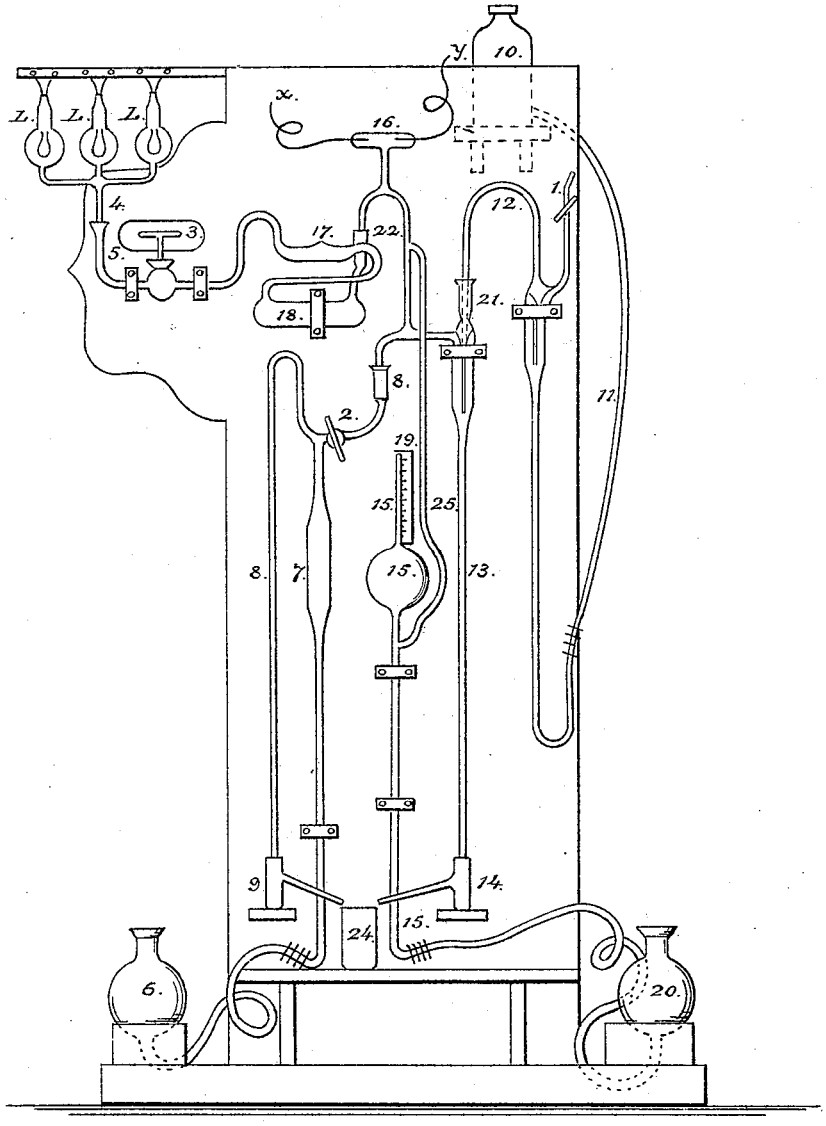
(No Model.) 3 Sheets—Sheet 1.

T. A. EDISON.

APPARATUS FOR PRODUCING HIGH VACUUMS.

No. 248,425. Patented Oct. 18, 1881.

Fig. 1.



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(No Model.) 3 Sheets—Sheet 2.

