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APPARATUS FOR EVAPORATING LIQUIDS.

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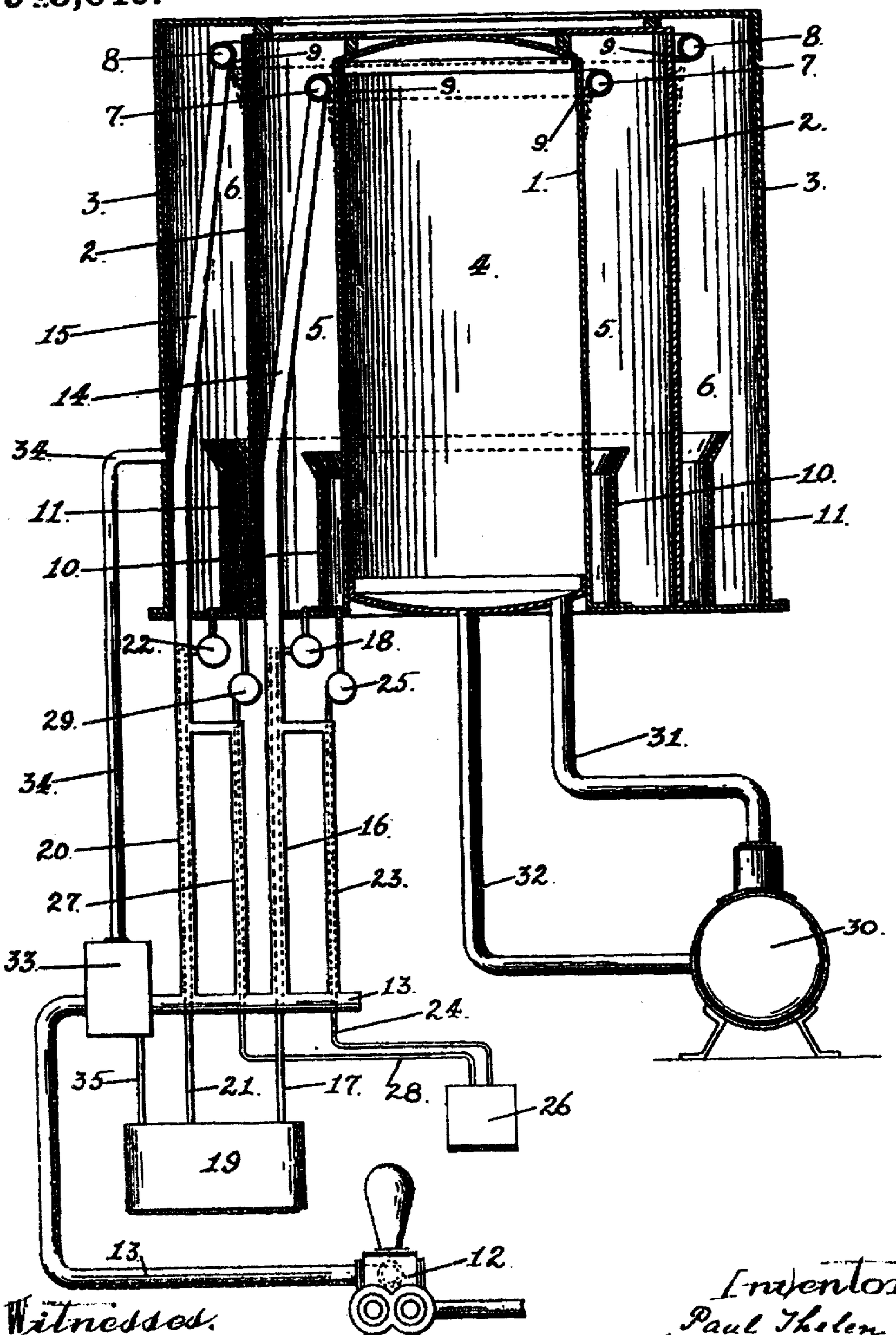
945,640. Patented Jan. 4, 1910.



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APPARATUS FOR EVAPORATING LIQUIDS.

943,640. Specification of Letters Patent. Patented Jan. 4, 1910.

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To all whom it may concern:

Be it known that we, PAUL THELEN and JAMES BUCKNER SPEED, citizens of the United States, residing the said THELEN at the city and county of San Francisco and State of California and the said SPEED at Berkeley, Alameda county, California, have invented certain new and useful Improvements in Apparatus for Evaporating Liquids, of which the following is a specification.

