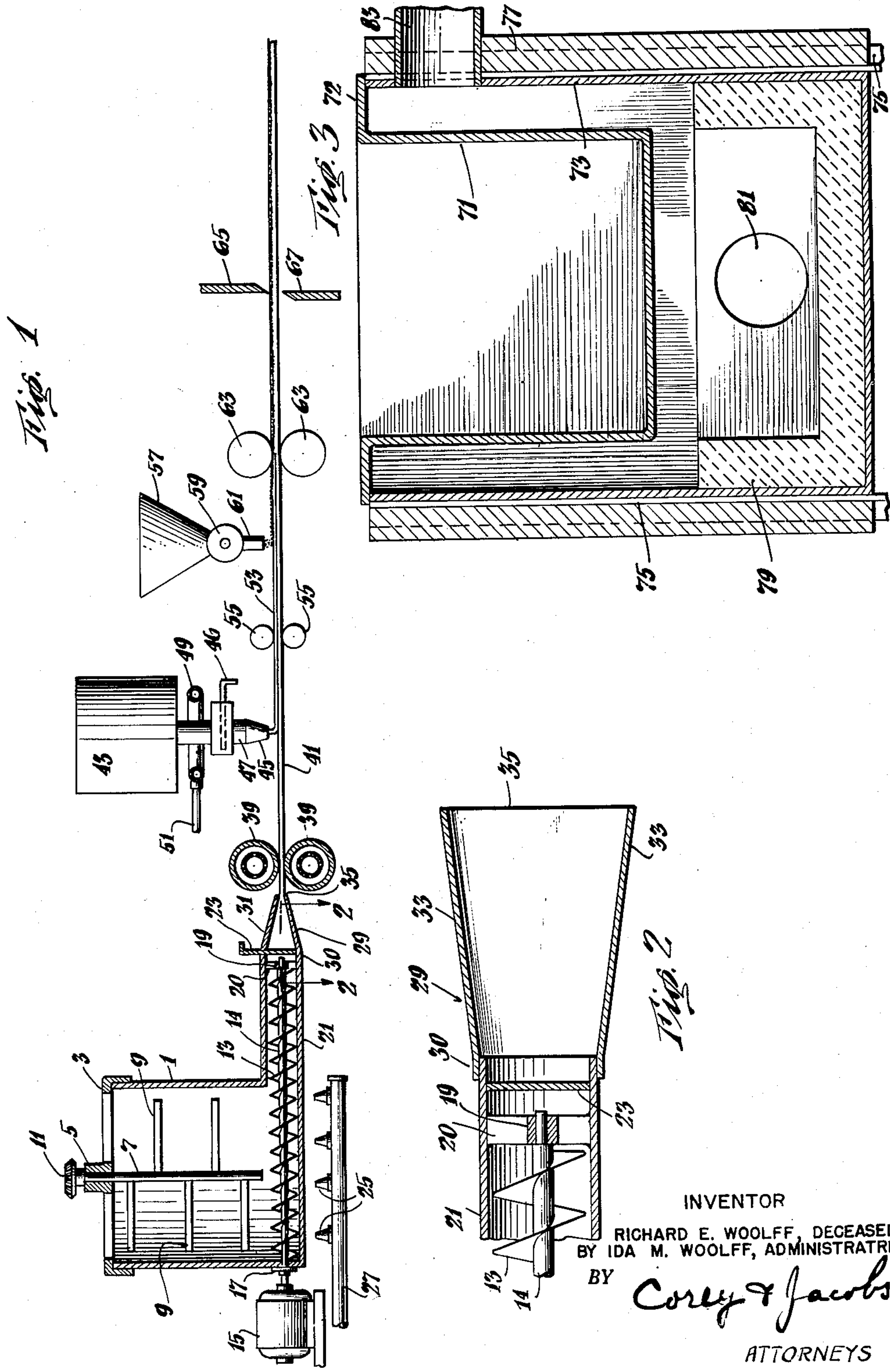
Dec. 2, 1952 R. E. WOOLFF 2,619,675

COMPOSITION, PROCESS, AND APPARATUS FOR MANUFACTURE OF ROOFING

Filed Aug. 11, 1948 2 SHEETS—SHEET 1



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Filed Aug. 11, 1948 2 SHEETS—SHEET 2

Fig. 5

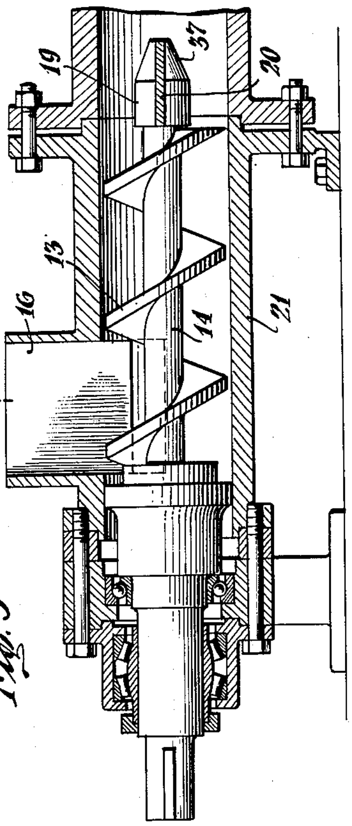


Fig. 6

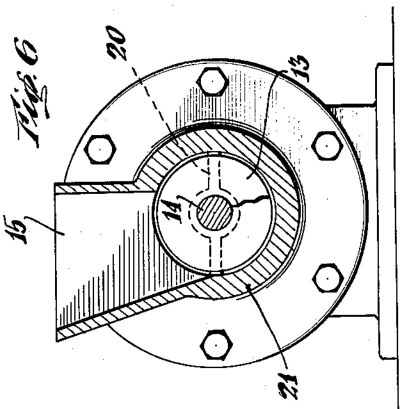
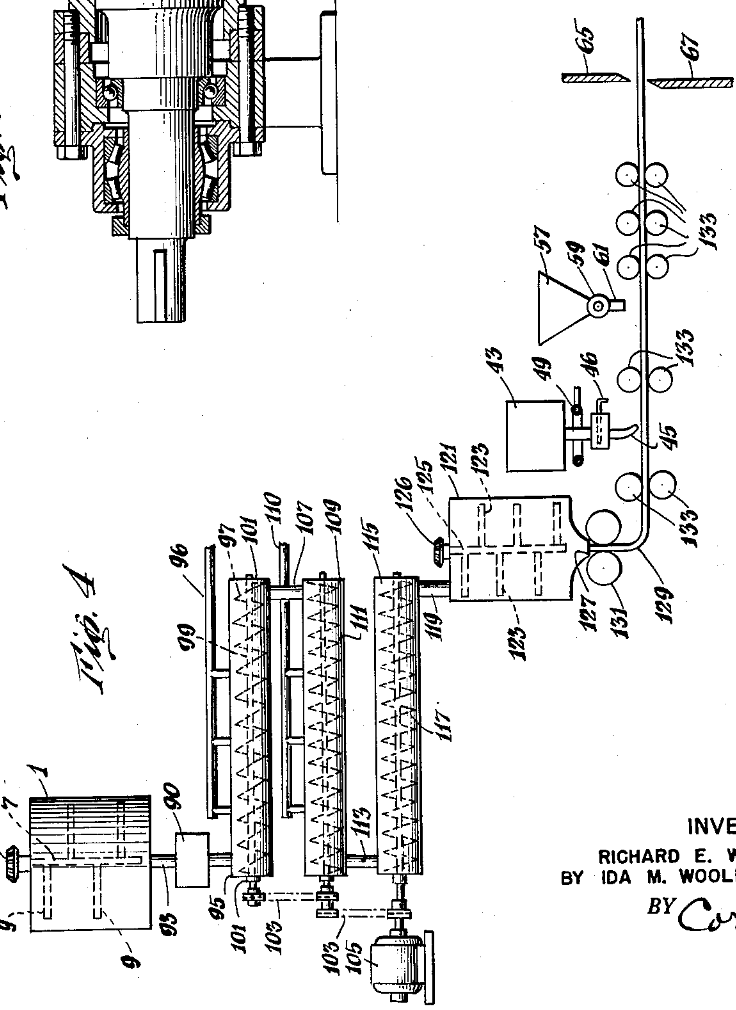


Fig. 4



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COMPOSITION, PROCESS, AND APPARATUS FOR MANUFACTURE OF ROOFING

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20 Claims. (Cl. 18—4)

1

This invention relates to thermoplastic bituminous compositions suitable for weatherproofing and waterproofing. The invention particularly relates to roofing sheets and shingles requiring a structure in the finished product which is capable of self-support and which, nevertheless, shall have a substantial degree of flexibility as well as the other qualities commonly required in roofing.

