This invention relates to matted and webbed fabrics of mineral fibers in which the fibers that make up the fabric are bonded one to another. More particularly, the invention relates in part to a thin, porous sheet or mat of glass fibers having the properties of high tensile and tear strength, resiliency, good flexibility and resistance to moisture, to high and low temperatures, to the attack of elements ordinarily in the ground or in the air, and to the destruction of the glass fibers during application or in position of use.

The mat of the invention is from 1 to 80 thousandths of an inch in thickness and is well adapted for use as a resinous reinforcement in plastics, as a carrier and reinforcing agent for resinous impregnants and tarry substances in roofing, water proofing membranes, underground pipe wrap and pipe shields, and as an air filter.

Further, this invention relates, in part, to a batch of closely associated or intermatted mineral fibers having the characteristics of strength, high resilience, fixed dimension, good feel, resistance to fiber disintegration when the batch is flexed, good recovery after considerable deformation, and the ability to be fabricated to various degrees of softness and densities in accordance with the particular purposes to which the mass is to be put. This batch is of substantial thickness, say from 1 to 6 inches, and for building and railroad car insulation is desirable at a density of 1 to 3 pounds per cubic foot, whereas, for heat insulation in refrigerators and stoves a density in the order of 3 to 5 pounds per cubic foot is desirable. Where the batch is to be employed in sound and heat insulation in the form of a rigid or semi-rigid board, it is formed into a sheet having a density in the range of 6 to 10 pounds per cubic foot.

Various methods have been devised by which fibrous material can be manufactured in the form of products of the type just described. The United States Patents to Slayter et al., No. 2,133,236, dated October 11, 1938, Slayter et al., No. 2,206,058, dated July 2, 1940, Simpson No. 2,230,270, dated February 4, 1941, Bergin et al., No. 2,252,157, dated August 12, 1941 and Slayter No. 2,306,347, dated December 22, 1942 describe some of these methods. Generally, the glass fibers are rammed down from above and collected in thin or thick webs or mats, as desired, on a moving foraminable belt. During their fall, the long and substantially continuous fibers are interlaced to some extent as they come to rest in more or less parallelism with the collecting surface although they may extend in random directions with respect to each other. The interlacing and intermatting of the fibers that results from the manner in which they are deposited and collected provides a certain degree of mass integrity which is substantially increased when desired by the addition of bonding agents.

Concerning the latter type products, many types of resinsous materials have been tried as the bonding agent, but the majority of these, in general, are either water soluble or thermoplastic. If water soluble, such for example as binders formulated principally of sodium silicate, glue, polyvinyl alcohol or the like, they have for that reason been found unsatisfactory when subject to conditions of high humidity or complete immersion in water, as experienced in underground applications, for when large amounts of moisture are absorbed the binder is substantially dissolved in water or overly softened and the desirable characteristics of fixing the fibers in predetermined relation is entirely lost.

On the other hand, if the bonding agents are thermoplastic, such for example, as asphalt resin, pitch, or the synthetic thermoplastic resins material such for example, as the cellulose esters, cellulose ethers, vinyl copolymers, acrylates, polystyrenes or the like, they become softened when exposed to elevated temperature conditions whereby the properties of maintaining the fibers in fixed relation is substantially lost. In addition, such commonly used binder materials as rosin and asphalt affected by aging and oxidation causing embrittlement, and sodium silicate may attack the filaments to such an extent that there is a reduction of the strength and flexibility of the fibers. These materials in general are permanently soluble in various organic solvents, liquids or compounds so that under certain conditions they are incapable of functioning as a binder. These same thermoplastic resinsous materials generally are subject to cold flow and the mat or bat does not tend to return completely to its original form when compressed or otherwise deformed.

Greater inertness is to be found amongst those materials which are, in their final stage, relatively insoluble and infusible. Unfortunately the greater majority of these are for other reasons considered unsatisfactory as the mat binder where certain properties are required in the mat. For example, the phenolic and urea formaldehyde reaction products and the acid catalyzed reaction product of furfuryl alcohol, furfuryl alcohol and furfural or phenol-furfural are relatively hard and brittle and, as a result, the desired feel and flexibility are not obtained.

When the mass bonded with these materials is tensioned or flexed to marked extent, the rigid resinous binder holds the glass fibers against relative movement with the result that the fibers break. When this occurs, a glass dust is thrown from the mass and this may produce an industrial hazard.

