to A A. The Square of 6 ½ the Half of the Root is 42 ¼; from which ſubſtracting 32, there remains 10 ¼, the Root of which is 3 ¼ a little leſs: Take that from 6 ½, and there remains 3 and ¼; add that to 6 ½, and it will make 9 ¾; and theſe 3 ¼ and ¾ will be the two Roots; which ſhews that the Water can never riſe when the Barrel is empty, above 3 foot ¼ and a little more, tho' you play the Piſton as long as you pleaſe; but if you had fill'd the Barrel 9 Foot ⅛, you might make the Water riſe 12 Foot compleat by ſeveral Strokes of the Piſton.

Let us ſuppoſe now that the Barrel is 14 Foot up to the Piſton, and that the Stroke of the Piſton is 2 Foot; 32 — A will be to 32, as 14 — A to 16 — A. To find the Equation eaſily, you muſt multiply 32 by 2, the Difference of 14 and 16: The Product is 64 for the abſolute Number, and that of 16 A, will be the Number of the Roots, and A A will be equal to 16 A — 64; the Square of half the Root is 64; from whence ſubtracting 64, there remains 0, whoſe Root is 0, which being taken from and added to 8, ſtill makes 8; which ſhews that there is but one Root, and that the Water can't riſe above 8 Foot; but if you make the Piſton play ever ſo little higher than 2 Foot, the Water will riſe 14 Foot. The Analogy is eaſy; for the Piſton being raiſed 2 Foot, the Barrel will be 16 Foot, and that Water being at 8 Foot, there will remain 6 Foot of Air; but 32 is to 24 the Complement of 8 Foot to 32, as 8 Foot of rarified Air to 6 Foot of common Air; then the Water will raiſe no higher than 8 Foot, if the Piſton plays but 2 Foot.

Thence you ſee, that to draw up Water to a conſiderable Height, as 20 Foot, the Breadth of the Pump-Barrel muſt be diminiſh'd, and a ſufficient Space muſt be allow'd for the Stroke of the Piſton; for, ſuppoſing that the Surface of the Piſton be 4 times broader than the Baſe of the Barrel, the riſing of the Piſton 1 Foot, will have the ſame Effect as if it roſe 4, if the Diameter of the Piſton were only equal to that of the Barrel; if then the Srroke be a Foot and a half, it will be the ſame as if it roſe 6 Foot, and were of the ſame Breadth: Now the 4 Terms of Equation being 32 — A; 32, 20 — A, 26 — A, there will be 6 times 32, *viz.* 192 for one Term of the Equation, and 26 A for the other, according to what has been ſaid; there will be then A A equal to 26 A — 192; the Square of half the Roots is 169 leſs than 192; and conſequently if you pump a long time, you may raiſe the Water 20 Foot.

If in the Example above-mention'd, you take 8 Foot for the higheſt Term of the Water, when the Barrel is 14 Foot, and the Stroke of the Piſton 2 Foot, 'tis eaſy to prove, that if you ſuppoſe 9 Foot of Water upon the Clack, it will continue to riſe by the playing of the Piſton 2 Foot; for there will remain 5 Foot of Air. Now there is a leſs Proportion betwixt 5 and 7, than there is betwixt 27, the Complement of 5 to 32, and 32, and conſequently the Water will riſe higher than 9 Foot The Proportion will ſtill be more unequal, if you take 10 or 11 Foot; and if you take 7 inſtead of 8 Foot, the Water will ſtill riſe, for there will remain 7 Foot of Air; now 25, the Complement of 7 to 32, is to 32 as 7 to 8 ⅘; then if the Piſton goes 2 Foot, it will raiſe the Water higher than 7 Foot; it will riſe ſtill more eaſily, if you pour in only 6 Foot of Water; for there will be 8 Foot of Air. Now the Complement 26 is to 32 as 8 to 9 ⅘; then if inſtead of 9 ⅘, which makes the *Equilibrium*, the Piſton goes 10 Foot, it will make the Water riſe ſtill better than when it was at 7 Foot; and better ſtill than when it is at 5 Foot, *&c.* If you would know what Play the Piſton muſt have to raiſe the Water 30 Foot, you muſt take a Number a little greater than the half of 30, as 16, at which Point pretty near the Water, will riſe with the greateſt Difficulty; the Complement is 16, the Remainder of Air is 14; as 16 is to 32, ſo is 14 to 28. The Piſton then muſt riſe 14 Foot; or if the Barrel be 2 Inches Diameter, the Piſton muſt be 7 Inches ½; for the Square of 7 ½ is 56 ¼, which is a little more than 14 times 4 the Square of 2 Inches; and then it will be ſufficient that the Stroke of the Piſton be one Foot; but as it is ſtill more difficult at an Elevation of 18 Foot, the Piſton muſt be 8 Inches Diameter, to raiſe the Water above 18 Foot, when its Stroke is but one Foot.