Roof coverings or the like which ordinarily are in use comprise a waterproofing and weatherproofing material, such as a thermoplastic bituminous material, usually asphalt, which is carried by a fabric base sheet. This fabric has an absorptive capacity and is saturated with the thermoplastic bituminous material. In roofing to be exposed to the weather such a saturated base sheet ordinarily carries a coating of thermoplastic bituminous material, usually a "coating asphalt," which affords a substantial weather resistance and provides a watertight structure when sheets of the roofing or shingles made therefrom are laid in conventional manner on the roof.

The provision of an absorptive base, usually a felted web of cellulosic fibers made from waste material, such as rags, or which may utilize wood fibers, waste paper and other waste fiber materials, requires the formation of the web in a paper making process. Such a process involves substantial investment and expense for manufacture. It also necessitates care in the preparation of the web as well as in the steps of saturation and coating thereof in order that the watertightness and weatherproofing qualities of the finished product may be obtained. It is well known that the life of such a roofing sheet is determined for the most part by the quality of the asphalt used in the saturation and coating thereof and the care used in its manufacture, the base felt serving merely as a carrier for these asphaltic materials.

Heretofore it has been proposed to form a sheet of roofing or a covering element of a thermoplastic bituminous material without a supporting fibrous web. To this end it has been proposed to extrude a mixture of a bituminous material and fibers, such as waste cotton, wool or asbestos fibers, through an extrusion die to form the desired covering. Such efforts have experienced, and have not satisfactorily solved, the problem of maintaining the sheet or covering element as a self-supporting structure which, however, shall have sufficient flexibility to permit bending thereof without cracking and which will maintain its waterproofing and weatherproofing capacity throughout the range of ordinary atmospheric temperatures to which it may be subjected. Other important requisites which such roofing must meet are that the thermoplastic material shall withstand checking due to weathering and that it be resistant to the effects of sunlight.

In ordinary roofing utilizing a saturated felt base the saturant is of a relatively low melting

2

point, ordinarily in the range between 140 and 160° F. by the ring and ball method, in order to secure a high degree of saturation of the felt, thereby to carry a high percentage of the saturant in the finished product for a given weight of the felt base. The characteristics of the asphalt used for coating the saturated felt base are different from those of the saturant. The coating asphalt has a higher melting point, ordinarily in the range between 200° and 230° F. by the ring and ball method and a penetration in the range between 7 and 20 at 77° F.—100 grams—5 seconds on a standard penetrometer using the standard needle for asphalts.

The susceptibility index should be as low as possible and the coating should be practically non-flowable at ordinary temperatures.

It is an object of the invention to provide an improved composition suitable for roofing and the like which may be utilized as a self-supporting structure not requiring a supporting web.

It is another object of the invention to provide a roofing or covering material in sheet form which will meet the requirements for ordinary asphalt saturated and asphalt coated roofing but without the use of a supporting base sheet.

It is a further object of the invention to provide such an unsupported covering sheet or an element made therefrom which will have improved heat and fire resisting characteristics compared with ordinary roofing.

It is a still further object of the invention to provide a roofing sheet or element utilizing a thermoplastic bituminous material in which the waterproofing and weatherproofing qualities of the coating in ordinary roofing are secured throughout the whole mass of the sheet or element.

It is another object of the invention to provide a process of producing a roofing sheet or element of the thermoplastic bituminous material unsupported by a web.

It is a still further object of the invention to provide a process of extruding a roofing sheet or shingle without utilizing a supporting web.

It is an additional object of the invention to provide apparatus for carrying out the process of producing the roofing and the covering elements having the characteristics above set forth.

It is a feature of the invention that it provides a composition material which utilizes a thermoplastic bituminous material to form the main mass or matrix of the composite material in which fibers of amorphous siliceous material are distributed. The thermoplastic bituminous material is in predominant amount in the mixture and preferably, to secure the desirable characteristics of roofing material as to weather resistance and waterproofing, it is in a ratio by weight to the amount of the amorphous siliceous fibers distributed therethrough which is not substantially less than 4 to 1. While within the scope of the invention somewhat greater amounts of the fibers in relation to the thermoplastic bituminous matrix in which they are incorporated may be used, in general it is found, particularly for the economic production of roofing sheets and shingles, that the ratio is substantially in the range between 4 to 1 and 14 to 1, and preferably in the range between 9 to 1 and 12 to 1. Preferably also for the purposes of the invention "coating asphalt," as this term ordinarily is understood in the manufacture of conventional asphalt roofing, is used as the thermoplastic bituminous material. The characteristics and advantages of such coating material in conventional roofing are secured in the roofing of the invention throughout the thickness of the sheet and throughout the life thereof.

The amorphous siliceous fibers which are utilized in the composition of the invention are to be distinguished from other mineral fibers such as asbestos, chrysotile and others occurring in nature which have a crystal structure and which heretofore have been used in roofing. The fibers of the composition of the invention are artificially produced and preferably are manufactured from the siliceous materials which ordinarily are utilized in producing glass. The composite silicates which generally constitute the materials designated as glass are amorphous and are fusible to a pasty mass which may be variously treated to produce fibers therefrom. Preferably for the purposes of the invention the amorphous siliceous fibers used are those in the form of fine filaments which sometimes are designated as "glass cotton" and which have a smaller diameter than the mineral fibers produced by the blowing of molten glass or rock which generally are known as "mineral wool."

The fibers or filaments of glass which have been used in producing the composition of the invention have a diameter not greatly in excess of 10 microns and may have a range of diameter substantially from 5 microns, .000197'', to 10 microns, .000394''. Fibers of this type in their primary manufacture may be of relatively great length. In producing some types of such primary glass fibers the molten glass is drawn into strands of indefinite length. In others the individual fiber length may be as much as 15 inches with an average of the degree of 9 inches. The fibers which are utilized in the invention may be produced from fibers which originally were made in such indefinite or definite lengths but they have been materially reduced in length by subjecting the long fibers to the action of a hammermill. Although the fibers of the invention may be manufactured directly from the primary glass fibers which because of their long length are suitable for the manufacture of textile yarns, for making fireproof fabrics, electrical insulation and the like, for the purposes of the invention the fibers may be produced from the waste material of such textile manufacture or of conversion processes utilizing such primary fibers or such textile yarn of glass fibers. It is contemplated, moreover, that without departing widely from the above mentioned micron diameters amorphous siliceous filaments artificially produced and of larger or smaller diameter which maintain the characteristic strength and flexibility of the glass fibers which have been used may be successfully used for the purposes of the invention.

The hammermill may be provided with a screen through which the milled fibers must pass before they may leave the zone of action of the mill.

The length of the fibers thereby may be reduced so that the maximum length is of the degree of 1½'' with a minimum length which is a substantial multiple of the diameter of the individual fibers so that the fibers exist as elongated elements or filaments. Because, however, of the particular conditions of such hammermill treatment the actual maximum length of some individual fibers may be materially greater than 1½'' and the predominant minimum length may be many times the diameter of the individual fiber. For the purposes of the invention as a general statement the length of the individual fibers or filaments may be such that the predominance of maximum length is of the degree of 1½'' and the minimum length may be expressed as of the degree of $\frac{1}{8}$''. The invention is not to be understood, however, as limited strictly to compositions in which the fiber lengths are of these numerical maximum and minimum values. Because of the small micron diameter and the inherent strength and flexibility of these fibers the length may vary over a wide range and the fibers may be distributed through the bituminous material to cooperate therewith in the manner to be described.

