture and the structure resulting therefrom. For example, the fibrous backing structure of an abrasive disk made as herein proposed will not only have a tensile strength com-

parable to the strength of vulcanized fiber backings but the strength will be substantially uniformly high in all directions because of the plurality of directions in which the various fibrous layers have been deposited. Furthermore, the provision of an adhesive-starved top fibrous layer produces a slightly roughened top surface promoting a strong adherence of surface grain and adhesive thereto without the necessity of resorting to use of woven cloth fabrics. The economic saving obtained by being able to make the finished product directly from the raw materials, which in themselves are relatively cheap as compared to the vulcanized fiber backings heretofore used, is of considerable value. Other advantages and benefits accruing from the present invention are apparent and obvious from the above description and explanation.

In practicing the invention any of the abrasive materials in common use may be employed, such as silicon carbide, fused aluminum oxide, flint, corundum, emery and similar substances. The size of the abrasive particles may vary depending upon the type of grinding operation to which the disk material is to be put.

The present invention has been described as a continuous process in which the abrasive coating is preferably applied to the fibrous backing at the time that the backing is formed. However, it is within the scope of the present invention that a felted fibrous disk backing may be formed in the manner described or may be obtained in substantially similar felted form by any suitable but substantially equivalent procedure and the abrasive coating adhesively applied and secured to the backing as a later and separate operation.

While the preferred embodiments of the invention have been specifically illustrated and described, it is to be understood that the invention may be otherwise embodied and practiced within the scope of the appended claims.

We claim:

1. The method of making flexible abrasive disks which comprises dry-forming a felted fibrous disk backing material, applying an adhesive binder thereto and consolidating said backing, applying a fibrous layer to the upper surface of the consolidated backing after the application of the adhesive binder to the main fibrous body structure, combining the backing and top fibrous layer and setting the adhesive to provide a backing having the upper surface starved of adhesive and therefore receptive to a strong adhesive attachment of abrasive grains thereto, coating the upper surface with an adhesive, applying a layer of abrasive grain to the adhesively coated surface, setting the adhesive binder to secure the abrasive grains to the backing material and cutting abrasive disks therefrom.

2. The method of making flexible abrasive disks which comprises dry-forming a felted fibrous backing, introducing an adhesive binder into said fibrous body to render it strong and dense, applying a top facing of fibrous material to the backing after the application of the adhesive binder to the main fibrous body structure but while the adhesive binder remains uncured, maturing the adhesive binder to provide a backing having the upper surface starved of adhesive and therefore receptive to a strong adhesive attachment of abrasive grains thereto, applying a surface layer of abrasive grains and adhesive binder therefor, setting the adhesive to secure the abrasive grain and cutting abrasive disks therefrom.

3. The method of making flexible abrasive disks which comprises feeding plurality of layers of carded fibrous membranes, the fibers of which run lengthwise thereof, onto a moving conveyor in a direction transverse to the direction of travel of the said conveyor whereby the superimposed layers of fibrous material lie in a plurality of directions throughout the body of the structure obliquely transverse to the lengthwise direction of the resulting fibrous web so as to impart a varied fiber disposition whereby a high strength in all directions in said web is produced, introducing an adhesive into the fibrous web so made and consolidating the same, maturing said adhesive, coating a surface of the fibrous web so formed with a layer of adhesive, applying abrasive grain to the adhesively coated surface, setting the adhesive to secure the abrasive grain, and cutting abrasive disks therefrom.

4. The method of making flexible abrasive disks which comprises feeding longitudinally upon a traveling conveyor a base layer of fibrous material, feeding thereon a plurality of layers of a carded fibrous sheet material, the fibers of which run lengthwise thereof, in a direction transverse to the direction of travel of the said conveyor whereby the superimposed layers of fibrous material lie in a plurality of directions throughout the body of the structure obliquely transverse to the lengthwise direction of the resulting fibrous web so as to impart a varied fiber disposition whereby a high strength in all directions in said web is produced, introducing an adhesive binder into the fibrous web so made and consolidating the same, maturing said adhesive binder, coating the surface of the fibrous web so formed with additional adhesive binder, applying abrasive grain to the adhesively coated surface, setting the adhesive to secure the abrasive grain, and cutting abrasive disks therefrom.

5. The method of making flexible abrasive disks in accordance with claim 3 in which a fibrous layer is applied to the upper surface of the compacted web backing after the introduction of the adhesive binder into the web backing.

6. The method of making flexible abrasive disks in accordance with claim 3 in which a layer of fabric is applied to the upper surface of the compacted web backing after the introduction of the adhesive binder into the web backing.

7. A flexible abrasive disk comprising a felted fibrous backing formed from a plurality of heterogeneously arranged fibrous layers, the general directional disposition of the fibers of each layer throughout the body of the abrasive disk being different from that of adjacent layers, said layers being adhesively consolidated by presence of an adhesive therein to form a dense structure and an upper surface layer of partially felted fibers having a lower content of consolidating adhesive for reception of abrasive granules, said backing having a surface layer of abrasive grain adhesively secured to the fabric coated face of said backing.

8. An abrasive disk comprising a backing having a layer of abrasive grains adhesively attached to a surface thereof, said backing comprising a plurality of membranes formed of cardable fibers, the major proportion of the fibers of each of said membranes having their longitudinal axes lying generally parallel and lengthwise thereof whereby each of the said membranes is stronger in the lengthwise direction than in the crosswise direction, and the membranes being so positioned with respect to each other that the longitudinal axes of the major proportion of the fibers of any membrane form an angle with the longitudinal axes of

the major proportion of the fibers of adjacent membranes whereby the backing is substantially uniform in strength in all directions.

9. An abrasive coated article adapted for the manufacture of flexible abrasive disks, said article comprising a backing having a layer of abrasive grains adhesively attached to a surface thereof, said backing comprising a plurality of membranes formed of cardable fibers, the major proportion of the fibers of each of said membranes having their longitudinal axes lying generally parallel and lengthwise thereof whereby each of the said membranes is stronger in the lengthwise direction than in the crosswise direction, and the membranes being so positioned with respect to each other that the longitudinal axes of the major proportion of the fibers of any membrane form an angle with the longitudinal axes of the major proportion of the fibers of adjacent membranes whereby the backing is substantially uniform in strength in all directions.

ROMIE L. MELTON.
RAYMOND C. BENNER.