Our invention relates to that class of liquid evaporators in which a multiple process of distillation or concentration is performed according to the method of concentric shells, and it consists in the novel arrangement and combination of parts which we shall hereinafter fully describe, together with the objects and advantages of the invention.

Referring to the accompanying drawings, the figure is a sectional elevation of our apparatus.

For the purposes of this application we will assume the liquid to be handled is water which contains dissolved inorganic salts; that the process is one of distillation; that the multiple effect is triple, all above atmospheric pressure; and that the concentric shells have a vertical axis. These assumptions are, however, merely illustrative, as we shall hereinafter show; for the liquid handled may be other than water; the process may be one of concentration or may include for its object both concentration and distillation; the effects may be of other multiple than triple, and may be below atmospheric pressure, or part above and part below; and the shells may be inclined or have other than a vertical axis. All these variations and others fall within our invention, and may be readily made as will be fully shown hereinafter.

In this apparatus the still-unit is composed of three cylindrical shells, the inner one being designated by 1, the middle one by 2, and the outer one by 3. These shells are nested in such a way as to furnish one cylindrical compartment 4, and two compartments 5 and 6, respectively, whose horizontal section is an annulus. A distributer pipe 7 girdles the inner shell 1, near its top; and another distributer pipe 8, girdles the middle shell 2, near its top. Each of these pipes has discharge holes 9, so disposed as to divide uniformly, by means of jets, the raw water which is to be distilled, and to divide it in such a way that a film of water is maintained all over the outside surfaces of the two shells 1 and 2. At the bottom of the still in the base of compartments 5 and 6 are two cylindrical partition walls 10 and 11 respectively, of any suitable height, though here shown as relatively low, each of which divides the annular compartment in which it is located into two smaller annuluses of which the outer will handle distillate and the inner concentrate.

12 is a pump by which the raw water is supplied to the still under pressure. The pipe 13 from the pump connects, through certain heat-interchangers, presently to be described, with the delivery pipes 14 and 15 which lead to the distributer pipes 7 and 8 respectively.

The heat-interchangers may be of any suitable conventional or standard type, say for example, concentric spaced pipes. In the present instance there are four heat-interchangers, two for handling the distillate and two for the concentrate. One of the former is composed of an outer pipe 16 which communicates below with the pump pipe 13 and above with the delivery pipe 14 to the distributer 7; and an inner pipe 17 which communicates above with a steam-trap 18, and below with the distillate tank 19. The steam-trap 18 communicates with the distillate annulus in the base of compartment 5. The other distillate heat-interchanger is similarly composed of an outer pipe 20 communicating below with the pump pipe 13 and above with the delivery 15 to the distributer 8; and an inner pipe 21 communicating above with a steam-trap 22 and below with the distillate tank 19. The steam-trap 22 communicates with the distillate annulus in the base of compartment 6. One of the two heat interchangers for the concentrate is composed of an outer pipe 23, which communicates below with the pump-pipe 13 and above with the outer pipe 16 of the first heat interchanger for the distillate; and an inner pipe 24 which communicates above with a steam trap 25, and below with the concentrate tank 26. The steam trap 25 communicates with the concentrate annulus in the base of compartment 5. The other heat interchanger for the concentrate is composed of an outer pipe 27 which commmuni-

cates below with the pump pipe 13 and above with the outer pipe 20 of the second heat interchanger for the distillate; and an inner pipe 28 which communicates above with a steam trap 29 and below with the concentrate tank 26. The steam trap 29 communicates with the concentrate annulus in the base of compartment 6.

The several steam traps may be of any suitable or standard type and need no detailed description or illustration, their function being merely to discharge automatically from the still the condensed steam and the residue from evaporation, which two liquids have been termed above respectively distillate and concentrate. The heat-interchangers serve as pre-heaters for the raw water and as coolers for the waters from the steam traps discharge.

30 is a boiler, from which high pressure steam is discharged through a pipe 31 into the inner shell 1 of the still. The condensation from this steam is discharged from said shell by gravity back to the boiler, through the pipe 32.

