Feb. 9, 1926. 1,572,629

P. E. WELTON

METHOD OF MAKING FUEL BRIQUETTES

Filed May 19, 1924 4 Sheets-Sheet 1

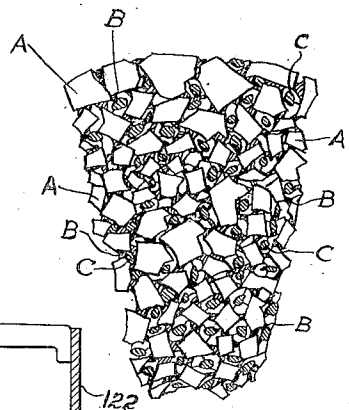


Fig. 1

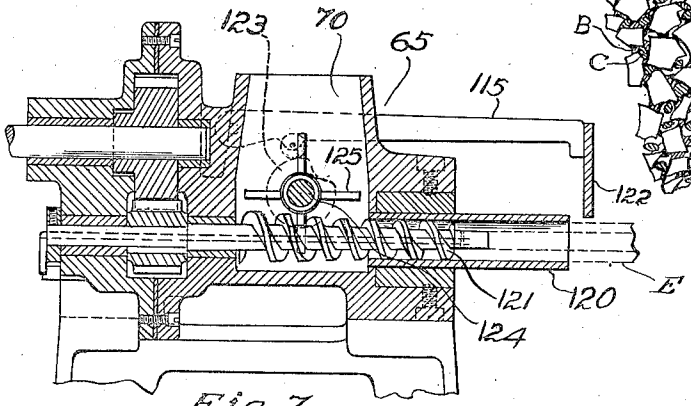


Fig. 7

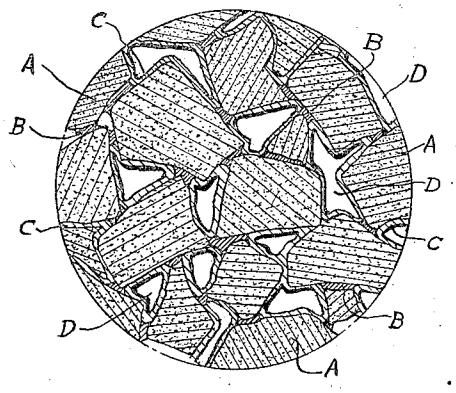


Fig. 2

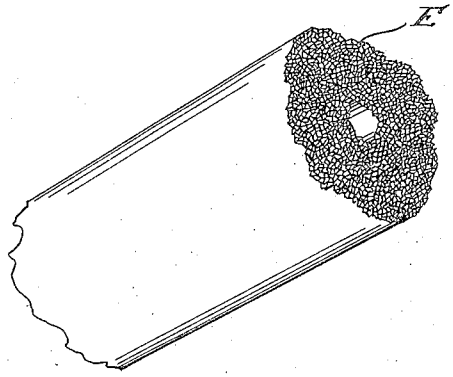


Fig. 3

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METHOD OF MAKING FUEL BRIQUETTES