As previously pointed out these undesirable characteristics result from the rigidity of the resinous binder and many attempts have been made to plastizice these materials. The phenolic, urea and furfuryl type materials are difficult to plastizice and, where achieved, the undesirable properties generally reappear in a short space of time as a result of the oxidation or loss of the plastizicer.

Various other disadvantages have attended the use of these insoluble and infusible resinous reaction products as binders for very thin, say 10 mils thick, mats of interlaced glass fibers, especially when these binders are applied in their unmodified form as phenol-formaldehyde or urea formaldehyde. The thin layer of interlaced glass fibers does not form a mat having sufficient strength to resist the tensions existing while the mat is traveled through stations where it is impregnated with the resinsous material and where the material is baked or cured. To offset this, a small amount of resinous material is applied to the fibers while they are in a set condition or the collectors are in an interlaced fashion on the collecting surface. The resinsous material, which for purpose of compatibility and convenience may be the same as that later to be applied at the impregnation station, should have a slow reaction rate, otherwise its adhesive characteristics are lost before the fibers are in the position they are to assume in the fabric and they would have no effect in aiding the mass integrity of the mat. Generally the unmodified and even some of the modified phenolic and urea resins
are so rapid in their cure that adhesiveness and integrity are not imparted to the mat. I have found that a suitable binder having the desirable properties of inerse, strength and adhesion to glass surfaces as well as the characteristic to impart permanent flexibility, efficiency and feel to the glass fiber mat may be obtained in a compound of an aldehyde condensation product such as phenol-formaldehyde and a rubber of the type including the copolymerization of butadiene with acrylonitrile. When these materials are compounded in proportions, such as for example, one part from one to the reaction of the rubbery rubber to one part of the aldehyde condensation product, the final resinous product has the hardness, inertness, and the adhesion of the phenolic resin component and the flexibility, adhesion, resiliency and strength of the synthetic rubber. The composite mass, as a result, has improved electrical properties, high tensile, tear and impact strength, good elongation and resistance to moisture and to extremes of high and low temperatures while all the other physical properties of each of these constituents individually are either maintained or changed only slightly. The rubber component appears to slow down the reaction rate of the aldehyde condensation product sufficiently to enable the binder to flow along the fiber surfaces and cool at the junctures so that interbonding of the fibers may be accomplished with less binder material. This effect might be considered as resulting from the dilution of the phenolic component or from the high viscosity of the rubbery component.

Each of these materials may be compounded separately into intermediate reaction products and then diluted in a manner to enable them to be mixed together to form a homogeneous treating material for application to the glass fiber surface. At the preliminary stage of the reaction, the thiol preferentially is mixed with water to form an aqueous mixture which provides no industrial hazard. It is plain, however, that organic solvents capable of dissolving both of these materials may just as well be used. For example, the intermediate reaction product of phenol-formaldehyde herein referred to as being in the "A" stage is water soluble, whereas the copolymer of butadiene and the acrylonitrile forms a stable aqueous emulsion or dispersion, especially if an alkaline soap or dispersing agent is present. These materials may then be blended together to form a homogeneous binder. In the blending, various precautious steps are to be observed. Otherwise the rubber materials are coagulated and thrown out of the solution. In some instances, it is preferable separately to dilute the phenol-formaldehyde and the rubbery components and then slowly pour the phenolic component into the rubbery component with mixing, a stable homogeneous blend is obtained which may then be further diluted with additional water to the desired solid content. Although the resinous solids content may be maintained in a range of from 1 to 20 per cent, I prefer to use a treating material having a solid content of from 1 to 3 per cent and at this dilution the treating material is sufficiently stable to enable application and handling through the usual circulation system, pump sprayer or dip tank.

In operation, a small amount of the resinous binder is sprayed onto the glass fibers while in the collecting chamber. The binder, as previously pointed out, operates to impart increased mass integrity to the fiberglass mat and to enhance the interlocking of this mat of the fiberglass. The mat is then led over rollers into an impregnating area where the mat is fully wetted with the treating material. The impregnation may be effected by submergence of the mat in a dip tank, by means of a flow coat process effecting while the mat is passing over or between rolls, or some other suitable impregnation means such as spraying. The excess binder which drips from the impregnated mat may be collected in a trough and returned to the supply reservoir and, subsequently, a pair of wiping rolls may smooth out the resinous application and remove further excess of binder from the mat.