Moreover, because of the particular method of the treatment of the fibers some of them may become twisted together and agglomerations thereof may be formed in which the fibers are matted together. Such agglomeration and matting of the fibers, however, in the material before it is incorporated in the thermoplastic bituminous material are not such as to interfere with adequate or generally uniform distribution of the fibers throughout the thermoplastic bituminous material. Whether as individual fibers before mixing or as those which become separated from the others in the process of mixing the fibers with the thermoplastic bituminous material or as fibers in the matted or agglomerated condition, the fibers thus produced by reduction in the hammermill and sometimes called "glass cotton" are sufficiently loosely associated so that in such a mixing process to a high degree they may be individually wetted by and surrounded by the thermoplastic bituminous material when this bituminous material is heated to a fluid condition. Having regard to the proportions in which they are mixed with the thermoplastic material and the large surface provided by the extremely large number of filaments of micron diameter, such wetting and surrounding of the individual fibers and of the agglomerations thereof secures the interaction of the fibers with the thermoplastic bituminous material necessary for producing a composite material capable of self-support while also being flexible. The fibers in a dry mass thereof before being wetted by the thermoplastic material extend in a multiplicity of directions across each other. This condition is maintained to a very high degree in the composite mixture in order to secure the acton of the fibers in all directions. As the glass fibers or filaments individually are strong and flexible they reinforce the thermoplastic mixture in all directions to secure the requisite strength and flexibility when a mass of the composite material is set, particularly of a sheet or shingle, the prevention of cracking in handling and the requisite capacity to be penetrated by nails or other fasteners.

By forming the composite material with the thermoplastic matrix in predominant amount by weight and preferably in the ratio not substantially less than 4 to 1 with respect to the amount of the amorphous siliceous fibers and by effecting thorough mixture, the fibers may be surrounded and wetted by the thermoplastic bituminous material in a suitable mixing process. This thermoplastic material in predominant amount and as the continuous phase is in condition to act as does the coating asphalt in conventional roofing to provide a waterproofing and weatherproofing layer to be exposed to the weather in the roofing sheet or shingle. Moreover, the composite material thereby is capable of bonding to itself a surfacing material such as granular slate, slag, talc or other conventional surfacing materials, usually of mineral origin, which serve the purpose of resisting attrition and mechanical injury to or puncturing of the sheet as well as protecting the bituminous matrix from the action of sunlight when surfacing materials which are naturally opaque or are rendered so by conventional methods are used. Within the scope of the invention, however, and because the thermoplastic material of the matrix is the continuous phase a coating may be applied to the surface of the composite roofing sheet or shingle of the invention for bonding to such sheet or shingle surfacing material of whatever form is desired. Preferably such applied coating will be a coating asphalt which, when the composite sheet of the invention is composed of a matrix of coating asphalt and glass fibers of the type above described, will have a good affinity for the matrix and will coalesce readily therewith. In the manufacture of some roofing products it may be preferable thus to produce a finished sheet or shingle because such a coating of asphalt may be applied to the base sheet or shingle in which the thermoplastic matrix previously has set. Reheating of the formed matrix or sheet to secure the requisite bond of the granular surfacing material, therefore, is obviated.

Within the scope of the invention the composition thereof may and preferably does include a filler of nonfibrous mineral material in finely comminuted form. Materials such as slate dust, ground limestone and similar siliceous or calcareous materials may be utilized, these materials being ground to a fineness which is of a similar degree to that of the materials which are conventionally used in the roofing art as fillers in coating asphalts which are applied to the surface of a saturated felt base as hereinabove referred to. Ordinarily the range of particle size of such fillers is such that all of the filler will pass through a 100 mesh screen and all of it may pass through a 300 mesh screen. The amount of such finely ground filler which may be incorporated in the composition of the invention composed of the thermoplastic bituminous material and the amorphous siliceous fibers may be of the same degree by weight as the amount of the thermoplastic bituminous material itself. The ratio by weight of the thermoplastic bituminous material to the comminuted filler may be substantially in the range between 1 and 1 and 1.6 to 1. Some variations beyond the limits of this range may be practiced without departing widely therefrom for the purpose of securing particular characteristics in the roofing sheet or shingle while maintaining the advantages secured by the composition of the invention. The filler material is preferably thoroughly mixed with and distributed through the thermoplastic material and so as to be distributed also among the fibers contained in the matrix.

An important feature of the invention is the

fire resisting capacity of the roofing material which is provided by the fibrous material and the filler material which are incorporated in the thermoplastic matrix, both of these incorporated materials being non-combustible. It is well known that asphalt, although itself combustible, when prevented from flowing on a base or roof deck on which it is carried resists rapid combustion. Various proposals have been made heretofore for holding the asphalt from flowing on the roof, particularly on an inclined surface, when subjected to the heat and the impingement of flame, the flow leaving the felt base used in conventional roofing uncovered and subjected to the heat of the flame with consequent ignition and burning of the felt and ultimate ignition and burning of the roof deck when constructed of combustible material such as wood. The incombustible glass fibers which are incorporated in the asphalt matrix in accordance with the invention with or without the inclusion in the composition of the comminuted mineral filler serve to resist flow of the asphalt because of the thorough wetting of the fibers to which the asphalt clings. Since in the roofing of the invention no base sheet of combustible material is utilized and the glass fibers are distributed through the whole of the thickness of the sheet, this resistance to flow continues as long as any aphalt remains unburned and in contact with the fibers. Moreover, the carbon residue from the burned asphalt is retained in place by the fibers. When the preferred composition in which the finely comminuted mineral filler is included is used, the incombustible filler also is held in place by the fibers. The roof deck, even though constructed of combustible material, therefore is protected by the matted glass fibers and the filler distributed among these fibers and thus a high degree of protection to the roof deck against the propagation of the fire is secured.

The invention contemplates also a process of producing roofing of the composition above generally described in which the mixing of the thermoplastic bituminous material and the fibers or of the thermoplastic bituminous material and the fibers and the filler is carried out under controlled conditions of temperature in order to secure the desired wetting of the fibers by the thermoplastic bituminous material and the distribution of these fibers therethrough as well as to secure the distribution of the filler through the matrix in interplaced relation to the fibers or the agglomerations thereof which may exist within the matrix.

In order to produce a roofing sheet or shingles of the composition of the invention the temperature of the composite material being worked upon also is controlled, having regard to the fact that the fluidity and mobility of the asphalt are sharply decreased by the mixture therewith of the fibers and of the filler material. In order to make possible the formation of a sheet by means of press rolls or by extrusion, thus immediately to attain the form of the product suitable for roofing or similar covering, it has been discovered that the temperature of the composite mixture may be reduced from that necessary for mixing to secure such a plastic condition thereof that mechanical treatment may be carried out to change a formless mass of the composition to a roofing sheet or shingle of the desired thickness and width. Preferably, however, the mechanical apparatus or the extrusion device is maintained at such a temperature as will prevent undue cooling of the mass of the composition being worked upon so as to maintain the requisite plastic but nonfluid condition until the sheet is formed or shingles or other units are cut therefrom.

Within the scope of the invention a continuous process is contemplated in which the glass fibers are continuously mixed with the asphalt or with the asphalt with which previously the filler had been mixed, the composite mixture being continuously delivered to and through the extrusion device or other mechanical means for forming the sheet. Where it is desired to apply a coating to the composite sheet and to apply a granular surfacing thereto, the sheet may be continuously delivered from the extruding or forming device and the coating may be continuously applied thereto. Thereafter granular surfacing material may be applied to the coating in a continuous operation. The sheet then may be cut into any desired form and of any length and width and shingles may be formed therefrom by intermittently operating cutters or by cylinder cutters in the conventional manner as practiced in the roofing art. In such a continuous process the invention contemplates the maintaining of the mixing apparatus and the several feeders, conveyors and the like at the requisite temperatures to maintain the desired fluid condition or plastic condition, as the case may be, of the materials in the different steps of the continuous process. To this end suitable jackets or other heating means may be utilized.

