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(54) **Method and apparatus for making stable blocks from organic material.**

(57) An apparatus for making stable blocks from organic material includes means for tearing the materials into fragments of a predetermined size and means for forcing the fragments through a high resistance die at high pressures and temperatures for forming the particles or fragments into a stable block without the addition of adnesives. The dies are coated with a material such as a matrix of tungsten carbide in a nickel alloy for controlling die resistance and to increase die life.

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METHOD AND APPARATUS FOR MAKING STABLE BLOCKS FROM ORGANIC MATERIAL

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for forming stable blocks of particle materials without the addition of an adhesive.

Prior U. S. Patent No. 3,949,036, and U. S. Patent No. 4,060,363, granted to co-inventor G. B. Nelson discloses method and apparatus for forming stable blocks from shredded paper like material. The advantages of forming particle materials to be handled into stable blocks in accordance with the disclosures of the above patents are well known. The application of the principles to numerous materials has been demonstrated. However, efforts to extend this concept to other materials without the addition of adhesives has not been successful in the past.

One application of the principle of forming stable blocks of material is the cubing of hay for the agricultural industry. The cubing of alfalfa and legumes of that character has been known for some time. Machines for this purpose are in wide use today and are made, for example, by the John Deere Company for this purpose. Such machines however, are limited to use in cubing alfalfa and other plants of similar character. The alfalfa cube quality is best early in the haying season and deteriorates toward the end of the season. A binder such as Bentonite is often added to enhance the quality or stability which also increases the costs of cubing.

It is well known in the industry that grasses cannot be effectively cubed, and that alfalfa having a grass content of 10% or more cannot be effectively cubed. The specifications for such machines, including advertising literature, clearly specify that alfalfa to be cubed must not contain over 10% grass. This is a distinct limitation on the methods and apparatus of the prior art. The precise reason for the failure of such machines to be capable of cubing grasses is unknown. The applicant, however, has developed methods and apparatus unexpectedly having this capability.

The cubing of materials for fuel and other uses is also desirable. Many waste products can be useful for fuel if formed into the cube or highly compact state. For example, wood shavings and sawdust, bark, leaves, nut hulls and the like can be used as fuel.

Certain low grade fuel products, e.g. low grade coals and similar products such as lignite can be better handled or further processed from the compacted state.

A considerable amount of money and effort has been expanded in attempts to form cubes from refuse from cities and the like. The advantages of forming such materials into stable blocks are obvious. For example, such materials can be easily and conveniently transported and recyclable materials can be formed into blocks and easily and conveniently handled for shipping. It is also recognized that considerable amount of combustible material is disposed of at the city dumps. This material could be conveniently utilized as fuel for the generation of electrical power and the like and thereby conserve natural resources.

Many efforts to form refuse and the like into stable blocks have not been successful. For example, the National Recycling Center in Gary, Indiana, expended a great deal of time, effort and money trying to obtain stable blocks from refuse and the like. They were unable to obtain satisfactory blocks. The results of their efforts were low production and low density.

In addition to the inability of the prior art apparatus for forming suitable stable blocks from many materials, such prior art devices also have a short life and are therefore expensive. While known techniques of hardening and surfacing of the parts of such machines have improved the life of the machines, such life is still not satisfactory from an economical point of view. Additional drawbacks to the prior art methods include the inability of the machines to accomplish the purposes thereof with prior art resurfacing materials and techniques.

One difficulty with the formation of stable blocks from refuse material is the existence of plastic sheeting, plastic coated materials such as milk cartons and wax coated materials and cartons therein. Such materials exist in all refuse to the extent that it is believed that this is a primary hindrance to the formation of stable blocks. Fairly low percentages of these coated materials and the sheeting material can prevent the formation of stable blocks.

Lignite and certain low grade coals can be processed by gasification and other methods into useful fuel. Pelletizing such materials would considerably enhance the handling as well as gasification process. However, no effective method of pelletizing such materials has been available hereto fore.

It is therefore desirable that methods and apparatus be provided whch can economically form stable and uniform blocks from a wide variety of particulate materials without the addition of binders.

It is also desirable to be able to form stable blocks of organic and other materials, such as sawdust, wood splinters, oak sawdust and splinters, oak bark, pencil shavings, bushes, weeds, peat moss, nut hulls, lignite and other similar materials, without the addition of binders.

SUMMARY AND OBJECTS OF THE INVENTION

An object of the present invention is to provide an improved method and apparatus for forming stable blocks of organic and other particle materials.

A further object of the present invention is to provide improved apparatus having long life for the forming of stable blocks of organic and other particle materials.