In many instances, it is desirable to expose the freshly impregnated mat to a flash heat in the range of 400-800° F. for purposes of driving off the main portion of the volatiles. This reduces the flow of the resinous binder sufficiently to prevent such imperfections as might result from the collection of resinous materials along the lines where the mat is engaged by rollers or belt which convey the mat through the baking operation.

The baking ovens are maintained at temperatures in the range of 250-450° F. and as the impregnated mat passes therethrough the binder is converted to its cured stage. It is manifest, that the open flames and high temperatures in the oven would provide an industrial hazard if combustible type diluents were used and that the materials of the invention, which enable dilution with water, provide a distinct advantage in this regard, as well as in greatly reduced costs when compared to the more expensive solvents. In this connection, when some binders such as furfuryl alcohol, and its derivatives are used as the binding agent, the evolved fumes and odors are not only unpleasant but in many instances harmful. A distinct clarification of the surrounding atmosphere is to be noticed when practicing my invention.

The resulting mat develops adequate strength with a minimum of resinous binder because the major part of the resinous material has ample time due to its slow rate of cure to migrate along the lengths of fiber and gather in higher concentrations at junctures of the fibers where it operates more efficiently and efficiently to bind the fiber together in the mat. The mat is highly porous and this may be due to the fact that the emulsion does not have a tendency to form a continuous film. It is flexible, resilient and still has the property of fixed dimension. It has the hardness and inertness of the cured phenolics and the softness, feel, extensibility and flexibility generally attributable to the rubber component.

From numerous observations, it appears that the mat is bound with a material having the better characteristics of the rubber component and the resin component when considered separately and yet none of their undesirable characteristics. For example, the mat is not limp as it would be from use of the rubber component alone as is the binder. The binder is not swelled or softened materially by oils or solvents; the binder is not hard and brittle but instead it is flexible and resilient. Thus the fibers of the mat do not break down as a result of considerable flexing or tensioning. A mat of the type described is suitable as a pipe wrap for winding by hand or machine about an asphalt-coated pipe. The mat deforms sufficiently to cover projecting pipe patches and attachments; when it is applied to pipes by wrapping machines, the undesirable condition of flying glass particles is substantially eliminated and the mat is thin, light in weight and covers a large area in a manner to serve its purpose as an anchor for the coating material, which it is desired should freely flow through the fabric interstices.

These improved characteristics of the binder which impart increased tear and breaking strength to the mat, as well as better porosity, resiliency and feel are attributable to the fact that the components of the binder appear to act as though they are in a single-phase system. That is, as though one co-reacts with the other during the polymerization to form a single reaction product, or, as though one is completely soluble in the other to form what appears as a single reaction product. The resulting characteristics are unlike those derived merely from a dispersion of one of the components in the other. Although improved results are to be found in such resinous dispersions, it is obvious that those elements which previously attacked one or the other of the components are still able to effect their desired action, and also the strength of bonding of one with the other and the glass surface is not as great. Dispersible resinous binders of the type described do not
contribute to the tear and breaking strengths of my one phase system, nor is the degree of collection at the junctures of fibers as pronounced in view of the fact that in the dispersible binder each component cures separately and is unaffected by the other.

Although the exact mechanism of the reaction is, for the present, difficult to explain, there is reason to believe that these advantageous properties result when the acrylonitrile component in the synthetic rubber is less than that ordinarily employed in Buna N type rubbers. For example, the acrylonitrile content suitable for the compounding with the phenolic resin component contains 25–40 parts of acrylonitrile per 60–75 parts of butadiene. The latter is formed in an aqueous dispersion which is maintained on the alkaline side by the use of alkaline soaps and dispersing agents. Further, these binder properties result when the phenolic resin component is not a straight phenol-formaldehyde resin reaction product of the type that is ordinarily used in the molding of thermosetting plastics but is instead a phenolic resin formed of phenol modified by the presence of resorcin rather polyhydric phenol or cresol in widely varying proportions of which are reacted in the presence of an alkaline catalyst with formaldehyde or other aldehyde where the ratio of aldehyde to the phenolic is greater than 0.9 to 1 and preferably present in the ratio of about 2 mols of the aldehyde to 1 mol of the phenolic component. Resinous materials of the type capable of use in the practice of this invention in combination with the butadiene-acrylonitrile copolymer are manufactured and sold by the Durez Plastics and Chemical Corporation of Tonawanda, New York, under the trade name "Durez 12369" or by the Catalin Corporation of New York, under the trade name "Catarav 156." A suitable formulation of the binder and its application on the glass fibers to form a mat may be carried out as follows:

