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(54) **COMPOSITE CARBONACEOUS FUEL  
COMPACT**

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(57) **ABSTRACT**

A carbonaceous compact is provided by the present disclosure that includes a body having a partially or fully carbonaceous biomass composition and an adhesive additive. The adhesive additive includes a starch and a hydroxide. The porous nature of the carbonaceous material provides means for nutrient retention or filtering means. Carbon is activated through chemical or thermal reaction from pyrolyzed wood/nut.

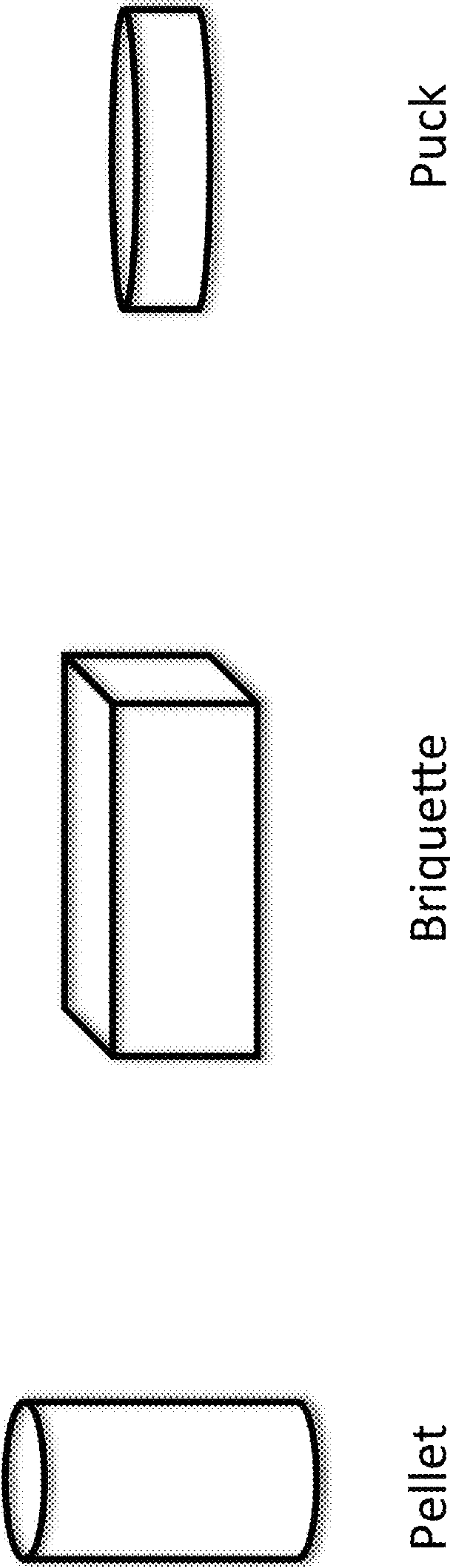


