March 15, 1966 E. E. EYRE, JR 3,240,573

APPARATUS FOR MANUFACTURE OF SYNTHETIC FUEL LOG

Filed Aug. 5, 1963 4 Sheets-Sheet 1

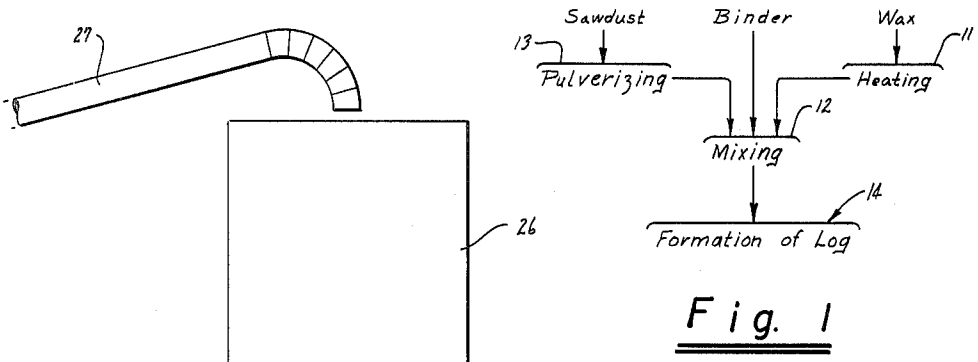


Fig. 1

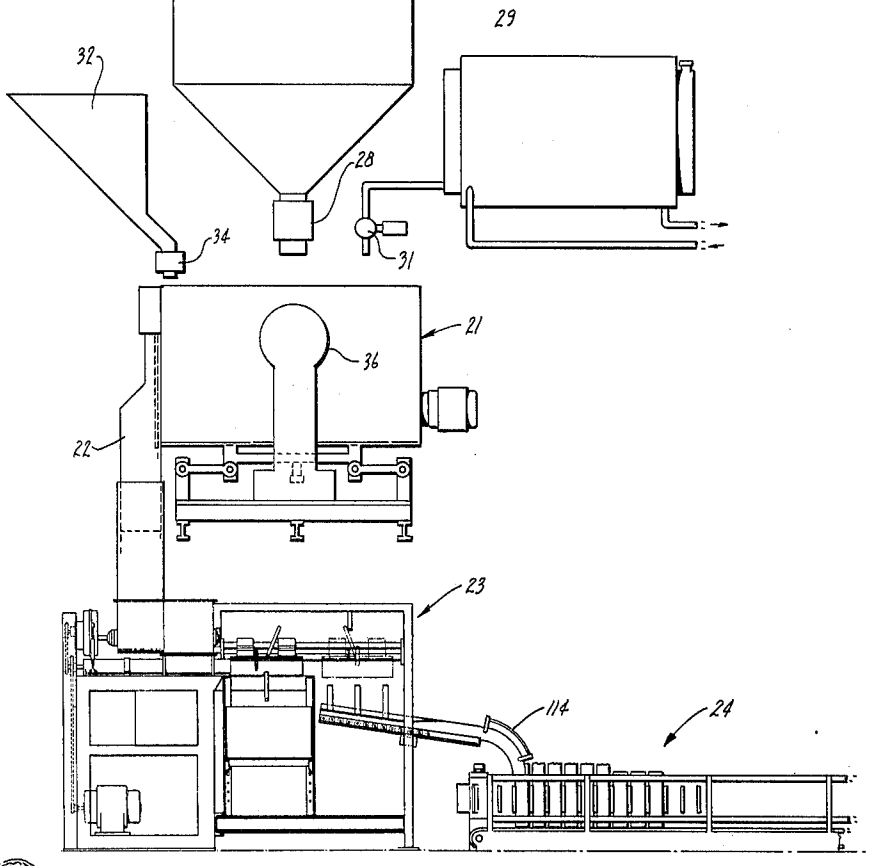


Fig. 2

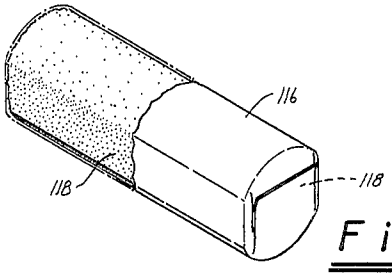


Fig. 8

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APPARATUS FOR MANUFACTURE OF SYNTHETIC FUEL LOG

Filed Aug. 5, 1963 4 Sheets-Sheet 2

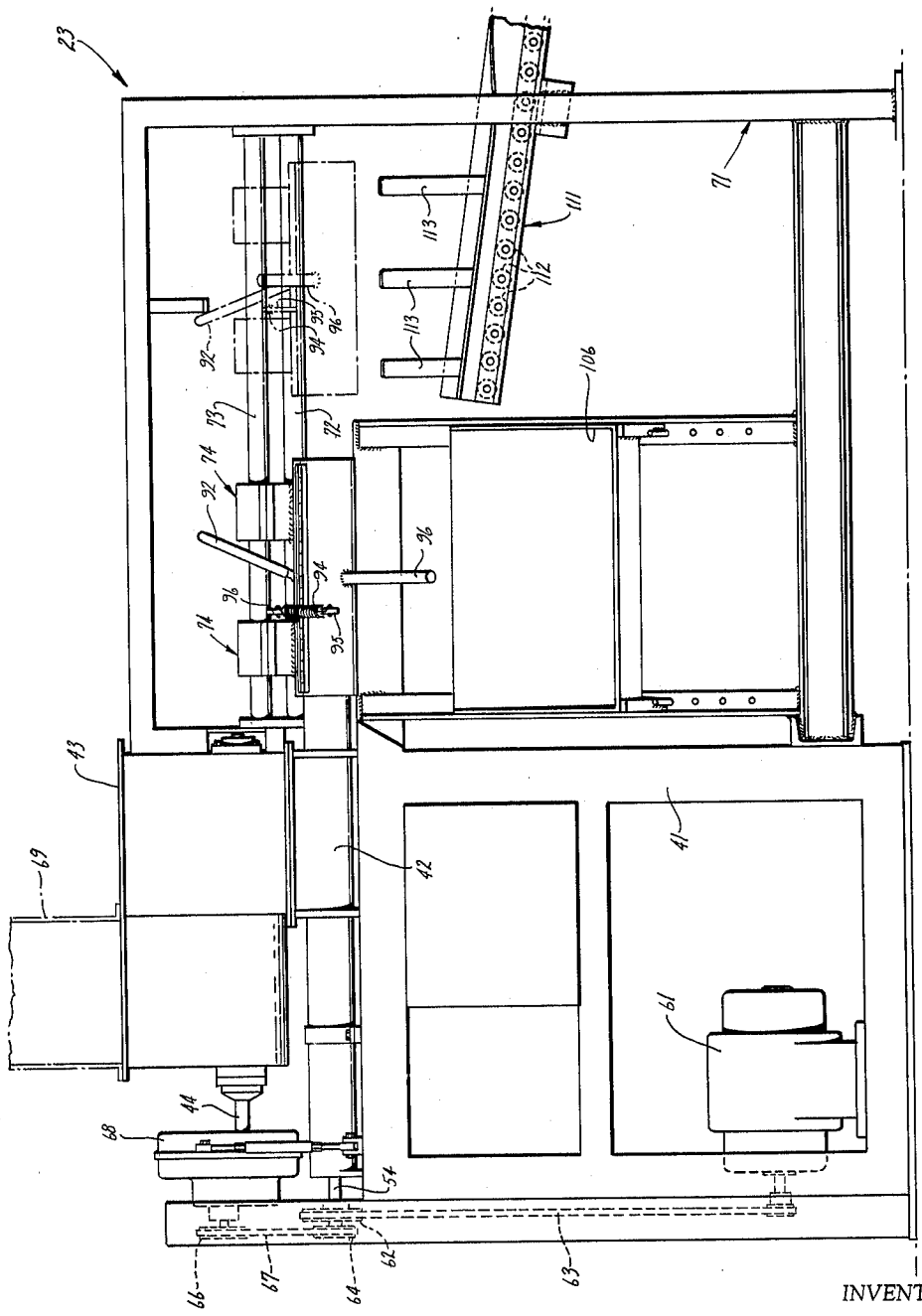


Fig. 3