In accordance with the primary aspects of the present invention extruding dies for the formation of pellets, cubes, and other stable blocks of materials are coated with a hardened material such as tungsten carbide having a roughened surface for increasing the resistance and compressive forces on the material and coated in other portions of the die with a material such as hard chrome, nickel, chrome, boron, or other nickel alloys, to provide a smooth surface with improved life and long wear characteristics. The surfacing on the dies may also be shaped to enhance and improve the wear characteristics and life thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and advantages of the present invention will become apparent from the following description when read in conjunction with the drawings, wherein:

Figure 1 is a schematic illustration of a cubing apparatus and method in accordance with the invention.

Figure 2 is a perspective view of a cube of material in accordance with the invention.

Figure 3 is a diametrical sectional view showing details of the cubing extruder.

Figure 4 is a perspective view of an extrusion die in accordance with the invention.

Figure 5 is a view taken generally on lines 5-5 of Figure 3, showing the arrangement of three of the die sections.

Figure 6 is an enlarged fragmentary view showing the engagement of the compression wheel with an extrusion die section.

Figure 7 is a sectional view taken on line 7-7 of Figure 6.

Figure 8 is a sectional view taken on lines 8-8 of Figure 6.

Figure 9 is a detailed enlarged view illustrating the die and wear and resistance wear coating.

Figure 10 is a view like Figure 8 of a modification of the die.

Figure 11 is a sectional view of an alternate die.

Figure 12 is a sectional view of a modification of the die of Figure 11.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Turning to Figure 1 of the drawings there is schematically illustrated a cubing apparatus and/or system in accordance with the present invention. The cubing apparatus or system may be such as that illustrated and fully described in U. S. Patent No. 3,949,036, issued April 6, 1976 to the inventor hereof. That patent is fully incorporated herein by reference as though fully set forth. The system may also be constructed like machines sold as hay cubers by the John Deere Company such as those identified as the Model 425 Self Propelled Cuber or the Model 390 Stationary Cuber. The subject matter of the present invention involves modifications in such prior art machines which give such machines the capacity for cubing a great variety of materials not heretofore capable of being formed into cubes by these machines without the addition of binders. Such materials are, for example, grasses or hay of a high grass content, wood shavings and wood sawdust, nut hulls, peat moss, lignite and other such similar materials. Other materials capable of being cubed in the method and apparatus of the present invention include refuse consisting primarily of organic materials and including a fiber content such as paper, paper board and the like in combination with plastic materials such as polyethelene, wax coated papers, plastic coated papers, polyethelene sheeting and other similar materials.

The system as generally illustrated in Figure 1 and designated generally by the numeral 10 consists of a shredder or grinder 12 for receiving and shredding or grinding the materials into an appropriate size if necessary with the materials then fed to a fluffer where necessary 14 then to a moisture control apparatus 16 for adjusting the moisture of the materials, then to a heater if necessary, and then into a cubing extruder 18. In most instances the material must be prepared in one way or another prior to feeding it into the cubing extruder. The material that emerges from the cubing extruder will consist of cubes, such as a cube 20, as illustrated in Figure 2. This cube of material will consist of a tightly compressed cube consisting primarily of layers or particles of the materials highly compressed together under sufficient heat and pressure as developed in the extruding process to cause the materials to be fused or otherwise secured or bonded together by natural adhesives or the like within the material without the addition of external or synthetic adhesives or binders. The block in many instances will be substantially as described in my aforementioned patent. In some instances the block will have a fused outer surface or shell with tightly compacted particles or layers inside. In other instances the block may be a fused mass throughout.

The basic process for forming the cube is also such as that described in the aforementioned patent, with the exception that specific preparation may be necessary for specific material. Grasses or hay and the like must be at least partially cured or dried and then cut to an appropriate length to fit in the die. The length of the materials, of course, would depend on the size of the die and preferably will have a length that is as to the majority of the materials that is no greater than the cross sectional length or width of the die openings. It may be necessary in many instances to appropriately control the moisture by either drying the material or adding moisture thereto.

The preparation of sawdust and like materials would not require the step of grinding, but would require a moisture conditioning in most instances. Certain sawdust, such as that containing resins, may not need much moisture and may be formable with a lower moisture content than other sawdust, such as non-resin containing sawdust of the hardwoods.

The preparation of municipal waste and refuse will in general require the addtional steps of separating and sorting unsuitable materials, such as metal and the like, from the materials to be cubed. Sheeting material, such as papers, cardboard, and the like must be fragmented into fragments of a sufficient size to be fed into the extrusion dies. The materials especially those wherein a percentage of wax or plastic coating is involved, may also require a shredding or tearing in a fashion to expose fibers at the edges thereof. In most instances a clean cutting, such as by knives, of coated paper of the like, would be unsuitable. It is often necessary that jagged fiber exposing edges be formed on many of the particles of material, especially those which are plastic coated or mixed in with plastic sheeting and coatings. As to the critical methods or steps of the invention such appear to reside in a common step of raising the compressive pressures and temperatures of the outer surface of the material during the extrusion process to a sufficiently high level to form the necessary bond. It is also speculated, as in the aforementioned patents, that roughening of the surfaces of many of the materials, such as sheeting materials, may aid in the bonding process.