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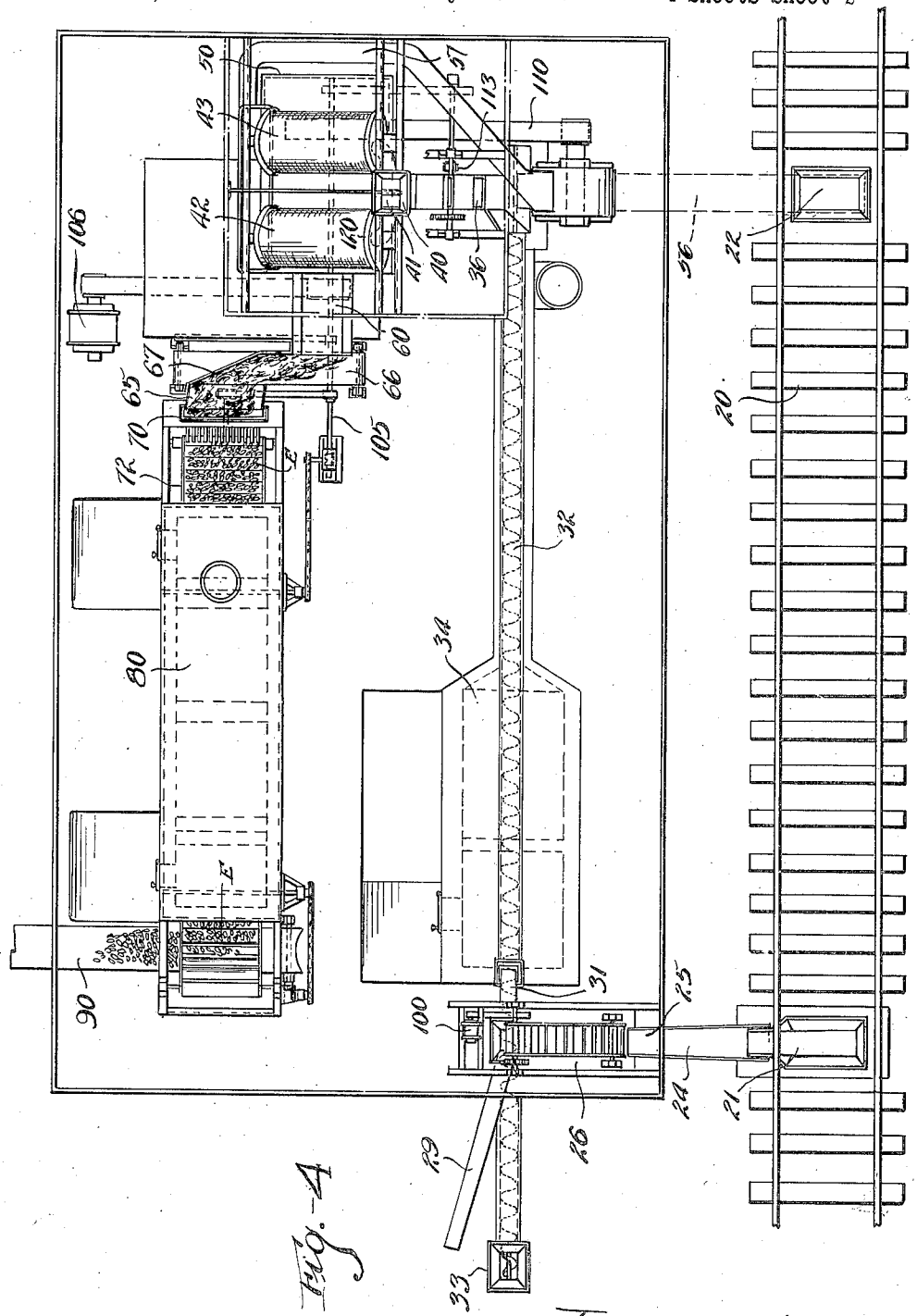


Fig. 4

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METHOD OF MAKING FUEL BRIQUETTES