FIG. 1

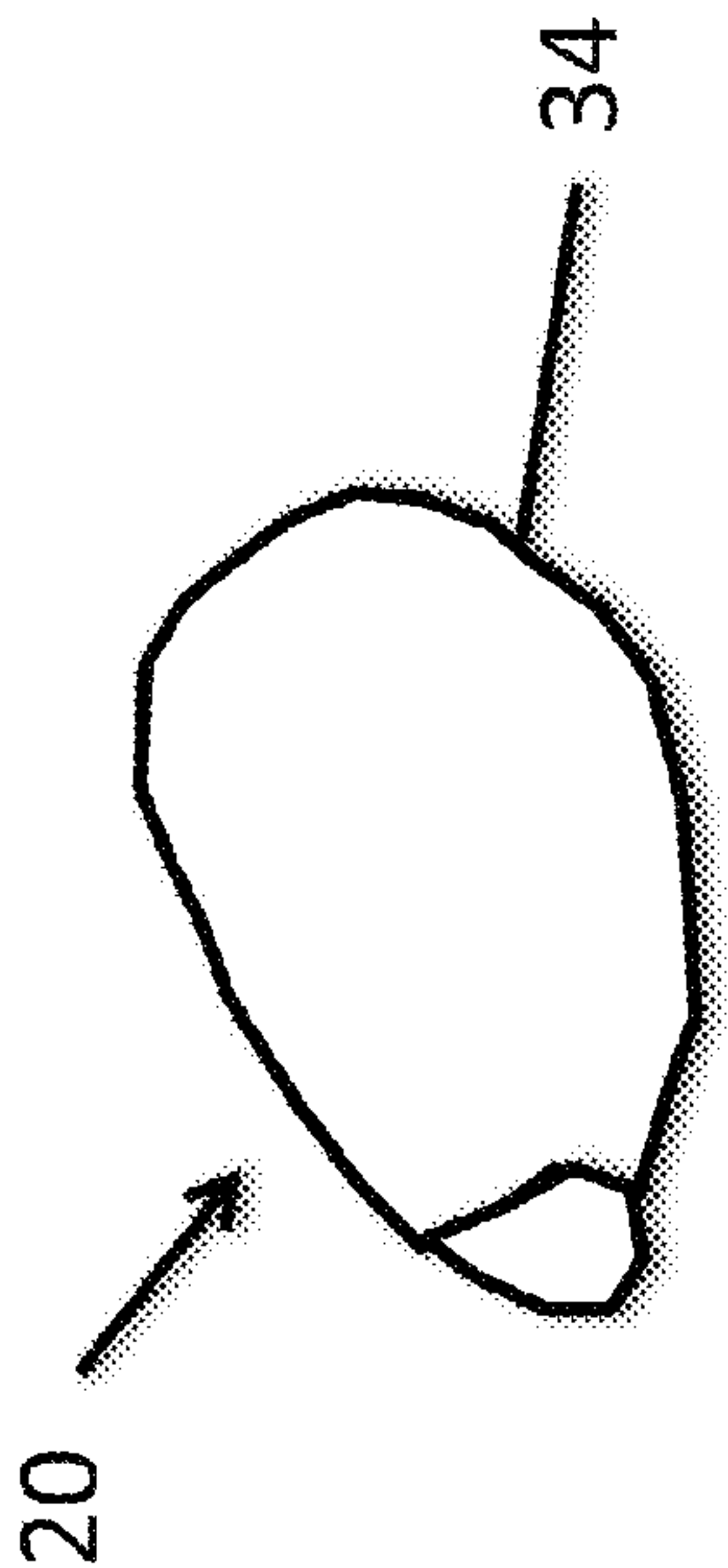


FIG. 2A

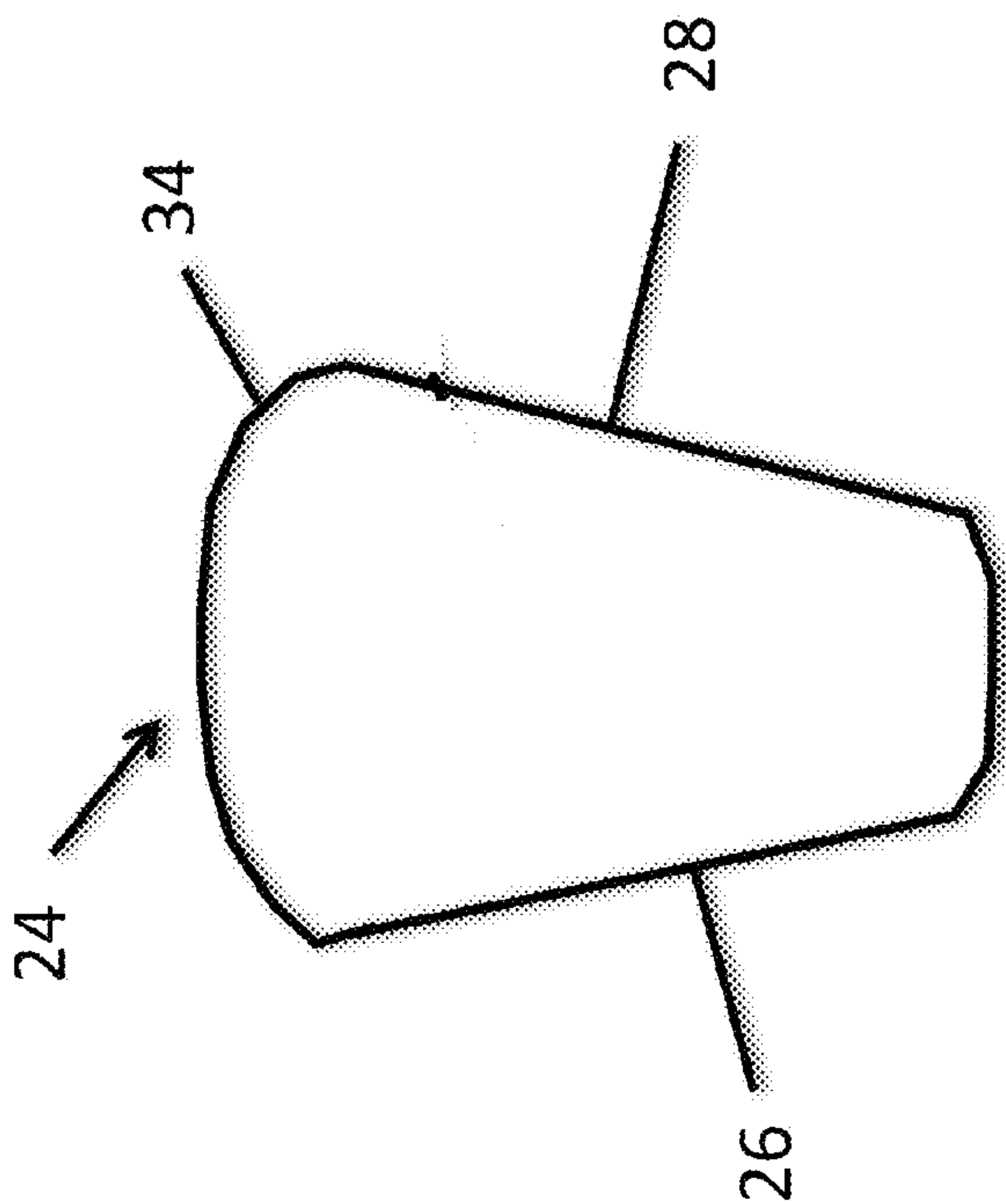


FIG. 2B

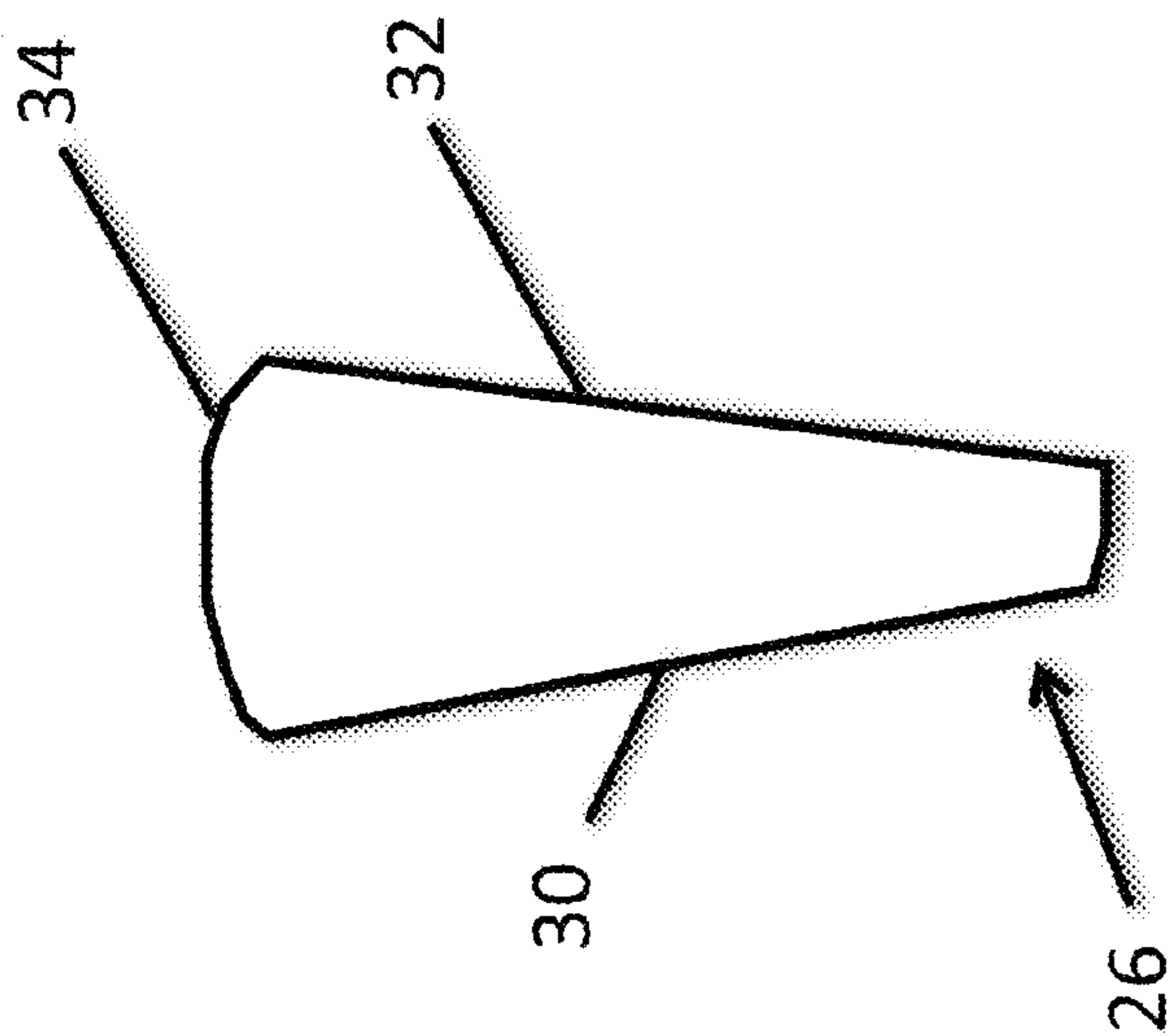


FIG. 2C



## COMPOSITE CARBONACEOUS FUEL COMPACT

### CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application is a continuation-in-part application of U.S. application Ser. No. 13/018,211, filed on Jan. 31, 2011, which claims the benefit of Provisional Patent Application Ser. No. 61/336,989, entitled “Improved Biomass Fuel Pellet,” filed Jan. 29, 2010, the contents of which are incorporated herein by reference in their entirety and continued preservation of which is requested. This application is also related to the U.S. application Ser. No. 13/018,155, titled “Biomass Fuel Compact Processing Method” and filed on May 26, 2011, the content of which is incorporated herein by reference in their entirety.

### FIELD

**[0002]** The present disclosure relates to bio-char and carbon from biomass sources.

### BACKGROUND

**[0003]** The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

**[0004]** With the recent emphasis on renewable energy sources, efforts have been made in the art to create so-called “biomass” materials, in which a bio-char and carbon combination of nutshell and waste are combined and processed to create an energy resource that can take the place of, or be combined with, for example, coal.

**[0005]** Bio-char is produced from any biomass source through low temperature carbonization termed “pyrolysis” at around 500 C., while carbon is produced also by pyrolysis above 518° C. to 572° C.

### SUMMARY

**[0006]** In one form of the present disclosure, a carbonaceous compact is provided that comprises a body having a combustible biomass composition and an adhesive additive, wherein the adhesive additive comprises a starch and a hydroxide.

