No. 771,675. PATENTED OCT. 4, 1904.

G. L. SMITH.

CRUCIBLE FURNACE AND CRUCIBLE.

APPLICATION FILED APR. 27, 1903.

NO MODEL.

FIG. 1.

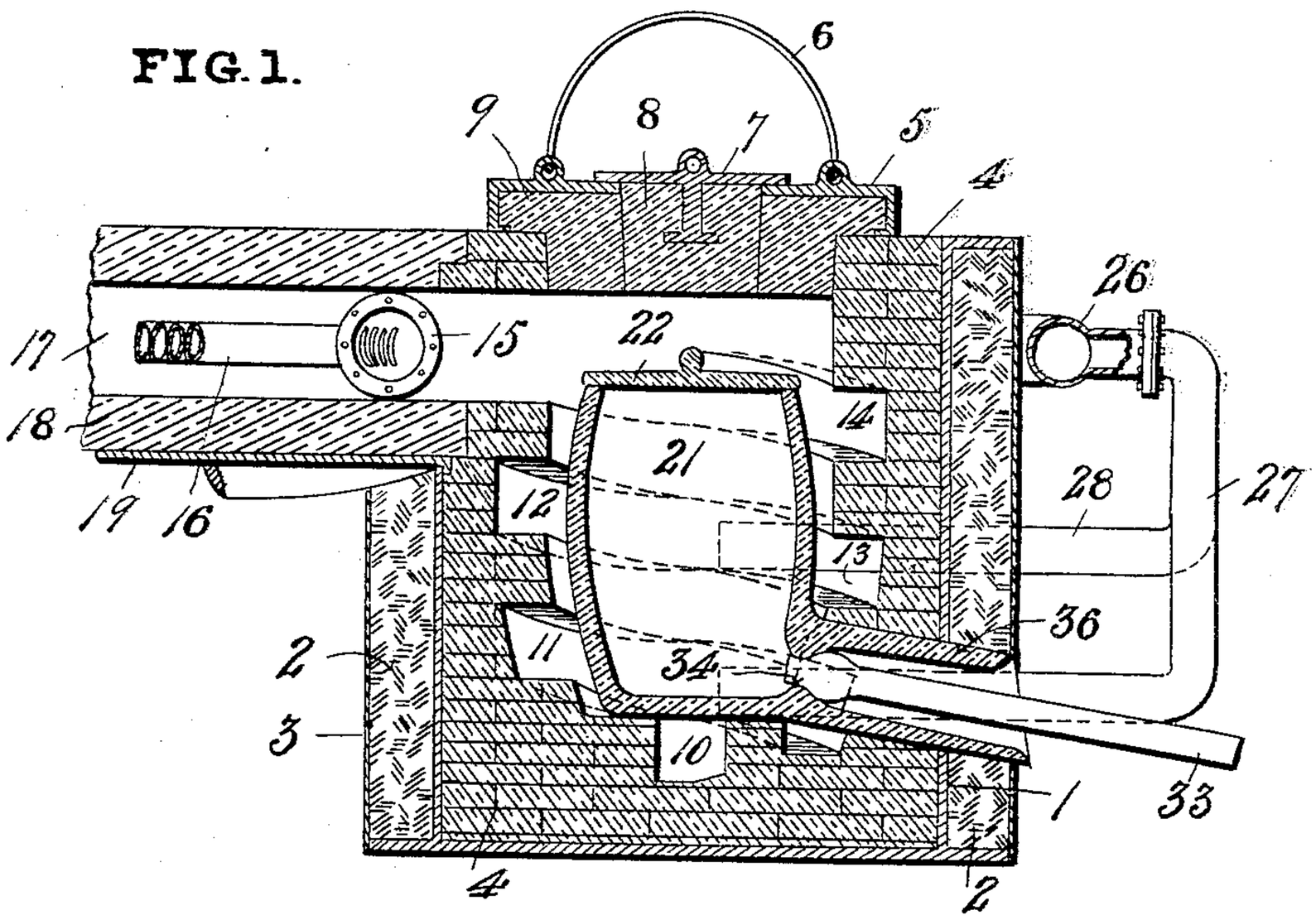
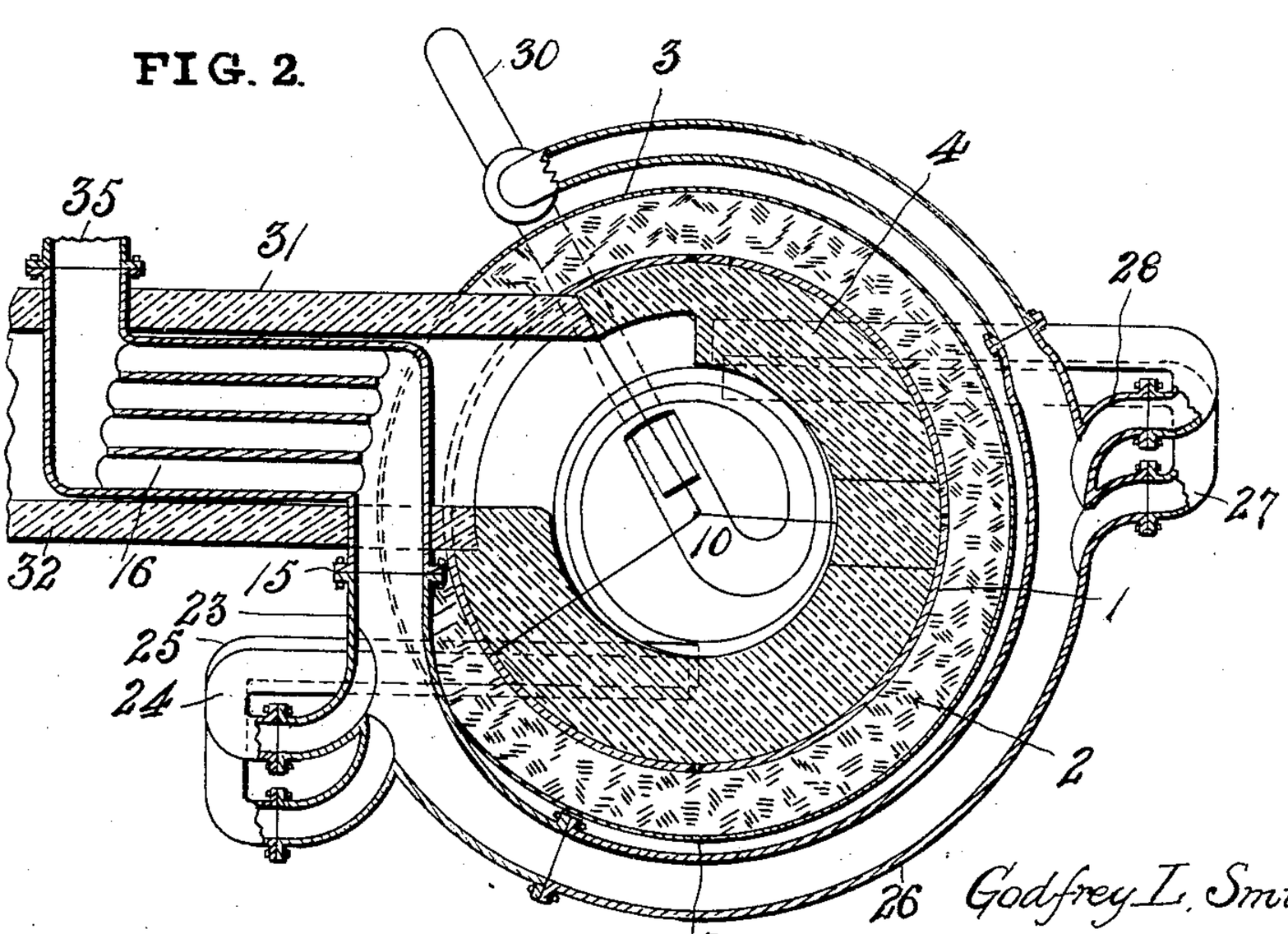