We have found that the most effective method of raising the pressure to a sufficient height to obtain the necessary bonding is by increasing the resistance to or at the entrance of the materials into the die cavities. This is accomplished by a roughening of the surface at the entrance to the die. This roughening is carried out by a special coating applied to the die surfaces which also incidently increases the life of the dies. Minor modifications in the die structure and the cooperating compression wheel structure also enhances both the ability to obtain the necessary compressive forces as well as the life of the dies.

Such modifications as we provide, although seemingly minor at this point in time, have escaped the minds of the experts of the industry for many years. Such minor modifications, as will be described, spell success in achieving the end results wherein others have failed after many years and highly expensive efforts. In summary, we have developed method and apparatus having the capability of forming cubes from substantially any substance having a high percentage of organic material including those having some fibrous content when combined with slick sheeting materials of plastic or wax.

In conjunction with the development of apparatus for carrying out the above process, we have also developed improvements for increasing the life of the dies in cooperative association with compression wheels. In many instances, the one modification or structure serves both functions.

Turning to Figure 3 of the drawing there is illustrated an example of a cubing extruder suitable for the purposes herein. The cuber 18 in the illustrated embodiment comprises a housing 22 having a generally cylindrical auger conveyor 24 which receives material at 26 in a stream from a chute or the like 28 and feeds it into a generally annular extrusion chamber 30. The extrusion chamber is defined by an end plate 32 having a circular generally disc configuration secured by suitable bolts or the like to annular bell shaped housing portion 34 which also functions as a cam for breaking the extruded material into selected lengths. The housing 32 is secured to the bell shaped housing portion 34 or suitable bolts clamping a plurality of die elements 36 therebetween. The die elements cooperate as shown in Figure 5, for forming a plurality of die cavities. The die cavities have generally parallel opposing walls defining a generally square or rectangular cross-section, and are arranged radially around and outward of the extrusion chamber 30 and are in a plane of and fed by an excentrically mounted compression wheel 40. The compression wheel is rotatably mounted on a journal 42 of the auger assembly and forces the materials 26 to be extruded outward through the radially directed die cavities 38.

Turning to Figure 4, each of the die pieces or elements 36 comprise a pair of spaced apart side blocks 44 and 46 defining opposed generally parallel walls connected together by means of a generally wedge shaped web member 48 extending between the die blocks. The wedge portion 48 has an entrance edge 50 spaced downward from the top of the side blocks 44 and 46 thus defining when connected with the plurality of similar block sections as shown in Figure 6, an inlet portion having side walls defined by the side walls of the side blocks 44 and 46 prior to entry into the die cavity.

In accordance with one aspect of the invention as illustrated in Figures 4 and 5, the inlet portion of the die piece or section is coated with a roughening and hardened coating 52 for increasing the resistance to the entrance of materials into the inlet to the die passage. This coating extends at lest downward from the forward end 50 of the wedge shaped webb portion 48 and preferably partially around the side walls or the facing thereof. This provides a resistance to the passage of material through the die cavity and increases the pressure on the material. Once the material is past this portion of the cavity,the walls of the die piece are preferably smooth and coated with a hardened material, such as nickel alloy or chromium or other materials to be described. Preferably the resistance to the entrance of material into the die cavity is at the entrance to the cavity for the primary purpose of permitting the high compression forces to be developed at this point. The high compression forces can be controlled by controlling the roughness of the die and in some instances by the moisture content of the material being compressed. The die coating is selected to optimize the compressive forces and to optimize die life. The die roughness can be tailored to specific materials where 4 feasible as will be described. A roughness of between 80 and 180 microinches is preferred for most materials.

Another aspect of the present invention, as illustrated in Figure 6, is that the portion of the press wheel fitting between the sides 44 and 46 is coated with a coarse coating of tungsten carbide of about 25 to 50 mesh in a nickel composite alloy matrix material. This construction, in contrast to the prior art, maintains the edges of the press wheels 40 in a sharp configuration. In addition, the corners at 56 of the juncture between the upper edge 50 of the web and the side walls of the side block are undercut as shown in dotted line and similarly coated with a rough hardened material. Thick coating results in an increased life of the dies and is also found to aid and increase in the compressive forces acting on the material to be compacted.

