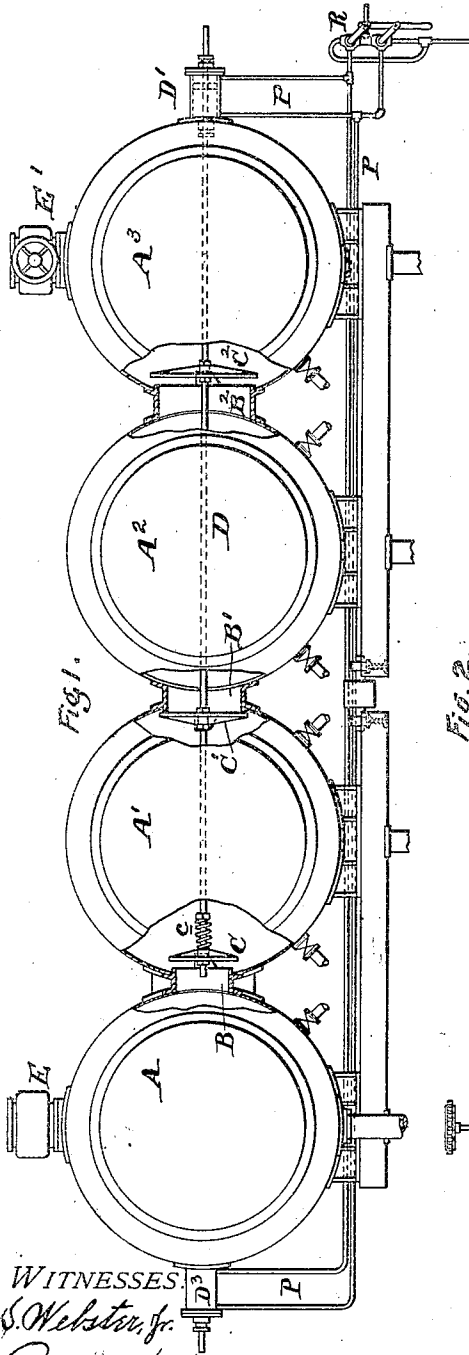


S. M. LILLIE.
 MULTIPLE EFFECT EVAPORATING APPARATUS.
 APPLICATION FILED JUNE 18, 1906.

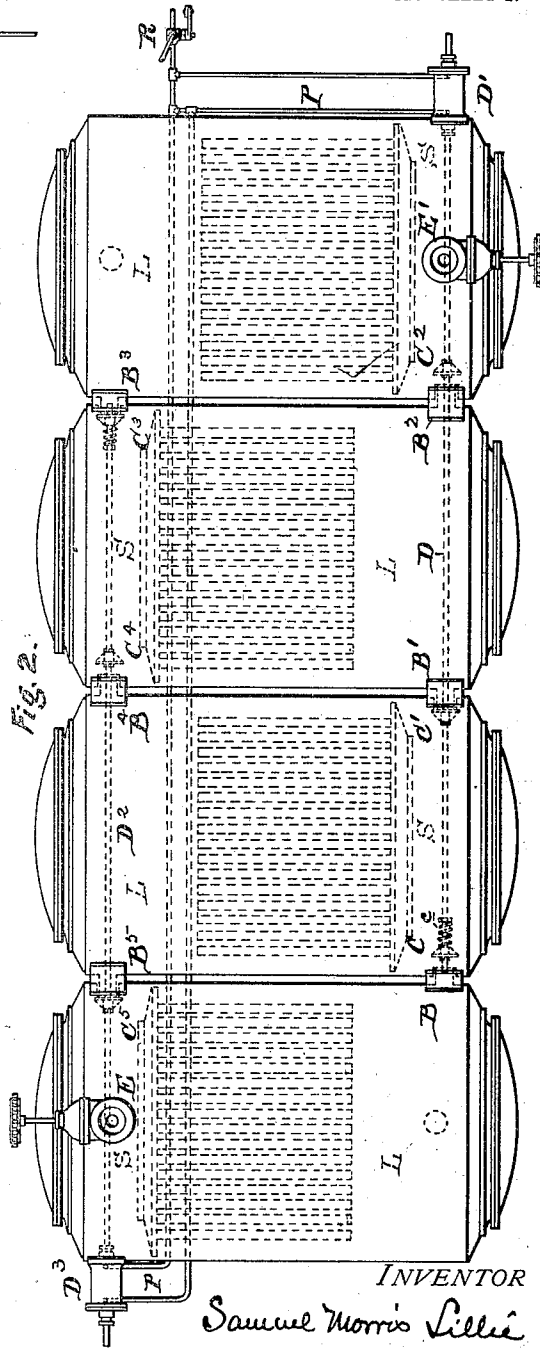
948,376.

