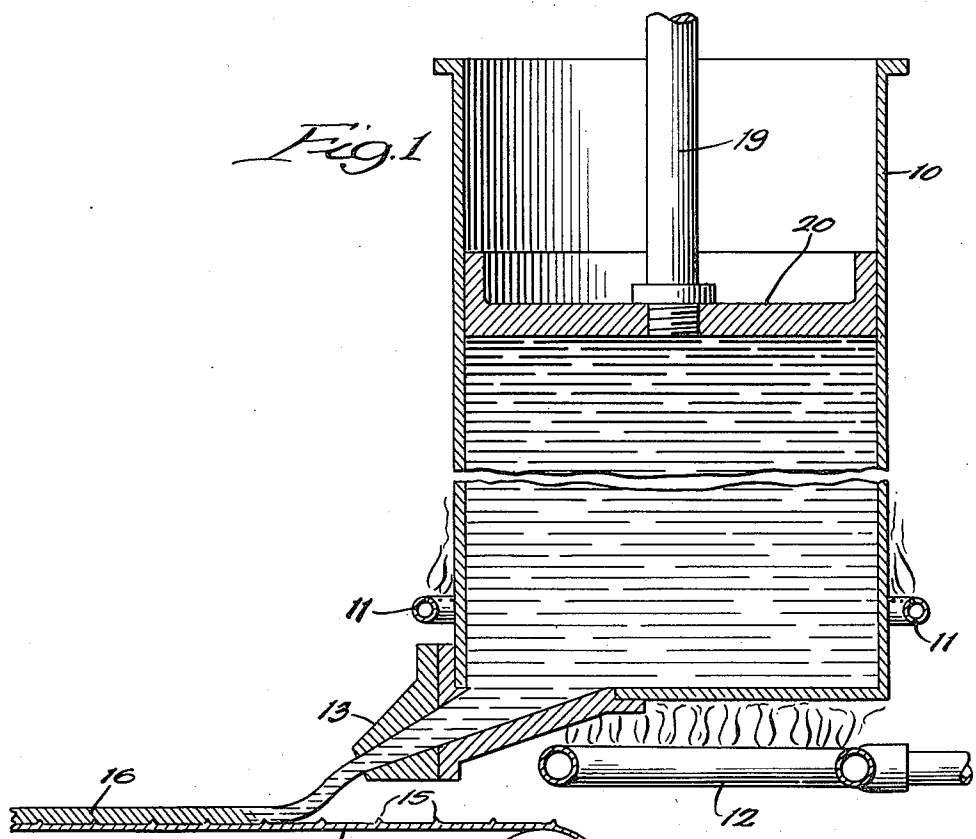
April 3, 1951 R. H. CHURCHILL 2,547,691

FUEL

Filed June 22, 1946

Fig. 1



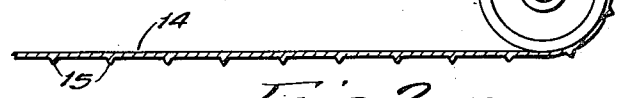


Fig. 2

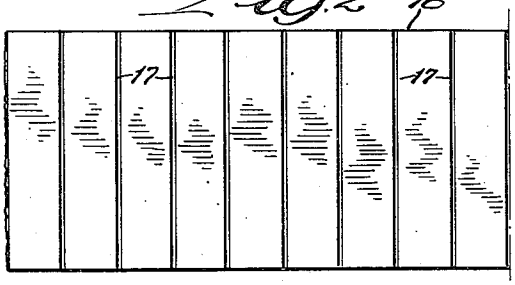


Fig. 3



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Patented Apr. 3, 1951

2,547,691

UNITED STATES PATENT OFFICE

2,547,691

FUEL

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Application June 22, 1946, Serial No. 678,677

4 Claims. (Cl. 18—55)

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This invention relates to fuel and more particularly to a compact block type of fuel which is useful for vulcanizing and other special operations.

For several decades, it has been customary to use a powdered metallic material including aluminum, lead, iron, etc. in combination with sulphur as a vulcanizing fuel. The product has serious disadvantages by reason of its powder form. Considerable care is required in measuring the quantity of fuel for the heating operation and it is common to put in too much or too little of the powder. Further, the powder is spilled in removing it from the container and in placing it in the mold. The powder condition further gives rise to greater hazard since there is always a possibility of dust explosions, etc. The keeping qualities of the product are not so good because of the exposure of the iron, etc. to the air, moisture, etc. Further, the material in powder form is difficult to light.