Turning to Figure 7, in addition to the above described aspect, the upper edge and corners 58 of the web 50 are also ground down or knocked off and a coating of hardened material provided there. This undercutting and coating is shaped as shown in Figures 6 and 7 and extends downward at the side edges (i.e. in the corners) at the juncture between the faces of the web 48 and the side walls of the block and fills the corner junctions therebetween extending downward to points at each side in the corners. This coating, and this configuration considerably increases the life of the die from five (5) to ten (10) times. The rounded corners also prevent the hard corners from breaking off.

As also shown in Figure 7, a portion of the wall or side walls in each of the dies above the forward end 50 of the wedge 48 is undercut as shown at 60 and 62 in Figures 7 and 8 and filled with a matrix of a hardened material such as tungsten carbide in a hard binder material such as nickel or a nickel alloy. This rough surfacing is primarily for the purpose of reducing the tendancy of the materials to escape past the sides of the press wheel. This undercut portion considerably increases the life of the die by insuring that the necessary thickness of hardened material appears at the appropriate position (i.e. extreme wear areas) on the die surface at the die entrance thereof. The hard surface has greater depth at higher wear points as illustrated, varying from .010 to .050 inches.

Turning to Figure 9, an enlarged section of a surfacing is illustrated. In the preferred embodiment, the coating material comprises a matrix of a plurality of particles of tungsten carbide 66 in a binder material 68. The binder materials are preferably extremely wear resistant such as nickel alloys and includes a mixture of materials such as iron, carbon, chromium, nickel and boron. A typical alloy would have about 0.3% carbon, 1.8% silicon, 5.6% chromium, 1.2% boron, and 1.6% iron with the balance nickel.

In the preferred embodiment, the tungsten carbide particles in the surfacing is for roughness control. The base material for the main die body is a high wear resistant and tough material such as 4140 chrome molybdenum steel hardened to a Rockwell 45 hardness (C scale). The above binder material in combination with the tungsten carbide provides an ideal coating having a high wear resistance and excellent bonding qualities. The tungsten carbide particles should make up about 60% of the matrix or coating material.

The coating material is preferably applied by flame spraying and includes tungsten carbide grit or particles of between 100 and 300 mesh in a bonding material that supports the particles but can also wear away to expose further particles to maintain roughness. The roughness should be on the order of between 80 and 160 microinches.

Turning to Figure 10 a special alfalfa and lignite dies is illustrated. In this embodiment the faces 70 and 72 of the die are coated with a suitable material to make it smooth. This provides a die that forms a uniform block of alfalfa or lignite having complete uniform corners. This configuration has been found to correct the problem found when dies with rough corners such as shown in Figure 8 have been used for these materials.

It is necessary that other portions of the die such as downstream from the roughened or pressure control portion be quite smooth and have a hardened surface. Applicant has material consisting primarily of an alloy sold under the trademark Met Co 36C. This alloy consists of about 8% tungsten carbide in particle form, 35% nickel composition, 11% chromium, 2-1/2% iron, 0.5% carbon and 46% pure nickel. The nickel composition includes some tungsten carbide in solution with the particles being in large block form rather than grannular.

Another material which appears suitable for this purpose consists of fine grains of silicon carbide in a matrix of nickel cobalt. These silicon carbide particles are of a size in the range of from 5 to 10 microns. This material can give a surface smoothness on the order of less than 20 microns. In certain circumstances, the entire working surface of the die can be coated with this material. In other desirable circumstances mixtures of tungsten carbide is necessary to provide the required resistance to movement of material through the die in order to develop the necesary temperature and pressures.

This downstream area of the die is referred to as the dwell area and requires a length sufficient to enable the block of mass to stabilize and to provide the required back pressure on the material. The length can vary with the material but a die on the order of about six (6) inches has been found to be satisfactory for most lignite and most biomass. For material containing more than about 8% polyethylene the die length should be increased to about 8 to 12 inches depending upon the percentage of the plastic. The material should also be preheated prior to die entrance to about 140 degrees F.

The pressure and a certain amount of the temperature, especially the skin or surface temperature of the formed blocks are controlled by die resistance. The die resistance is controlled primarily by the roughness coating. This can be controlled both by the area coated (i.e. extent of the coating) as well as the roughness of the coating. We have found for example that coating a portion of one of the four sides at the entry to the die is sufficient for some materials.

In our preferred arrangement we coat two opposing sides within each die extending around and including small areas adjacent the corners of the other sides. This provides an optimum construction for most materials.

We have found that smooth corners are preferably for alfalfa and for lignite. These materials have tended to form unstable corners in dies having the roughening extending into the corners. The material frequently hangs up or sticks to the die in the corner, thereby reducing the effective die area, material throughput, and block stability. This has been eliminated by providing smooth corners as shown in Figure 10. The facing between the corners are roughened but the corners and an area immediately adjacent thereto are left smooth.