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APPARATUS FOR MANUFACTURE OF SYNTHETIC FUEL LOG

Filed Aug. 5, 1963 4 Sheets-Sheet 3

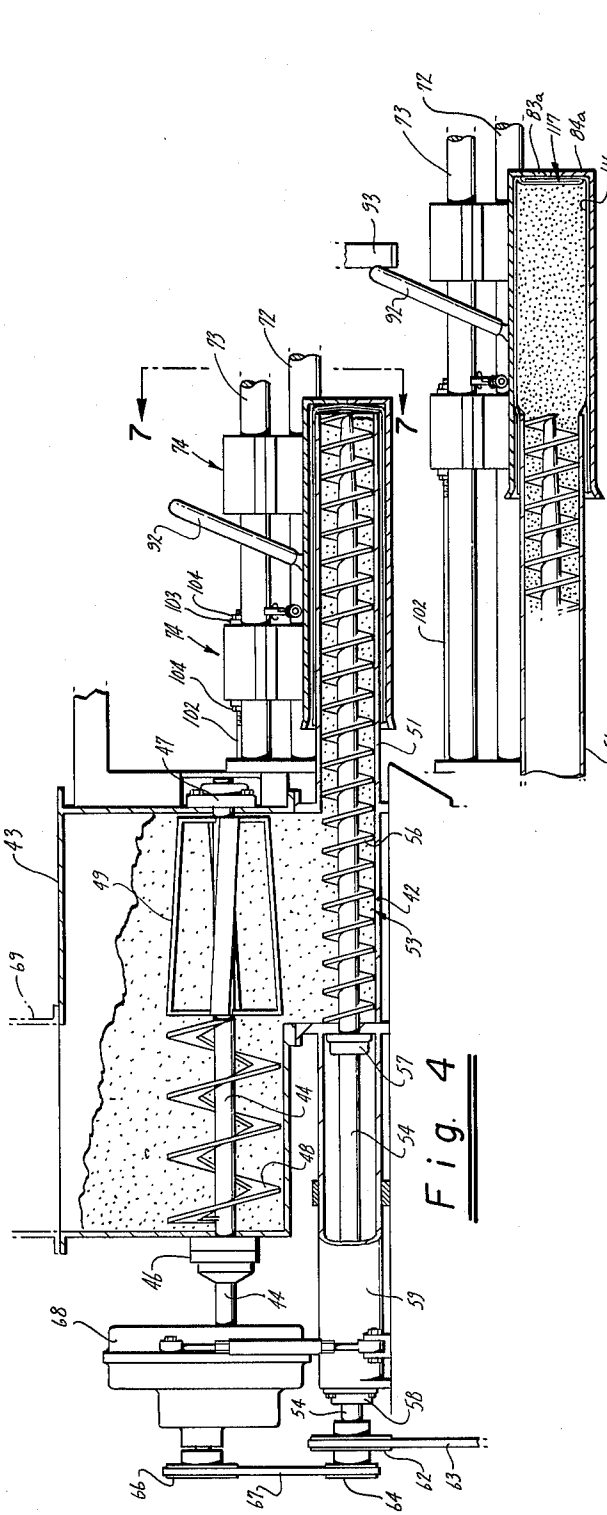


Fig. 4

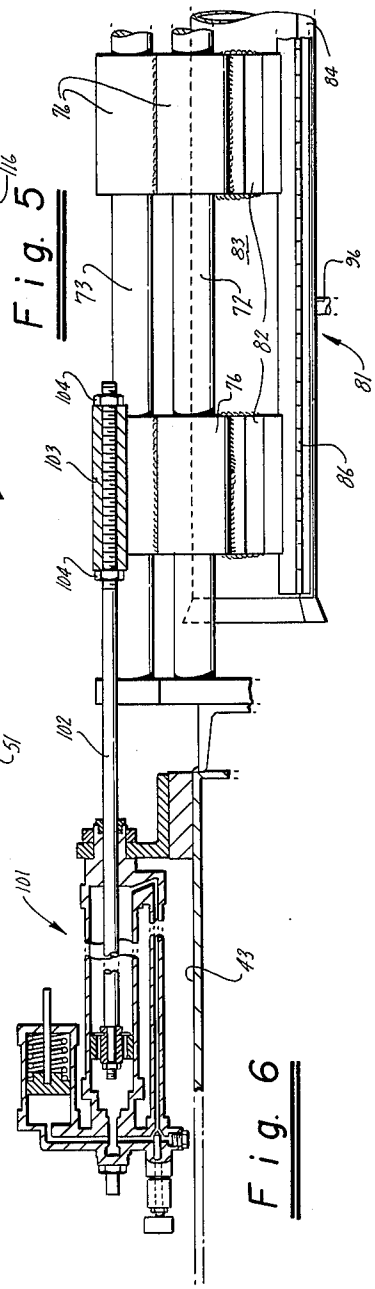


Fig. 5

Fig. 6

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APPARATUS FOR MANUFACTURE OF SYNTHETIC FUEL LOG

Filed Aug. 5, 1963 4 Sheets-Sheet 4

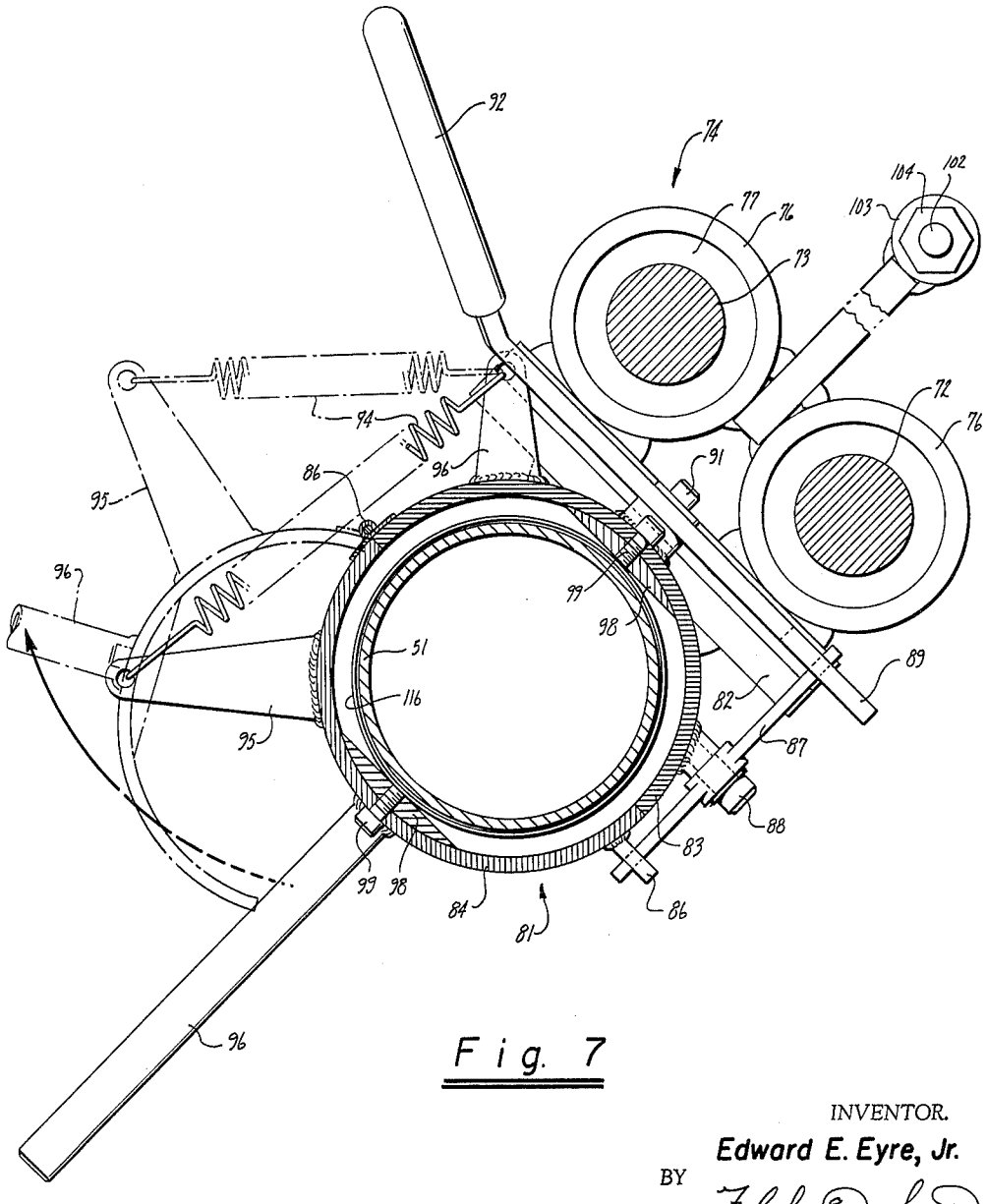


Fig. 7

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United States Patent Office 3,240,573 Patented Mar. 15, 1966

3,240,573
APPARATUS FOR MANUFACTURE OF SYNTHETIC FUEL LOG

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Filed Aug. 5, 1963, Ser. No. 299,760
4 Claims. (Cl. 44—13)

This invention relates generally to a synthetic fuel log, to the method or process for the manufacture of the same and to the apparatus used in the method or process for the manufacture of the synthetic fuel log.

