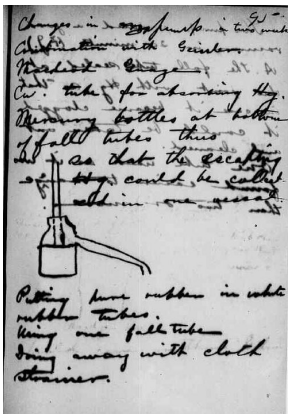
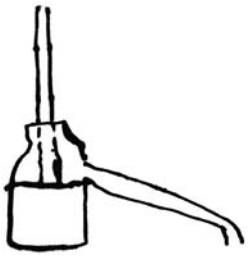
[Menlo Park,] Oct 2d 1879

Notebook Entry: Electric Lighting



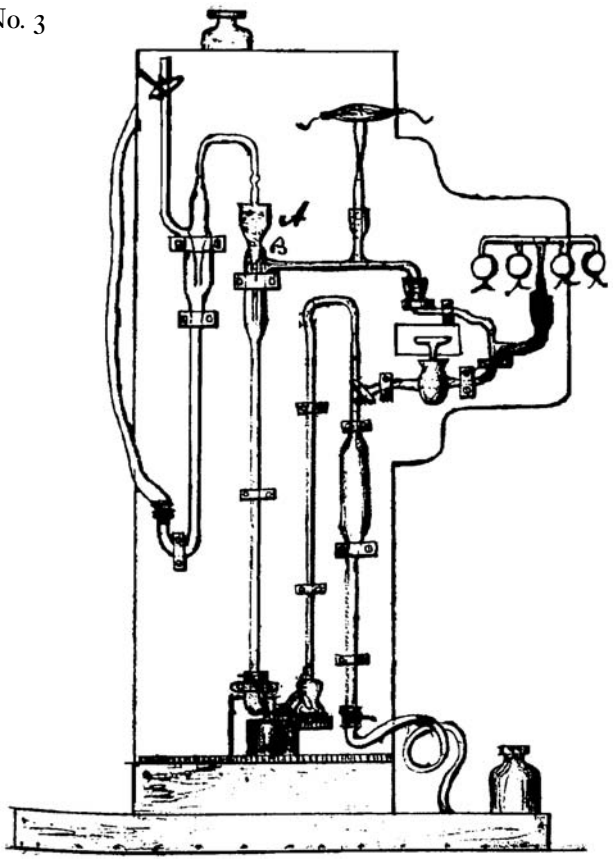
Changes in [---][a] pump in two weeks.[1]

Combination with Geissler.[2]
Macleod Guage.[3]
Cu. tube for absorbing Hg[4]
Mercury bottles at bottom of fall tubes thus



so that the escaping Hg. could be collected in one vessel.
Putting pure rubber in white rubber tubes.
Using one fall tube
Doing away with cloth strainer.