By reason of the above disadvantages, it has been desired for many years and for decades to provide a fuel of this character in block form which may be scored to provide accurate units for a vulcanizing operation and thus to avoid the hazard of explosions and the other above mentioned disadvantages. The desired product has not been produced and it has generally been regarded by the trade as infeasible to produce such a product because of the danger involved in melting such a mixture or portions thereof and because even if the sulphur shou'd be melted, the resultant product is a viscous mass resisting any effort to handle it or spread it with a spatula or other instrument.

Attempts have been made to tablet the aluminum, iron and sulphur powder by pressure means so as to avoid the above disadvantages but such efforts have been met with failure because the material does not form a compact block which remains fairly coherent. The tablet does not retain its form and because of its fragile character is useless as a means for maintaining a measured quantity of the fuel in unit form.

I have discovered that the metallic powder of the mixture can be compactly united in hard, coherent blocks and in a safe manner by the use of specific steps which will be outlined hereinafter, and an object of the invention is to provide a process for the production of fuel in such form. A further object of the invention is to provide a simple and effective process for forming metallic powder fuels in hard and compact blocks separable in units of pre-determined size

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so that accurate use of the fuel may be made for specific vulcanizing, etc. operations. Yet another object is to provide a new process in which aluminum and iron or the like, in finely divided form, may be united by molten sulphur in a solid and coherent product of a desired shape. Other specific objects and advantages will appear as the specification proceeds.

The process may be carried on in apparatus of any suitable type and more particularly in apparatus illustrated in the accompanying drawing, in which—

Fig. 1 is a broken vertical sectional view of apparatus in which the process may be carried out; Fig. 2, a broken bottom plan view of a portion of the block product produced in accordance with my invention; and Fig. 3, a top plan view of one of the segments broken from the block shown in Fig. 2.

In the illustration given in the drawing, 10 designates a container which may, if desired, be heated by burners 11 and 12. The container is equipped with discharge nozzle 13 for discharging the molten material in thin sheet form upon a conveyor 14. I prefer to equip the conveyor with transverse ribs 15 for forming indentations within the block 16. The ribs 15 form the indentations 17 extending transversely of the block so that the block may be broken up readily into separate strips or segments 18, as illustrated best in Figs. 2 and 3.

The container is provided with a presser shaft 19 secured at its lower end to a pressure head 20.

My new process comprises broadly the bringing together of sulphur, aluminum and a heat retaining metallic powder such as, for example, iron, thoroughly mixing the constituents, raising the temperature of the mixture to the melting point of sulphur, while applying pressure to cause the sulphur to flow through the mass and integrate the material. Preferably, the mixture is maintained in an extruding chamber and under pressure while the temperatures are being raised. When the temperature reaches the melting point of sulphur, the molten mass is discharged through the extrusion slot and it is found that the extruded material solidifies with great rapidity as it leaves the extrusion mold.

The aluminum powder, iron powder and a finely divided sulphur may be mixed in varying proportions while still obtaining satisfactory results. Generally, a mixture of the materials in about equal volume gives a very satisfactory product but such proportions may be varied considerably depending upon the specific form of

block product desired. A temperature in the neighborhood of 114° C. at which the sulphur begins to flow is found satisfactory, but since sulphur melts at different temperatures, there may be a variation in the temperature employed. I prefer the lower melting temperature as a safety precaution.

The heat retaining material may be any suitable metallic powder such as finely divided metallic iron, lead or other material.

The pressure may be varied considerably and, when the sulphur has reached a molten or plastic stage, need not be high. The product has been formed in plastic extrusion machines and at relatively low pressures. In fact, the product may be satisfactorily formed in sausage stuffing machines where suitable extrusion molds are provided. Pressures below 100 pounds per square inch have been employed with good results.

As a specific example, equal parts of sulphur, aluminum and iron by volume, all being finely divided, were mixed and placed in an extrusion mold and the mold heated to a temperature about 114° C. while maintaining a pressure in the neighborhood of 100 pounds upon the material. When the melting point of the sulphur was reached, an extremely quick extrusion operation resulted with the mass flowing through the extrusion slot and solidifying before the material had extended more than two feet. While the material was leaving the extrusion mold and while still plastic, the ribbon was scored at spaced distances to provide, as a final product, a strip of block material with score lines equally spaced therein.