There have been numerous attempts to manufacture synthetic fuel logs. However, up to the present time, such synthetic fuel logs have lacked many desirable characteristics. For example, the artificial fireplace log disclosed in Stevens Patent 2,789,890 requires the use of a liner of flame-resistant material. In addition, the method and apparatus utilized for manufacturing such an artificial fireplace log is unduly complicated and expensive. There is, therefore, a need for a new and improved synthetic fuel log together with a new and improved method and apparatus for the manufacture of the same.

In general, it is an object of the present invention to provide a synthetic fuel log which can be readily and economically manufactured.

Another object of the invention is to provide a synthetic fuel log of the above character which is largely formed of a basic flame-supporting wax and a combustible filler or extender.

Another object of the invention is to provide a synthetic fuel log of the above character which is covered with an oil-resistant covering.

Another object of the invention is to provide a synthetic fuel log of the above character in which the fuel log will remain reasonably intact during burning and can be turned over with a poker or other fireplace tool without breaking apart.

Another object of the invention is to provide a synthetic fuel log of the above character which ignites rapidly and which will burn evenly and briskly for a relatively long period of time.

Another object of the invention is to provide a synthetic fuel log of the above character which, during burning, will give off a substantially uniform flame which virtually surrounds the log.

Another object of the invention is to provide a synthetic fuel log of the above character which will burn without objectionable odor or smoke.

Another object of the invention is to provide a method or process and apparatus by which the synthetic fuel logs can be readily formed.

Another object of the invention is to provide a method or process and apparatus of the above character for the manufacture of a synthetic fuel log in which the synthetic fuel log is extruded directly into an oil-resistant cover.

Additional objects and features of the invention will appear from the following description in which the preferred embodiment is set forth in detail in conjunction wtih the accompanying drawings.

Referring to the drawings:

FIGURE 1 is a flow sheet illustrating one procedure for carrying out the present invention.

FIGURE 2 is a side elevational view of apparatus incorporating my invention for manufacturing synthetic fuel logs in accordance with the procedure shown in FIGURE 1.

FIGURE 3 is an enlarged detail side elevational view of the apparatus for forming the synthetic fuel logs.

FIGURE 4 is an enlarged cross-sectional view of a portion of the apparatus shown in FIGURE 3.

FIGURE 5 is a partial cross-sectional view of a portion of the apparatus shown in FIGURE 4 showing a bag almost completely filled.

FIGURE 6 is a top plan view, partially in cross-section, of a portion of the apparatus shown in FIGURE 3.

FIGURE 7 is an enlarged cross-sectional view taken along the line 7—7 of FIGURE 4.

FIGURE 8 is an isometric view of a synthetic fuel log made in accordance with the present invention.

The present invention involves the production of a synthetic fuel log from a flame-supporting material which is solid at room temperature. A filler or extender of a combustible type is combined with the flame-supporting material. The flame-supporting material and the extender are combined with a binder to provide an elongate synthetic fuel log which will remain intact during burning.

Referring first to the simplified flow diagram shown in FIGURE 1, the flame-supporting material which can be in the form of a wax is heated as shown in step **11**. It is then combined in a mixing operation **12** with a filler or extender such as sawdust. The sawdust can first be pulverized in step **13** to provide a filler or extender which is substantially uniform in size. The filler can also be dried in step **13** to stabilize a standard level of moisture within. This will increase the filler's ability to absorb the wax and will improve the log's initial kindling and eventual combustibility. A binder is also supplied to the mixing step. After the materials have all been properly intermixed in the mixing step **12**, the mixture can be formed into logs as indicated by the step **14** by preferably compacting the mixture into the desired shape by the utilization of pressure. Thereafter, the shaped log is allowed to cool and solidify into a mass which will remain cohesive at room temperature and which will remain reasonably intact while burning.

A machine or apparatus suitable for forming synthetic fuel logs from the ingredients or materials indicated in FIGURE 1 is shown in FIGURES 2–6. This apparatus consists of a conventional type Marion mixer **21**, such as that manufactured by Rapids Machinery Co. Inc., mounted on a conventional type tank scale **21***a* such as that manufactured by Howe Richardson Scale Co., of Clifton, New Jersey. The mixing and weighing apparatus **21** is provided with a discharge hopper **22** which supplies the mixed product to a packer **23** which forms the synthetic fuel logs in bags. The bags are supplied to a moving conveyor **24**, after which they are moved to a sealing or closing station (not shown).

The apparatus also consists of a large storage hopper **26** which is utilized for storing a supply of a suitable filler or extender such as sawdust which is supplied to the hopper through a supply pipe **27**. The hopper is provided with a discharge gate **28** so that a controlled amount of the sawdust or other material carried within the hopper **26** can be supplied to the mixing and weighing apparatus **21**. A heated tank **29** contains a suitable flame-supporting material such as wax which can be supplied to the mixing and weighing apparatus **21** through a valve **31**. The wax can be heated to the desired temperature by steam, or water or heated air supplied to piping **32**. Means is provided for supplying a suitable binder to the mixer **21** and consists of a hopper **33** which is provided with a gate **34** for feeding controlled amounts of binder to the mixer **21**.

The mixing and weighing apparatus **21** includes a scale **36** so that each component for the mixture to be mixed within the mixture **21** can be carefully weighed into the mixer, either manually or by automatic means (not shown).