No. 3



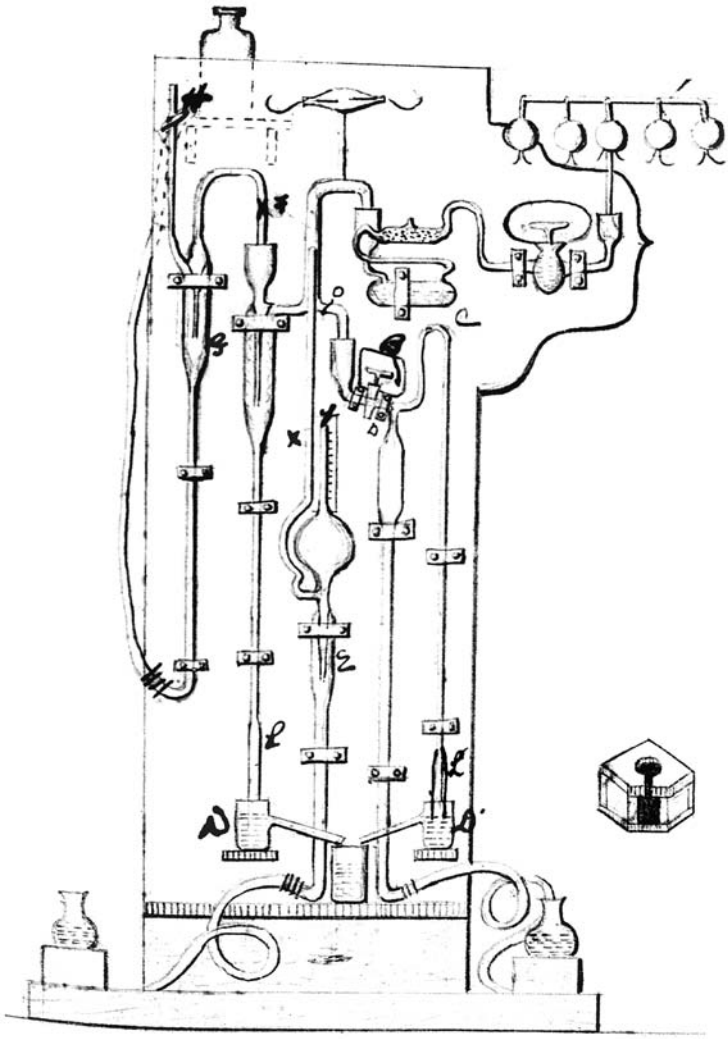
This pump produced a good vacuum in 20 minutes (F[rancis]. J[ehl].)

A. The fall tube sealed at this point with Hg so that in case it became clogged it could be taken out and cleaned.

One tube used as it was found easier to manage[b] than two or more.

B. The pump broke here. No reason given.

No. 4.[5]



S. D. Mott

X, NjWOE, Lab. N-79-08-22:95, 97, 96, 99 (*TAEM* 35:830–32; *TAED* No85:47–49). Written by Francis Upton; drawings of vacuum pumps No. 3 and No. 4 by Samuel Mott, who signed and dated them. [a]Canceled. [b]Second "a" interlined above.

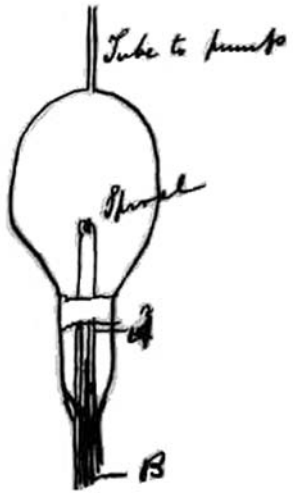
1. See Doc. 1803 for earlier pump designs.

2. In his 1887 paper on "The Development of the Mercurial Air Pump," Silvanus Thompson noted that a combination of the Geissler and Sprengel pumps such as that suggested by Edison "consists merely in sealing the exhaust tubes of each pump together and to the lamp, [and] cannot be recommended. If the Geissler exhausts more perfectly than the Sprengel, or *vice versa,* then the other pump is useless." Thompson 1887, 663.

3. This gauge, designed by H. McLeod in 1874 to measure extremely low pressures in a vacuum pump, is still in use. The McLeod gauge works by condensing a known volume of the residual gas in a vacuum pump into a much smaller volume and then using Boyle's law to measure the pressure of the gas in the pump by determining the ratio between the level of mercury in the closed tube containing that smaller volume and the level in an open tube. In Edison's McLeod gauge he used a paper scale rather than etching dividing marks on the glass tubes to represent these ratios. In the drawing of pump No. 4 the mercury is raised in tube **E** until it traps a sampling volume of gas in the small tube **f**. The volume of mercury continues to be raised in the adjoining open tube **x** so that it reaches a known mark. Nothing is known about how Edison graded his scale but see N-79-08-22 Lab. (TAEM 35:876–93; *TAED* No85:93–96) for an example of the readings. McLeod 1874.