FIG. 2.



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No. 771,675. Patented October 4, 1904.

UNITED STATES PATENT OFFICE.

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CRUCIBLE-FURNACE AND CRUCIBLE.

SPECIFICATION forming part of Letters Patent No. 771,675, dated October 4, 1904.

Application filed April 27, 1903. Serial No. 154,560. (No model.)

To all whom it may concern:

Be it known that I, GODFREY L. SMITH, a citizen of the United States, residing at Newport News, in the county of Warwick and State of Virginia, have invented certain new and useful Improvements in Crucible-Furnaces and Crucibles, of which the following is a specification.

My invention relates to metal or alloy melting-furnaces, in which the material to be melted is placed in a crucible and the latter heated by suitable means to any desired temperature, the walls of the cruible transmitting heat to the contents, so that the metal or alloy is rendered molten; and it has for its object the provision of an improved furnace of the type described for the rapid, economical, and satisfactory melting of such metals as cast-iron, steel, copper, silver, gold, nickel, &c., and such alloys as the various brasses and bronzes, &c., and the avoidance of the deleterious effects of the fuel, both on the material melted and on the crucible, such as are met with in ordinary crucible-furnace practice.

In the ordinary form of furnace now in use there are several points of disadvantage, among them being the excessive time required to melt a charge, due to the necessarily slow combustion of the fuel employed; the uneven heating of the crucible and charge, due largely to the method of supplying the fuel and air; the inconvenience, danger, and in some cases impossibility of handling large quantities of metal in one charge, and the consequent unevenness of temperature and composition in a mixture of the contents of several crucibles, and the rapid destruction of the crucibles due to the rapid and extreme changes in temperature to which the crucibles are subjected on their withdrawal from the furnace and to the action of the fuel on the outside of the crucibles. The first of these difficulties I have overcome by the use of a more suitable form of fuel, such as gas or oil, the regulation of the products of combustion, and the utilization of a portion of the waste heat in the escaping gases; the second I have overcome by the proper distribution of the burners throughout the surface to be heated; the third by making my system adapted to any size of crucible; the fourth by arranging my crucible so that its withdrawal from the furnace is not necessary.

In order to explain clearly the features thus described in general terms and to point out additional important features, I will proceed to describe my invention in detail, reference being had to the accompanying drawings, which form a part of this specification, and in which—

Figure 1 is a vertical axial section showing the interior of the furnace with the crucible (also in section) in place; and Fig. 2 is a horizontal section through the center of the flue and heater-box, the crucible being removed.

As shown in the two figures, the furnace consists of a body 4, of fire-brick, graphite, or other resistant material, surrounded and supported by a shell 1, of cast-iron or other suitable material, made in two or more pieces to allow for expansion. The shell 1 is in turn surrounded by a covering of non-conducting material 2, such as magnesia, to prevent excessive radiation of heat, and this non-conducting sheathing is itself inclosed in an outer shell 3, of sheet-metal or other material, to prevent abrasion.

The body 4 of resistant material may be made of any thickness to suit the conditions to be met; but it is essential that there should be a sufficient thickness to prevent its heating through to such an extent that the shell may be injured. In practice the body 4 will be fitted into the shell in sections, about four in number, to allow for its convenient renewal in case it is broken or burned out. The outside of the body 4 conforms to the shape of the shell 1 and the inside, in general, to the shape of the crucible, a small annular space being purposely left between crucible and body to permit the partial flow of the gases generated between the surfaces of the two.

Piercing the lower portion of the body 4 and traversing the bottom of the crucible is a passage 10, which merges into the spiral passage 11 12 13 14 on the inner face of the body 4. The passages thus shown are provided for the purpose of affording a fixed path for the flame and products of combustion and of preventing the direct impinging of the flame on the cru-

cible. At the top of the furnace, and preferably at one side, tangentially disposed, is a flue 17 for the purpose of carrying the products of combustion into a chimney or into the open air. Located in this flue is a heater-box 16, provided for the purpose of preheating the air-supply to the burners, as will be described later.

The method of heating the furnace is by means of burners of any suitable number disposed tangentially to the crucible and introduced at suitable intervals throughout the spiral passage. As I have shown them in the drawings they are five in number, although this number may be either increased or diminished to suit conditions to be met. In practice I have arranged them very nearly as shown, the first entering through the passage 10 and the others introduced at successive half-turns in the spiral, this arrangement effecting a very even heating of the crucible throughout its whole surface.

Although any kind of liquid fuel and any pressure of air may be used at the burners, provided only that sufficient fuel is satisfactorily burned, I have found it advantageous to employ either kerosene-oil or fuel-oil and comparatively low-pressure air-blast, such as is obtainable from a centrifugal fan-blower or a rotary blower. In the drawings I have not indicated the oil-piping or the valves, either air or oil, but their arrangement is simple and is omitted only in order to simplify the drawings. The arrangement of air-piping which is shown somewhat fully represents what I have found to be the most effective arrangement, and as it forms an essential part of the furnace it merits a description.