Patented Feb. 8, 1910.

2 SHEETS—SHEET 1.



WITNESSES
S. Webster, Jr.
R. M. Kelly



INVENTOR
Samuel Morris Lillie
 BY *[Signature]*
 Attorney

948,376.

2 SHEETS—SHEET 2.

This technical drawing is a cross-sectional view of a mechanical assembly, possibly a steam engine or a pump. The central chamber is labeled *L*. At the top, a curved, domed structure is labeled *A'*. Below this, a horizontal rod or shaft passes through the assembly, with components labeled *S*, *C⁵*, *B⁵*, *D²*, *B*, *C⁴*, and *S*. The bottom of the assembly features a series of vertical rods or pistons, each with a hatched base, resting on a common horizontal support. Below this support, another horizontal rod or shaft is shown, with components labeled *L*, *B*, *C_c*, *S*, *D_c*, *C'*, *B'*, and *L*. The entire device is enclosed within a complex frame with various structural details and hatching indicating different materials or sections.

Daniel Webster, Jr.
P. M. Kelly.

Samuel Morris Lillie INVENTOR
BY Attorney ATTORNEY

UNITED STATES PATENT OFFICE.

SAMUEL MORRIS LILLIE, OF PHILADELPHIA, PENNSYLVANIA.

MULTIPLE-EFFECT EVAPORATING APPARATUS.

948,376.

Specification of Letters Patent.

Patented Feb. 8, 1910.

Application filed June 18, 1906. Serial No. 322,190.

To all whom it may concern:

Be it known that I, SAMUEL MORRIS LILLIE, of the city and county of Philadelphia and State of Pennsylvania, have invented an Improvement in Multiple-Effect Evaporating Apparatus, of which the following is a specification.

My invention has reference to multiple-effect evaporating apparatus; and it consists of certain improvements, which are fully set forth in the following specification and shown in the accompanying drawings, which form a part thereof.

Multiple-effect evaporating and apparatus for practicing it are well known in the arts, and it is unnecessary here to give explanation of either in detail other, perhaps, than to say that the heat is used repeatedly in a series of evaporators or "effects", as usually, and as hereinafter termed, in which the temperatures range between certain extremes. The heat (commonly contained in steam) is used for evaporation first in its hottest effect, while the vapors from the coolest effect usually pass into a condenser. As a rule one solution is evaporated in the series and is taken into the hottest effect and after passing through the intermediate effects in succession, suffering evaporation in each, due to the vapors from the next hotter effect, it passes into the coolest effect and away from it concentrated to the desired degree.

When the liquid being concentrated contains in solution scale-forming materials, incrustations are usually formed on the heating-surfaces in one or all of the effects. Usually the incrustations are the greater the degree of concentration in the solution, and consequently following the above-described sequence they increase in the effect from the hottest to the coolest. Sometimes they are largely confined to the last or coolest effect. I have been able to largely prevent adherence of this incrustation to the heating surface by employing the apparatus set out in Letters Patent No. 777,114, granted to me on December 13, 1904, and by which I accomplish the frequent varying of the temperature in the several effects by reversing the direction of the heat through the series, each reversal making what was before the hottest effect the coolest effect and what was before the coolest effect the hottest effect, the heat passing through the series in

the reverse order to which it passed before reversal. The solution being concentrated is reversed at the same time the direction of the heat is reversed, as a result of which the dilute solution after reversal enters the effect that was before the coolest and contains the heaviest incrustations. The purpose of this is to take advantage of what is often the fact that a dilute solution has a solvent effect upon the incrustations which deposit from it in the concentrated state.