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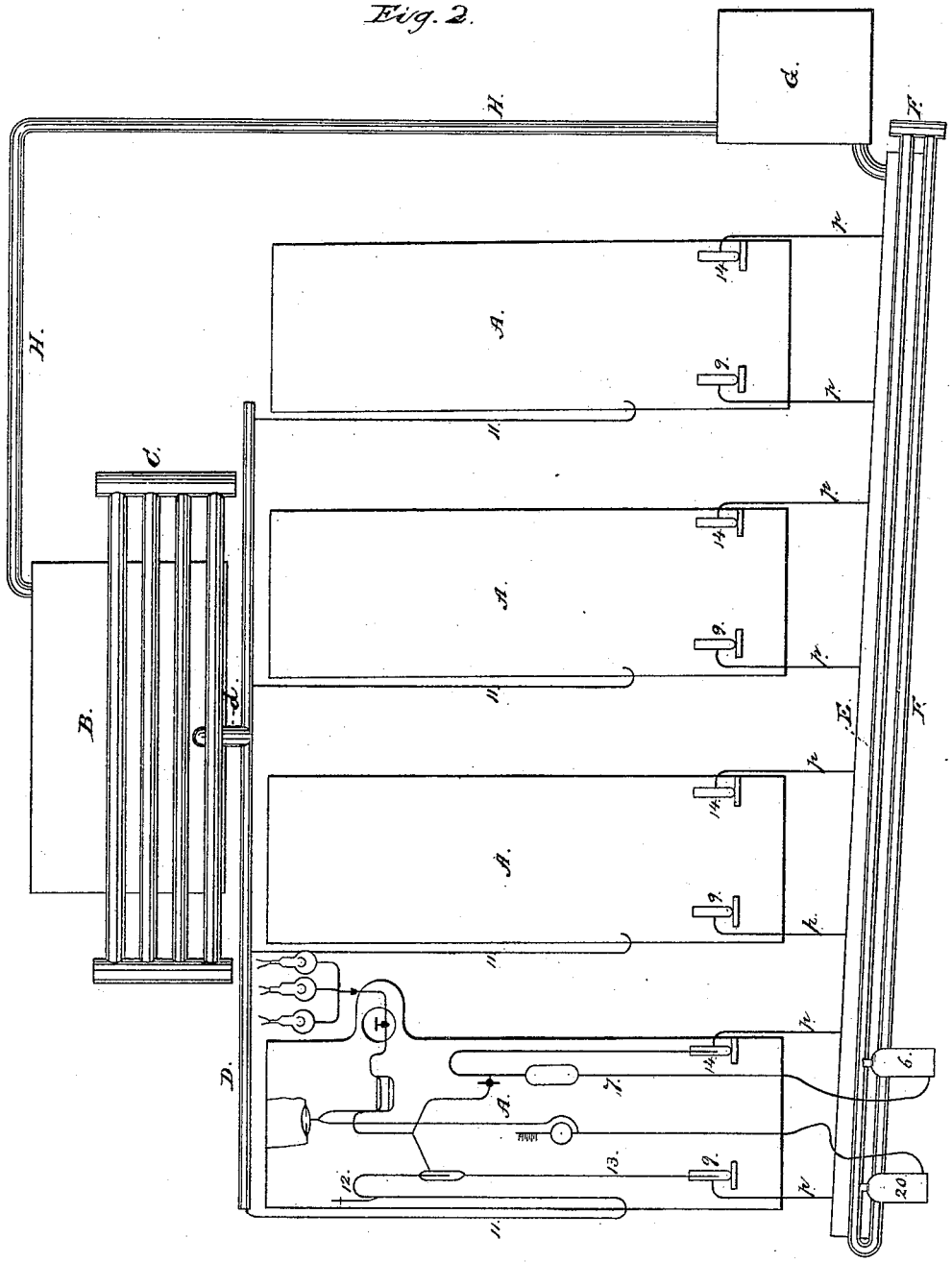
Fig. 2.



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his Atty's

(No Model.) 3 Sheets—Sheet 3.

