Figure 12.1 shows a reservoir of very large capacity, supplying a small vessel via a pipe. If the head of water in the vessel is less than that in the reservoir, a current of water will flow along the pipe to the vessel, but as soon as the head of water is the same as that in the reservoir, this flow of water ceases. The filling of the vessel is thus accomplished by a current of temporary nature. Let \( E \) be the constant head of water in the reservoir and \( V \) the head in the vessel at any instant, then current in the pipe will flow as long as \( E > V \) and will cease when \( E = V \).

Let the capacity of the vessel be reckoned, not by the amount of water required to fill it when poured in from the top, but by the amount from the reservoir required to make \( V \) equal to unity. Represent this by \( C \). Then when the vessel is filled and \( V \) has its maximum value \( V = E \), the quantity of water in it is \( CV \). Suppose the system is such that \( CV \) is the weight of water, then since the centre of gravity \( G \) is at a height of \( V/2 \)

\[
\text{Potential energy} = \left(\frac{V}{2}\right) \times VC \\
= \frac{1}{2} CV^2
\]

H. Cotton, *Basic Electrotechnology*  
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The above simple hydraulic system is the analogue of the electric capacitor which is simply two conductors insulated from one another, figure 12.2, which shows a capacitor consisting of two parallel metal plates joined to the terminals of a battery of e.m.f. $E$. The plates will acquire the potentials of the terminals to which they are connected and to do this electrons will flow to the negative plate $B$, thereby creating a p.d. which, at any instant, we represent by $V$. As long as $V > E$ this electron flow will take place, this being equivalent to a conventional current $i$ out at the $+$ terminal of the battery and in at the $-$ terminal. This current does not flow between the capacitor plates, its function being to supply electrons to plate $B$. It is therefore called a displacement current. When sufficient electrons have been displaced to make the p.d. equal to $E$ the displacement current ceases.

It will be seen that the capacitor p.d. is in opposition to $E$ as far as the battery circuit is concerned and therefore energy must be expended by the battery in order that the displacement current may flow. This energy is converted to the potential energy of the electric field which is created between the plates.

Let $C$ equal the quantity of electricity in coulombs required to raise the p.d. between the plates by 1 V. Then $C$ is the capacity of the capacitor. The unit is clearly the coulomb per volt. The SI unit of capacitance is called the Farad, symbol $F$, and is defined as follows.

The farad is the capacitance of a capacitor between the plates of