Filed May 19, 1924 4 Sheets-Sheet 3

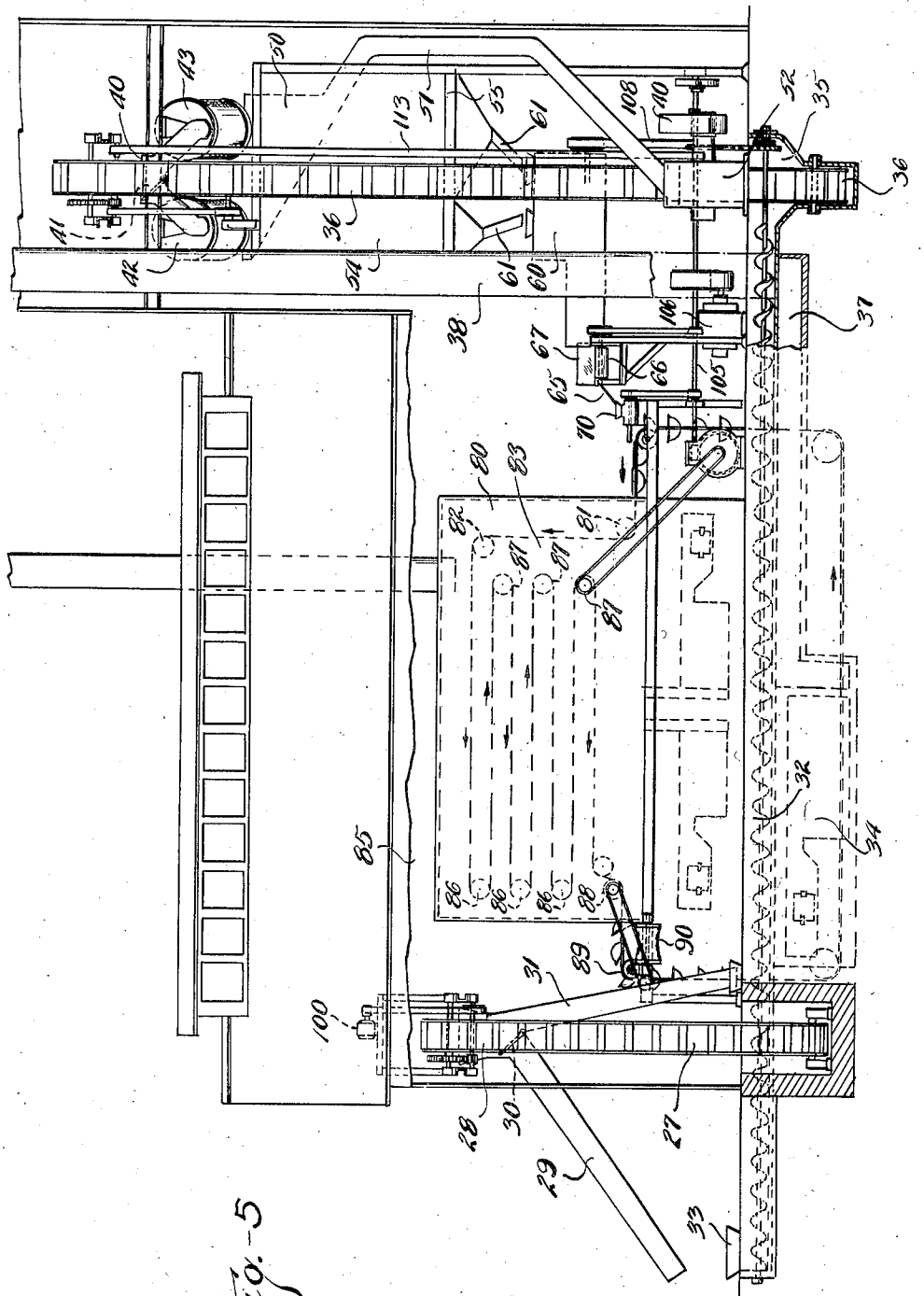


Fig. 5

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METHOD OF MAKING FUEL BRIQUETTES

Filed May 19, 1924 4 Sheets-Sheet 4

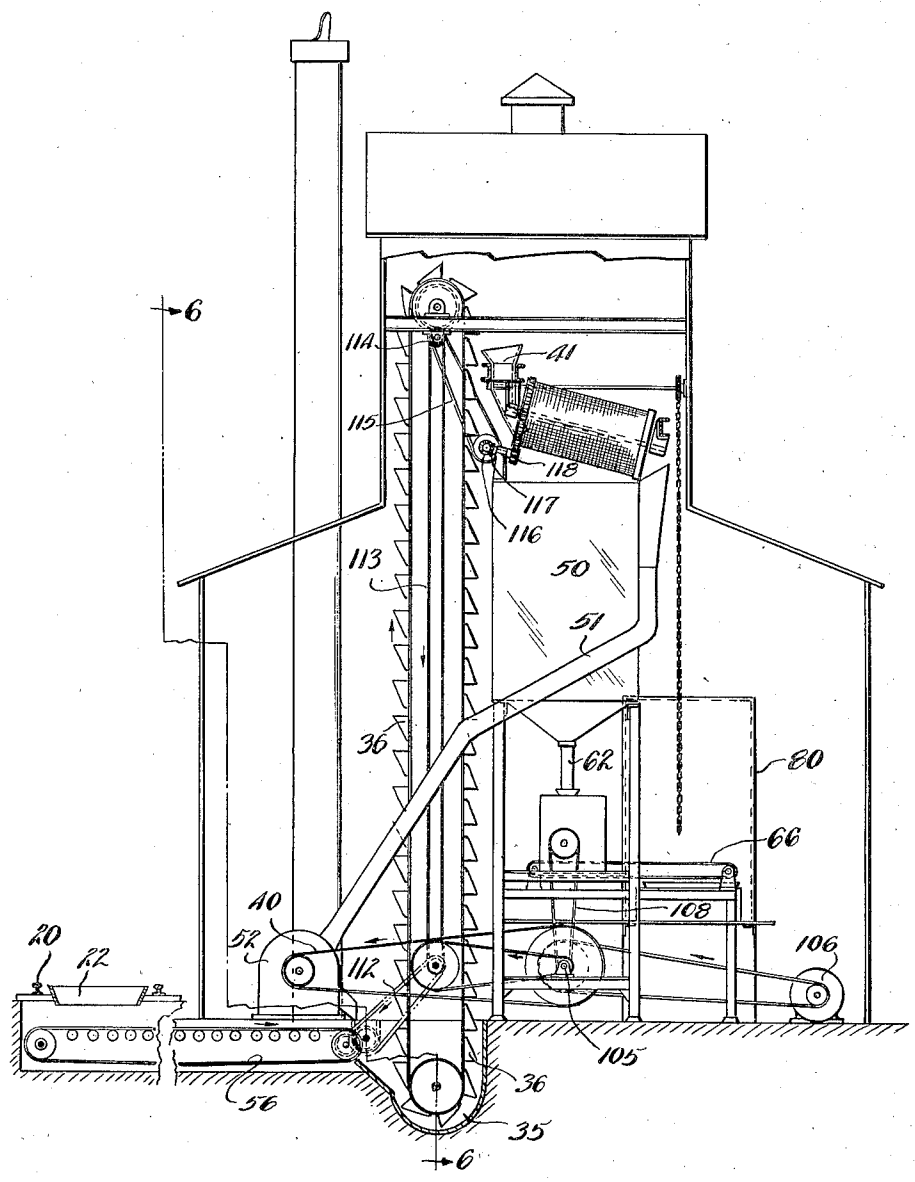


Fig. - 6

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UNITED STATES PATENT OFFICE.