The final scored strip product was hard, compact and coherent. It has the appearance of a gray, cast product with a smooth skin exterior and a compact interior. The product is hard but by reason of the scoring may be broken at the spaced intervals at which the score lines occur. In the use of the product, a unit will be broken off as needed along a score line and there is thus provided a measured amount of fuel of relatively small bulk and there is no possibility of loss of the material through spilling, etc. Further, the product keeps better in that the iron is coated by the outer skin of the block and by the sulphur, thus preventing oxidation. The block may be allowed to remain in water for several days and then upon being removed may be fractured and readily ignited. In contrast, the fuel in powder form when wetted with water in this manner cannot be ignited. With the new product there is substantially no fire hazard because no dust is present with which to produce an explosion, etc.

While the mixture mixed with molten sulphur becomes extremely viscous and is substantially impossible to handle in an open vessel, I find that it can be handled with extremely accurate results under pressure while in a plastic state. I prefer to extrude the mixture because the extrusion method responds quickly to the change that occurs in the sulphur at the melting point and produces a rapid discharge of molten material which sets almost immediately. However, it will be understood that the metal may be cast in different types of molds and otherwise treated while in plastic condition to obtain the desired solid block product. The product may be formed by calendering, as by heating and rolling under pressure and by other means.

I prefer, however, to extrude the material because of the speed in operation, the lack of hazard, and the excellent quality of the product.

The final product may be formed in any desired shape. I prefer to form the product in the shape of a thick ribbon having transverse scoring or grooves along the top or bottom thereof to permit ready breaking off of the desired individual units. It will also be understood that the product may be extruded in the form of sheets with longitudinal and transverse scoring to permit the quick separation of the individual rectangles, squares, or other shaped units.

The block is found to have a very smooth exterior surface or skin which because of its density and smoothness serves as a protector for the interior of the block which, while dense, may have small air spaces or openings therein.

While I have set out herein sulphur as the binder which integrates all the material, it will be understood that other suitable binders may be used. I prefere to employ combustible binders which are useful not only in burning, but also as a means for liberating oxygen. It will be understood, however, that any binder material which is combustible and which changes from a molten to a solid state, and thus unites the material, may be employed. By way of example, cellulose nitrate, resins (synthetic or natural), potassium nitrate, etc., may be used.

While in the foregoing specification I have set forth a description of the process and of the product in great detail, it will be understood that such details may be varied widely by those skilled in the art without departing from the spirit of my invention.

I claim:

1. A process for forming fuel in sheet form, comprising mixing sulphur, aluminum and iron, all in finely-divided form, confining the material under pressure in communication with an extruding, sheet-forming opening, raising the temperature of the mixture to the melting temperature of the sulphur whereby under the influence of pressure the mixture flows through the opening immediately upon the attaining of said melting temperature, and air-cooling the extruded material to form a solid sheet immediately after extrusion.

2. A process for forming fuel in sheet form, comprising intimately mixing sulphur, aluminum, and a heavy heat-retaining agent in the form of a metallic powder, all being in finely-divided condition, confining the mixed material under pressure and in communication with a sheet-forming extrusion opening, bringing the temperature of the mixture to the melting point of the sulphur whereby under the influence of pressure the mixture flows immediately upon the attaining of the melting temperature of the sulphur through the extrusion opening, and air-cooling the extruded material to solidify the sheet immediately following the extrusion.

3. A process for forming fuel in sheet form, comprising mixing sulphur, aluminum and iron, all in finely-divided condition and in substantially equal volumes, to form an intimate and uniform mixture thereof, confining the mixture in communication with a sheet-forming extrusion opening, subjecting the mixture to pressure, and bringing the temperature of the mixture to about 114° C. whereby under the influence of pressure the mixture upon reaching the above temperature flows through the extrusion opening to form an extruded sheet, and air-cooling the extruded sheet to solidify the same immediately after it leaves said extrusion opening.

4. A process for forming fuel in sheet form, comprising mixing sulphur, aluminum and iron,

all in finely-divided condition, to form an intimate and uniform mixture, confining the mixture in communication with a sheet-forming extrusion opening, subjecting the mixture to a pressure of about 100 pounds per square inch, heating the mixture to a temperature of about 114° C. whereby under the influence of pressure and the melting of the sulphur the mixture flows quickly through the opening to form an extruded sheet, scoring the extruded sheet, and cooling the extruded material to form a solid sheet.

RALPH H. CHURCHILL.

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