shall have $p = \frac{d V^2 A^3}{2 g b^2}$ considerably greater than before. We cannot ascertain this value with great precision, because it is extremely difficult, if possible, to determine the resistance in so complicated a case. But the formula is exact, if b can be given exactly; and we know within very moderate limits what it may amount to. In a pump of the very best construction, with a button-valve, b cannot exceed one-half of A; and therefore $\frac{A^3}{b^2}$ cannot be less than 8. In this case, $\frac{V^2 A^3}{2 g b^2}$ will be $\frac{V^2}{8}$. In a good steam-engine pump V is about three feet per second, and $\frac{V^2}{8}$ is about $1\frac{1}{8}$ feet, which is but a small matter.

We have hitherto been considering the sucking-pump alone: but the forcing-pump is of more importance, and apparently more difficult of investigation.—Here we have to overcome the obstructions in long pipes, with many bends, contractions, and other obstructions. But the consideration of what relates merely to the pump is abundantly simple. In most cases we have only to force the water into an air-vessel, in opposition to the elasticity of the air compressed in it, and to send it thither with a certain velocity, regulated by the quantity of water discharged in a given time. The elasticity of the air in the air-vessel propels it along the *Main*. We are not now speaking of the force necessary for counterbalancing this pressure of the air in the air-vessel, *which is equivalent to all the subsequent obstructions*, but only of the force necessary for propelling the water out of the pump with the proper velocity.

We have in a manner determined this already. The piston is solid, and the water which it forces has to pass through a valve in the lateral pipe, and then to move in the direction of the Main. The change of direction requires an addition of force to what is necessary for merely im-