PARK E. WELTON, OF AKRON, OHIO.

METHOD OF MAKING FUEL BRIQUETTES.

Applicatoin filed May 19, 1924. Scrial No. 714,358.

To all whom it may concern:

Be it known that I, PARK E. WELTON, a citizen of the United States, residing at Akron, in the county of Summit and State of Ohio, have invented a certain new and useful Improvement in a Method of Making Fuel Briquettes, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

This invention is directed to the manufacture of combustible briquettes and has for its general object the provision of a novel process for manufacturing briquettes from the by-products of basic industries at a very low cost.

More specifically my invention is directed to the provision of a process for the reclamation of coal culm, which, when treated by my process in a continuously operable apparatus, is formed into briquettes which are sufficiently compact to be readily handled but of such porosity as to be ready combustible with a low ash content.

A further object of my invention is the provision of a novel process for manufacturing briquettes whereby the finished briquettes may be of an anhydrous and moisture-proof crystalline structure.

In carrying out my process, I may employ suitable apparatus including means for treating coal culm to remove surplus moisture therefrom, to mix it with certain ingredients to facilitate the formation of the culm into briquettes and to subject the briquette to a drying or tempering process whereby the briquette partakes of the non-slaking characteristics of the better grades of bituminous coal.

Other objects of my invention will hereinafter be set forth in the following description referring to the drawings illustrating a novel apparatus for fulfilling the various steps in my novel method of manufacturing briquettes.

Fig. 1 is an enlarged cross-sectional view of the granular structure of the briquette when completely formed but prior to the baking or tempering thereof; Fig. 2 is an enlarged cross-sectional view of the granular structure of the briquette after the drying and baking treatment; Fig. 3 is a perspective view of the finished product; Fig. 4 is a plan view of my apparatus for continuously forming briquettes and is directed to the fulfilling of the steps of my process; Fig. 5 is a side elevational view of the apparatus and Fig. 6 is an end elevation thereof and Fig. 7 is an enlarged detailed cross-section of a portion of a briquette forming machine.

My invention contemplates the treating of coal culm, either anthracite or bituminous, by first driving off all the free moisture in the clump and then treating the clump with a binder which will cause the particles of coal to adhere together. Considerable experience has disclosed that a suitable binder which will not deter the combustible characteristics of the clump and which may be economically used, may comprise a sulphite liquor formed of an aqueous solution of a paper mill by-product available in large quantities and commonly known as sulphite liquor. Such by-product is reduced to a powder state at the paper mill whereby it may be conveniently shipped and qualitatively comprises calcium sulphite, sodium carbonate and organic matter in the form of cellulose. While this by-product comprises a very desirable binder in so far as effecting the formation of the briquette is concerned, its use nevertheless involves the solution of another problem, namely, that when the binder is thoroughly dried in the briquette, it is thereafter an anhydrous material which will absorb moisture, thus resulting in a slacking or crumbling of the briquette after protracted exposure to the air.

To overcome this difficulty, I introduce a water-proofing material which may comprise granulated asphaltum or hard petroleum residuum thoroughly commingled with the coal culm and binder to form a homogeneous mixture. This mass may then be compressed into briquettes by any suitable apparatus. I prefer, however, to pass the mixed material through an extruding machine whereby a continuous hollow cylindrical column is formed under such pressure as to cause the coal particles and water-proofing material to be brought into intimate contact whereupon they adhere together but leave the column porous. A drying or baking of the extruded column, which is broken into briquette units as it is being continuously extruded, to drive off the moisture in the binder results in the crystals or grains of coal being thoroughly bound together in a hard mass. Subjecting these briquette units to a higher temperature, results in the melt-

ing and flowing of the water-proofing particles in the briquette thus coating the dry binder material and coal crystals whereby exposure of the binder to the effects of moisture is prevented. The melting of the solid water-proofing material in this manner increases the porosity of the briquette thereby greatly increasing its combustibility.

The coal culm is preferably graded by screening to have a homogeneous mixture of substantially the following sizes:

	Mesh.
25%	16
25%	48
25%	75
25%	100

The culm is first subjected to heat to remove all free moisture by passing it through a drying conveyer which agitates the clump as it is being conveyed. I find that an economical method of grading the culm is to subject it to a screening and then a crushing operation, the rolls of the crusher being regulated to reduce the culm to the proper sizes.