The coating material can be varied in its roughness an amount to suit the particular material being processed by providing the proper resistance to raise the pressure and temperature to the bonding range.

By way of example, lignite can have a moisture content of between 10% and 40% but the preferred range is between about 20% and 35%. The natural moisture content is frequently as high as 40%. The pressure required is between 6,000 and 10,000 pounds per square inch, with about 8,000 being the usual pressure required. Lignite must be fused throughout the mass in order to form stable blocks that can be easily gassified. The temperature must be raised in the range of between 300 and 500 degrees F. during the high pressure step, particularly on the outer surface.

Materials which we refer to generally as biomass includes grasses, straw, sugarcane bagasse, nut hulls and shells, wood particles such as sawdust, bark, shavings, forest waste and municipal solid waste and commercial waste, and can be formed into stable blocks with the invention. The moisture content can vary between 10% and 40% with a preferred range of about 12 to 25%. The pressure can vary from about 5,000 psi up to about 10,000 psi. The surface temperature under pressure would be in the range of about 300 to 500 degrees F. These materials can be compacted into stable blocks in accordance with the invention without the addition of binders.

The temperature at which the material bonds into a stable block is herein referred to as the fusion point or temperature. This fusion point is the temperature at which natural binders of whatever nature inthe material functions to form a cohesive bond. This will vary with the material and with moisture content and pressure for each material. The manner of fusion may also vary from material to material. Plant life will generally have a natural binder commonly known as ligin. Other materials may be bonded together by means of other natural binder substances therein.

The moisture within the material may serve two different functions. One function is to liquify the binder and the other function is as a lubricant. Thus, moisture within certain limits can help control pressure.

Turning to Figure 11 of the drawing an alternate configuration or construction is shown for lining of dies which cannot be coated by flame spraying. The extrusion die, for example, designated by the numeral 82 is provided with a central bore 84 of a generally conical configuration. A generally conically shaped liner 86 of a high wear material such as tungsten carbide in a suitable binder material has an outer conical surface 88 fitting in the bore 84. An inner through bore 90 of the desired die configuration is formed on the inner diameter of the liner 76. With this arrangement, relatively thin liners of a long wear die material can be constructed and inserted into basic die structures. The liners can be mounted in the basic die structures such as by brazing, soldering or the like, to the base structure material or metal. The inlet to the die is at the top when viewed in Figure 11 and can be roughened at the entrance as required.

An alternate embodiment is shown in Figure 12 wherein a die 92 having a central through passage 94 is provided with a sleeve 96 of the desired high wear material. Preferably the die 92 is provided with an upper shoulder 98 which is engaged by a similar opposing shoulder 100 on the liner 96. The inlet or entrance to the die is at the upper end. With this arrangement the dies can be constructed to have replaceable liners and only the liner need be replaced when excessive wear occurs.

In another process, this coating is placed on the die surface in the appropriate position and thereafter an additional coating of high resistant wear material of a suitable composition is plated over this portion. Sufficient plating is put on the coating to cover the matrix binder but not to cover and smooth the roughened portion. With this construction, the surfaces at the entrance of the die are left roughened. The die life is considerably increased by the extra coating which protects the matrix or binder material from wearing away between the particles of tungsten carbide material. The roughness of the surface portion can be adjusted in accordance with the requirements of the materials to be processed. Increasing the roughness will increase the resistance to the entrance of material into the die cavities and will thereby increase the pressure necessary to force the material therein. The rounding of the edges of the die faces at the entrance also contributes to the increased force because it ceases to act as a shear for cutting larger particles that do not fit precisely within the cavity as is the common practice in the art. Thus, the high forces necessary to force the material into the die cavity results in sufficiently high compressive forces and pressures to cause a bond to be formed between the particles of materials.

While we have primarily discussed and referred to the use of tungsten carbide throughout this specification as the roughening material, other materials may be used. Any material having a suitable hardness, preferably greater than Rockwell 70 (C scale), that can be formed into small particles having sharp points and/or edges (i.e. an irregular shape) would be suitable. For example materials such as diamonds, silicon carbide, vanadium carbide, titanium carbide, and many of the other carbides and like materials.

It should again be emphasized that we are concerned here with extrusion dies having parallel sides rather than tapered dies. Such systems as described herein use much lower energy such as about 10 killowatt hour per ton as compared to about 40 killowatt hour per ton for certain pellet mills. The present system is therefore much more economical.

We are also primarily concerned with forming a block or stable mass of material wherein the bonding takes place primarily at the outer surface. This also takes less energy because only the outer surface of the mass of material flowing through the die must be raised to the bonding temperature. This bond is believed to be formed by natural lignin found in the material. The temperature at which plant material will bond (i.e. form a stable bond) is believed to be related to the amount of natural lignin found in the material or at least to the temperature at which the lignin will be released and flow to form a bond.

