is in such particulars, unheeded by the ordinary herd of engineers or pump-makers, that the superiority of an intel­ligent practitioner is to be seen.

Another material point in the conduct of water in pipes is the distribution of it to the different persons who have occasion for it. This is rarely done from the rising main. It is usual to send the whole into a cistern, from which it is afterwards conducted to different places in separate pipes. Till the discovery of the general theorem by the Chevalier du Buat, this has been done with great inaccuracy. Engineers think that the different purchasers from water­works receive in proportion to their respective bargains when they give them pipes whose areas are proportional to these payments; but we now see that when these pipes are of any considerable length, the waters of a larger pipe run with a greater velocity than those of a smaller pipe having the same slope. A pipe of two inches diameter will give much more water than four pipes of one inch diameter ; it will give as much as five and a half such pipes or more ; be­cause the squares of the discharges are very nearly as the fifth powers of the diameters. This point ought therefore to be carefully considered in the bargains made with the proprietors of water-works, and the payments made in this proportion. Perhaps the most unexceptionable method would be to make a double distribution. Let the water be first let off in its proper proportions into a second series of small cisterns, and let each have a pipe which will convey the whole water that is discharged into it. The first distribu­tion may be made entirely by pipes of one inch in dia­meter ; this would leave nothing to the calculation of the distributor, for every man would pay in proportion to thc number of such pipes which runs into his own cistern.

In many cases, however, water is distributed by pipes derived from a main ; and here another circumstance comes into action. When water is passing along a pipe, its pressure on the sides of the pipe is diminished by its velocity ; and if a pipe is now derived from it, the quan­tity drawn off is also diminished in the subduplicate ratio of the pressures. If the pressure is reduced to one fourth, one ninth, one sixteenth, &c. the discharge from the lateral pipe is reduced to one half, one third, one fourth, &c. It is therefore of great importance to determine what this di­minution of pressure is which arises from the motion along the main.

It is plain, that if the water suffered no resistance in the main, its velocity would be that with which it entered, and it would pass along without exerting any pressure. If the pipe were shut at the end, the pressure on the sides would be the full pressure of the head of water. If the head of water remain the same, and the end of the tube be con­tracted, but not stopped entirely, the velocity in the pipe is diminished. If we would have the velocity in the pipe with this contracted mouth augmented to what it was be­fore the contraction was made, we must employ the pres­sure of a piston, or of a head of water. This is propagated through the fluid, and thus a pressure is immediately ex­cited on the sides of the pipe. New obstructions of any kind, arising from friction or any other cause, produce a diminution of velocity in the pipe : but when the natural velocity is checked, the particles re-act on what obstructs their motion ; and this action is uniformly propagated through a perfect fluid in every direction. The resistance therefore which we thus ascribe to friction, produces the same lateral pressure which a contraction of the orifice, which equally diminishes the velocity in the pipe, would do. Indeed this is demonstrable from any distinct notions that we can form of these obstructions. They proceed from the want of perfect smoothness, which obliges the particles next the sides to move in undulated lines. This excites transverse forces in the same manner as any con­strained curvilineal motion. A particle in its undulated

path tends to escape from it, and acts on the lateral par­ticles in the same manner that it would do if moving singly in a capillary tube having the same undulations ; it would press on the concave side of every such undulation. Thus a pressure is exerted among the particles, which is propa­gated to the sides of the pipe ; or the diminution of velo­city may arise from a viscidity or want of perfect fluidity. This obliges the particle immediately pressed to drag along with it another particle which is withheld by adhesion to the sides. This requires additional pressure from a piston, or an additional head of water ; and this pressure also is propagated to the sides of the pipe.

Hence it should follow, that the pressure which water in motion exerts on the sides of its conduit is equal to that which is competent to the head of water which impels it into the pipe, diminished by the head of water competent to the actual velocity with which it moves along the pipe. Let H represent the head of water which impels it into the entry of the pipe, and *h* the head which would produce the actual velocity ; then H — *h* is the column which would produce the pressure exerted on its sides.

This is abundantly verified by very simple experiments. Let an upright pipe be inserted into the side of the main pipe. When the water runs out by the mouth of the main, it will rise in this branch till the weight of the co­lumn balances the pressure that supports it ; and if we then ascertain the velocity of the issuing water by means of the quantity discharged, and compute the head or height necessary for producing this velocity, and subtract this from the height of water above the entry of the main, we shall find the height in the branch precisely equal to their difference. Our readers may see this by examining the experiments related by Gravesande, and still better by examining the experiments related by Bossut, which are detailed with great minuteness. The results corresponded accurately with this proposition. The experiments indeed were not heights of water supported by this pressure, but water expelled by it through the same orifice. Indeed the truth of the proposition appears in every way we can con­sider the motion of water. And as it is of the first import­ance in the practice of conducting water (for reasons which will presently appear), it merits a particular attention. When an inclined tube is in train, the accelerating power of the water (or its weight diminished in the proportion of the length of the oblique column to its vertical height, or its weight multiplied by the fraction -, which expresses the slope) is in equilibrio with the obstructions ; and therefore it exerts no pressure on the pipe but what arises from its weight alone. Any part of it would continue to slide down the inclined plane with a constant velocity, though detached from what follows it. It therefore derives no pressure from the head of water which impelled it into the pipe. The same must be said of a horizontal pipe infi­nitely smooth, or opposing no resistance. The water would move in this pipe with the full velocity due to the head of water which impels it into the cntry. But when the pipe opposes an obstruction, the head of water is greater than that which would impel it into the pipe with the velocity that it actually has in it ; and this additional pressure is propagated along the pipe, where it is balanced by the actual resistance, and therefore excites a *guoguaversum* pressure on the pipe. In short, whatever part of the head of water in the reservoir, or of the pressure which impels it along the tube, is not employed in producing velocity, is employed in acting against some obstruction, and excites, by the re-action of this obstruction, an equal pressure on the tube. The rule therefore is general, but is subject to some modifications which deserve our attention.

In the simply inclined pipe BC (fig.4), the pressure on any point S is equal to that of the head of water AB which im-