More particularly, the object of my present invention is to provide positive means under control of the attendant for reversing the valves controlling communication between the several effects when employed in combination with evaporating apparatus of the character set out in my Letters Patent No. 777,114 aforesaid, at time when it is desired to reverse the circulation of the vapors therein.

In carrying out my invention I provide in a multiple effect two vapor-passages between each pair of adjacent effects one passage connecting the vapor-chamber of one effect with the heating-chamber of the other and the other passage connecting the heating-chamber of the one with the vapor-chamber of the other and combine therewith valves, whereby either passage may be opened or closed at will, and means under the control of the attendant for operating said valves, preferably in both of the passages, so that when one is closed the other is opened and vice versa.

My invention also embodies details of construction, which, together with the above features of invention, will be better understood by reference to the accompanying drawings, in which, for purposes of illustration, I have shown an evaporator of my own invention commercially known as the "Lillie" type.

In the drawings, Figure 1 is an elevation of a multiple-effect evaporating apparatus embodying my invention; Fig. 2 is a plan view of same and Fig. 3 is a sectional plan view of one of the effects and connections with adjacent effects.

A, A', A² and A³ are four effects and, as arranged, have the steam-chambers S of adjacent effects at opposite ends.

L represents the evaporating and liquor chambers. The details of construction of the effects for evaporating and circulating

the liquid are not described in this application as they may be similar to what is shown in my Letters Patent No. 777,114 aforesaid. The liquor is supplied to the several effects in series, beginning with either effect A or A³, by suitable pipes. The circulation of the liquor through the several effects and its reversal is fully set out in my aforesaid Letters Patent, and in lieu of specific description here, reference is made thereto. The steam is supplied by valve pipe E to the steam-chamber S of effect A. The vapors from the evaporating-chamber L of effect A pass through passage B into the steam chamber S of effect A'. The vapor from the evaporating chamber L of this effect A' pass through passage B into the steam chamber S of effect A'. The vapors from the evaporating chamber L of this effect pass by passage B¹ into the steam-chamber S of effect A². The vapors from effect A² pass by passage B² into the steam-chamber of effect A³, and the vapors of the evaporating-chamber L of this last effect are condensed by a suitable condenser such as shown for example in my Patent No. 777,114, hereinbefore referred to. The various passages B to B⁵ are controlled by valves, such as shown at C to C⁵ respectively, for example the valves in the passages B, B² and B⁴ being open and the valves in the remaining passages closed when the heat or vapors are passing as just described. When the system is to be reversed, the liquor is circulated in the reverse direction. The flow of the liquor having been reversed through the several effects, the valves in the passages B to B⁵ are reversed also, and then the vapors pass as follows: Steam is shut off by valve E and admitted to the steam-chamber S of effect A³ by steam valve E', where it is condensed. The vapors generated in the evaporating-chamber of this effect pass through passage B³ into the steam-chamber of effect A² and are condensed. The vapors of the evaporating chamber of effect A² pass by passage B' into the steam-chamber of effect A' and are condensed. The vapors from this effect pass by passage B⁵ into the steam-chamber of effect A and are condensed, and the vapors of the evaporating-chamber of effect A are condensed by a suitable condenser.