The cold air coming from the blower enters the heater-box 16 at the inlet 35, traverses the heater-box toward the furnace proper, thus increasing in temperature and leaving the heater-box at 15, where the air-piping proper begins. At suitable intervals branches are taken off the main air-pipe and carried down to the burners 24 25 27 28. The blower is thus called on to handle cold air only and the burners are furnished with hot air, thus adding to the temperature of the flame produced, as the fuel does not have to heat through as great a range of temperature the air with which it combines. While I regard this as one of the points of economy in my furnace, it is by no means an indispensable feature, and in some cases it may be advisable to omit it.

Centrally located in the top of the body 4 is an opening, which is ordinarily closed by the cover 9, which may be lifted out by means of the bail 6, attached to the plate 5, for the purpose of examining the interior of the furnace or removing the crucible. Located centrally in this cover 9 is a smaller cover or plug 8, provided with the lifting-plate 7. By removing the smaller cover the condition of the charge may be ascertained and metals or other ingredients added to it, the operator not being exposed to the heat of the flame and the interior of the furnace not being exposed to the air.

Resting on the inside of the bottom of the body 4 is the crucible 21. This crucible differs from the form ordinarily employed for similar purposes only in the fact of its having an opening at one side near the bottom and a spout forming part of the body of the crucible, which spout serves to deliver the contents of the crucible into any desired receptacle without the necessity of removing the crucible from the furnace.

Experience and observation have demonstrated to me that the two causes which tend to most shorten the life of the crucible as ordinarily employed are the action of the fuel on the crucible and the rapid changes in temperature to which it is subjected on removal from the fire. By the use of liquid or gaseous fuel I have shown how part of the first trouble may be avoided. By the introduction of the flame in such a direction that it does not directly impinge on the crucible I have overcome the remainder of the first trouble. In order to overcome the second trouble—*i. e.*, to prevent sudden cooling—the only practicable course of procedure is to leave the crucible in the furnace all the time; but this necessitates a special device for removing the contents of the crucible at the right time. There are several available, the three simplest being to siphon the contents out over the edge of the furnace, to pour the contents out over the edge of the crucible, (this necessitates either a tipping of the furnace as a whole or the tipping of the crucible within the furnace,) or to draw off the contents through a tap-hole in the bottom of the crucible in much the same way as the charge is tapped out of a cupola. Experiments which I have made and practical tests of the principle have demonstrated the entire practicability of the third method, and I have accordingly adopted it, providing for the purpose a contraction 34 in the neck of the crucible into which fits neatly the plug-handle 33, which is made of graphite or other resistant material. A slight clay wash is sufficient to make a perfectly tight joint, and the friction between the stopper and the neck is all that is necessary to retain the plug in place when it is once set. By a slight lateral motion the stopper or plug-handle 33 is disengaged and may be withdrawn, thus permitting the metal to flow freely into any desired receptacle. The stream may at any time be interrupted by the reinsertion of the plug into the opening.

While I believe that the maximum efficiency will be obtained with a crucible such as I have

described and have shown in the drawings, the principles of the method of introduction of the fuel and the constraint exercised on the path and composition of the products of combustion (I purpose to seal the burners into the shell, so that the relative and absolute amounts of fuel and air can be regulated at will by the operator) will apply equally well to the ordinary form of crucible, which may be lifted out and poured and replaced before it has cooled down to the temperature of the surrounding air.