Example 1
Binder formulation:
To 14 pounds of acrylonitrile—butadiene copolymer which may be supplied as 35 pounds of Hycar OR—25 latex containing 40 per cent by weight of the rubber component in aqueous dispersion, water is added in an amount sufficient to increase its volume to about 25 gallons. To 10 pounds of phenolic resin which may be supplied as a 60 per cent water solution, as in "Durez 12369" or "Catarav 156," water is added in an amount sufficient to increase the volume to about 50 gallons. The phenolic resin solution is then poured slowly into the dispersion with a mixing action. The blend is then further diluted with water to a volume of about 130 gallons in which the solids are present in an amount of about 2 per cent.

Although the ratio of the rubbery component to the phenolic resin component is approximately 2.2 to 1 in the above formula, it is to be understood that the ratio may vary in a range, for instance, from 1 to 3 parts of the rubbery component to 1 part of the phenolic resin.

Mat fabrication:
A small amount of this mixture is sprayed onto the glass fibers as they are arranged on the collecting belt and an excessive amount is later poured onto a roller over which the wetted mat travels. The superfine binder, which passes through the interstices of the mat and is removed from the mat by the wiping rolls, is returned to the binder storage chamber. The imregnated mat then passes through the concentrated heat of direct fired or radiant burners and then into baking ovens at a temperature of 250–450°F. In the space of time of 10 to 25 minutes the resinous material is fully converted to its cured state.

When the water is fully driven from the binder, the remaining resins and rubbery materials are apparently so repelled by the hydrophilic nature of the glass surface that they migrate along the length of the fiber toward the fiber intersections where they gather as a resinous pool. This migration takes place only while the resinous materials are yet fluid. As a result, it is desirable to employ resins of materials which have a desirable slow curing rate. Although a small portion of binder generally remains about the fibers to act as a surface protecting agent, it is still evident that the desired degree of bond can be effected with a noticeable reduction in the amount of binder ordinarily used. This is because the binder is concentrated at the fiber intersections whereby it operates to hold the fibers together at a point where it is most effective. The amount of binder deposited on the fibers of the mat may be varied from between about 5 and 25 per cent, but ordinarily most satisfactory results are obtained with a binder content of 15 per cent by weight of the finished mat.

Mats having even greater strength and tear resistance can be fabricated with a binder in which the rubbery component is vulcanized during the cure. A suitable binder illustrating this last principle may be formulated as follows:

Example 2
Binder:
12 pounds Hycar OR25 latex, 40 percent solids
3 pounds phenolic resin (Catavar 156), 60 percent solids
4 grams sulphur
27.5 grams Phenex (a phenol derivative accelerator)
31.5 grams Methocel (methyl cellulose)

The phenolic resin and the Hycar are separately diluted with water and blended as described in connection with Example No. 1 except that the volumes to which they are diluted are in the order of ¾ that set forth. The other ingredients are mixed into the blend which is then diluted to approximately 50 gallons. The treating material is stable so that it can be handled in conventional equipment for treating purposes as described in connection with Example 1 to form the cured mat.

In this modification, the sulphur is less than that ordinarily required to effect vulcanization of rubber. The Phenex is an accelerator for the vulcanization process and it is to be understood that any of the large number of other activators and accelerators ordinarily used for such purposes may be employed. The methyl cellulose is a water soluble cellulosic compound which imparts stability and body to the composition and some adhesiveness immediately upon application of the binder composition to the glass fiber surfaces. Instead of methyl cellulose, other water soluble cellulose ethers and esters, such as hydroxy ethyl cellulose, carboxyl methyl cellulose, and the like may be added, or water soluble resins or proteins may be added for the purpose of introducing temporary adhesiveness and as a bodying agent such as polvvinyl alcohol, casein, gelatin, glue, and the like. These may be employed to advantage in amounts ranging from 1–5 per cent by weight of the resinous and rubbery components, although more may be used when it is desired to secure greater body or adhesiveness in the treating composition.

If it is desired to fabricate a thermal or sound insulating product of glass fibers a substantially greater thickness of the glass fibers are permitted to collect on the porous moving belt. The fibers contact another at irregular intervals and the area of contact is a small fraction of their total area.