We have found that we can form material containing a large percentage of organic material into stable blocks by bonding the material at or on the outer surface (i.e. the material at the die surface) leaving the material on the interior of the block closely compacted. By selectively roughening the die at particular areas for particular materials an optimum resistance can be established for particular materials. Thus, many materials not heretofore thought to be capable of being formed into stable blocks can be done so in accordance with the subject invention.

The surface temperatures of the material (i.e. at the die face) has been found to be critical to the formation of stable blocks from these materials without the addition of binders. The process requires that the outer surface of the material (at the die face or surface) reach it's bonding temperature, about 300 degrees F. to 600 degrees F., for most materials shortly after entering the die and then cool down to it's stabilizing temperature of about 120 degrees F. to 175 degrees F. at the exit of the die. Thus, the dies normally require preheating, and in some instances the material may require preheating. In many instances, the dies can be heated to the required bonding temperature by running some of the material to be cubed through them.

The rising of the temperature occurs in the high friction area of the entrance to the die with the die and material beginning to cool down as soon as the material passes into the smoother area of the die. The heat from the surface migrates into the interior of the block or cube of material lowering the surface temperature to a stable temperature. The system is therefore self stabilizing.

From the above description and the accompanying drawings, it can be seen that we have provided a new and useful method and apparatus for the cubing and pelletizing of various materials not heretofore able to be cubed or pelletized. In addition, we have provided apparatus that has long and unusual die life. The dies are of a construction both as to configuration and materials which contribute both the optimum functioning of the cubing and pelletizing function, as well as contributed to a long and useful life of the die itself.

While we have illustrated and described our invention by means of specific embodiments, it is to be understood that numerous changes and modifications may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

Having described our invention, we now claim:

CLAIMS:-

1. An apparatus for making stable blocks from fragments of organic materials, comprising:

means for adjusting the content of the particles,

extruding means including a die and means for forcing said particles into said die at high pressure, and said die including high resistance means at the entrance thereof for resisting the entrance of said material into said die for thereby raising the pressure and temperature of at least a portion of said material to its fusion point.

2. The apparatus of claim 1, wherein said high resistance means comprises a roughened coating disposed solely at the entrance to said die.

3. The apparatus of claims 1 or 2 wherein the coating consists essentially of grains of material taken from the group consisting of tungsten carbide, silicon carbide, vanadium carbide, titanium carbide, and diamonds in a matrix of binder material.

4. The apparatus of claim 3 in which the coating has a smoothness of the order of between 80 and 160 microinches, and the remaining portion of said walls having a smoothness of between about 5 and 20 microinches.

5. The apparatus of claims 1 to 4 wherein said die comprises a pair of spaced apart blocks connected together by means of a wedge shaped web for thereby defining a pair of rectangular channels having a uniform depth throughout the length thereof, said web having a flat forward end.

6. The apparatus of any of claims 1 to 5 wherein high wear areas adjacent the entrance to said die are undercut and the undercut filled with a material of high wear resistance.

7. The apparatus of any of claims 3 to 6 wherein

said binder material is an alloy taken from the group consisting of nickel, chrome, boron, silicon, iron, and carbon; nickel, chrome and boron; and tungsten carbide particles in a nickel alloy matrix.

8. A method of forming stable blocks of organic material, said method comprising the steps of:

selecting a mass of organic material in the form of multiple particles,

selecting a die of a desired shape,

forcing said mass of organic material through said die and simultaneously therewith applying a pressure to said mass of between 4,000 and 10,000 pounds per square inch and raising the temperature of at least the outer surface of said mass to between 300 and 500 degrees F. and maintaining said mass under pressure and temperature for a period of time sufficient to stabilize said mass to a stable block.

9. The method of claim 18 wherein the moisture content of said mass is adjusted between about 10% and 40% by weight.

10. The method of claims 8 or 9 wherein the period of time of pressure and temperature on said mass is selected by selecting the length of the die to have a length of between 6 and 12 inches.