The water-proofer and binder are preferably mixed in dry form, the water-proofer as stated, comprising a grade A asphaltum or petroleum residuum of a grade taken just before the coke residue is formed. The mixture may comprise ten parts of powdered bituminous coal, three parts of sulphite by-product in powdered form and four parts of petroleum or asphaltum in granular form. This mixture may then be thoroughly mixed with the dried graded coal culm in the following proportions.

8½ parts of water-proofer and binder.
1½ parts of ash or clay.
8½ parts of water.
90 parts of graded coal culm.

The addition of a small amount of ash or clay serves the purpose of absorbing part of the binder in liquid state when this homogeneous mixture is subsequently subjected to pressure to prevent the squeezing out or separation of the liquid from the mass during this forming process.

The water is added during the final stages of the mixing of the above materials, thus assuring a homogeneous mix of all the dry particles comprising the briquette before the mixture is moistened.

Subjecting the formed briquette to a low temperature of about 212° F. serves to drive off the free moisture in the binder and to cause the particles comprising the briquette to be thoroughly bound together. The temperature of the briquette may then be gradually raised from about 212° to approximately 450° F., to which temperature it may be subjected for a period whereupon the water-proofer in the solid form will be melted and cerate or flow around the binder and culm crystals and thus solidifies in this relationship when the briquette subsequently cools. The binding material or sulphite is thus prevented from absorbing moisture regardless of the period the briquettes are stored.

A cylindrical form of briquette is preferred for the reason that briquettes having the structure hereinbefore described may be formed in an extruding machine, wherein a screw or worm is the material propelling medium and the cylindrical form of die offers just sufficient frictional resistance to the movement of the material whereby it is compressed by the action of the screw with just the desired compactness to assure the retention of its extruded form and the structure of the extruded cylinder column is porous. This porosity is quite advantageous in the drying and baking periods of the process in that the moisture introduced in the form of water may be expeditiously driven from the briquettes and the evaporating or steaming motion is longitudinal of the briquette structure.

This physical condition of the briquette also greatly decreases the drying period of the briquetting process in that the moisture in the form of steam is driven out of the briquette during the drying period longitudinally of the crystalline structure of the briquette wall. When the briquette is placed in its intimate environment, namely, in the fire box and subjected to the heat of the fire, the volatile matter or petroleum substance is driven out of the briquette structure in the form of a combustible gas which escapes at the jagged ends thereof whereupon it burns in close proximity to these ends, thus greatly facilitating the igniting or kindling of the briquette. The hollow core of the briquette permits a more rapid baking of the briquette when in the process of manufacture and the baking heat has access to the briquette structure through the hollow core, as well as about the exterior surfaces thereof. The briquette is thus baked in a uniform manner whereupon the shrinkage is accordingly uniform and normal and the presence of shrinkage cracks is thus avoided.

Referring to the drawings. in Fig. 1, I show, greatly enlarged, the general relation of the coal clump particles after having been dried and graded, mixed with binder and water-proofer and subjected to pressure to form it. It will be noted that the clump crystals A are of varying sizes in accordance with the grading of the culm and the water-proofer, which is in the form of solid asphaltum or petroleum particles B, is homogeneously mixed with the clump and the binder material comprising the sulphite, bituminous powder and clay C. In Fig. 2, I show a greatly enlarged cross-section of the granular structure of the briquette after it has been subjected to the baking tempera-

ture. It will be noted that the culm crystals A where they contact with each other are bound together by the dried sulphite C which is insulated or cerated by the thin layer of asphaltum or petroleum waterproofer C.

It will be also noted from Fig. 2 that voids D are increased in size due to the melting of the solid water-proofing material, thus greatly increasing the porosity of the briquette.

I have provided apparatus for carrying out the foregoing described novel process of forming briquettes, which may be maintained in continuous operation and wherein the culm or major by-product being utilized is fed directly from a hopper comprising a switch car dump, through the drying, grading, mixing, forming and baking operations. Such an apparatus may comprise a manufacturing plant including a switch or railroad siding 20 beneath which may be constructed a dump hopper 21 for receiving the coal culm and a dump hopper 22 for receiving the other materials such as asphaltum or petroleum residuum and the binder material in the form of a powder. Associated with the hopper 21 is a chute 24. The chute 24 leads to a belt conveyer extending into the plant to a dump pit 26 into which extends a vertical elevator bucket conveyer 27. The bucket conveyer discharges into a distributing hopper 28, disposed at sufficient elevation above the ground level of the plant whereby the coal culm may be discharged from the hopper either through a chute 29 extending to storage bins or by proper positioning of a door 30 in the bottom of the hopper, the clump may be discharged through a chute 31 to a screw conveyer 32. The screw conveyer extends longitudinally of the plant at ground level and is provided with an end opening 33 for receiving clump from the storage yard.