In the process of producing sheet material of the composition of the invention it has been found preferable first to mix the comminuted mineral filler material with the asphalt and thereafter mix the fibers with the filled asphalt. As an example of the steps to be carried out and the control of the temperatures requisite for the distribution of the filler and of the fibers in the asphalt as the continuous phase and to produce the proper plastic condition of the mixture for the purpose of forming a sheet by press rolls or by extrusion or both, coating asphalt having a melting point of substantially 215° F. and a penetration of 16 at 77° F. may be heated in a suitable kettle to a temperature of the degree of 475° F. or higher to secure a highly fluid condition for pumping or otherwise conveying the asphalt to the mixer. The comminuted filler material is added to this fluid asphalt in a suitable mixer and mixed thoroughly therewith while maintaining the temperature of the material generally in the range between 420° and 550° F. Thorough and continuous agitation of the liquid mass is carried out until the filler becomes thoroughly distributed in the asphalt, the proportion of the ingredients used in part determining the temperature and the time necessary to effect complete mixture.

To this mixture of asphalt and filler glass fibers the diameter of the individual fibers of which may be in the range between 5.6 microns, .00022″, and 8.1 microns, .00032″, are added gradually with constant agitation of the mixture to distribute the fibers therethrough and to thoroughly wet the individual fibers whether existing separately in the portions added or in more or less agglomerated condition with other fibers, as has been referred to above. In order to secure such distribution and wetting of the fibers by the asphalt the temperature of the mass as it is being mixed and agitated may be generally in the range indicated above for mixing the filler with the asphalt but preferably is main-

tained in a higher range between 500° and 560° F., especially where larger proportions of the fiber are used. Both in the step of adding the comminuted filler to the asphalt and that of adding the fibers to the filled asphalt the fluidity of the mixture is substantially decreased with respect to the fluidity of the asphalt itself at a given temperature. It has been found that the mixing of the fibers may be carried out at the temperatures within the range stated above and the wetting of the fibers and their distribution in the asphalt continuous phase may be accomplished even though such temperature approaches or may exceed the flash point of the constituent asphalt. The mixing is expedited by the high temperature so that it may be completed without destructive effect upon the asphalt.

Although in accordance with usual experience the fluidity of the composite material containing the filler and the glass fibers is greatly reduced with respect to the asphalt at the same temperature and for practical manufacture power mixers are required to effect the distribution, nevertheless, and contrary to what may be expected, for the purpose of forming a sheet suitable for roofing or shingles or the like from this composite material it is necessary to reduce the temperature from that at which the mixing is finished in order that a suitable plastic condition may be secured to enable the composite material to be extruded through a suitable extrusion die or pressed between press rolls or to be first extruded and then pressed. Where it is desired to produce a sheet material of a thickness of the degree of an ordinary sheet of asphalt roofing of conventional standard or extra heavy weight, it is necessary to reduce the temperature of the composite material containing coating asphalt, filler and glass fibers so as to be generally in the range between 340° and 425° F. as the mass is delivered to the extrusion die. If the temperature is too high the device for feeding the mass to the die, such as a screw operating in a suitable casing, is not capable of forcing the material through the restricted opening of the die because it is of too great fluidity or plasticity properly to form the sheet. When, however, the temperature is too low, the friction and the resistance of the material forced to cling to the walls of the die by the pressure exerted prevent uniform movement of the material through the die. It has been found for the conditions of the example above given that where the temperature of the mass of the composition of the invention delivered to the extrusion die is generally in the range stated above, the temperature of the extruded mass may be of the degree of 240° to 290° F. for satisfactory formation of the sheet. This temperature may be varied, however, to suit the different conditions of thickness and width of the sheet and variations in the composition while generally maintaining the temperature of the extruded calendered or pressed sheet reduced below that of the composition as its enters the forming die or similar device.

In order to control the temperatures as above outlined, and particularly where a continuous process is used with the material delivered from the mixer to the extrusion die through suitable conveying devices, it is advantageous to maintain a uniform temperature of these devices by providing them with jackets or other heating means, a heating fluid being delivered thereto at a temperature suitable to control the temperature of the composite material as it arrives at the extrusion die. The extrusion die itself also may be jacketed to control its temperature so that the temperature of the extruded sheet can be maintained in the relation above stated.

While for the purpose of securing the requisite qualities in the product of the invention the asphalt suitable therefor may be sufficiently defined by its melting point and its penetration test at 77° F., for the purpose of carrying out the process of producing this product it is desirable in order to facilitate the wetting of the fibers that a high degree fluidity shall be obtained at the temperature above the melting point, namely within the range between 500° and 560° F., at which the fibers may be preferably mixed with the asphalt. It is to be understood that different asphalts will have different flow characteristics at the same elevated temperature and that to secure the requisite wetting of the fibers and the fillers and their distribution in the matrix as well as to secure the requisite plastic condition in the process for handling and extrusion or otherwise forming the mass, variations may be made in the proportions used of the fibers and fillers without departing widely from those stated above. The asphalt preferred for the purpose of the invention, however, is one which is of low susceptibility particularly in the ordinary range of temperatures to which the roofing will be subjected and coating asphalts as ordinarily used in the manufacture of asphalt roofing are suitable, it being possible to secure the requisite fluidity for wetting the fibers and distributing them through the asphalt as the continuous phase by controlling the temperatures at which the mixing and forming are effected as above described or the proportions of the ingredients or both.

The composite material of the invention may have a density in pounds per cubic feet generally in the range between 70 and 115, depending upon the ratio of the asphalt to the glass fibers and the ratio of the asphalt to the filler. This density also will depend somewhat upon the pressure utilized or developed in the extrusion or calendering operations in which a sheet is formed from a plastic mass of the composite material. With a mixture of asphalt 55%, filler 40% and fibers 5%, the ratio of the asphalt to the fibers being 11 to 1 and of the asphalt to the filler being 1.37 to 1, the density of the sheet produced may be approximately 85 to 90 pounds per cubic foot. Within the scope of the invention also for different purposes, to secure different degrees of rigidity of the roofing sheet or shingle and to secure different weights of the roofing sheets of elements, the proportions of the ingredients of the composite material may be varied.

Because the composition of the invention is a uniform mixture of the asphalt, the filler and the fibers, waste of material is avoided in the process of producing the composite mixture and the sheets or shingles made therefrom. Since it is possible to extrude or to press the sheet or the shingles substantially to the desired width and thickness thereof, trimming to size ordinarily is not necessary. If, however, for particular purposes trimming is required or for other reasons waste is made before application to such roofing sheet or shingles of granular surfacing material, the waste may be reheated to a suitable temperature for melting the asphalt content thereof and again forming a uniformly mixed mass or such waste material may be mixed with fresh ingredients forming the composite mixture above described during the mixing operation thereof. It will be understood that the composition of the invention provides a stabilized asphalt product particularly suitable for roofing and shingles and also adapted for use for other purposes in which at ordinary temperatures of such use and over a substantial range of temperatures the product does not readily slump or become changed in shape and the asphalt content thereof does not flow out or bleed from the composite mixture but is retained as the continuous phase in wetting contact with the fibers and the filler with which it cooperates to maintain the composite mixture as a self-supporting structure and of permanent form in the product made therefrom.

The features and objects of the invention above described and others within the scope thereof and the apparatus for carrying out the process of producing the product of the invention may be more clearly understood from the description which follows of the drawings in which:

Fig. 1 shows in one embodiment the apparatus for producing the product of the invention.

Fig. 2 shows a section of the extruding device taken on line 2—2 of Fig. 1.

