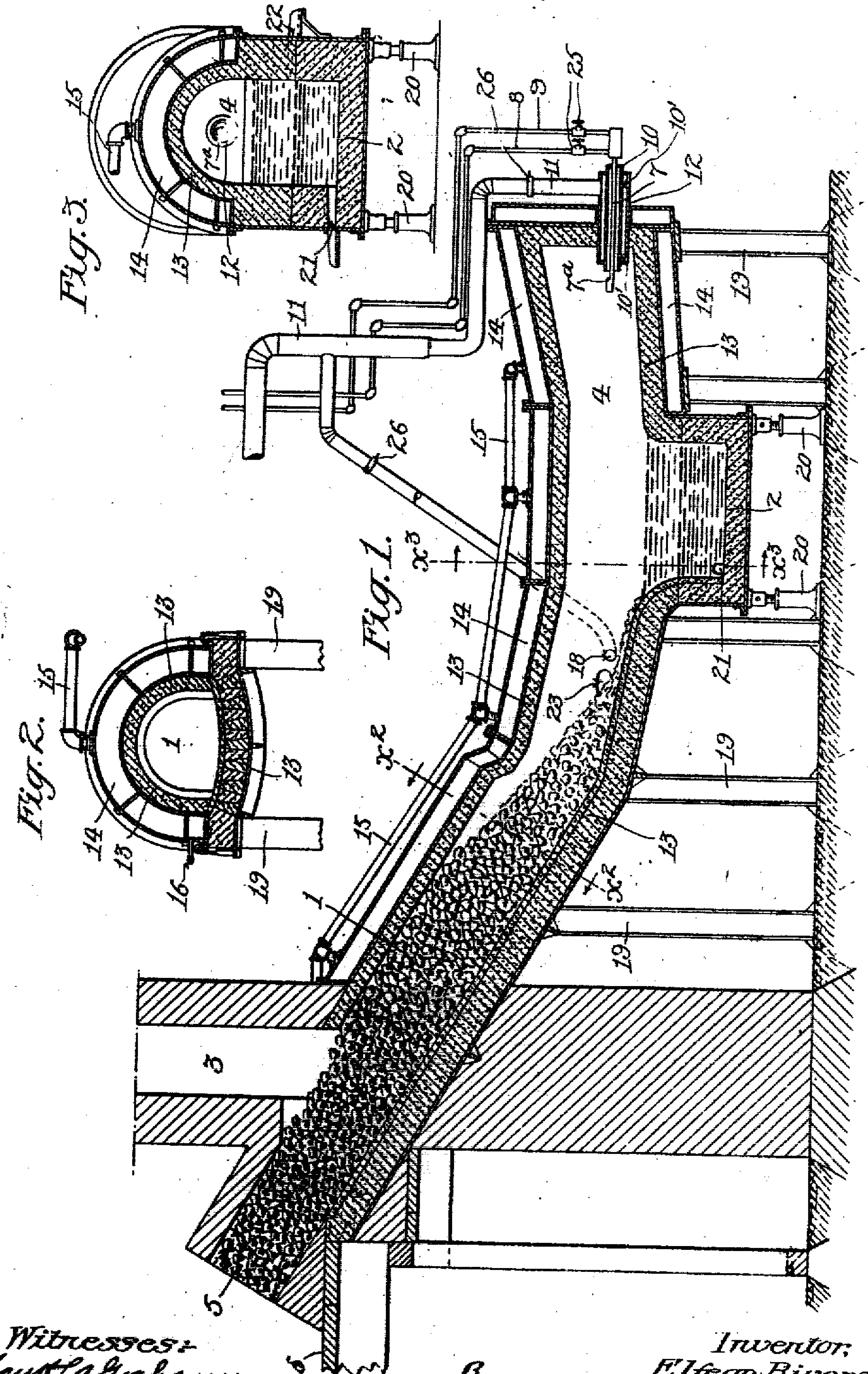
No. 820,134. PATENTED MAY 8, 1906.

E. RIVEROLL.

PROCESS OF SMELTING ORES.

APPLICATION FILED OCT. 12, 1905.



Witnesses:
Frank L. A. Graham
J. A. Mansfield

Inventor:
Elfego Riveroll.
By Townsend, Lyon, Hackley & Knight
His Attys.

UNITED STATES PATENT OFFICE.

ELFEGO RIVEROLL, OF LOS ANGELES, CALIFORNIA.

PROCESS OF SMELTING ORES.