In glass wool products, the same properties of fixed fiber arrangement, resiliency, feel, freedom from fiber disintegration, and permanency of form are desired. Particular emphasis is placed on the ability of the mat to recover its original thickness after being compressed for a substantial length of time. The bulky light weight mats can be compressed into very compact packages for shipment and when the package is opened the mat will return substantially to its original dimensions. The characteristics of density and fixed dimension can be controlled readily by the amount of resin material and the degree of compression on the mat during the time the binder is hardened. But the property of sub-
stantially full recovery from a compressed state negatives the use of a resinous binder that is readily ruptured or that is rigid to such extent that the glass fibers break when flexed, or one that is subject to cold flow, whereby the compressed mat is incapable of returning to its original shape or form.

Although the thermosetting type aldehyde condensation products are substantially incapable of hot or cold flow, they are friable and so rigidly hold the glass fibers that the fibers tend to break when the mat is greatly cold pressed. Consequently the mat is not thereafter capable of being returned to its original dimensions.

In the fabrication of a glass wool product, the entire complement of resinous binder is incorporated with the glass fibers while they are being down onto the foraminous collecting belt. In many instances the temperature in the region of fiber deposition is fairly high and more reactive resinous material such as the nitrogenous and phenolic aldehyde condensation products may have their cure advanced before the fibers have assumed their final relative positions. If the resins pre-cure in this way, they are less effective as binders.

I have found that a greatly improved glass fiber product can be manufactured if glass wool fibers are bonded together with the reaction product of a phenolic resin and a copolymer of butadiene and acrylonitrile compounded as previously described in connection with this invention. With this binder it is possible to make use of an incompatible oligomeric lubricant which imparts greater lubricty and protection to the fibers and encourages migration of the resin to the fiber intersections.

Such lubricants, which may be used in amounts ranging from 0.1 to 5 percent by weight of the treating composition and preferably within the range of 0.5 to 3 percent by weight, may be selected of oils such as petroleum oil, mineral oil, hydrocarbon oils, sulfonated petroleum oils, fuse oil, or tempering oils of the type described in the Williams and Bone Patent No. 2,107,284, or waxes, such as paraffin wax, petroleum wax and the like. For example, the binder composition of Example 1 may have 0.2 percent by weight of a sulfonated petroleum oil incorporated therewith.

For this purpose, treating materials formulated in accordance with Examples 1 and 2 may be used. The binder in aqueous vehicle may be sprayed onto the fibers while they are being down onto the collecting surface. As previously described, the rate of cure of each is substantially retarded by the presence of the other and the danger of pre-cure is avoided. The amount of resins and solids deposited on the fibers is regulated in relation to its subsequent use. If the treated product is to be used for building or railroad car insulation, a deposit in the range of 0.5 to 3 percent resins and solids by weight of the finished product is made, and if the product is to be used for a moldable type of insulation for refrigerators, insulating board, and the like a substantially greater deposit in the range of 3 to 10 percent is sufficient. When greater densities are desired, the mass is compressed between caterpillar belts while traveling through the curing ovens and the cured resins tend to hold the fibers in their compressed condition.

The ability of the binder to effect the desired mass integrity and fixed dimension with such low percentages of cured solids is attributable to the fact that after the greater portion of the water has been removed, the remaining non-polar resins of the binder migrates along the length of the fibers until the fiber junctures are reached where a partial flow is formed due to the cohesive forces of the binder. As a result, only a small portion of the binder coats the fibers along their length, the greater part gathering at the fiber junctures where it operates most efficiently to bind one fiber to another. This desirable migration is dependent upon the rate of cure, it being desirable that the binder remain liquid for a time even after the diluent has been completely removed. This desirable characteristic is found in the compound of the invention.

As previously pointed out, the binder retains the resiliency, flexibility, feel and recovery properties of the rubbery component and the hardness, inertness, strength and adhesiveness of the phenolic resin component without substantial alteration of their other characteristics. Thus the final product can be compressed to as much as one quarter or more of its original dimension and yet return almost immediately to its original form on release of the compressive forces. Thus, the cured and molded wool insulation product can be compressed into a small package and shipped to distant stations at a lower overall cost, and, when released from the package, the product recovers substantially all of its original form whereby it is capable of filling the space for which it was intended.