The various passages B to B⁵ are controlled by suitable valves. As shown, they consist of flat valves connected by rod D, so as to normally close the valves C to C² and open valve C' in the passages B, B², and B', respectively, or vice versa. In the other passages, B³, B⁴, and B⁵, a similar arrangement of valves C³, C⁴, C⁵ is employed on rod D². The valves C and C³ are supported on their respective rods D, D² with provision for adjustment and as shown are pressed forward by coil springs *c*. The ob-

ject of this is, that when these rods are shifted, each to simultaneously close two valves one of each of said pairs of valves is given this yielding support so as to insure both valves of each pair closing tightly, as it would be almost impossible to insure them both seating the exact same instant in actual practice if rigidly secured to the rod. The valves and passages are made larger when the vapors passing are less dense, so as to secure the greater area with the lower pressures.

The rods D, D², extend through the several effects and thence through cylinders D', D³ respectively secured to the sides of the most distant effects and are provided with pistons therefor so that the said shafts may be reciprocated under the power of these devices as motors, which may be hydraulically or otherwise operated. Water is supplied to these hydraulic cylinders by pipes P P and simultaneously controlled by hand or valve device R, by which water under pressure may be simultaneously admitted to the similar or corresponding ends of the cylinders D', D³, and exhausted from the other ends, or vice versa, whereby the rods D, D² and their valves are operated, at the same time and in directions to reverse the direction of the valve. In this way the valves in the two series of passages of the effects are adjusted at the same time and without any special care on the part of the attendant. The motors for operating the valve rods D, D² may be operated by steam or other motive fluid such as gas or air instead of water if so desired. Any mechanical motors or power devices for moving the rods D, D² may be employed under the term motor. In the particular construction shown the several valves for the two series of upper passages of the effects are secured to their respective rods and the power, hydraulically or otherwise, is applied to the rods for moving them, but broadly considered, my invention comprehends means extending from the valves to without the effects for operating said valves under manual control.

I have shown my invention applied to a type of multiple effect known to the trade as the "Lillie" effect; but it is to be understood that my invention is applicable to any type of multiple effect.

While for convenience of construction I have arranged the steam ends alternately at opposite ends of the effects, I do not limit myself to such an arrangement as the adjacent effects may be connected by cross tubular connections between the steam and evaporating chambers, for example.

The various valves in the passages between the steam and vapor chambers of the several effects may be constructed and operated in any manner desired so long as they

control the circulation of the vapors and permit them to be reversed in the manner set out.

In this specification and in the following claims the expression "adjacent effects" is used to designate consecutive effects in the course of the vapors—*i. e.*, one of the adjacent effects either receives vapor from the other or yields vapor to the other, depending upon whether the series is operating with the vapors (heat) passing through it in one direction or in the other.

While the construction set out is adapted for the employment of my invention in practice, I do not limit myself to the details, as they may be modified without departure from the spirit of the invention.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a multiple effect apparatus the combination of a series of effects comprising horizontal and parallel vessels having steam and evaporating chambers and in which the adjacent effects have their steam-chambers located on opposite ends, valved passages between the steam-chambers and evaporating-chambers of adjacent effects, and positively actuating and manually controlled means independent of the valves for simultaneously operating the several valves of said valved passages by directly moving them.

2. In a multiple effect apparatus the combination of a series of effects comprising horizontal and parallel vessels having steam and evaporating chambers and in which the adjacent effects have their steam chambers located on opposite ends, valved passages between the steam chambers and evaporating chambers of adjacent effects at both ends, independent means independent of the valves but directly connecting with them for positively operating the valves of said valved passages at the opposite ends of the effects, and manually controlled devices for simultaneously controlling the operating of both of said independent means for operating the valves.

3. In a multiple effect apparatus the combination of a series of effects comprising horizontal and parallel vessels having steam and evaporating chambers and in which the adjacent effects have their steam chambers located on opposite ends, valved vapor passages between the steam chambers and evaporating chambers of adjacent effects at both ends, independent means for operating the valves of said valved passages at the opposite ends of the effects, valve operating rods for moving the valves, motors independent of the valves for moving the rods, and manually controlled devices for controlling the motors.