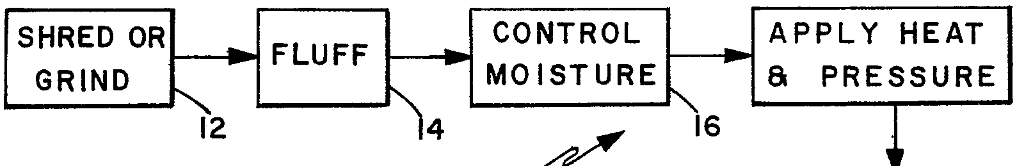

Fig. 1

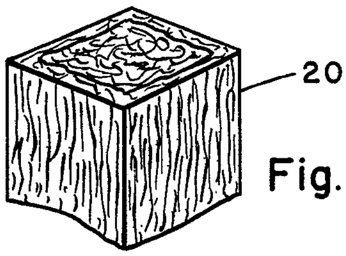

Fig. 2

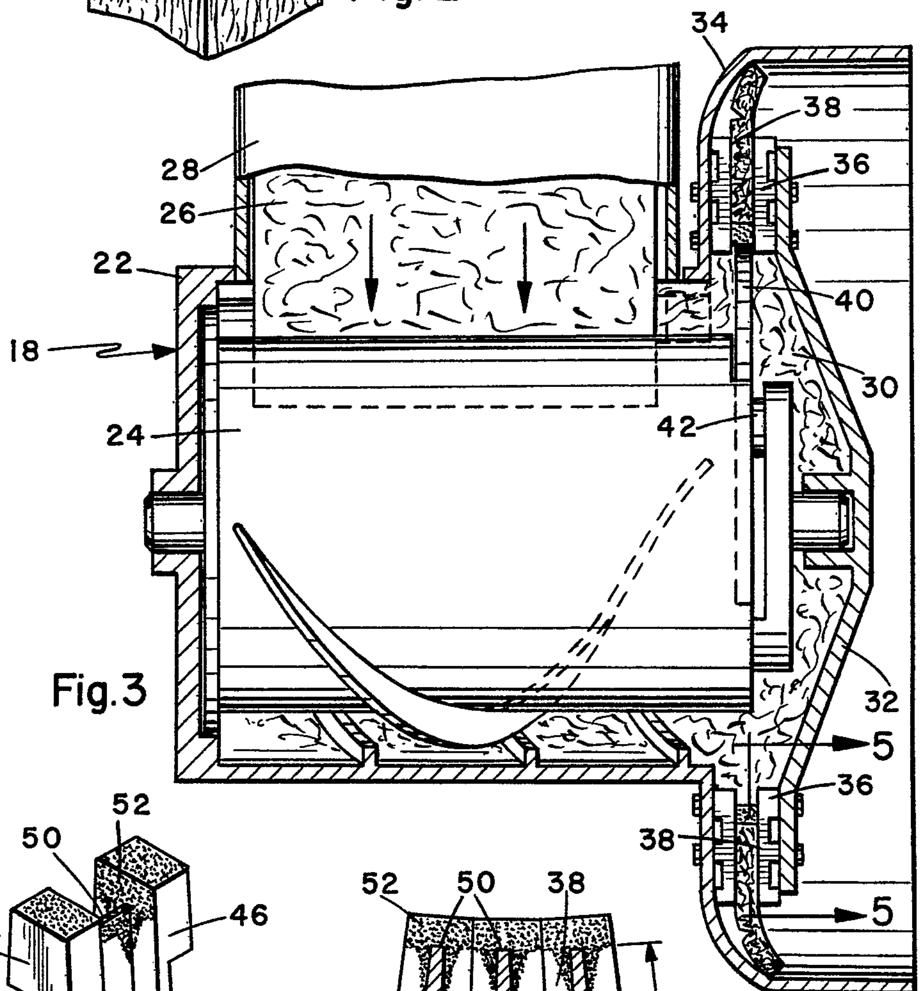

Fig. 3

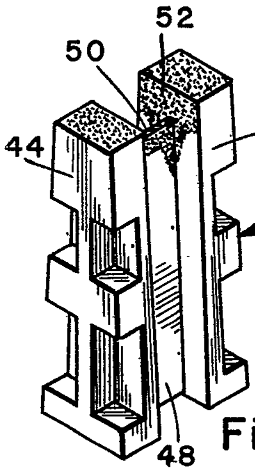

Fig. 4

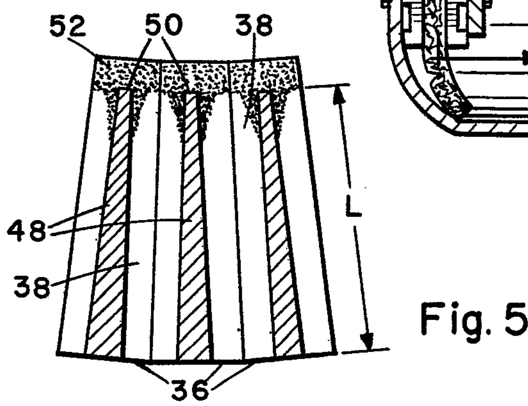

Fig. 5

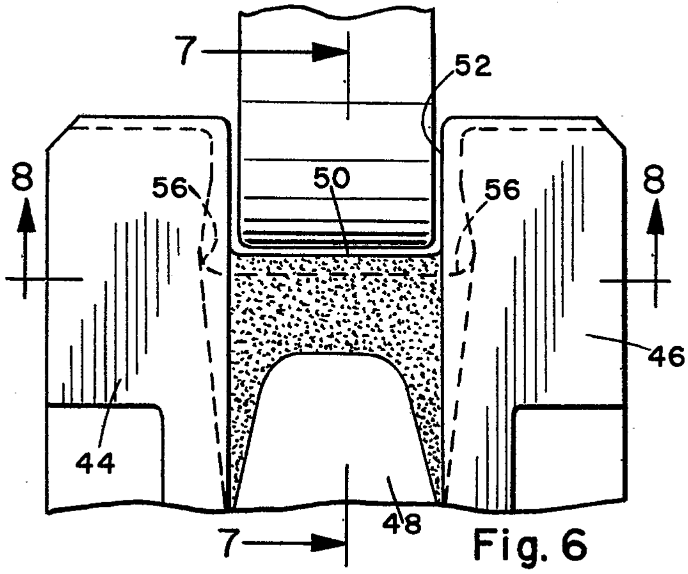

Fig. 6