**[0007]** In another form, a carbonaceous compact is provided that comprises biomass composition and an adhesive additive. The adhesive additive comprises at least one of a starch and a hydroxide.

**[0008]** In variations of these carbonaceous compacts, the hydroxide is selected from the group consisting of alkali metal hydroxides, alkaline earth hydroxides, sodium hydroxide, potassium hydroxide, calcium hydroxide, lithium hydroxide, and caustic soda. Further additives may also include a silicate additive, (which may be a liquid or powder form), and beneficial bacteria. Low temperature bio-char cannot use grass, which is a high cellulose material. Additionally, various geometries and compositions for the carbonaceous compacts are also provided by the teachings of the present disclosure.

**[0009]** Further areas of applicability will become apparent from the description provided herein. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

### DRAWINGS

**[0010]** In order that the disclosure may be well understood, there will now be described various forms thereof, given by way of example, reference being made to the accompanying drawings, in which:

**[0011]** FIG. 1 is a perspective view of various geometric forms of a body of a carbonaceous compact constructed in accordance with the principles of the present disclosure; and

**[0012]** FIG. 2A is a perspective view of an alternate form of a body for the carbonaceous compact in accordance with the principles of the present disclosure;

**[0013]** FIG. 2B is a front view of the alternate form of the body for the carbonaceous compact of FIG. 2A accordance with the principles of the present disclosure; and

**[0014]** FIG. 2C is a side view of the alternate form of the body for the carbonaceous compact of FIG. 2A accordance with the principles of the present disclosure.

**[0015]** The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.

### DETAILED DESCRIPTION

**[0016]** The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses.

**[0017]** According to the principles of the present disclosure, a carbonaceous compact is provided that comprises a body, which may be in any shape or form, such as the exemplary forms shown in FIG. 1. As indicated, the body 10 may be in the form of a pellet, a briquette, or a puck. It should be understood that these geometric forms are merely exemplary and thus they should not be construed as limiting the scope of the present disclosure.

**[0018]** The body 10 comprises a carbonaceous biomass composition that can essentially be any biomass materials, or combination of biomass materials, and/or their use waste. By way of example, these materials may include saw dust, cardboard and chipboard, grass, switchgrass, energy crops, hay, tree bark, sweetgum seed pods, pinecones, newsprint, wheat straw, duckweed, pine needles, mixed leaves, yard waste, agricultural waste, cotton waste, grape and wine offal, corn stover, crop stovers, peat, tobacco waste, tea waste, coffee waste, food processing waste, food packaging waste, nut meats and shells, chestnut hulls, pecan shells, paper waste, pallets, egg cartons, animal waste, livestock waste, mammal waste, and bone.

**[0019]** Advantageously, the carbonaceous compact is highly durable do to its inventive adhesive additive. Generally, the carbonaceous compact uses a Stein Hall type adhesive made from starch, or any other suitable material to replace the natural lignins as set forth above. In a Stein Hall adhesive, about 5% to 20% of the total starch content is gelatinized into a high viscosity paste called primary starch. The remainder of the starch (about 80% to 90%) stays ungelatinized and is called secondary starch. The starch may be one produced from wheat, oats, rice, corn, wheat middling, wheat waste or even wood and the like, but containing a gelatinized fraction that upon substantial drying will tightly bond the biomass composition.

**[0020]** Additionally, the adhesive additive includes a hydroxide. The hydroxide may be, for example, alkali metal hydroxides, alkaline earth hydroxides, sodium hydroxide, potassium hydroxide, calcium hydroxide, lithium hydroxide,



and caustic soda, among others. The synergistic combination of starch and hydroxide provide a highly durable carbonaceous compact, in which any number of constituent biomass materials may be used, without relying on any natural lignins or other undesirable binders.

**[0021]** In one form, the innovative adhesive is provided to bind the constituent biomass composition and also to form a substantially continuous shell around the exterior portion of the fuel compact. With this shell, the carbonaceous compact according to the present disclosure is highly durable and significantly reduces the traditional dust issues associated with biomass compositions, as set forth above.