The packer **23** in many respects is similar to a bag

packer Model DX VP manufactured by the H. L. Stoker Company of Claremont, California. This packer consists of a frame **41** with a barrel **42** mounted on top of the framework. A hopper **43** is mounted on top of the barrel and is open at the bottom forward end so that material in the hopper can be fed into the barrel **42** which is open on its top side. A shaft **44** extends longitudinally of the barrel and is rotatably mounted in bearings **46** and **47** affixed to the ends of the hopper. A helical agitator **48** is mounted upon the rear portion of the shaft **44** within the hopper **43** and a cone-shaped member **49** is mounted upon the shaft in the forward end of the hopper and overlying the opening to the barrel.

An elongate spout **51** is formed as an integral part of the barrel **42** and extends axially therefrom. An elongate filling auger **53** is mounted within the barrel **42** and the spout **51** and consists of an elongate shaft **54** upon which is mounted a helical flight **56**. The shaft **54** extends rearwardly and is supported by bearings **57** and **58** mounted upon a tubular extension enclosing the shaft **54**.

Suitable means is provided for driving the shafts **44** and **54** and consists of an electric motor **61** mounted upon the base **41** and driving a pulley **62** affixed to the shaft **54** by a belt **63**. Another pulley **64** is mounted on the shaft **54** and drives another pulley **66** through a belt **67**. The pulley **66** is mounted upon input shaft of a speed reducer **68** which is connected to the shaft **44**.

A feed chute **69** is mounted on the hopper **43** and is adapted to receive material from the chute **22** provided on the mixer **21**. An additional frame **71** is mounted on the frame **41** and to the hopper **43**. A pair of spaced parallel shafts **72** and **73** extending longitudinally of the frame **71** and parallel to the axis of the spout **51** are mounted within the framework **71**. A pair of bearing assemblies **74** are slidably mounted on the shafts **72** and **73** and each consists of a pair of sleeves **76** slidably mounted upon the shafts **72** and **73** by suitable means such as bearings **77**.

A bag retaining housing assembly **81** is secured to the bearing assemblies by brackets **82**. The housing assembly **81** consists of a pair of semi-circular elongate sections **83** and **84** in which section **83** is secured to the brackets **82** and in which the section **84** has one side thereof secured to one side of the section **83** by suitable means such as a piano hinge **86**. The section **83** and **84** are provided with end portions **83***a* and **84***a*, respectively, which form a closed end for the housing assembly **81**. Means is provided for releasably securing the other side of the semi-cylindrical section **84** to the other side of the semi-cylindrical section **83** and consists of a latch **86** secured to the section **84** and which is adapted to be engaged by a latch member **87** pivotally mounted upon a pin **88** secured to the section **83**. Means is provided for operating the latch member **87** and consists of a lever **89** which is pivotally mounted upon a pin **91** also secured to the section **84**. A handle **92** is mounted on the lever **89** to facilitate operation of the lever. Means is provided for causing automatic operation of the lever **92** and consists of a fixed arm **93** which is engaged by the lever **92** as hereinafter described.

Means is provided for retaining the latch **86** and the latch member **87** in engagement with each other to retain the two sections **83** and **84** in a closed position and consists of a spring **94** which has one end secured to an arm **95** affixed to the section **84** and the other end secured to an arm **96** affixed to the section **83**. Means is provided for moving the section **84** into a closed position against the force of the yieldable spring **94** and consists of a handle **97** which extends radially from the section **84**.

Means is provided within the housing **81** for shaping the log which is formed therein, as hereinafter described, and consists of sector-shaped members **98** secured to the inner surfaces of the sections **83** and **84** by suitable means such as cap screws **99**. As shown, the members **98** are dimensioned so that they clear the spout **51**.

Means is provided for adjustably controlling the force which must be provided to shift the bag housing or holder **81** to the right as viewed in FIGURE 4. As shown particularly in FIGURE 6, this means can consist of a hydraulic control assembly **101** of a suitable type such as that manufactured by Bellows-Valvair of Akron, Ohio. This hydraulic control assembly is provided with a shaft **102** which extends through a bracket **103** and which is secured to the bracket **103** by nuts **104**. The bracket **103** is affixed to one of the bearing assemblies **74**, as shown particularly in FIGURE 7 by suitable means such as welding. As is well known to those skilled in the art, such hydraulic control assemblies can be utilized to provide a fully adjustable opposing force to the forward or outward movement of the bag housing **81**. As soon as the forward movement has been completed, the bag holder can be rapidly and easily returned to its rearmost position because of check valve means provided in the control assembly **101**.

A bag holder **106** is mounted in the frame **71** adjacent the frame **41** and generally underlies the bag housing assembly **81** when it is in its rearmost position.

Means is provided for receiving the bags after they have been filled and are released from the housing assembly, as hereinafter described, and consists of a conveyor **111** which is provided with rollers **112**. The conveyor **111** is also provided with upstanding curved arms **113** which serve to prevent a filled bag from overshooting the conveyor **111** when it is discharged from the bag holder or bag housing assembly **81**. As shown in FIGURE 2, the conveyor **111** is provided with a curved member **114** which causes the filled bags to be turned downwardly so that they are deposited in an upright or vertical position in the conveyor **24**.