T. A. EDISON.

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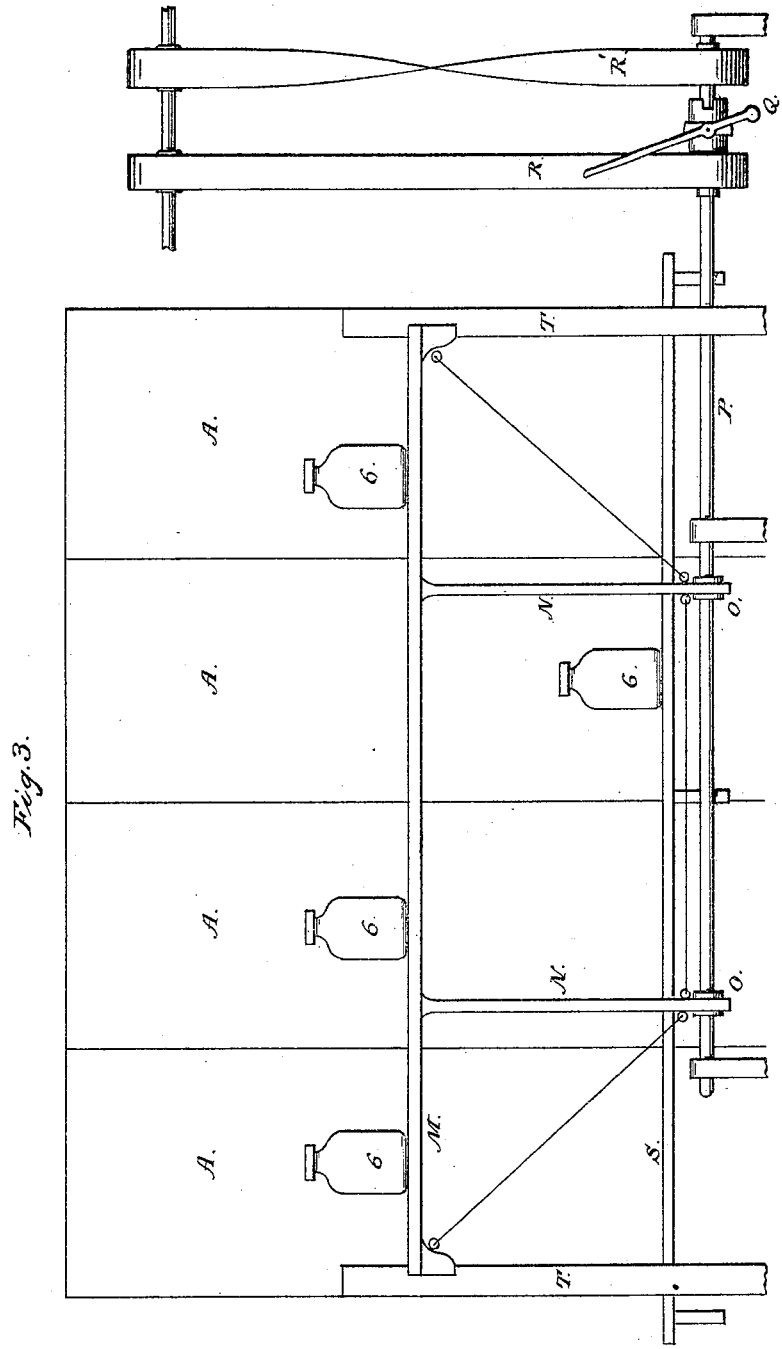

Fig. 3.

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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

APPARATUS FOR PRODUCING HIGH VACUUMS.

SPECIFICATION forming part of Letters Patent No. 248,425, dated October 18, 1881.

Application filed March 29, 1880. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Menlo Park, in the State of New Jersey, have made certain new and useful Improvements in Apparatus for Producing High Vacuums, of which the following is a specification.

Heretofore high vacua have been only produced in the laboratory by the expenditure of much time and care and by men celebrated for their skill in that department—such as Sprengel, Geissler, Warren, De La Rué, and Wm. Crookes. Bulbs exhausted by the means these savants employ are very expensive, as the operation was tedious and the precautions many, so that any device where a part is a highly-exhausted receiver could not, except in rare cases, be made a commercial success, on account of the tediousness and expense of producing the high vacuum, which increases as the exhaustion is carried higher.

In my electric lamps containing an incandescent conductor of carbon it is essential that very high exhaustions should be attained to insure the permanency of the conductor, by reducing the amount of nitrogen and oxygen in the bulb to an amount inappreciable, as compared with the mass of the conductor, which itself is ordinarily but the one-eighth of a grain. Being necessary to produce these lamps in vast quantities and very cheaply, in order to insure their adoption, the cost of production should be brought down to a minimum. To aid in this the time required for exhausting the bulbs should be reduced many times less than in the laboratory experiments heretofore noted, and such arrangements or combinations should be devised and used as will allow of one person attending to many exhausters.