**[0022]** In one exemplary composition of the present disclosure, the carbonaceous compact comprises, by percent weight, about 69-98% biomass composition, about 1-30% starch, and less than 1% hydroxide. Another composition is about 90-95% carbonaceous biomass and about 5-10% of the inventive adhesive additive.

**[0023]** Further additives are also provided by the present disclosure, which may include, by way of example, a silicate additive, (which may be a liquid or powder form). The silicate additive is included to provide added weather resistance and hydrogen bonding of carbonaceous biomass particles. The silicate may include sodium, potassium, or lithium, or mixtures of these three in one form of the present disclosure. Bacteria may be added. Bacteria is used to inoculate crops that sequester nitrogen from the air. Bacteria "*Aspergillus Niger*" or "arbuscular mycorrhizal fungi" breaks down biomass to element products releasing minerals for plant uptake Calcium (Ca), Magnesium (Mg), Phosphorus (P) and Potassium (K). In another form, the preservative may include sodium tetraborate or borax containing compounds at a concentration of about 1 to about 5%, and more particularly, about 1 to about 2%. Moreover, sodium silicate may be added to improve water repellency.

**[0024]** The additives may also include materials that will benefit the sequestering of carbon and nitrogen in soils. When calcium hydroxide is used as a source of hydroxide, it may react to form calcium silicate, which scavenges sulfur dioxide and nitrous oxides in air emissions from combustion in flue gas. When lithium hydroxide is used, it may react and form lithium silicate, which forms a zeolite capable of sequestering carbon dioxide from biogenic process.

**[0025]** In a further exemplary composition, the carbonaceous compact comprises about 50-95% biomass, about 5-50% starch, about 0.005-0.05% hydroxide, about 0.1-5% silicate additive, and about 0.1-2% bacteria. Further compositions according to the teachings of the present disclosure are set forth below in Table 1, with an exemplary target value for one biomass composition that comprises grass, corn stover, or a mixture thereof, according to the teachings of the present disclosure:

TABLE 1

	Biomass	Starch	Hydroxide	Silicate
Range	50-90%	5-50%	0.005-0.05%	0-5%
Target	60	10	0.02	2.5

**[0026]** Referring now to FIGS. 2A-2C, one innovative form of the body for the carbonaceous compact is illustrated and generally indicated by reference numeral 20. Generally, the body is modeled after a kernel of corn, which is has a hard outer shell, is transportable, has relatively flat sides, and an

advantageous aspect ratio in order to be highly durable for handling and downstream operations.

**[0027]** As shown, the body 20 has an upper portion 22, a lower portion 24, and tapered sidewalls 26, 28, 30, and 32 extending from the upper portion 22 to the lower portion 24, wherein the upper portion 22 is wider than the lower portion 24. In one form, the body 20 comprises rounded edges 34 as shown, in order to provide increased durability. The tapered sidewalls 26 and 28 are generally parallel and opposed as shown, as are the tapered walls 30 and 32. At least one of the tapered sidewalls 26, 28, 30, and 32 defines a flat surface in one form of the present disclosure. It should be understood that this geometry, along with the pellet, puck, and briquette as previously set forth, are merely exemplary and should not be construed as limiting the scope of the present disclosure.

**[0028]** Accordingly, a composite carbonaceous compact is provided by the present disclosure that is durable, that reduces the amount of dust normally associated with known biomass compositions, that is lower cost, higher efficiency.

**[0029]** The bio-char soil management can deliver tradable carbon emissions production. Pyrolyzed wood particles produced in accordance with the teachings of the present disclosure is in 7.6  $\mu$ m pellets with particle sizes from 0.125-0.005 inches.