Fig. 3 shows in section the construction of a kettle for heating the materials utilized.

Fig. 4 shows in elevation a modification of the apparatus of the invention.

Fig. 5 is a longitudinal section of a feeder adapted to cooperate with an extrusion device.

Fig. 6 is a section taken on line 6—6 of Fig. 5.

In Fig. 1 is shown a mixing chamber **1** provided at its upper end with a spider **3** carrying a central bearing **5** supporting a shaft **7** extending vertically within the chamber **1** and carrying a plurality of paddles or mixing arms **9**. The shaft **7** may be driven by suitable means of which only one element, the gear **11**, is shown in Fig. 1, to rotate the shaft on the vertical axis to revolve the arms **9** within the space of the chamber **1**. Within the chamber through the openings of the spider **3** a mixture of the thermoplastic bituminous material, the filler and the fiber in the proportions above described may be placed and this composite mixture may be delivered from the chamber **1** by means of the screw feeder **13** at the lower end of this chamber. The screw feeder **13** may be driven by a suitable motor **15** having its horizontal shaft directly connected to the shaft **14** of the screw feeder **13**. The shaft **14** is journaled at its ends in bearings **17** and **19**, the bearing **19** being formed in a spider **20** providing passages between the arms thereof for movement of the composite material therethrough as it is impelled toward the right in Figs. 1 and 2 by the screw feeder **13**.

The right hand portion of the screw feeder **13** is rotatable within a conduit or casing **21** connected at the lower end of the chamber **1** to confine therein the composite mixture as it is fed toward the right by the screw feeder **13**. Adjacent the outlet end of this conduit **21** a gate or valve **23** is provided slidable through the wall of the conduit and serving when closed to cut off discharge of the composite mixture from the chamber **1**. This gate may serve for confining materials for the composite mixture within the chamber **1** when it is desired to prepare the composite mixture within the chamber **1** or when it is desired to heat up a mass of the composite mixture otherwise prepared to the proper plastic condition for effecting the feeding movement thereof through the conduit 21 to the forming device about to be described.

In order to maintain the composite material at a temperature above stated in the range between 340 deg. F. and 425 deg. F. suitable for the feeding action of the screw feeder 13 burners 25 are provided beneath the chamber 1. By supplying a fluid fuel, such as gas or oil, to these burners through the pipe 27 the chamber 1 may be heated prior to and during the operation of the screw feeder 13. It will be understood also that by closing the gate 23 and preferably with the motor 15 stopped mixing of the several ingredients of the composite material delivered into the chamber 1 through the openings in the spider 3 at the top thereof may be carried out within the chamber 1 in the manner hereinabove described. The asphalt may be melted in the chamber 1 and brought to the required temperature, as above stated, in the range between 420 deg. F. and 550 deg. F. for incorporation of the filler therewith and thereafter the fibers may be mixed with the filled asphalt, the temperature being maintained preferably between 500 deg. F. and 560 deg. F. During these several steps of heating and mixing these temperatures may be controlled by suitable control of the fuel supply to the burners 25.

If the composite mixture however prepared is placed within the chamber 1 and maintained at the requisite temperature, in the particular example given above between 340 deg. F and 425 deg. F., by control of the heat of the burners 25, upon operation of the motor 15 the mixture in the requisite plastic condition may be propelled through the conduit 21 to the extruding device 29, the gate 23 now being open. As shown in Figs. 1 and 2, the cross section of the left hand portion 30 of the extruding device adjacent the gate 23 is substantially circular conforming generally to that of conduit 21. This section changes in the direction toward the right in Figs. 1 and 2, the top and bottom walls 31 of the device converging toward the outlet end of the extruding device and the lateral walls 33 thereof diverging outwardly somewhat in this direction. The outlet opening or orifice 35 thus becomes rectangular and in the device suitable for making certain sizes of shingles may be of the degree of ¼″ in height (Fig. 1) and 5″ in width (Fig. 2), the diameter of the screw feeder 13 being 2½″ and the internal diameter of the conduit 21 being sufficient merely to provide the requisite clearance while maintaining the function of the conduit of confining the composite mixture between the turns of the helical vane of the screw feeder 13 so as to force the composite mixture forward into the extruding device 29 and through the outlet orifice 35 thereof. Preferably, as shown in Fig. 5, the spider 20 may carry a conical portion 37 tapering toward the outlet orifice of the extruding device to control the reuniting, after they pass the spider 20, of the portions of the composite mixture which are separated as they pass the spider 20 and the bearing 19. As above indicated, it is proposed to control the temperature of the mass of the composite mixture which is being extruded so that the temperature of the extruded mass may be of the degree of 240 deg. F. to 290 deg. F. If necessary, to accomplish this control additional burners, similar to the burners 25, may be provided along the conduit 21 and adjacent the extruding device 29. Under some conditions, however, such control may be satisfactorily obtained merely by the provision of suitable insulation for the conduit 21 and the extruding device 29 or cooling means may be provided, since the temperature of the mass as it reaches the extruding device should be less than the temperature at which the mixture is effected.

From the extruding orifice 35 the sheet or continuous strip 41 of the extruded composite material, which in the example under discussion is ¼″ thick and 5″ wide, is passed through calendering or press rolls 39 which may substantially reduce the thickness of the sheet with a corresponding increase in the width thereof. For the production of shingles of 8″ width the sheet delivered to the press rolls 39 with the width of 5″ and the thickness of ¼″ may be reduced in thickness to about ⅛″ thickness and increased in width to about 8″ in the finished product, the mass being compacted somewhat under the pressure of the rolls 39 and contracting somewhat on cooling to the dimensions given. Depending upon the particular composition used and the pressure exerted by the rolls 39 as well as the temperature of the extruded sheet received by the rolls 39 from the extruding device 29 a different ratio of decrease of thickness and increase of width in relation to those of the extruded mass may be secured. Utilizing an extruding device having an orifice ¼″ by 5″ and with a composition in which the ratio of the asphalt to the fiber is approximately of 11 to 1 and the ratio of the asphalt to the filler is approximately 1.40 to 1 and by controlling the temperatures in the manner generally described hereinabove the strip or sheet 41 extruded through such orifice may be reduced in thickness to about ⅛″ and increased in width to 8″ by passing the strip through the press rolls 39 with sufficient uniformity generally to avoid the necessity of tlimming of the sheet to width. There is thus produced a strip from which shingles of suitable length, for example, 16″, may be cut which are of finished form and are of a self-supporting structure though flexible and suitable for the purposes of conventional shingles in the roofing art. They are, however, as above disclosed, of uniform structure throughout their thickness and width and have the properties and characteristics which have been hereinabove set forth which are obtained with the composition of the invention.

If desired, the sheet or strip 41 may be used in the form as delivered from the rolls 39 when cut to any desired length. It will be understood also that, if desired, the sheet or strip may be used in the form as it leaves the orifice 35 and may be cut into roofing units of desired length having the thickness of the strip as extruded. It will be understood further that by providing a screw feeder of suitable size and a conduit cooperating therewith an extruding device having a different entrance cross section at the portion 30 relative to the orifice 35 may be utilized and the relation of the converging walls and diverging walls of the extruding device may be such as to produce sheets or strips of different thickness and width. With a larger diameter, for example, of the entrance cross section of the extruding device and with the same height but a greater width of the orifice 35 a wider sheet may be made having the same thickness as compared with the ¼″ height by 5″ width above described. By suitable choice of the entrance cross section all the walls of the extruding device may converge to the orifice 35 or, when a still wider sheet for the same thickness is desired, may diverge somewhat from the larger entrance section in the manner shown in Fig. 2. Too great a divergence of the lateral walls 33, however, results in imperfect formation of the sheet because the mass of the composite material then cannot be forced laterally into contact with the walls 33 to fill the outlet orifice. Such variations in the apparatus for carrying out the process of the invention may be made to provide for particular sizes of the product desired and to suit particular conditions while maintaining the essential features of the invention.