It is manifest that a wool product can be manufactured by the application of a single treatment to impregnate a product having greatly improved properties of feel, resistance to fiber breakage, permanent dimensions, controlled density, compressibility, substantially full recovery after compression, flexibility, resiliency and strength. The wool product is capable of use in atmospheres of elevated or low temperatures, high humidities or in highly corrosive atmospheres without loss of strength or alteration of its properties. A wool product fabricated in the manner described is capable of lower manufacturing costs in view of the greater efficiencies in resin distribution and handling and lower shipping and packaging costs.

This invention is applicable to many applications as a further development of the invention as described in my copending application Ser. No. 735,552, filed on March 18, 1947.

It is to be understood that other changes in the binder formulation, application and fiber or resin distribution and arrangement can be effected without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. The method of manufacturing a porous bonded mat of glass fibers comprising the steps of impregnating a porous layer of glass fibers with a latex of a butadiene-acrylonitrile copolymer in combination with a phenolic resin formed of phenol and another phenolic component selected from the group consisting of polyhydric phenols and cresols reacted together with formaldehyde to an intermediate water soluble stage and present in the ratio of one part by weight phenolic resin to 1-3 parts by weight butadiene-acrylonitrile copolymer, and heating the impregnated mat at a temperature within the range of 250-450° F. during which major portion of the binder composition migrates to the glass fiber intersections and is advanced to a homogeneous cured binder.

2. The method of manufacturing a porous bonded mat of glass fibers comprising the steps of impregnating a porous layer of glass fibers with a latex of a butadiene-acrylonitrile copolymer with a solution of a phenolic resin formulated of a phenol and another phenolic component selected from the group consisting of polyhydric phenols and cresols reacted with formaldehyde to an intermediate water soluble stage, the dispersion containing 1-20 percent by weight of the rubbery and resins components which are present in the ratio of one part by weight phenolic resin to 1-3 parts by weight butadiene-acrylonitrile copolymer, and heating the impregnated mat at a temperature within the range of 250-450° F. whereby the major portion of the binder composition migrates to the glass fiber intersections and is advanced to a homogeneous cured binder.

3. The method of manufacturing a porous bonded mat of glass fibers comprising the steps of impregnating a porous layer of glass fibers with a latex of a butadiene-acrylonitrile copolymer dispersed in a water solution of
a phenolic resin formulated of a phenol and another phenolic component selected from the group consisting of polyhydric phenols and cresols reacted with formaldehyde to an intermediate water soluble stage and present in the ratio of one part by weight phenolic resin to 1–3 parts by weight butadiene-acrylonitrile copolymer and a small amount of a cellulosic bonding agent selected from the group consisting of cellulose ethers and cellulose esters, the total solids content of the binder substances ranging from 1–20 percent by weight of the aqueous composition, and heating the impregnated layer at a temperature within the range of 250–450° F. whereby the major portion of the binder composition migrates to the glass fiber intersections and is advanced to a homogeneous advanced stage.

4. The method as claimed in claim 2 in which a small amount of an incompatible oil is dispersed in the aqueous binder composition.

5. A porous bonded mat formed of glass fibers and a binder securing the fibers one to another at their intersections comprising the cured product of a latex of a butadiene-acrylonitrile copolymer and a phenolic resin formed of a phenol and another phenolic component selected from the group consisting of polyhydric phenols and cresols reacted together with formaldehyde to an intermediate water soluble stage and present in the ratio of 1 part by weight phenolic resin to 1–3 parts by weight of the butadiene-acrylonitrile copolymer.

6. A porous bonded mat formed of glass fibers and a binder securing the fibers one to another at their intersections comprising the product secured by the thermal reaction at 250–400° F. between a latex of butadiene-acrylonitrile copolymer and a phenolic resin formulated of a phenol and another phenolic component selected from the group consisting of polyhydric phenols and cresols reacted with formaldehyde to an intermediate water soluble stage and present in the ratio of 1 part by weight of the phenolic resin to 1–3 parts by weight of the butadiene-acrylonitrile copolymer.

7. A porous bonded mat as claimed in claim 6 in which the binder composition securing the fibers one to another at their intersections contains a small amount of a cellulosic plastic selected from the group consisting of cellulose ethers and cellulose esters.

8. A porous bonded mat as claimed in claim 6 in which a small amount of an oil incompatible with the cured binder is present on the glass fiber surfaces for lubricating the fibers and for causing the cured binder to migrate to the glass fiber intersections.

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