No. 820,134. Specification of Letters Patent. May 8, 1906.

Application filed October 12, 1905. Serial No. 282,375.

To all whom it may concern:

Be it known that I, ELFEGO RIVEROLL, a citizen of Mexico, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Process for Smelting Ores, of which the following is a specification.

An important object of the present invention is to provide a process for ore-smelting which will be continuous, or substantially so.

Another object of the invention is to provide a process for smelting ores by the use of fluid fuel, such as hydrocarbons or petroleum.

The process is particularly adapted for smelting of copper ores and is herein described in that connection, although it is applicable to some extent in connection with other ores.

An important feature of the process is that the smelting heat is applied to the ore by the combustion of fuel located externally of the ore instead of mixed with the ore. In the ordinary reverberatory process the heat is also applied by external means. In that case the ore is heated by radiation and conduction from above and difficulty is encountered in bringing the heat in effective contact with the ore. On the other hand, attempts to apply the externally-generated heat in a blast-furnace process have failed on account of the clogging of the blast by melted material.

The present invention provides for bringing the heat in effective contact with all parts of the ore and for maintaining the body of ore continually in condition to allow free passage of the heating agent therethrough. The heating and smelting agent in this case consists of the hot gases resulting from the combustion of hydrocarbon or oil with a suitable quantity of air, and by properly proportioning the amount of fuel and air said agent may be made of either an oxidizing, reducing, or neutral nature, according to the effect it is desired to produce on the ore.

The process comprises, essentially, the following steps: supplying and confining the ore in a chamber in such manner that while a new supply is continually or from time to time added at one end of the body of ore the other end of the body of ore remains at a substantially fixed position and the chamber is blocked or choked by the body of ore and applying the smelting agent, consisting of the hot gases aforesaid, under pressure in said chamber in such manner that said hot gases will be forced through the body of ore in their passage out of the chamber, thereby continually melting down the ore as it reaches the position aforesaid and allowing it to flow away from the unmelted body of ore and keeping the said unmelted ore continually open for the passage of the hot gases.

The invention further comprises placing the ore on an inclined support, the inclination being such as to cause the ore to feed down along said support by gravity, arresting the motion of the ore at a certain position on said support and applying at such point of arrest hot gases under pressure and confining the course of such hot gases to cause them to be forced through and between the body of ore to melt the ore.

The accompanying drawings illustrate an apparatus suitable for carrying out the invention.

Figure 1 is a longitudinal vertical section of the furnace. Fig. 2 is a vertical section on the line x^2 x^2 in Fig. 1. Fig. 3 is a section on the line x^3 x^3 in Fig. 1.

Referring to the drawings, 1 designates an ore chute or chamber, and 2 a well or receptacle at the lower end of said chute or chamber, the said chute or chamber extending upwardly at an inclination from said well and communicating at or near its upper end with a stack or flue 3.

4 designates a combustion-chamber at the side of the well 2 opposite the chute 1.

Means are provided for supplying ore into the upper end of the chute 1, said means consisting, for example, of a charging hole or passage 5, formed by an extension of the chute 1 beyond the stack 3, the ore being dumped or charged into said passage from a suitable source of supply—for example, a platform 6—the said passage being of sufficient size to enable the ore-chute 1 to be completely charged or filled at its upper end with the ore and the ore sliding down from the upper end by gravity toward the lower part of the chute. At or near the lower end of the chute means are provided for obstructing or arresting the downward passage of the ore. For this purpose the lower end of the floor of the chute is extended at an inclination to the upper part or main body of the chute, the inclination of this part of the chute being such that the ore will not pass forward thereon by gravity and will therefore accumulate or become checked in its downward movement.

7 designates a burner for supplying combustible fluid to the combustion-chamber 4,

the said burner comprising a burner-head 7^a, connected to an oil-supply pipe 8 and a steam-supply pipe 9 in such manner as to inject or atomize the fluid fuel into the combustion-chamber. Air-supply means is also provided, consisting of a nozzle or inlet-pipe 10, surrounding the burner 7 and communicating with an air-supply pipe 11, the said pipe entering a drum 12, surrounding a rearward extension of nozzle 10, said extension being perforated at 10′ to enable passage of air into the nozzle, thereby producing an annular jet or blast of air surrounding the jet of atomized fuel. The fuel and air nozzles are preferably positioned so as to direct the jet of flame or hot gases therefrom on the lower end of the body of ore. The air-supply pipe 11 is connected to any suitable source of air-supply under pressure—for example, a blower or fan. (Not shown.) An auxiliary air-supply inlet is provided at 18 in the sides of the ore-chute 1 at or below the smelting zone.