It is desirable that the free moisture in the clump be removed before the grading or screening thereof. Hence associated with the screw conveyer 32, is a furnace 34, disposed therebeneath for feeding hot gases through the screw conveyer whereby the coal culm, as it traverses the conveyer and is agitated thereby, has all the surplus moisture removed therefrom. The conveyer of course is suitably housed to confine the gases throughout the conveyer length and to a stack 38. The discharge end of the screw conveyer 32 comprises a pit 35 into which extends a second vertically extending bucket conveyer 36. The position of this bucket conveyer is such as to lie outside of the foundation for the furnace flues 37 of the furnace 34 whereby the stack 38 may extend from the end of the furnace flues 37 upwardly to discharge the moisture and gases being driven off from the coal clump as it is agitated by the screw conveyer. The dry clump is conveyed from the pit 35 upwardly to a hopper 40 provided with a door 41 whereby the contents of the conveyer buckets may be discharged into either one of the screening cylinders 42 or 43. The cylinders 42 and 43 are inclined and the oversized clump lumps are discharged into an end hopper 50 provided with a downwardly extending gravity conduit 51 which discharges into a crushing machine 52 positioned adjacent the pit 35 whereby the crushed material flowing therefrom may be returned by gravity to the conveyer pit 35. The coarse clump is thus crushed and returned to the screen. Disposed beneath the screening cylinders 42 and 43 are hoppers 54 and 55 respectively, the latter being of considerably greater capacity than the former and is adapted for the reception of the graded and dried culm. The hopper 54 comprises a storage bin for the water-proofing and binder materials. It should be here noted that the conveyer 36 is adapted for the elevation of either the binder, the water-proofing material or the coal culm. When, however, it is desired to store binder or water-proofing material in the hopper 54, the door 41 may be properly shifted, operation of the screw conveyer 32 is interrupted and material, discharged into the track hopper 22, may be conveyed to the bottom of the pit 35 by the belt conveyer 56.

Disposed immediately beneath the storage hoppers 54 and 55 is a mixing machine 60 into which the material, in proper proportions, is discharged from the storage bins 54 and 55 through funnels 61 and 62 respectively.

The apparatus for forming the briquettes may comprise any means for compressing the mixed material. Extensive experimentations has disclosed, however, that a very economical apparatus for forming the material into briquettes may comprise a multiple extruding machine, which may be continuously operated to extrude hollow cylindrical columns which are broken into suitable lengths or briquette units as the columns move out of the extruding dies of the machine. I show such a machine diagrammatically as indicated at 65 in Fig. 4 and in cross section in Fig. 7. The extruding machine has dies or sleeves 120, (see Fig. 7) of a bore corresponding to the size of briquette to be formed and extruding worms or screws 121 driven at a speed to conform to the travel of a drying or baking conveyer hereinafter described. The extruded columns of material are broken into briquette units at the die mouths by a bar 122 suspended on end members 115, which are actuated by cams 123. The cams 123 may be mounted on the ends of a shaft 124, which carries a plurality of agitating blades

125 disposed in the receiving throat of the extruding machine. The shaft and extruding worms may be driven by any suitable means.

A belt conveyer 66 is provided to extend transversely of the extruding machine dies and the discharging end of the mixing machine 60 whereby the material when discharged from the mixing machine is conveyed to the extruding machine. A scraper or trimmer 67 is provided to extend diagonally across the upper face of the conveyer 66 whereby the material is uniformly discharged into the receiving throat or hopper 70 of the extruding machine 65.

The material, as it passes out of the extruding machine in the form of cylindrical columns, is deposited in the buckets or trays of a conveyer 72. The bucket conveyer 72 is arranged to pass through a baking oven or furnace 80 and is of a sufficient length whereby a number of stretches of the conveyer will be present within the oven 80. A convenient arrangement, as shown in Fig. 5, may comprise sprockets 81, disposed adjacent the entrance aperture of the belt conveyer to the oven and around which the conveyer passes in a vertical direction to the sprockets 82. The oven is provided with a wall partition 83 whereby the vertical extensions of conveyer belt may pass through a temperature zone which is relatively low in comparison to the prevailing temperature within the major portion of the oven.

I find that a preliminary temperature of approximately 212° F., for a short period of time is sufficient to drive off the moisture present in the binder but is not of sufficient magnitude to cause the solid water-proofing material within the briquettes to be melted. Adjacent the top of the partition walls 83 of the oven 80, I provide an aperture whereby the conveyer belt may extend in a horizontal direction across the top of the main compartment 85 of the baking oven, and then pass alternately back and forth over sprockets 86 and 87. The length of these stretches, of course, is dependent upon the desired rate of production and the most efficient extruding feed of the extruding machine. I find that a baking temperature of substantially 450° F. for a period of fifteen minutes is sufficient to thoroughly melt all of the water-proofing material and cause it to be reduced to a condition of fluidity to flow about and cerate the binder material present in the briquette. The conveyer passes out of the opposite end of the oven 80 over sprockets 88 and 89 and associated with the latter, may be any suitable means for causing the buckets on the conveyer to dump and discharge their contents upon a transversely extending belt conveyer 90, leading out of the plant to suitable storage space.