In connection with the pump-pipe 13 is a condenser 33 of any suitable type, said pump-pipe leading into and emerging from the condenser. This condenser communicates by a pipe 34 with the interior of the outer shell 3, and said condenser discharges by a pipe 35 into the distillate tank 19. Some of the steam from shell 3 passes down into the condenser 33, and is therein, due to the cold raw-water passing through said condenser, reduced to a distillate and passes down to the tank 19, while the raw-water itself, in effecting this condensation, has its temperature raised. The condeuser thus serves, both as a pre-heater for the raw water and as a distillate condenser.

The method of operation of this apparatus is as follows: The boiler 30 discharges high pressure steam into the inner shell or cylinder 1 of the still. This steam condenses and discharges by gravity back to the boiler. It condenses on the inner surface of the inner shell 1, by virtue of a film of cooler water which is maintained by the distributer pipe 7 on the outer surface of said shell. A portion of this film of water is evaporated off progressively at intermediate pressure, by virtue of the heat of condensation of the high pressure steam. The water evaporated off here into steam condenses similarly on the inside surface of the second shell 2, and evaporates, at low pressure, a portion of the film of still cooler water, which is maintained by the distributer pipe 8, on the outer surface of said second shell 2. The water evaporated off into steam from this outer surface of shell 2 condenses in part on the inner surface of the outer shell 3 and in part in the condenser 33. The water which is evaporated and condensed within the still becomes distillate and flows down in a film on the inner surfaces of shells 2 and 3. It passes into the distillate annuluses in the bottom of compartments 5 and 6 and from these is delivered through the steam traps 18 and 22 to their respective heat-interchangers, in which it loses of its heat to the incoming raw water from the pump, and is finally voided, luke-warm, into the distillate tank 19. A portion of this condensed water also reaches the distillate tank through the condenser 33. The raw water, which flows in a film down the outer surfaces of shells 2 and 3 loses progressively of its mass by evaporation, and becomes a concentrate, which contains all the salts of the original water. This concentrate enters the inner annuluses in compartments 4 and 5 and thence is discharged through the steam traps 25 and 29 to their respective heat interchangers, and thence it finds its way, luke-warm into the concentrate tank 26. The entire body of raw water is pumped through the condenser and pre-heater 33 and thence through the interchangers to the distributer pipes.

An apparatus of this type may be varied to cover a wide range, with respect, first, to the number of effects; second, to the pressure and temperature range; third, to the process; and, fourth, to the distribution of the liquids.

First. The number of effects may be varied at will, either by changing the number of concentric shells, or by running several stills in series.

Second. The pressures may all be above atmospheric, making a pressure plant; or all below atmospheric, making a vacuum plant; or they may range from above atmosphere to below atmosphere, making a combined pressure and vacuum plant.

Third. When the process is distillation for distilled water, the distillate is the valuable product, while the concentrate is either discarded or further treated for what salts it may have in solution. When the process is concentration, as in sugar house practice, the concentrate is the primary valuable product, while the distillate is distilled water, which is also valuable.

Fourth. One untreated liquid under pressure may supply all effects; and all effects may discharge concentrates of the same density; or the concentrates from the effects of higher temperature may be discharged at a lesser density and may then become the untreated liquid for the effects of lower temperature within which a further concentration may then be effected.

All concentrated liquids and condensed vapors being automatically discharged by the steam traps, there is no labor cost for this item.

The arrangement of the evaporating liquid in this novel type of film causes a quiet steaming though in immense volume. It

does away entirely with boiling or spitting and contributes very materially to the high heat transmissions which are obtained.

Having thus described our invention what we claim as new and desire to secure by Letters Patent is:—

1. In an apparatus for evaporating liquids in multiple effect, a series of nested, spaced shells; means for supplying the raw liquid filmwise to the outer surface of each shell inclosed in the series; means for applying heat sufficient for all effects, to the interior of the innermost shell, and means for separately collecting from the opposing surfaces of adjacent shells the concentrated liquid from one surface and the distilled liquid from the other surface.

2. In an apparatus for evaporating liquids in multiple effect, a series of nested, spaced shells; means for supplying the raw liquid filmwise to the outer surface of each shell inclosed in the series; means for applying heat sufficient for all effects, to the interior of the innermost shell; a partition wall in each intershell space for collecting separately the concentrated liquid coming from the outer surface of one shell from the distilled water coming from the inner surface of the adjacent shell; and means for separately discharging said liquids.