In operating the furnace as I have described it the charge may be introduced into the crucible either before lighting the burners or after the crucible is hot. Let us suppose that the charge is introduced before the ignition of the burners. The amounts of air and oil being absolutely under the control of the operator and the furnace being thus a sort of retort it is possible to obtain a combustion of the fuel without excess of air. In other words, we may obtain what is termed an "explosive" fire at each burner. I have experimented with several forms of burners and oil fuels and find that the treatment varies with the nature of the oil. Supposing that all of the burners are lighted and are operting satisfactorily, the flame from each of them will be confined for the most part to the spiral passage 11 12 13 14, any particles of oil not consumed at the mouth of the burner being ignited by contact with the sides of the passage. The flame is thus kept from impinging directly against the walls of the crucible, and the latter is thus protected from chemical combination with the fuel and the air, which action is very violent at the high temperatures attained. The products of combustion containing only heated gases are constrained to travel around the crucible, for the most part in the spiral passage, by virtue of the centrifugal action of the tangentially-disposed burners. A portion of the gases, however, escapes directly into the flue between the inside of the body 4 and the outside of the crucible. Outside of this action the crucible is heated largely by the radiation of the inner faces of the body 4. A portion of the products of combustion thus passes between the crucible and the body and joins the remainder in the flue 17, through which they pass, imparting a portion of their heat to the heater-box 16, which in turn imparts it to the air which passes through it. As soon as the charge is melted (this is ascertained by removing the cover 8) it is stirred and the ladle into which it is desired to pour it is placed before the spout. The plug or stopper 33 is removed and the molten charge flows out. Whatever solid infusible refuse there is in the crucible remains in the bottom after the pouring and is spooned out, the furnace then being ready for the next charge. Needless to say, the second charge will run much more rapidly than the first, the walls of the furnace and the crucible being hot to start with. It will be readily seen that it is more economical to run a series of heats in succession than to run only one or two a day. It is also more economical to run a number of furnaces by the same blower and oil-pump, arranging them side by side to facilitate attendance.

It will be noted by reference to the drawings that I have placed the throat of the crucible at the inside end of the spout. This is done to avoid the possibility of the chilling of the contents of the spout in case the stopper were at the outer end. I have found in practice that the metal in flowing through the spout does not chill materially, as its flow is very rapid owing to the presssure of the molten metal above it.

As I have described, and shown my invention in the drawings, the crucible is provided with a spout of a certain relative size and is provided with a cover. There is a stated number of burners, and the spiral passage has a certain number of turns, &c.; but I do not wish to confine myself to the specific dimensions and proportions as shown, and I claim the right to alter or omit any of the individual features, provided that in so doing I do not alter any of the essential features or functions of my invention.

I am aware that the principle of using a vortex of flame around a crucible is not new, and I know that a spiral passage has been used around a crucible, and, further, that a crucible with a tap-hole at the bottom is mentioned in one patent; but in every case the purpose and functions of the features mentioned are different from the corresponding ones in my invention, and I am not aware that a combination of any two of these features has ever been patented or used.

I do not wish to be understood as claiming, broadly, a furnace operated by liquid or gaseous fuel; but

What I do claim, and desire to protect by Letters Patent, is--

1. In a crucible-furnace, the combination of a crucible having a gravity discharge-spout, means for stoppering the same at its inner extremity, a body of resistant material inclosing the crucible provided on its inner surface with a continuous spiral passage and pierced by a series of burners disposed tangentially to the crucible distributed throughout the extent of the spiral and sealed into the body, an annular space between the crucible and the body and a removable cover in the top of the body located centrally of the crucible and smaller in diameter than the crucible to permit access to the crucible without exposing the interior of the furnace to the air or the operator to the heat radiated by the walls of the furnace.

2. In a crucible-furnace, the combination of a crucible having a gravity discharge-spout, means for stoppering the same at its inner extremity, a body of resistant material inclosing the crucible provided on its inner surface with a spiral passage, approximately rectangular in cross-section, and pierced by a series of burners disposed tangentially to the crucible distributed throughout the extent of the spiral and sealed into the body, an annular space between the crucible and the body, a removable cover in the top of the body located centrally of the crucible and smaller in diameter than the crucible, and a heater-box located in the flue through which the air-supply to the burners is conducted and within which it is preheated by the waste heat in the flue-gases.

3. A furnace consisting of a sectional resistant receptacle provided with means carrying the products of combustion around the crucible located in said furnace, a sectional metallic envelop surrounding said furnace, there being a space between the crucible and the inner wall of the furnace or receptacle, a series of burners entering the receptacle tangentially to its inner walls, an air-inlet and a heater therein for heating the air, as, it is fed to the furnace, by the outgoing products of combustion.

4. In a furnace as described, the combination of a crucible, having a gravity discharge-spout and means for stoppering the same, with a sectional heat-resistant receptacle provided on its inner surface with a spiral passage and pierced by a series of burners disposed tangentially to the crucible, there being an annular space between the crucible and inner wall of the furnace, a removable cover for the receptacle of smaller diameter than the crucible; a flue for the products of combustion and a heater-box located therein and connected to the air-supply, whereby the incoming air is fed by the outgoing products of combustion, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

GODFREY L. SMITH.

Witnesses:

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W. T. CHAPIN.