In the apparatus of Fig. 1 a tank 43 suitably supported above the sheet or strip 41 may contain coating asphalt to be applied to the upper surface of the sheet 41 as it moves toward the right, the asphalt flowing downwardly through a suitable delivery nozzle 45 controlled by valve 46 in the pipe 47 connected between the tank 43 and the nozzle 45. A heating element 49 may be supplied with fuel through the pipe 51 for maintaining the asphalt in the tank 43 in fluid condition for flow through the pipe 47 and the nozzle 45. The sheet 41 with the coating 53 applied thereto may be passed between the gauge rolls 55 to determine the thickness of the coating 53 on the sheet 41.

Within a hopper 57 supported above the coated sheet may be contained granular surfacing material which is fed downwardly under control of the feeder 59 of conventional type through outlet 61 for application to the upper surface of the coating 53 as the sheet 41 moves continuously toward the right in Fig. 1. The sheet 41, now coated and surfaced, passes between the drums 63 for pressing the granular material into the coating 53. The surfaced sheet passes between knife blades 65, 67, the upper blade 65 being movable vertically relative to the fixed blade 67 positioned beneath the sheet for severing the sheet or strip into units of desired length.

It will be apparent that if it is desired to cut the sheet or strip 41 into length or into shingles without the application of the coating or of the surfacing thereto, the feeding of the coating from the tank 43 and of the granular material from the hopper 57 may be stopped and the pressure of the rolls 55 and of the drums 63 may be relieved. The knives 65, 67 then will be effective to sever the uncoated and unsurfaced sheet or strip of the composite material of the applicant's invention. It will be apparent also that the coated sheet as delivered toward the right from the gauge rolls 55 may be severed by the knives 65, 67 without the surfacing or granular material having been applied thereto if only the feeder 59 is stopped.

In Fig. 3 is shown a kettle or tank in which the thermoplastic bituminous material or asphalt may be heated and in which, if desired, the mixture with the asphalt of the comminuted filler material and of the amorphous siliceous fibers may be effected. The tank 71 is supported with a casing 73 by struts 75 which may be welded or otherwise fastened to the wall of the casing 73. The tank 71 is formed with a flange 72 at its upper end which rests upon the upper edge of the casing 73 and the struts 75 to provide such support. The casing is enclosed in a layer 77 of insulating material, such as rock wool, which may be held in place by any suitable means.

The wall of the tank 71 is spaced inwardly from the casing 73 to provide space for heating gases in contact with the tank and the bottom of the tank is positioned sufficiently above the bottom of the casing to provide for lining the combustion space with a firebrick lining 79. The lining 79 has an opening 81 therein which registers with a corresponding opening in the casing 73 to provide for a fuel supply device such as an oil burner. A flue connection 83 is made through the insulation and the casing adjacent the top thereof to provide for carrying off the combustion gases.

The tank 71 may be removably supported within the casing for the purpose of transferring the contents thereof to the mixing chamber 1. If the mixing is effected in the tank 71, the composite material may be transferred therein and delivered directly to the entrance chamber 16 of the feeder 13 within the conduit 21, as shown in Figs. 5 and 6. The mixing may be effected in the tank 71 manually by means of a paddle or similar tool or, if desired, a portable power-driven rotatable paddle similar to the device comprising the shaft 7 and the blades 9 of Fig. 1 may be inserted in the tank and removed therefrom when the mixing operation is finished. Control of the temperatures requisite for carrying out the mixing steps of the process of the invention as above described may be accomplished by suitable control of the fuel supply of the burner inserted in the opening 81. It will be understood, moreover, that the construction of the chamber 1, Fig. 1, may be the same as or similar to that of Fig. 3 with respect to the means for heating the contents of the chamber 1, the feed screw 13 being arranged within a tank, such as the tank 71, and an outlet conduit therefrom corresponding to the conduit 21 being provided from the tank 71 leading to the extruding device 29.

The apparatus above described in connection with Figs. 1, 2 and 3 for mixing and for feeding the composite mixture to the extruding device from the chamber 1 is adapted more particularly for the preparation of batches of the composite material and the conversion of these batches into elongated sheets or strips which may be severed into individual units, such as shingles. It will be apparent, however, that the feeding of the composite material to the extruding device 29 and the formation of the sheet 41 may be continuous as long as the screw feeder 13 is supplied with the composite material.

In Fig. 4 is shown a modification of the apparatus suitable for continuously carrying out the process of the invention. This apparatus includes a mixing chamber 1 provided with paddles 9 carried on a vertical shaft 7 driven by gear 11 as in Fig. 1. In the chamber 1 the mixture of the asphalt and the comminuted filler material may be effected, suitable heating means, not shown, being provided to maintain the requisite temperature in the range between 420 and 550 deg. F., the mass being continuously agitated by the paddles 9. The asphalt and the filler material may be delivered to the chamber 1 in batches of suitable amount of these ingredients to provide for a substantial run of the product. If desired, however, continuous feeding means of conventional construction may be utilized to deliver the asphalt and the filler material continuously to the chamber 1 concomitantly with the continuous operation of the mixing paddles 9.

A continuously operating feeder or pump 90 is provided in pipe 93 connected from the chamber 1 to one end of the casing 95 enclosing a screw feeder 97. In the apparatus shown in Fig. 4 the shaft 99 of the screw feeder 97 is supported in bearings 101 carried by the casing 95, the shaft being driven by a chain drive 103 from the motor 105. At the opposite end of the screw feeder casing 95 this casing is connected by pipe 107 to the adjacent end of a similar screw feeder casing 109 enclosing a second screw feeder 111 also driven by the motor 105 and chain drive 103 so as to effect feeding movement toward the opposite left hand end of the casing 109. To this casing at this end is connected a pipe 113 leading to the adjacent end of the screw feeder casing 115 enclosing a third screw feeder 117 in the particular embodiment being described. This screw feeder also is driven by the motor 105 for effecting delivery toward the right hand end of the casing 115. A pipe 119 is connected between this right hand end of the casing 115 and a final mixing chamber 121 in which paddles 123 are carried by the vertical shaft 125 driven by gear 126 of a suitable power drive.

Adjacent respectively to the feeder casings 95 and 109 and provided with a plurality of lateral connections thereto feed pipes 96 and 110 are arranged for feeding the amorphous siliceous fiber, particularly glass cotton, having the characteristics above described, respectively to the screw feeders 97 and 111. In this embodiment these screw feeders, as they move the filled asphalt horizontally therethrough respectively to the right and then to the left, receive at a plurality of points therealong a certain amount of the glass fibers. The screw feeder, by virtue of the rotary and translational components effecting movement of the plastic material through the respective casings, may effect mixture to a substantial degree of the fibers with the filled asphalt. By delivering the fibers at a plurality of successive points along the travel of the more or less flowable or plastic mass moving through the screw feeder casings 95 and 109 mixture of these fibers with the filled asphalt and a substantial wetting thereof may be accomplished while effecting delivery of the materials from the primary mixing chamber 1 to the final mixing chamber 121. If desired, a fiber feed pipe similar to the feed pipes 96 and 110 may be connected to the casing 115. In general as many of the screw feeder casings and horizontally extending screw feeders and as many fiber feed pipes and connections may be used as are necessary to effect the mixture in the desired proportion of the fibers with the filled asphalt preparatory to the final mixing in the chamber 121.

The composite material containing asphalt, filler and fibers in the requisite proportions is delivered through the pipe 119 to the mixing chamber 121 in which by continuous operation of the paddles 123 the final mixing and complete wetting of the fibers may be accomplished before delivery of the material through a suitable orifice or opening 127 formed in the bottom of the chamber 121. Having regard to the desired plastic condition for extruding the composite material the paddles 123 may be formed as propeller blades for forcing the composite mixture through the orifice 127 or a screw feeder similar to that shown in Figs. 5 and 6 may be arranged adjacent the orifice 127 for forcing the plastic mass through this orifice to extrude it as a sheet or strip 129. The thickness and width of this sheet may be determined further by the press rolls 131 similar to the press rolls 39 in Fig. 1. As the sheet is still plastic it may be carried into the horizontal plane, as shown in Fig. 4, thereafter to pass between several sets of carrier rolls 133.