3. In an apparatus for evaporating liquids in multiple effect, a series of nested, spaced shells; means for supplying the raw liquid filmwise to the outer-surface of each shell inclosed in the series; means for applying heat sufficient for all effects, to the interior of the innermost shell; a partition wall in each intershell space dividing said space into two intercommunicating spaces one adjacent to the outer surface of one shell and the other adjacent to the inner surface of the next shell; and means for separately discharging the liquids from said two spaces.

4. In an apparatus for evaporating liquids in multiple effect, a series of nested, spaced shells; means for supplying the raw liquid filmwise to the outer surface of each shell inclosed in the series; means for applying heat sufficient for all effects to the interior of the innermost shell; a relatively low partition wall in the lower end of each intershell space dividing said space into two spaces one adjacent to the outer surface of one shell and the other to the inner surface of the next shell; and means for separately discharging the liquids from said two spaces.

5. In an apparatus for evaporating liquids in multiple effect, a series of nested, spaced shells; means for supplying the raw liquid filmwise to the outer surface of each shell inclosed in the series; means for applying heat sufficient for all effects to the interior of the innermost shell; means for separately collecting from the opposing surfaces of adjacent shells the concentrated liquid from one surface and the distilled liquid from the other surface; and steam traps for separately discharging said liquids from the collecting means.

6. In an apparatus for evaporating liquids in multiple effect, a series of nested, spaced shells, pipes for feeding the raw liquid to the series of shells; distributing pipes for supplying the raw liquid filmwise to the outer surface of each shell inclosed in the series; means for applying heat sufficient for all effects to the interior of the innermost shell; means for separately collecting from the opposing surfaces of adjacent shells the concentrated liquid from one surface and the distilled liquid from the other surface; separate discharge pipes from said collecting means; and a series of heat-interchangers involving the feed pipes for raw liquid and the discharge pipes from the collecting means.

7. In an apparatus for evaporating liquids in multiple effect, a series of nested, spaced shells, pipes for feeding the raw liquid to the series of shells; distributing pipes for supplying the raw liquid filmwise to the outer surface of each shell inclosed in the series; means for applying heat sufficient for all effects to the interior of the innermost shell; means for separately collecting from the opposing surfaces of adjacent shells the concentrated liquid from one surface and the distilled liquid from the other surface; a series of steam traps for separately discharging said liquids from the collecting means; discharge pipes from said steam traps; and a series of heat interchangers involving the feed pipes for raw liquid and the discharge pipes from the steam traps.

8. In an apparatus for evaporating liquids in multiple effect, a series of nested, spaced shells; a feed pipe for the raw liquid; distributer pipes for supplying the raw liquid filmwise to the outer surface of each shell inclosed in the series; means for applying heat sufficient for all effects, to the interior of the innermost shell; means for separately collecting from opposing surfaces of adjacent shells the concentrated liquid from one surface and the distilled liquid from the other surface; pipes for separately discharging said liquids from the collecting means; and a condenser communicating with the interior of the outermost shell to receive a portion of the steam therefrom and condense it, said condenser being so disposed relatively to the raw liquid feed pipe as to serve both as a condenser for the steam and pre-heater for the raw liquid.

9. In an apparatus for evaporating liquids in multiple effect, a series of nested, spaced shells; a feed pipe for the raw liquid; distributer pipes for supplying the raw liquid filmwise to the outer surface of each shell inclosed in the series; means for applying heat

sufficient for all effects, to the interior of the innermost shell; means for separately collecting from opposing surfaces of adjacent shells the concentrated liquid from one surface and the distilled liquid from the other surface; a series of steam traps for separately discharging said liquids from the collecting means; a series of heat interchangers involving the trap discharges and the feed pipe for the raw liquid; and a condenser communicating with the interior of the outermost shell to receive a portion of the steam therefrom and condense it, said condenser being so disposed relatively to the raw liquid feed pipe as to serve both as a condenser for the steam and a pre-heater for the raw liquid.

10. In an apparatus for evaporating liquids, in multiple effect, a series of nested, spaced shells; means for supplying the raw liquid filmwise to the outer surface of each shell inclosed in the series; a boiler, having a steam pipe leading to the innermost shell and a return pipe to said boiler for the water of condensation from said shell; and means for separately collecting from the opposing surfaces of adjacent shells the concentrated liquid from one surface and the distilled liquid from the other surface.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

PAUL THELEN.
JAMES BUCKNER SPEED.

Witnesses:
WM. F. BOOTH,
D. B. RICHARDS.