Operation of the apparatus is shown in FIGURES 2–7 for performing my method or process for the manufacture of synthetic fuel logs may now be briefly described as follows. Let it be assumed that the flame-supporting material is a wax and that it has been heated to the desired temperature in the heater **29** and that properly pulverized sawdust, to be used as the extender, has been supplied to the hopper **26**. Also, let it be assumed that a suitable binder has been supplied to the hopper **33** and that suitable quantities of all these materials have been supplied to the mixer **21** and that they have been thoroughly intermixed for the required amount of time in the mixer. Also, let it be assumed that a suitable quantity of this mixture has been supplied to the hopper **43** of the packer **23**. A folded bag **116** is then taken from the bag holder **106** and opened. As shown, particularly in FIGURES 4 and 5, one end of this bag is already sealed as shown at **117**. With the bag housing **81** in the open position shown in broken lines in FIGURE 7, the bag is placed over the spout **51** so that the spout **51** extends completely into the bag. Thereafter, the housing **81** is shifted to the left or to its rearmost position as viewed in FIGURE 4 and the section **84** moved to a closed position so that the latch member **87** engages the latch **86** to hold the bag upon the spout **51**. As soon as this has been completed, power is supplied to the motor **61** to drive the filling auger **53** and to also drive the agitating helix **48**. As the filling auger forces the mixture through the spout **51** and into the bag **116**, the bag **116** and the holder **81** are forced to the right as viewed in FIGURE 4 against the yieldable but constant force supplied by the hydraulic control assembly **101** so that the mixture is forced into the bag under a substantially uniform predetermined pressure to prevent bridging of the material and to obtain the desired even compaction within the bag. Even compaction is important to keep the log from breaking into segments during burning and to ensure even flames and uniform burning time.

Filling continues until the handle **92** engages the stop **93** which causes operation of the latch member **87** to release the lower section **84** of the housing **81** and to permit it to swing open under the force of the spring **94**. At the same time this occurs, means (not shown) is provided for denergizing the motor **61** to stop the operation of the filling auger **53**. The filled bag drops downwardly into the conveyor **111**, after which it is turned by the guide member **114** so that it drops downwardly into the conveyor **24** so that its closed end is on the bottom and its open end is facing upwardly. Thereafter, the bags are moved into a closing station (not shown) wherein the top ends of the bags are folded and sealed with suitable means such as glue or heat-sealing to provide a filled bag which has much the appearance of a fireplace log. For example, such a log can have a diameter of 5 inches and a length of 16 inches. In order to facilitate stacking of the logs, the sector-shaped members **98** which have been provided within the housing **81** form flats **118** on opposite sides of the logs, as shown in FIGURE 8.

As soon as a filled bag has been ejected from the packer, another open bag can be placed upon the spout and the same operation repeated. Thus, it can be seen that bags can be filled in succession rather rapidly with very little delay. The use of the hydraulic control assembly makes it possible to fill all the bags with a uniformly packed mixture. As soon as the mixture in the bag cools, the wax solidifies to provides a synthetic fuel log which is solid at room temperature.

Although I have described the operation of my synthetic fuel log with the utilization of a bag formed of a combustible material, the primary purpose of the bag is to retain the mixture in the desired shape during the time that the mixture is cooling to permit the wax to solidify and also to facilitate handling and shipping of the logs. If desired, the use of a bag or other enclosing material can be eliminated by the provision of means which cools the mixture as it is extruded so that the wax will solidfy to provide a rigid solid mass. The extruded material can then be cut or chopped into suitable lengths to also provide suitable fireplace logs. However, even though the log can be manufactured without an enclosing material, the aforementioned bag does provide certain advantages, i.e., it increases the log's attractiveness and makes it neat and clean to handle, even as an individual unit.

Although I have described the manufacture of my synthetic fuel logs with a batch type apparatus, it is readily apparent to anyone skilled in the art that my synthetic fuel logs can also be manufactured by apparatus utilizing a continuous process.

In the manufacture of my synthetic fuel logs, numerous parameters must be considered. In addition, the functions of the various components in the mixture must be clearly understood. For example, the sawdust which is utilized serves as a vehicle for sustaining the flame during the burning of the synthetic fuel log as, for example, in a fireplace. In addition, the sawdust also serves as a heating element. In other words, the sawdust acts as a substrate from which the wax can vaporize and burn. Without the provision of such an extender or substrate, the wax in and of itself would not combust. In order to obtain adequate combustion of the wax, it is necessary that adequate surface area be provided from which vaporization can occur.

There is a wide range of types of sawdust which is dependent upon the type of wood from which the sawdust is formed which can be used in making the synthetic fuel log. The sawdust from soft woods such as fir or pine will burn much more readily with a greater and hotter flame but will burn out more quickly. On the other hand, sawdust from certain types of hardwood such as ash or birch will last much longer but will not give a large flame. For this reason, in order to obtain optimum characteristics, a combination of sawdusts from different types of woods is most satisfactory. However, I have found

that any type of sawdust will form a satisfactory product. In order to obtain the desired uniformity in the product, it is preferable that the sawdust be pulverized so that any large wood chips and the like are properly sized.

Although I have described my synthetic fuel log as utilizing sawdust, other organic material substances can be utilized. For example, rice hulls or even shredded paper can be used to form a satisfactory product.

The primary flame-supporting material utilized in my synthetic fuel log consists of a wax. Various types of waxes can be utilized. However, I have found that a wax which is particularly suitable for use in the formation of a synthetic fuel log and which is also relatively economical is commonly known as "slack wax." Slack wax is not a fully refined wax. Fully refined waxes can be utilized, if desired.

As is well known to those skilled in the art, the slack waxes have not been completely de-oiled. Three primary characteristics can be utilized to describe a slack wax. They are: the distillation range, also known as boiling range, the melting point, and the molecular weight. The slack wax can also be characterized by the amount of two general types of waxes commonly known as paraffin wax and microcrystalline wax which it contains.

In analyzing the characteristics of slack wax which make it particularly desirable for use in my synthetic fuel log, I have found that the microcrystalline waxes in the slack wax provide the cohesive forces that maintain the log as a structural unit, whereas the paraffin waxes provide the desired volatility. The paraffin waxes are a relatively rigid, brittle material and in and of themselves normally would not provide sufficient cohesive forces for the synthetic fuel log.