Actuation of the foregoing described apparatus is effected by motors disposed about the plant, the control board of which may be positioned adjacent the extruding and mixing machines. The driving means comprise a motor 100 driving through suitable reduction gearing, the vertical belt conveyer 27. The screw conveyer 32 is driven from a main drive shaft 105 which is driven by a motor 106. The mixing machine 60 is driven from the shaft 105 by a convenient power transmitting means in the form of a belt 108 and the crushing machine 52 is similarly driven from the shaft 105 by the belt 110. The screw conveyer 32 is driven from the shaft 105 by a belt 112, and the screening cylinders 42 and 43 are driven from the shaft 105 by a vertically extending belt 113; the counter-shaft 114; a belt 115 extending therefrom to a second shaft 116 which drives the cylinder through bevel gears 118, the latter meshing with large gears 120 mounted on the cylinder.

Such an apparatus may be operated with a small crew of men for the reason that the intimate association of the various devices in the plant permits of a continuous operation thereof, with only an occasional inspection of the product and mixes. A briquette, produced in the manner described, is sufficiently compact to permit of its ready handling in the accustomed manner of handling coal and may be stored in the open for protractel periods without absorbing moisture. Furthermore, a briquette made by my process, is commercially feasible from the economical viewpoint.

I claim:

1. The process of forming combustible briquettes which comprises mixing coal culm with a suitable binder in plastic form, adding a water-proofing material to protect the binder, the water-proofing material being in a granulated form, mixing these ingredients to obtain a homogeneous consistency of the mass, subjecting the mass to sufficient pressure to cause it to temporarily retain its formed shape and subjecting the formed material to heat to cause the moisture in the binder material to be driven off and thereafter to cause the water-proofing material to be reduced to a liquid form, whereupon it may cerate the binder material and subsequently prevent the absorption of moisture by the binder material.

2. The process of forming combustible briquettes which includes subjecting graded coal culm to a pre-heating temperature to remove the free moisture therefrom, screening said culm to segregate a portion thereof, mixing the dry clump with a water-proofer in the form of a petroleum residuum, passing said clump through an extruding machine to form a hollow cylindrical column, breaking said column into briquette units, subjecting the briquettes to a temperature

below the melting point of the petroleum residuum contained in the briquette and finally subjecting said briquette to a temperature which is above the melting point of said petroleum residuum.

3. The process of forming combustible briquettes which comprises mixing coal culm with a suitable binder, adding a solid water-proofing material to protect the binder, mixing these ingredients to obtain a homogeneous consistency of the mass, subjecting the mass to sufficient pressure to cause it to temporarily retain its formed shape and subjecting the formed material to heat to cause the water-proofing material to be reduced to a liquid form, whereupon it may cerate the binder material.

4. The process of forming combustible briquettes which includes subjecting graded coal culm to a pre-heating temperature to remove the free moisture therefrom, screening said culm to grade it, mixing the dry culm with a solid water-proofer, passing said mixture through an extruding machine to form hollow cylindrical columns, breaking said columns into briquette units, and subjecting the briquettes to heat to melt the water-proofing material.

5. The process of forming combustible briquettes which comprises mixing coal culm with a suitable binder, adding a water-proofing material to protect the binder, the water-proofing material being in a granulated form, subjecting the mix to sufficient pressure to cause it to temporarily retain its formed shape and subjecting the formed material to heat to cause the moisture in the binder material to be driven off and finally raising its temperature, to cause the water-proofing material to be reduced to a condition of fluidity, whereupon it may cerate the binder material.

6. The process of forming combustible briquettes which includes mixing coal culm with a wet binder and with a water-proofer in the form of a finely divided solid, passing said mix through an extruding machine to form an extruded column, breaking said column into briquette units, subjecting the briquettes to a temperature below the melting point of the water-proofer contained in the briquette to dry the binder and finally subjecting said briquette to a temperature which is above the melting point of said water-proofer.

7. The process of forming briquettes which includes the steps of forming a homogeneous mixture of coal culm, a binder material and a binder insulating material subjecting a mass of such mixed materials to pressure to form a briquette, subjecting the formed briquette to a temperature which is below the melting point of the water-proofing material to eliminate moisture in the briquette and finally subjecting the briquette to a baking temperature which is in excess of the melting point of the water-proofing material.

8. The process of forming combustible briquettes which includes the steps of drying a quantity of coal culm to remove the free moisture therefrom, mixing a binder material comprising bituminous coal in powdered form, sulphite liquor and a moisture absorbing substance such as clay, commingling this mixture with the coal culm, adding a water-proofing material adapted to cerate the particles of coal culm and the interbonding material, the water-proofing material being mixed with the culm and binder in solid form, subjecting the mass to pressure to form a briquette and subsequently subjecting the formed briquette to heat to cause the solid water-proofing material to melt and cerate the particles of binder and coal clump.