**[0030]** Various forms of composite carbonaceous compacts described herein were tested for durability per the American Society of Agricultural and Biological Engineering ASABE S269.4, December 1991 (R2007) Sec. 5 Durability test standard. A "GAMET" Pellet durability test was utilized to run the testing experiments for 10 minutes @50 rpm at room temperature. A Pellet Durability Index (PDI) was defined by dividing the weight of the compacts before and after testing. After testing, the compacts are screened and the remaining whole compacts are weighted. The starting weight is standardized at 500 grams. The PDI equals the remainder after testing divided by 500 multiplied by 100 to arrive at a percentage.

**[0031]** Additional information related to various forms of the present disclosure are shown in Appendix A, which is incorporated herein by reference in its entirety.

**[0032]** It should be noted that the invention is not limited to the various forms described and illustrated as examples. A large variety of modifications have been described and more are part of the knowledge of the person skilled in the art. These and further modifications as well as any replacement by technical equivalents may be added to the description and figures, without leaving the scope of the protection of the disclosure and of the present patent.

What is claimed is:

1. A carbonaceous compact comprising:

a body comprising:

a carbonaceous biomass composition; and

an adhesive additive comprising:

a starch; and

a hydroxide.

2. The carbonaceous compact according to claim 1, wherein the hydroxide is selected from the group consisting of alkali metal hydroxides, alkaline earth hydroxides, sodium hydroxide, potassium hydroxide, calcium hydroxide, lithium hydroxide, and caustic soda.

3. The carbonaceous compact according to claim 1 further comprising at least one of a silicate additive, a viscosity additive, beneficial bacteria.



**4.** The carbonaceous compact according to claim **1**, wherein the biomass composition is selected from the group consisting of saw dust, cardboard and chipboard, grass, switchgrass, energy crops, hay, tree bark, sweetgum seed pods, pinecones, newsprint, wheat straw, duckweed, pine needles, mixed leaves, yard waste, agricultural waste, cotton waste, grape and wine offal, corn stover, crop stovers, peat, tobacco waste, tea waste, coffee waste, food processing waste, food packaging waste, nut meats and shells, chestnut hulls, pecan shells, paper waste, pallets, egg cartons, animal waste, livestock waste, mammal waste, and bone.

**5.** The carbonaceous compact according to claim **1** comprising, by percent weight:

69-98% biomass composition;  
1-30% starch; and  
less than 1% hydroxide.

**6.** The carbonaceous compact according to claim **1**, wherein the body has an upper portion, a lower portion, and tapered walls extending from the upper portion to the lower portion, wherein the upper portion is wider than the lower portion.

**7.** The carbonaceous compact according to claim **6**, wherein the body further comprises rounded edges.

**8.** The carbonaceous compact according to claim **1**, wherein the body comprises parallel opposed sidewalls and parallel opposed end walls, and at least one of the sidewalls defines a flat surface.

**9.** The carbonaceous compact according to claim **1**, wherein the body is selected from the group consisting of a pellet, a briquette, and a puck.

**10.** A carbonaceous compact comprising:  
a combustible biomass composition; and  
an adhesive additive comprising at least one of a starch and a hydroxide.

**11.** The carbonaceous compact according to claim **10**, wherein the hydroxide is selected from the group consisting of alkali metal hydroxides, alkaline earth hydroxides, sodium hydroxide, potassium hydroxide, calcium hydroxide, lithium hydroxide, and caustic soda.

**12.** The carbonaceous compact according to claim **10** further comprising at least one of a silicate additive and beneficial bacteria.

**13.** The carbonaceous compact according to claim **10**, wherein the carbonaceous compact comprises, by percent weight:

90-95% biomass; and  
5-10% adhesive additive.

**14.** A carbonaceous compact comprising:  
a body comprising:

a combustible biomass composition;  
an adhesive additive comprising:  
a starch; and  
a hydroxide;  
a silicate additive; and  
beneficial bacteria.

**15.** The carbonaceous compact according to claim **14**, wherein the carbonaceous compact comprises, by percent weight:

50-95% biomass;  
5-50% starch;  
0.005-0.05% hydroxide;  
0.1-5% silicate additive; and  
0.1-2% bacteria.

**16.** The carbonaceous compact according to claim **15** further comprising bacteria.

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