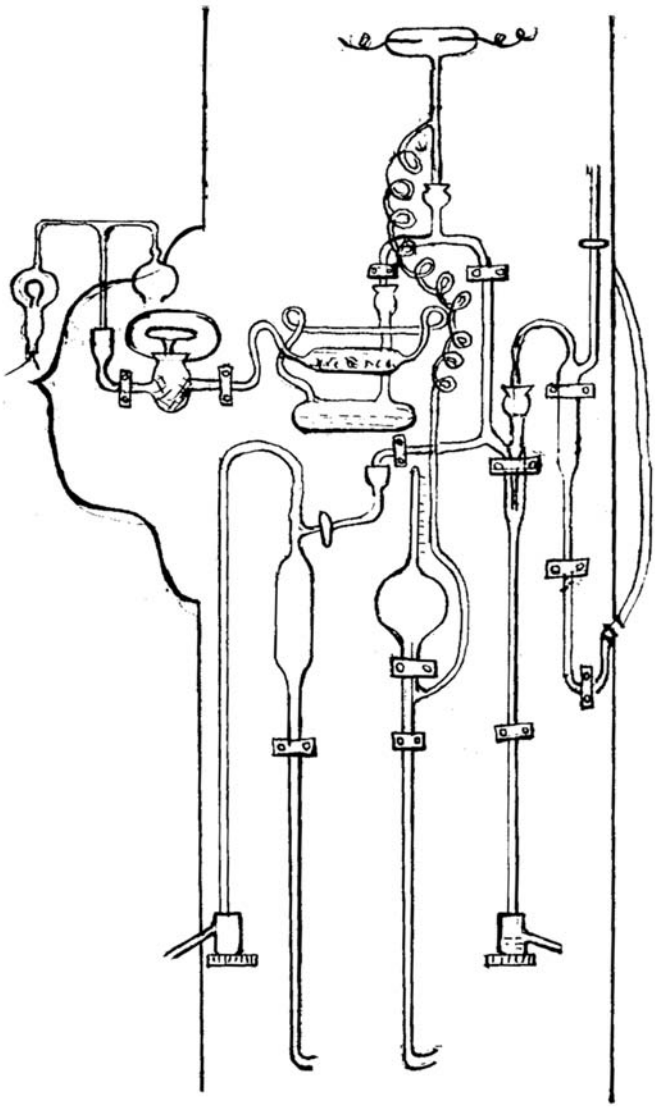
4. In notes accompanying a 3 October drawing like that of pump number 4 (see below), Samuel Mott referred to the addition of a chamber of "granulated Copper (to take up mercurial fumes)" (N-79-09-20: 8, 11, Lab. [*TAEM* 36:32; *TAED* No96:5]). By January 1880, when *Scientific American* illustrated Edison's standard pump at that time (see note 5), gold leaf had replaced the copper; the use of gold was one of the practices adopted by William Crookes (see Doc. 1714 n. 2).

5. On 8 October Upton noted that "Pump No. 4 was broken and is slightly changed and repaired. The stop cock B is now close to the main tube so that no air is held inside tube. The vessels D, D′ were made longer so that the Hg. would not splatter over. In starting the pump the