The microcrystalline waxes suitable for use in my synthetic fuel log can have an initial boiling point ranging from approximately 650° F. up to and about 1200° F. The melting point of these same microcrystalline waxes can range from approximately 100° F. up to 200° F. The molecular weight for the microcrysatlline waxes can range from 280 to 1200. The percentage of microcrystalline waxes necessary to provide a suitable log having a satisfactory cohesive strength can range from approximately 20% to 50% by weight of the total weight of the slack wax. Above 75%, the volatility of the combustion product is so low that difficulties occur in maintaining proper combustion of the synthetic fuel log.

At the present time, there are two definitions of slack wax commonly used in the trade. One is whole slack wax which consists of whole wax fractions removed from a lubricating oil refining process without any distillation treatment or de-oiling treatment. The other is a partially defined de-oiled fraction from an intermediate stage in refining. The oil content of this fraction would be lower than that of whole slack wax. The oil content of slack wax may thus vary from 10% to 30% by weight. In general, slack wax contains approximately 50% of material boiling above 1000° F. and 50% of material boiling below 1000° F. The initial boiling point is approximately 750° F. However, it is possible that certain slack waxes may include paraffinic type hydrocarbons having a boiling point as low as 550° which would have a melting point of approximately 65° F. Normally, a slack wax having any substantial proportion of such paraffinic type hydrocarbons would be undesirable because of the low melting point of the same.

From the foregoing, it can be seen that two primary factors must be considered in the utilization of the slack wax. One is cohesiveness and the other is volatility. The cohesiveness is very desirable because it gives the synthetic fuel log structural strength which makes it possible for the log to retain its shape even while it is burning. The volatility of the slack wax is desirable in that it facilitates the starting of the fireplace log and its burning with a good consistent flame. However, the volatility should not be so great that the wax is a liquid at room

temperature which would cause the synthetic fuel log to fall apart while it is burning.

The characteristics of a typical slack wax which has proved to be very satisfactory for use in my synthetic fuel log are set forth below.

Melting point, ° F.	150.0
Refractive index at 80° C.	1.452
Viscosity at 210° F. SSU	60.5
Oil content, percent	19
Molecular weight, average	500

In order to obtain a completely satisfactory synthetic fuel log, it is necessary that the wax be absorbed into the surface of the wood fibers during the time that the synthetic fuel log is being manufactured. The degree of absorption must be sufficient so that there is wax available for evaporation from the wood fiber surfaces during burning of the synthetic fuel log and that there be a sufficient amount of wax left over to provide the necessary cohesive forces to bond the wood fibers together. If too much absorption takes place, there would be insufficient wax to form the proper bonds. This absorption can be readily controlled during the manufacturing cycle by maintaining proper temperatures during the mixture of the wax and the sawdust by control of sawdust moisture content.

With the sawdust having a heated temperature of between 80° F. and 120° F., I have found that the temperature of the wax, when it is mixed with the sawdust, can range from approximately 160° F. to 350° F. However, to properly control the sawdust absorption of the wax, it is preferable that the temperature of the wax be kept below 300° F. The time during which the mixture is agitated also determines the amount of absorption of wax by the wood fibers. However, I have found that with such temperature, the mixing can range from approximately 5 minutes to 15 minutes, under most situations.

If desired, combustion aids can be provided in the synthetic fuel log in order to increase the speed of combustion. Such combustion aids can be readily introduced in the mixer **21** and incorporated into the product. The types of combustion aids which can be utilized fall into two general categories. One is the type of combustion aid which influences the burning of the carbon deposits formed during the combustion cycle and the other is the type of combustion aid which influences the actual burning of the volatilized hydrocarbons.

The types of combustion aids which influence the ignition temperature of the carbon deposits formed during the cycle of combustion which have been found to be satisfactory are metal organic compounds such as lead naphthanate. Other metal organic compounds can be utilized. However, the organic metal radical selected to carry the metal must be one which will give solubility in the wax which is being used. This is desirable because the wax containing the metal will deposit on the wood fibers and will remain on the surface during the combustion cycle and will have its greatest influence on the residual material and will reduce the temperature at which the residual carbon will burn by a sufficient degree so that the ash material, instead of being a black carbonaceous material, is soft, white and nearly completely combusted material.

A combustion aid of the other type is "Ferrocene" manufactured and sold by Ethyl Corporation which is volatile and will flow with the wax components and be vaporized, and thus will influence the combustion of the vaporized hydrocarbons whether they come from the sawdust or from the wax.

Relatively small amounts of such combustion aids are required. For example, an amount less than .1% by weight should be more than adequate.

As hereinbefore explained, an additional binder is provided in order to prevent the synthetic fuel log from breaking up during burning. The microcrystalline waxes in the slack wax, hereinbefore described, serve as a low temperature binder and serve to prevent the synthetic fuel log from falling apart at temperatures ranging up to approximately 160° F. For higher temperatures, the additional binder is utilized to prevent the synthetic fuel log from falling apart because the wax tends to reach its melting point prior to being vaporized and, therefore, loses its cohesive qualities. The high temperature binder can be of any suitable type as, for example, a lignin product identified as ammonium lignin sulfonates and sugars. One such product is Orzan A manufactured and distributed by the Crown-Zellerbach Corp. Other high temperature binders can be utilized as, for example, "Toranil" manufactured by the St. Regis Paper Co. In addition, phenol formaldehyde and urea formaldehyde resins probably can be utilized although they have certain obnoxious products of combustion.

If a product such as Orzan A is utilized which is in powder form, the mixing operation in step 12 should be such that the Orzan A is thoroughly dispersed throughout the mixture.

In order to add to the aesthetic features of the synthetic fuel log while it is burning, certain additives can be added to the mixture **21** such as sodium nitrate which will cause sizzling and crackling and a popping during burning to simulate the action of a real wood log. In the place of sodium nitrate, sodium nitrite, ammonium nitrate and potassium nitrate can be utilized if desired.