The heat of the smelting operation being intense, it is necessary to line the combustion-well and air-chambers with a refractory lining, (indicated at 13,) and in order to present sufficient mechanical support to said lining and prevent burning out thereof a water-jacket 14 is provided around these chambers, water supply and outlet pipes 15 16 being provided therefor.

The ore-chute and combustion-chamber are supported in a frame consisting of columns or piers 19, so arranged as to leave the bottom of the chamber-walls exposed for cooling by the air around the same. Well 2 may be removable, being supported on jacks 20.

21 designates the tap-hole or spout in the well, and 22 the slag-hole. The ore-chute 1 may be provided with poke-holes, (indicated at 23.) The oil-burner 7 and the air-pipe 11 are provided with valves or regulating means 25 26 to enable regulation of the fuel and air supply.

The process is carried out as follows: Ore of any suitable character—for example, copper ore, either in the form of carbonates, sulfids, or oxids, or mixture thereof, or compound ore of any kind, such as chalcopyrite—is delivered on the platform 6 and is charged continuously or from time to time into the upper end of the ore-chute 1 through the feed-passage 5. The ore rolls and slides down the chute until it reaches the floor portion of less inclination, at which point it will accumulate and pile up in a manner somewhat as shown in the drawings, and this charging or filling operation is continued until the body or pile of ore completely fills or chokes the conduit or chute 1 and extends substantially to the upper end thereof. The front or lower end of this body of ore will then have an inclination to the horizontal depending somewhat on the character of the ore, extending at its lower portion or foot toward the well 2 and receding therefrom upwardly. All the openings at the lower part of the combustion-chamber, chute, and well are closed. The burner having been turned on and ignited and the air-blast also having been turned on and the combustion-chamber, well, and lower part of the chute being closed against exit of air, the operation will proceed as follows: The jet or blast of combustible and air burns in the combustion-chamber, and passing over the well enters the ore-chute and is directed on the body of ore therein. The ore is assumed to be of such a size that it will permit the hot gases resulting from the combustion in the blast or jet to pass therethrough; but, owing to the obstruction caused by the choking or blocking of the passage by the ore mass, it is necessary to employ a substantial pressure to cause the hot gases to force their way through the ore to the stack. The charging-passage 5 may, if desired, be closed except when charging; but for practical purposes the obstruction caused by the ore therein is sufficient to deflect the waste gases up the chimney or stack. It is found in practice that the ore as it ordinarily comes from the mine can be used in this manner and is sufficiently open to permit the passage of the hot gases; but in some cases it will be desirable to crush the ore to a more or less uniform reduced size, it being understood that the smaller the size of the lumps or particles of ore the more rapid will be the heating thereof as long as the passage for the hot gases is not unduly constricted. The intense heat of the combined jet or blast of fuel and air directed onto the ore eventually melts the ore at the lower end of the pile, and as the ore melts it flows away down the lower inclined floor, the inclination of which is sufficient to permit of this, although not sufficient to allow gravitative movement of the unmelted ore. The ore in the chute will then move down and take the place of the ore that is melted, and if ore is continually supplied at the upper end this operation will continue. The melted ore runs from the inclined table into the well 2, where it accumulates and is kept in melted condition by radiation and reflection from the blast and overlying walls of the chamber.

The operation has been described as a simple melting operation; but it will be understood that, according to the character of ore, it can be made a roasting or oxidizing or a reducing or smelting operation, the effect being controlled, according to the character of ore and product, by varying the proportionate amounts of fuel and air admitted at the burner and blast. Thus in case of the chalcopyrite ore sufficient oxygen will be furnished, in addition to that required for combustion of the fuel, to roast or oxidize part of the sulfur, whereupon during fusion the usual reaction will take place between the oxidized portion and the unoxidized portion to form a matte more or less rich in copper which will separate from the slag containing the iron, silica, &c. If it is desired to obtain the copper in reduced form or metallic state, an excess of fluid combustible may be supplied to effect the reduction, and in some cases it may be necessary to provide for initial oxidation followed by reduction, this being provided for by the auxiliary blast at 18, which supplies at the fusion zone sufficient air to cause oxidation or roasting, the roasted or more or less oxidized material being then melted as it passes through the fusion zone and the melted product then passing down toward the burner and being subjected to a reducing-flame therefrom. It is found in practice that in working with copper ores in this manner it is possible to produce the copper either in the form of a matte or in the form of metallic copper, the process effecting not only the fusion of the ore, but the chemical and actual separation of the metallic constituent from the gangue or slag, the actual separation of the metallic part from the slag taking place in the well where the fused ore is kept exposed to the heat from the burner, blast, and furnace-walls.