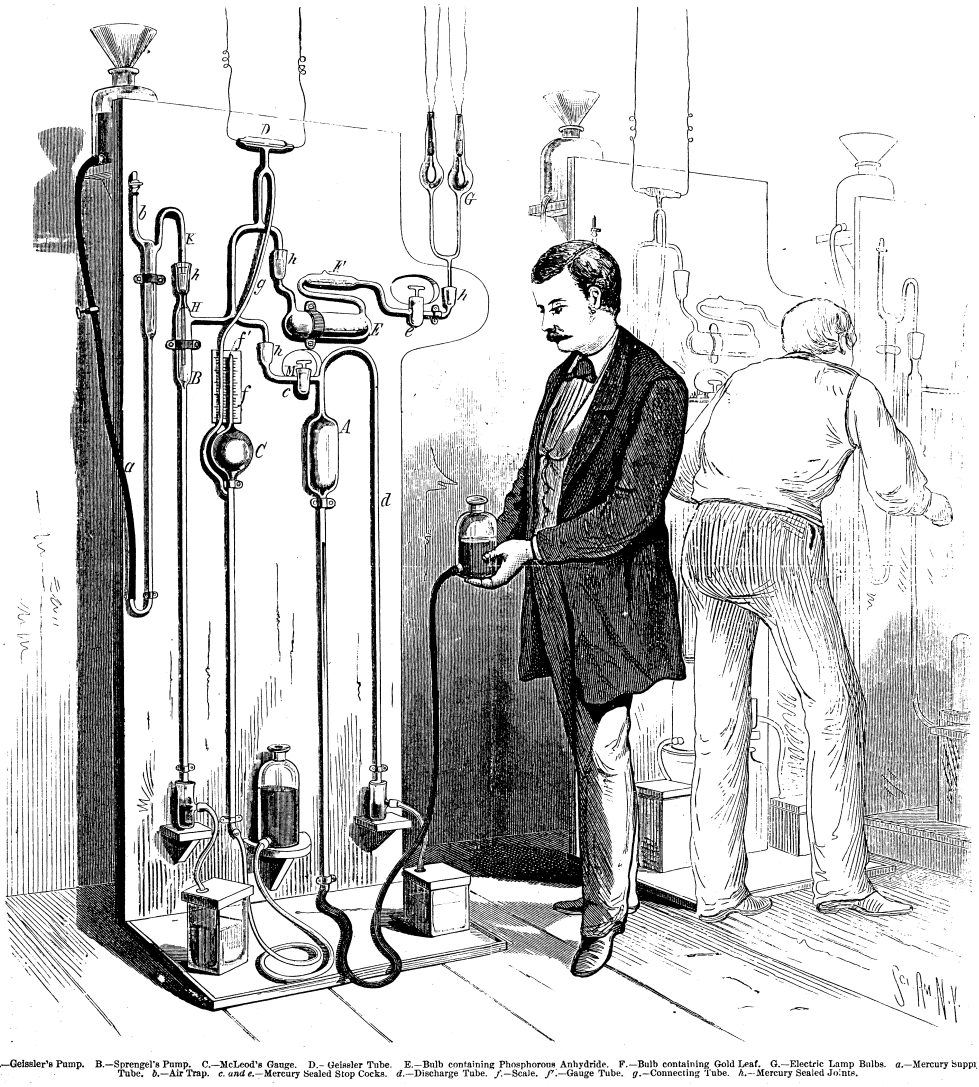


*The new method of sealing the bulbs on the vacuum pump involved using platinum leading wires from the spiral to point **A** and then copper wires, sealed in small tubes, from **A** to **B**.*

Experimental vacuum pump No. 5.



Geissler worked well, but the Sprengel pump required a long time." The laboratory staff found its operation impaired by dampness in the mercury and also by air in the copper dust, which was driven off by heating. Two days later they also altered the manner in which the spirals were sealed with the "leading" (lead-in) wires sealed in small tubes. Ludwig Böhm also made a new mercury seal. They continued to experiment with the pump design over the next few days. On 13 October they experimented with using the Geissler pump first until they had achieved good light from both poles of the lamp and then turned on the Sprengel pump to run at very fast rate. This seems to have produced a "Good vacuum to stop small spark in an hour." Over the next day or two they made



Edison's vacuum pump as illustrated in the 17 January 1880 Scientific American. *The Sprengel pump is* **B** *and the Geissler tube is* **d**. *The McLeod gauge is* **C**, *with the scale* **f**, *the closed "gauge tube" f′, and the connecting tube* **g**.

additional modifications that were incorporated into a fifth pump design. However, the standard Edison vacuum pump illustrated and described in the 17 January 1880 issue of *Scientific American* is identical in construction to No. 4. In operation the pumps differed in Edison's adoption of gold leaf (see note 4) and phosphorous anhydride for absorbing water vapor (see Doc. 1714 n. 2). N-79-08-22:131–35, 139, 159–61, 165–69, Lab. (*TAEM* 35:848–50, 852, 862–63, 865–67; *TAED* No85: 65–7, 69, 79–80, 82–4); "Edison's Vacuum Apparatus," *Sci. Am.* 42 (1880): 34–35.