The object of my invention is to accomplish this; and to that end there is combined with a series of pumps adapted to exhaust the air from closed receivers by the flow of mercury, of a general or common reservoir of mercury, a general or common mercury-well, and a pump worked by any suitable motor for continuously returning the mercury from the well to the reservoir. From the reservoir leads a pipe with branches to each exhaust-pump, and to the well leads a pipe into which all the exhaust-pumps discharge. The reservoir, the well, and the tubes or pipes therefrom and thereto are surrounded by heating-pipes—air or steam—or they are otherwise heated, in order that the mercury may be kept warm and free from moisture, for the reason that mercury used warm acts to produce a high vacuum in very much less time than when used cold. The individual exhaust-pumps are formed of the Geissler pump and the Sprengel drop-pump, with a MacLeod gage for determining the degree of exhaustion. With each individual pump is combined receptacles for containing material for absorbing moisture and mercurial fumes, and a Geissler tube for indicating readily when a certain degree of exhaustion has been reached. In using the Geissler pump and the MacLeod gage it is necessary to lift mercury-reservoirs, the general reservoir and pump for the Sprengel drop not being adapted therefor. To accomplish this readily two shelves are arranged, one stationary, one moving in ways and provided with mechanism for raising and lowering it. An attendant, seeing that it is requisite to raise the reservoirs of the Geissler pumps or of the gages of a number of pumps, simply slides the reservoirs therefor from the stationary to the moving shelf, and the entire number is raised and then lowered at once.

For a more particular description reference is to be had to the drawings accompanying and forming part of this specification, in which—

Figure 1 is a plan of an individual pump, and Fig. 2 a plan of a series. Fig. 3 is a view of the apparatus for raising and lowering the reservoirs connected with the Geissler pump and MacLeod gages.

In Fig. 1, the left-hand portion (6, 7, 8, are connections to the lamps L L L) is a Geissler pump, while the right-hand portion (11, 12, 13, &c.) is a Sprengel drop-pump. The lamps L L L, more or less in number, are attached to a tube, 4, which is secured to the pumps at the mercury-seal 5. The terminals 9 14 of the pumps are sealed by mercury. All joints and stop-cocks (for example 1, 2, 3, 21, 22, &c.) are provided with mercury-seals. 6, 10, and 20 are suitable mercury-reservoirs. The Geissler pump is first used. Stop-cocks 1 2 are opened and receptacle 6 is raised sufficiently high to fill 7 and 8. This forces the air in 7 out through 1, which is then closed, the receptacle 6 lowered,

and cock 3 opened. The mercury in 7 flows back into 6, creating a partial vacuum or attenuation of air in the lamp-bulbs L. The degree of attenuation obtained is due to the relative capacity of the enlargement of 7 and the remainder of the apparatus then in use, a quantity of air, or attenuated air, equal to that contained in 7 being withdrawn at each operation.

The operations described are repeated until a considerable degree of exhaustion in L L is obtained. The cocks 1 and 2 are then closed and the Sprengel pump alone used. The receptacle 10 is filled with mercury, which flows through 11 and 12 and drops into tube 13, the end of 12 being reduced in size so that drops only shall flow therefrom. Each drop falling from 12 into 13 acts as a piston, carrying before it a small quantity of attenuated air, which is forced out through 14, the overflow of mercury going into 24.

At 16 is combined with the pumps a Geissler tube, which is included in the circuit of an induction-coil, (represented by the conductors *x y*.) Upon the reaching of a high degree of vacuum the current ceases to pass therethrough, giving a visual test, which saves much time and labor, as so long as the current passes therethrough it is unnecessary to use the MacLeod gage 15, 19, 20.

In the line of pipes between the lamps and the pumps are the receptacles 17 18, in which are placed materials adapted to absorb moisture and mercurial fumes or vapors, so that neither moisture nor mercurial vapor may be present in the lamps, to their detriment after they shall have been exhausted of air.