4. In a multiple effect apparatus evaporator two vapor passages between each pair

of adjacent effects, one passage connecting the vapor end of the one effect with the steam of the other and the second connecting the steam end of the one with the vapor end of the other and valved whereby either passage may be closed or opened at will, and independent motor devices separate from the valves for operating the valves of the two passages.

5. In a multiple effect apparatus evaporator two vapor passages between each pair of adjacent effects, one passage connecting the vapor end of the one effect with the steam end of the other and the second connecting the steam end of the one with the vapor end of the other and valved whereby either passage may be closed or opened at will, independent motor devices separate from the valves for operating the valves of the two vapor passages, and manually controlled means for simultaneously controlling the operation of both motor devices.

6. In a multiple effect apparatus the combination of a series of effects having steam and evaporating chambers, valved passages between the steam chambers and evaporating chambers of adjacent effects at both ends, two sets of valved steam pipes to supply steam to the steam chambers of the end effects of the series, power devices independent of the valves for operating the valve of one set and located at one end of the series of effects, power devices independent of the valves for operating the valves of the other set and located at the other end of the series of effects, and manually controlled means for simultaneously controlling both of said power devices.

7. In a multiple effect apparatus the combination of a series of effects having steam and evaporating chambers, valved passages between the steam chambers and evaporating chambers of adjacent effects at both ends, valve rods for operating the valves in two sets, cylinders and pistons for operating the valve rods, and means for simultaneously controlling the power to the cylinders for operating the pistons thereof.

8. In a multiple effect apparatus the combination of a series of effects comprising horizontal and parallel vessels having steam and evaporating chambers and in which the adjacent effects have their steam chambers located on opposite ends, passages connecting the steam and evaporating chambers of adjacent effects, valves for said passages, connections between the valves of the passages so as to cause adjacent valves to operate on their valve seats in opposite directions to cause the passageways to be opened and closed alternately, motors independent of the valves for operating the connections between the valves, and means for controlling the operation of the motors.

9. The combination of three or more ef-

fects of a multiple effect apparatus provided with passages from the steam chamber of one effect to the evaporating chambers of two adjacent effects, valves to open one of said passages and close the other or vice versa, and manually controlled means common to both of the valves for operating them simultaneously.

10. The combination of three or more effects of a multiple effect apparatus provided with passages from the steam chamber of one effect to the evaporating chambers of two adjacent effects, valves to open one of said passages and close the other or vice versa, and manually controlled means for positively and mechanically operating both of the valves simultaneously extending to the outside of the effects.

11. The combination of three or more effects of a multiple effect apparatus provided with passages from the steam chamber to the evaporating chambers of two adjacent effects, valves to open one of said passages and close the other or vice versa, connections between the valves whereby they operate as a unit, and a motor independent of the valves for operating the connections and their valves.

12. The combination of three or more effects of a multiple effect apparatus provided with passages from the steam chamber to the evaporating chambers of two adjacent effects, valves to open one of said passages and close the other or vice versa, connections between the valves whereby they operate as a unit, a motor independent of

the valves for operating the connections and their valves, and manually controlled means outside of the effects for controlling the operation of the motor.

13. The combination of three or more effects of a multiple effect apparatus provided with passages from the steam chamber of one effect to the evaporating chambers of two adjacent effects, valves to open one of said passages and close the other or vice versa, manually controlled means for positively operating both of the valves consisting of a power motor independent of the valves to operate the valves, pressure fluid pipes for supplying fluid to the motor and valve mechanism to control the fluid in the fluid pipes.

14. In a multiple effect apparatus the combination of a series of effects having steam and evaporating chambers, valved passages between the steam chambers and evaporating chambers of adjacent effects at both ends, valved steam pipes to supply steam to the steam chambers of the end effects of the series, and means connecting with the valves extending to the outside of the effects for positively operating said valves independent of the steam pressures within the effects.

In testimony of which invention, I hereunto set my hand.

S. MORRIS LILLIE.

Witnesses:

JOHN J. WALTER,
COLIN D. SMITH.