By way of example, I have found that a synthetic fuel log formed of the following ingredients has very desirable characteristics.

	Percent by weight
Sawdust	42
Slack wax	48
Orzan A	5
Sodium nitrate	5

The sawdust was introduced into the mixer at a heated temperature of approximately 100° F. The Orzan A and sodium nitrate were introduced at an ambient temperature of 60° F. These ingredients were then mixed for a period of 10 minutes, after which the slack wax was sprayed into the mixer at a temperature of approximately 245° F. The product was then mixed for an additional 10 minutes, after which the fuel logs were formed in the packer.

Although the above example represents a preferred composition for my synthetic fuel log, satisfactory logs can be formed with the following ranges for the ingredients.

	By weight
Sawdust	25% to 75%
Wax	25% to 75%
Orzan A	2½% to 10%

The material for the aesthetic qualities can be omitted without affecting the quality of the synthetic fuel log.

Although the compaction of the mixture within the bag affects the burning characteristics of the synthetic fuel log, I have found that it is normally desirable to compact the mixture down. Thus, logs having a density ranging from 40 to 70 lbs. per cubic foot are quite satisfactory.

It is apparent from the foregoing that I have provided a new and improved synthetic fuel log and a method and apparatus for the manufacture of the same. The synthetic fuel log, because it is provided with an outer covering which is readily combustible, can be readily ignited. A log having a size of approximately 5 inches in diameter and 16 inches in length will burn evenly for over two hours and at the same time giving off a good and consistent flame which virtually surrounds the log and emits a very minimum of objectionable odors and smoke. Because the wax forms a low temperature binder and also because the high temperature binder is utilized, the log

will not break up during the burning even though it may be disturbed.

I claim:

1. In apparatus for the manufacture of synthetic fuel logs using elongate substantially cylindrical bags with a side wall and a closed end and with one open end, a mixing apparatus, means for supplying measured quantities of combustible particles and melted wax to the mixing apparatus, means for causing the mixing apparatus to mix the combustible particles and wax into a substantially homogeneous mixture, a packing apparatus having a substantially cylindrical elongate spout, means for supplying the homogenous mixture from the mixing apparatus to the packing apparatus, said packing apparatus including means for forcing the mixture through the spout, a bag holder adapted to receive a bag, said bag holder having a substantially cylindrical cavity open at one end for supporting the side wall and the closed end of the bag, said bag holder being dimensioned so that there is sufficient clearance between the spout and the bag holder to receive the bag and to permit the bag to receive the spout during the time the bag is supported by the bag holder and means mounting said bag holder on said packing apparatus permitting restrained relative axial movement between the spout and the bag holder, whereby said mixture is packed under substantially constant pressure in the bag as the mixture is forced from the spout.

2. Apparatus as in claim 1 wherein said bag holder is comprised of at least two parts movable between open and closed positions with respect to each other, said bag holder being disposed in a horizontal position so that when the bag holder is moved to an open position, the bag can drop therefrom by force of gravity and means positioned adjacent the bag holder for moving the bags into an upright position with their open ends facing upwardly after they have been filled and drop from the bag holder after the bag holder has been moved to an open position.

3. In apparatus for the manufacture of synthetic fuel logs using elongate substantially cylindrical bags with one closed end and one open end, a mixing apparatus, means for supplying measured quantities of combustible particles and melted wax to the mixing apparatus, means causing the mixing apparatus to mix the combustible particles and the melted wax into a substantially homogenous mixture, a packing apparatus having an elongate substantially cylindrical spout, means for supplying the mixture from the mixing apparatus to the packing apparatus, said packing apparatus including means for forcing the mixture through the spout, a bag holder having a substantially cylindrical cavity adapted to receive a bag, means mounting said packing apparatus and said bag holder to permit relative axial movement between the spout and the bag holder in which in a first position, the bag is disposed on the spout and the bag holder suports the bag so that it can be filled from the spout and a second position in which the bag is filled and is removable from the spout, said bag holder being dimensioned so that there is a space between the spout and the bag holder to receive a bag, and means mounting said bag holder on said packing apparatus permitting relative axial movement between said bag holder and said packing apparatus and including means restraining movement between the same from the first position to the second position so that the mixture is packed under pressure in the bag as the mixture is forced from the spout, said bag holder including means for opening the same to permit insertion and removal of bags into and from the cavity therein.

4. Apparatus as in claim 3 wherein said elongate spout is disposed in a horizontal position and wherein said bag holder is also disposed in a horizontal position and consists of first and second separable parts, latch means secured to the parts for retaining the parts in a closed position, means secured to the parts for yieldably urging the parts to an open position and means carried by the bag holder and the packing apparatus for automatically operating said latch means when said bag holder is moved to said second position to permit said parts to move to an open position under the force of the yieldable means and to thereby permit the filled bag to drop downwardly by force of gravity from the bag holder.

References Cited by the Examiner

UNITED STATES PATENTS

873,559	12/1907	Koontz	25—11
1,106,289	8/1914	Dymond	44—17
1,758,946	5/1930	Grupe	18—5
1,858,956	5/1932	Hepperle	25—14
1,983,560	12/1934	Palmer	44—17
1,990,632	2/1935	Bowling	44—10.02
2,015,001	9/1935	Bishop	25—11
2,107,054	2/1938	Haymond	44—41
2,164,950	7/1939	Shulze	44—13
2,215,536	9/1940	Bennett	44—14
2,789,890	4/1957	Stevens	44—41
2,849,300	8/1958	Berman et al.	44—17
2,885,727	5/1959	Wright	18—5
3,162,895	12/1964	Pusch	18—5

FOREIGN PATENTS

115,645	5/1919	Great Britain.
631,868	11/1949	Great Britain.

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