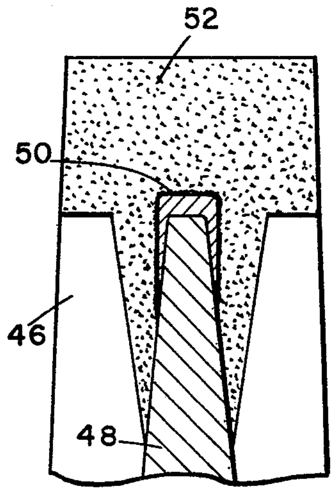

Fig. 7

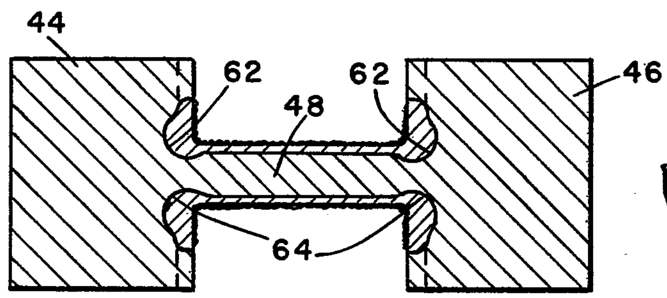

Fig. 8

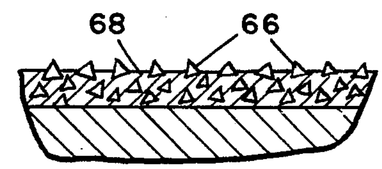

Fig. 9

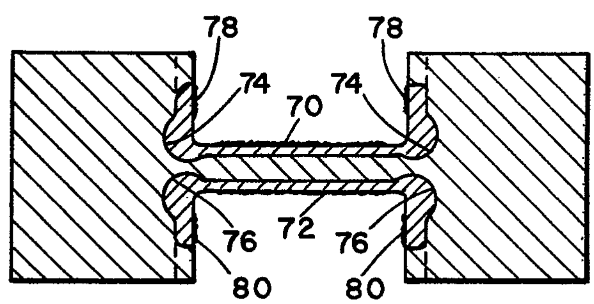

Fig. 10

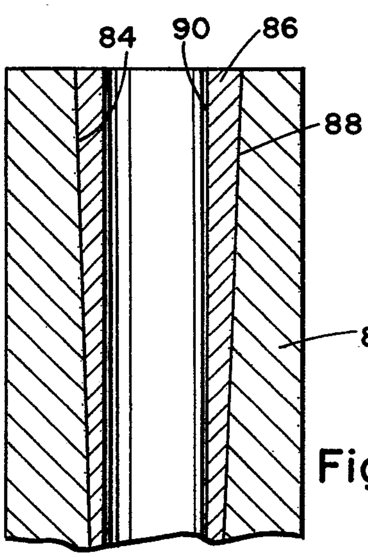

Fig. 11

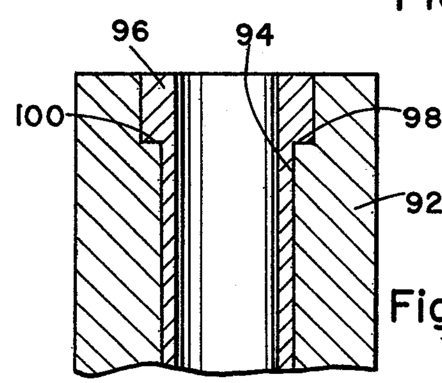

Fig. 12