9. The process of forming briquettes which includes the steps of forming a homogeneous mixture of coal culm, a binder material and a water-proofing material, subjecting a mass of such mixed material to pressure to form a briquette, subjecting the formed briquette to a temperature of substantially 212° C. to eliminate moisture in the briquette mixture and finally subjecting the briquette to a baking temperature of substantially 450° F. to melt the water-proofing material.

10. The process of forming combustible briquettes which includes the steps of drying a quantity of coal culm to remove the free moisture therefrom, mixing a binder material comprising a paper mill by-product in the form of sulphite liquor, commingling this mixture with the coal culm, adding a water-proofing material adapted to cerate the particles of coal culm and the interbonding material, the water-proofing material being mixed with the culm and binder in solid form, subjecting the mass to pressure to form a briquette and subsequently subjecting the formed briquette to heat to cause the solid water-proofing material to melt and cerate the particles of binder and coal culm.

11. The process of forming briquettes which include the steps of forming a homogeneous mixture of coal culm, a binder material and a water-proofing material subjecting a mass of such mixed material to pressure to form a briquette, subjecting the formed briquette to a binder drying temperature to eliminate moisture in the briquette and finally subjecting the briquette to a baking temperature which is in excess of the melting point of the water-proofing material.

12. The process of forming combustible briquettes which includes the steps of drying a quantity of coal culm to remove the clean moisture therefrom, mixing a binder ma-

terial comprising bituminous coal in powdered form and sulphite liquor, commingling this mixture with the coal culm, adding a solid water-proofing material adapted to cerate the particles of coal culm and the interbonding material, adding water subjecting the mass to pressure to form a briquette and subsequently subjecting the formed briquette to heat to cause the solid water-proofing material to melt and insulate the binder.

13. The process of forming briquettes which includes the steps of subjecting coal culm to a pre-heat to thereby remove free moisture therefrom, grading the coal culm to obtain substantially a consistency comprising 16-mesh, 48-mesh, 100-mesh and greater in the approximate proportions of one to one, forming a binder material by mixing bituminous coal in powdered form with a dry homogeneous mixture formed of clay and sulphite by-product, granulating a water-proofing material, forming a composite homogeneous mix comprising substantially eight parts of water-proofer and binder material and ninety parts of graded coal culm, subjecting the mass to pressure to form a briquette and subjecting the formed briquette to a temperature greater than the melting point of the water-proofing material whereby the water-proofing material is caused to melt and insulate the binder and coal particles and thereby increase the porosity of the briquette.

14. The process of forming briquettes which includes the steps of subjecting coal culm to a pre-heat to thereby remove free moisture therefrom, grading the coal culm to obtain substantially a consistency comprising 16-mesh, and finer, forming a binder material by mixing bituminous coal in powdered form with a mixture formed of clay and sulphite by-product, adding a granulated form of water-proofing material, forming a composite homogeneous mix comprising substantially 90% coal culm, extruding to form a briquette column dividing the column into briquette units and subjecting the formed briquettes to a temperature greater than the melting point of the water-proofing material whereby the water-proofing material is caused to melt and insulate the binder.

15. The process of forming combustible briquettes which includes the steps of mixing a quantity of coal culm, a binder material and a water-proofing material homogeneously, subjecting a mass of the mixed material to force it through an extruding die, whereby a column of extruded material is formed, breaking the column into briquette units as it is being extruded, subjecting the units to heat to eliminate the surplus moisture in the briquettes and finally subjecting the dried briquettes to a sufficiently high temperature to melt the water-proofer.

16. The process of forming combustible briquettes which comprises removing all free moisture from coal culm forming with the coal culm, a homogeneous mixture of dry sulphite by-product, oil refining residue fusible at a temperature above the boiling point of water and powdered bituminous coal, adding a definite per cent of water to the mass to wet the binder and finally forming the mass into briquettes by extruding it through dies whereupon it may be broken into units.

17. The process of forming combustible briquettes which comprises removing all free moisture from run of mine coal culm, grading the dried culm to obtain uniformity in the clump particle sizes, forming with the culm a homogeneous mixture dry sulphite by-product, a wax like water-proofing substance of a melting point greater than that of water and finely powdered bituminous coal, adding a definite quantity of water to wet the mass, subjecting the mass to pressure to form briquettes and finally subjecting the formed briquettes to a preliminary drying temperature substantially equal to the boiling point of water and then to a temperature which is greater than the melting point of the solid water-proofer in the briquettes.

In testimony whereof, I hereunto affix my signature.

PARK E. WELTON.