In the apparatus of Fig. 4 a coating tank 43 heated by a heating device 49 and having a nozzle 45 controlled by gate 46, similar to the device of Fig. 1, may be used for applying an additional coating of asphalt upon the upper face of the sheet 129. A hopper 57 provided with a feeder 59 and an outlet 61 similar to the device of Fig. 1 may be used for applying granular surfacing material directly to the sheet 129 or to the coating of asphalt carried on the upper face of the sheet.

It will be understood that by means of suitable burners supplied with fuel and associated respectively with the chamber 1 and the screw feeder casings 95, 109 and 115 and with the final mixing chamber 121 the control of the temperatures may be accomplished for mixing the filler material with the asphalt, for mixing the fibers with the filled asphalt and for finally completing the mixing of materials to a uniform composite mixture and the wetting of the fibers by the asphalt. Alternatively the chamber 1 may be provided with a jacket of conventional construction supplied with a heating fluid, such as superheated steam or hot oil, to maintain the desired temperature initially of the asphalt, that is, of the degree of 475 deg. F. and generally in the range between 450 deg. F. and 525 deg. F. and during the mixing of the filler material therewith a temperature generally in the range between 420 deg. F. and 550 deg. F. and preferably between 500 deg. F. and 550 deg. F. Similarly the screw feeder casings 95, 109, 115 may be provided with jackets for confining the heating fluid for maintaining the temperature of the material as the fibers are mixed therewith generally in the range between 420 deg. F. and 560 deg. F. and preferably between 500 deg. F. and 560 deg. F. for the preferred proportions of fiber, filler and asphalt. A similar jacket may be provided for the final mixing chamber 121 to secure this temperature range for complete wetting of the fibers and the distribution thereof in the asphalt in interplaced relation to the filler particles.

Such heating or jacketing of the final mixing chamber 121, however, should be accomplished so that the composite material as it approaches the orifice 121 is at a lower temperature, as above stated, namely between 340 deg. F. and 425 deg. F. and so that the temperature of the extruded mass is in the range of 240 deg. F. to 290 deg. F. and preferably 260 deg. F. to 280 deg. F. It will be understood that the apparatus of Fig. 4 is merely diagrammatically shown and that the proportions of the different sections thereof may be varied to obtain the requisite conditions for practical mixing and feeding of the materials and for controlling the temperatures thereof in the manner above described. The ranges of temperatures above indicated for jacket heating may be adopted also for the apparatus heated by other means.

It will be understood, moreover, that for the lower rolls 133 which are positioned beneath the sheet 129 may be substituted an endless belt supporting the sheet 129 on the upper horizontal stretch thereof, the upper rolls 133 acting as press rolls. The belt may be driven by suitable means concomitantly with the operation of the feeder forcing the material through the extruding device and with the operation of press rolls 131 to deliver the sheet 129 horizontally continuously toward the right in the embodiment of Fig. 4 to the cutting knives 65, 67.

It will be understood that the final mixing chamber 121 may be constructed, if desired, in the same manner as the chamber 1 shown in Fig. 1 and may be provided with a horizontal screw feeder operating within the bottom of the chamber 121 for effecting movement of the composite material therefrom through a horizontal conduit to a laterally disposed extruding device similar to the extruding device 29 of Fig. 1, the press rolls 131 in this case being arranged above and below the horizontal stretch of the sheet 129 and in a similar relation thereto and to the extruding device as are the rolls 39 in Fig. 1.

Within the scope of the invention also the composite material may be delivered directly to the press rolls 131 of Fig. 4 without forcing this material through the extruding orifice 127. This may be accomplished by substituting for the orifice 127 any suitable feeding device which will effect removal of the composite material in plastic condition from the bottom of the mixing chamber 121 to deliver it as a more or less formless mass to the bight of the rolls 131 through which, when these rolls are power driven, it may be drawn and reduced in thickness to that of the sheet 129 concomitantly with spreading thereof to form the width of the sheet 129. Depending upon the type of such feeding device, trimming of the lengthwise edges of the sheet 129 may or may not be necessary in order to secure a uniform width of the sheet from which shingle units of definite dimension may be cut.

Other modifications of the apparatus shown in the drawings may be made within the skill of the art while embodying the features herein disclosed for carrying out the process of the invention which produces the product of the invention having the characteristics and advantages which above have been described. All such variations are intended to be within the scope of the claims appended hereto.

What is claimed is:

1. A composition for roofing and the like which consists essentially of asphalt as the continuous phase having a melting point substantially in the range between 200–230° F., and drawn glass fibers having a diameter not substantially greater than 10 microns and having a substantial fiber length distributed through said asphalt and wetted thereby, the ratio by weight of the amount of the asphalt to the amount of the glass fibers being not substantially less than 4 to 1.

2. A composition for roofing and the like which consists essentially of asphalt as the continuous phase and having a melting point substantially in the range between 200 deg. F. and 230 deg. F., and filaments of glass having a diameter not substantially greater than 10 microns distributed through said asphalt, the ratio by weight of the amount of the asphalt to the amount of the glass filaments being substantially in the range between 4 to 1 and 14 to 1.

3. A composition for roofing and the like which consists essentially of asphalt as the continuous phase and having a melting point substantially in the range between 200 deg. F. and 230 deg. F., and glass fibers having a diameter substantially in the range between .00022″ and .00038″ and of substantial fiber length and of a maximum length for the most part of the degree of 1½″, the ratio by weight of the amount of the asphalt to the amount of the fiber in said mixture being substantially in the range between 9 to 1 and 12 to 1, said fibers being distributed through and wetted by said asphalt and providing therewith when set a self-supporting structure having substantial flexibility when formed into a sheet.

4. A composition for roofing and the like which consists essentially of asphalt as the continuous phase and having a melting point substantially in the range between 200 deg. F. and 230 deg. F. and a penetration test between 7 and 20 measured at 77 deg. F.—100 grams—5 seconds, and fibers of glass distributed through said asphalt and having a diameter substantially in the range between 5 and 10 microns and a length substantially in the range between $\frac{1}{16}$″ and 1½″, the ratio by weight of the amount of asphalt to the amount of the fiber in said mixture being substantially in the range between 9 to 1 and 12 to 1.

5. A composition for roofing and the like which consists essentially of asphalt as the continuous phase having a melting point substantially in the range between 200 and 230° F., artificially prepared fibers of glass distributed through said asphalt and wetted thereby, said fibers having a diameter not substantially greater than 10 microns, and a comminuted mineral filler material distributed through said asphalt and wetted thereby and in interplaced relation to said fibers, the particle size of said filler material being substantially greater than the diameter of said fibers, the ratio by weight of asphalt to fiber being not substantially less than 4 to 1 and the amount of the filler by weight being substantially greater than the amount by weight of the fiber in said mixture and not substantially greater than the amount of the asphalt.

6. A composition for roofing and the like which consists essentially of asphalt as the continuous phase and having a melting point substantially in the range between 200 and 230° F., glass fibers having a diameter substantially in the range between 5 and 10 microns distributed through said asphalt and wetted thereby, the ratio by weight of the amount of the asphalt to the amount of the glass fibers being substantially in the range between 4 to 1 and 14 to 1, and a comminuted mineral filler material distributed through said asphalt and wetted thereby and in interplaced relation to said fibers, the ratio by weight of the amount of the asphalt to the amount of said filler being not substantially less than 1 to 1.