For testing the degree of attenuation after the current ceases to pass through 16 recourse is had to a MacLeod gage, 15, which consists of a tube having a large bulb and ending in a capillary tube provided with a scale indicator, 19. The tube 15 is in communication with the system of pumps through 25, and is connected also by a flexible tube with a mercury-reservoir, 20. If 20 be raised to the height, say, of 19, the mercury flows through 15, in which, of course, is exactly the same degree of atmospheric tension as in the remainder of the system until the union of 15 and 25 is sealed, the mercury then acting to compress whatever of atmosphere there is in the bulbs of 15 into the tube. The scale indicator shows the degree of attenuation. When the proper degree of vacuum is thought to be reached an electric circuit is closed through the lamps and the conductor therein rendered incandescent. This aids to definitely determine if the proper degree has been reached. When ready the neck of each lamp is softened by heat and the parts sealed together, the current being kept on and the pumps operating in order that it may be seen if the proper vacuum is maintained during the process.

In practice I connect a very large number of pumps in one series, as shown diagramatically in Fig. 2, in which four pumps, A A A A, are shown, to which number, however, I am not limited, as the series may be extended to, say, one hundred pumps, each complete in itself.

A reservoir, B, of mercury is provided, from which leads by means of a tube, *d*, a general delivery-pipe, D, to which is connected the pipe 11 of each pump of the series.

The receptacles 9 14 of each pump are connected by small pipes *p p* to an inclined well, E, in which the mercury collects after passing from B through the pumps.

At G is located any suitable pump and motor, steam or magnetic, by which the mercury is continuously pumped back into B through the pipe H from the well E. The reservoir B and well E are surrounded by hot-air or steam pipes, or they are otherwise heated, so that the mercury may be kept quite warm. By thus heating the mercury any watery vapor therein contained is driven off, the mercury flows more readily and quickly, the pumps operate thereon more easily, so that a larger volume flows in a given time, the ultimate results being that no injurious vapor is left in the lamps, and the time necessary for the exhaustion of a lamp is shortened, with a consequent increase of amount of work accomplished by a pump. Each pipe 7 may also be connected to D, a suitable stop-cock being placed in 7.

In Fig. 3, M is a movable shelf sliding on ways, T T, and provided with racks N N, in which gear pinions or cogged wheels O O on shaft P, which receives motion through the medium of belts R R′. One of these belts, R′, is crossed, so that when in operation it shall give a motion the reverse of that given by R. These belts run over loose pulleys on P, a clutch or reversing gear, Q, being used to connect, as desired, one or the other to P.

S is a fixed shelf, and 6 6 represent reservoirs.

A A are a series of pumps.

It is evident that the reservoirs of a number of pumps can be moved from S to M and raised at one movement, simultaneously filling with mercury the Geissler pumps or MacLeod gages.

What I claim is—

1. The combination, with a vacuum-pump, of a Geissler tube, substantially as set forth.

2. The combination of a series of vacuum-pumps, a common mercury-reservoir, a common mercury-well, and a pump for returning the mercury to the reservoir from the well, substantially as set forth.

3. The combination, with a series of vacuum-pumps, of means for mechanically raising and lowering at will one or more of a series of mercury-reservoirs, substantially as set forth.

4. The combination, with a series of mercury-reservoirs, of a fixed shelf, a moving shelf, and actuating mechanism therefor capable of reciprocating movement, substantially as set forth.

5. The combination, with a series of vacuum-

pumps, a mercury-reservoir, and a mercury-well, of means for heating the mercury, substantially as set forth.

6. In treating mercury for use in drop or Sprengel pumps, the method of relieving the mercury of watery vapors and causing it to flow more readily, which consists in heating the mercury prior to its passage through the pumps, substantially as set forth.

In testimony whereof I have hereunto affixed my signature this 28th day of January, 1880.

THOS. A. EDISON.

Witnesses:
SAM. D. MOTT,
C. P. MOTT.