As illustrating the efficiency of the process applied to low-grade ores, the following results were obtained in practice, the charge consisting of iron ore and silicious ore of the following analyses: Iron ore or flux, Fe, 51.98; SiO_2, 15.62; S, 4.95; Cu, 1 per cent; Au, 4.13. Silicious ore, Fe, 8.33; SiO_2, 81.43; Cu, 1.45; Au, 7.44. The initial charge was seventy pounds of iron to forty pounds of silicious ore and fifty pounds of lime, followed by a working charge of one hundred pounds of iron ore, fifty pounds of silicious ore, fifty pounds of lime, and fifty pounds of slag. There was formed at the bottom of the well a matte containing fifty-one per cent. copper, besides a considerable portion (about ten per cent.) of black copper and metallic copper. The slag analyzed: silica, 32.4; iron, 26.4; lime, 16.

What I claim is—

1. The process for treating ores which consists in feeding and supporting the ore on an inclined surface, allowing the ore to move downward by gravity on said surface to a definite position thereon, arresting the downward movement of the ore in such definite position, passing a current of hot gas or gases through said ore to heat and melt the same and allowing the fused ore to drain away from the unfused ore to maintain the latter in condition for passage of the current of gases therethrough and withdrawing the hot gases from the body of ore before they reach the point at which the ore is fed to the inclined surface.

2. The process for treating ore which consists in feeding and supporting the ore on an inclined surface, allowing the ore to move downward on said surface by gravity, arresting the downward movement of the ore at a definite position, applying a blast of hot gases against the lower end of the body of ore, confining said hot gases to cause them to pass upwardly through the body of ore, withdrawing the hot gases from the body of ore before they reach the point at which the ore is fed to the inclined surface and allowing the fused ore at the lower end of the body of ore to drain from the unfused ore.

3. The process for treating ores which consists in charging the ore into an inclined chamber or chute and allowing the ore to feed downwardly into the chute by gravity, applying hot gases under pressure at the lower end of the chute, thereby forcing said gases through the body of ore in the chute, withdrawing the hot gases before they reach the point at which the ore is charged thereinto and applying a supplementary blast of air to the body of ore between the point of application of the hot gases and the point of withdrawal of such gases.

4. The process of treating ores which consists in charging the ore into an inclined chute in such manner as to block or choke the chute, allowing the ore to move downwardly into the chute by gravity, applying a current of hot gases under pressure to the lower end of said body of ore in the chute, confining said current to cause it to force its way through the body of ore and withdrawing the hot gases from the chute before they reach the point at which the ore is charged thereinto.

5. The process for treating ore which consists in feeding and supporting the ore on an inclined surface, allowing the ore to move downward on said surface by gravity, arresting the downward movement of the ore at a definite position, applying a blast of hot gases against the lower end of the body of ore, confining said hot gases to cause them to pass upwardly through the body of ore, withdrawing the hot gases from the body of ore before they reach the point at which the ore is fed to the inclined surface, and applying a supplementary blast of air to the body of ore between the point of application of the hot gases and the point of withdrawal of the hot gases and allowing the fused ore at the lower end of the body of ore to drain from the unfused ore, and maintaining the fused ore in heated condition to enable the metallic portion thereof to separate from the slag.

6. The process for treating ore which consists in feeding and supporting the ore on an inclined surface, allowing the ore to move downward on said surface by gravity, arresting the downward movement of the ore at a definite position, applying a burning blast of

oil and air against the lower end of the body of ore, confining the hot gases from said blast to cause them to pass upwardly through the body of ore, withdrawing the hot gases from the body of ore before they reach the point at which the ore is fed to the inclined surface, and applying a supplementary blast of air to the body of ore between the point of application of the hot gases and the point of withdrawal of the hot gases and allowing the fused ore at the lower end of the body of ore to drain from the unfused ore.

In testimony whereof I have hereunto set my hand, at Los Angeles, California, this 30th day of September, 1905.

ELFEGO RIVEROLL.

In presence of—
ARTHUR P. KNIGHT,
VERNA A. TALBERT.