7. A composition for roofing and the like which consists essentially of asphalt as the continuous phase and having a melting point substantially in the range between 200 and 230° F., glass fibers having a diameter substantially in the range between 5 and 10 microns and a length in the range from substantially $\frac{1}{16}$″ to not substantially greater for the most part than 1½″, the ratio by weight of the amount of the asphalt to the amount of fibers in said mixture being substantially in the range between 9 to 1 and 12 to 1, said fibers being distributed through and wetted by said asphalt, and a mineral filler in finely comminuted form distributed through and wetted by said asphalt and in interplaced relation to said fibers, the ratio by weight of the amount of said asphalt to the amount of said filler material being substantially in the range between 1 to 1 and 1.5 to 1.

8. A roofing sheet which consists essentially of a matrix of asphalt having a melting point substantially in the range between 200° and 230° F., and fibers of glass cotton having a diameter substantially in the range between .00022″ and .00038″ and a length in the range from substantially $\frac{1}{16}$″ to not substantially greater than 1½″, the ratio by weight of the amount of said asphalt

to the amount of said fiber being substantially in the range between 9 to 1 and 12 to 1, said fibers being distributed throughout said asphalt as a matrix and wetted thereby to form the mass of the sheet as a substantially uniform composite self-supporting structure of substantial flexibility and strength when said asphalt is set.

9. A roofing sheet as defined in claim 8 which comprises a surfacing of granular material bound upon a face of said sheet by the asphalt component thereof.

10. A roofing sheet as defined in claim 8 which comprises a coating of asphalt having a melting point substantially in the range between 200° and 230° F. applied to the matrix of said sheet and having a surfacing of granular material bound upon a face of said sheet by said asphalt coating.

11. Process of producing composition roofing and the like which comprises heating asphalt having a melting point substantially in the range between 200° and 230° F. to a fluid condition, mixing therewith fibers of glass having a diameter not substantially greater than 10 microns and of substantial fiber length, the ratio by weight of the asphalt to the fibers being substantially in the range between 4 to 1 and 14 to 1, continuing the mixing while maintaining the mass at a temperature substantially in the range between 420° and 560° F. until said fibers are substantially distributed through said asphalt as the continuous phase and are wetted thereby and the fluidity of the mixture is substantially less than that of the heated asphalt, cooling said mixture to a temperature at which the mass thereof is plastic but not set, and pressing said plastic mass to elongate said mass concomitantly with reducing the thickness thereof to form a sheet.

12. Process of producing a roofing sheet or the like which comprises heating asphalt having a melting point substantially in the range between 200° and 230° F. to a temperature substantially in the range between 420° and 560° F. to bring said asphalt to fluid condition, mixing with said asphalt at said temperature glass fibers in the ratio by weight of asphalt to fibers substantially in the range between 4 to 1 and 14 to 1, said fibers having a diameter substantially in the range between 5 microns and 10 microns and a length generally indicated by the range between $\frac{1}{16}$'' and 1½'', continuing the mixing until said fibers are distributed through said asphalt as the continuous phase and are wetted thereby and the fluidity of said mixture is substantially reduced, reducing the temperature of said mixture to a temperature substantially in the range between 340° and 425° F. to reduce the mobility of said mixture in a plastic condition, and extruding said mixture of said reduced temperature to effect elongation of the plastic mass thereof concomitantly with reduction of the thickness thereof to form the sheet.

13. Process of producing a roofing sheet or the like which comprises heating asphalt having a melting point substantially in the range between 200° and 230° F. to a temperature substantially in the range between 500° and 560° F. to bring said asphalt to a fluid condition, mixing with said asphalt at said temperature glass fibers in the ratio by weight of asphalt to fibers substantially in the range between 4 to 1 and 14 to 1, said fibers having a diameter substantially in the range between 5 microns and 10 microns and a length generally indicated by the range between $\frac{1}{16}$'' and 1½'', continuing the mixing until said fibers are distributed through said asphalt as the continuous phase and are wetted thereby and the fluidity of said mixture is substantially reduced, reducing the temperature of said mixture to a temperature substantially in the range between 340° and 425° F. to reduce the mobility of the mixture in a plastic condition, extruding said mixture of said reduced temperature to effect elongation of the plastic mass thereof concomitantly with reduction of the thickness thereof to form the sheet, and controlling the temperature of said plastic mass being extruded so that the temperature of the extruded mass is substantially in the range between 240° and 290° F.

14. Process of producing a roofing sheet or the like which comprises heating asphalt having a melting point substantially in the range between 200° and 230° F. to a temperature substantially in the range between 420° and 560° F. to bring said asphalt to a fluid condition, mixing with said asphalt finely comminuted mineral filler until said filler is distributed through said asphalt as the continuous phase, the ratio by weight of the amount of the asphalt to the amount of said mineral filler being not substantially less than 1 to 1, mixing with said filled asphalt while maintaining said asphalt at a temperature substantially in the range between 500° and 560° F. glass fibers in the ratio by weight of asphalt to fibers substantially in the range between 4 to 1 and 14 to 1, said fibers having a diameter not substantially greater than 10 microns and a length for the most part in the range between $\frac{1}{16}$'' and 1½'' until said fibers are distributed through said asphalt as the continuous phase and are wetted thereby and said filler and said fibers are in interplaced relation to each other in said asphalt, whereby the fluidity of said mixture is substantially reduced while maintaining said mixture at a temperature substantially in the range between 500° and 560° F., reducing the temperature of said mixture to a temperature substantially in the range between 340° and 425° F. to reduce the mobility of said mixture in a plastic condition, and extruding said mixture of said reduced temperature to effect elongation of the plastic mass thereof concomitantly with reduction of the thickness thereof to form the sheet.

15. Process of producing a roofing sheet as defined in claim 11 which comprises reducing the thickness of the mass in a plurality of successive steps concomitantly with the elongation thereof to produce the desired thickness of the sheet.

16. Process of producing a roofing sheet as defined in claim 14 which comprises controlling the temperature at which said mixture is extruded so that the temperature of the extruded sheet is substantially in the range between 260° F. and 280° F.

17. Apparatus for producing a product in sheet form as a composite mixture of a thermoplastic bituminous material settable at ordinary temperature and a comminuted mineral filler and mineral fibers which comprises a continuously operating mixer for mixing said thermoplastic bituminous material and said filler, means for maintaining said materials in said mixer at a temperature to secure a liquid condition of said thermoplastic material as the continuous phase, a conduit connected to said mixer to receive

therefrom the filled thermoplastic material, feeding and mixing means in said conduit continuously operating to move said filled thermoplastic material through said conduit and continuously mixing the material being moved therethrough, means cooperating with said continuously operating feeding and mixing means for continuously delivering said mineral fibers to said conduit for mixture with said filled thermoplastic bituminous material as said materials are fed through said conduit, means for maintaining said material in said conduit at an elevated temperature to secure wetting of said fiber by said thermoplastic material maintained as the continuous phase, and means connected to said conduit to receive therefrom the mixed composite material for continuously forming said composite material as a sheet of predetermined thickness and width, and means for cooling said composite mixture so as to be received by said forming means at a temperature less than said elevated temperature.

18. Apparatus as defined in claim 17 in which said continuously operating feeding and mixing means in said conduit comprises a screw feeder cooperating with said conduit to effect movement of the materials therethrough and mixing the material therein, and conveying means connected to said conduit for conveying said fibers to said conduit for mixture with the filled thermoplastic bituminous material under the action of said screw feeder as said screw feeder effects movement of said materials through said conduit.

19. Apparatus as defined in claim 17 which comprises a pair of cooperating rollers, and means for delivering the formed sheet between

said rollers to effect reduction in the thickness thereof concomitantly with increase in the width of the sheet.

20. A composition for roofing and the like having as a binder and carrier for any other ingredient of the composition a mixture consisting of asphalt having a melting point substantially in the range between 200° and 230° F., and glass fibers having a diameter not substantially greater than 10 microns and having a substantial fiber length distributed through said asphalt and wetted thereby, the ratio by weight of the amount of asphalt to the amount of glass fibers being not substantially less than 4 to 1, said asphalt being present in the composition in a continuous phase.

IDA M. WOOLFF,

Administratrix of the Estate of Richard E. Woolff, Deceased.

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