3. The curves of equal pressure PP will likewise be ellipses, but their common centre will be located below O and is not shown on our drawing. The curve of maximum pressures, (that is of points on each stream line, where the pressure is greatest for *that* curve) will be a hyperbola YOY, tangent to the plate at O.

Careful attention must be paid to the fact that the straight line OH, of minimum velocities, and the hyperbola YOY (of maximum pressures) do not coincide, so that minimum velocity does not mean greatest pressure, which excessive freedom with Bernoulli's theorem might lead us to think would always be the case. We readily

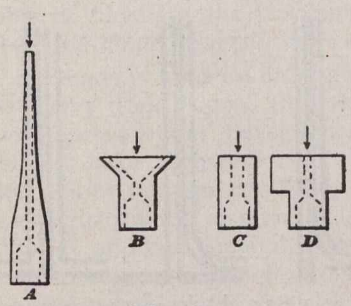

Fig. 3.

forget that Bernoulli's formula has been established for parallel flow only and that it does not hold good for any other kind of flow; at least not in the shape in which it is given in books on hydraulics.

Such, then, is the correct aspect of the phenomenon of a jet impinging upon a round plate. A plate, long and narrow, would mean a somewhat different distribution of velocities, etc., and all lines would appear somewhat different from those given in Fig. 2. It follows, therefore, that contrary to the established assumption, the point O cannot possibly be considered the true impact point. Here the "static" pressure is indeed maximum, but the velocity is zero and therefore it is really the ideal point from which to determine the true static pressure, undisturbed by any "suction" or "trailing" effect.

It will, of course, be understood that this static pressure represents the conditions somewhere "up stream" from the plate itself; for instance in Mr. White's experiment, it simply shows the height from which the water falls. In other words, we have here not the "velocity due to a certain head" but the head itself. This may be made to serve as a check, but in itself is not especially instructive or interesting in our present problem. But then, it is perfectly possible and feasible so to calculate almost anything of this sort as to give fairly good results; only, our layout, Fig. 2, or, for that matter, the "practical" sketch, Fig. 1, as given by Mr. White, shows that the middle point is merely subjected to the action of dead water. We might as well have a stationary column at that point.

Any other point, in the vicinity of the curve YOY, of maximum pressures, will be more likely to register the effect of impact, due to velocity, in addition to static pressure at this point.

All the foregoing refers, of course, to a stream acted upon by gravity and directed downward on a horizontal plate, in other words to the condition, illustrated in Mr. White's sketch. In a pipe, with water flowing under pressure, the foregoing conclusions may require suitable corrections.

It is, nevertheless, quite obvious that the point which is generally assumed to be the true impact point, apparently placed against the greatest action of the stream, may prove to be at a great disadvantage, so far as the determination of velocity is concerned.

The size of the plate, as has been already stated, does not enter into our deductions; and the nozzles B, C and D (Fig. 3, taken from Mr. White's paper) will naturally cause the same distribution of velocities and the same effect. The nozzle B is in the same class, because our mere desire to "catch" the energy by means of a funnel-shaped orifice does not in the least alter the fact of the central stream being perfectly neutral, while other stream lines may, indeed, assume a somewhat more fanciful shape than that given in Fig. 2.

So far as the nozzle A is concerned (Darcy's shape), it must be remembered that, unless the nozzle itself is reasonably long, the fittings, etc., back of it should not be neglected. It will be easily seen that a large T or L piece immediately back of a very thin nozzle will cause the formation of stream lines similar to the foregoing, with the same inevitable effect, viz., the neutral stream, possessing the greatest static pressure, but inert, dynamically.

That the rod itself, beside the nozzle proper, will exert a certain influence upon the results, has been very clearly demonstrated by Professors Easby and Pardoe, of the University of Pennsylvania. In their experiments a comparatively small pipe was chosen and the rod was of

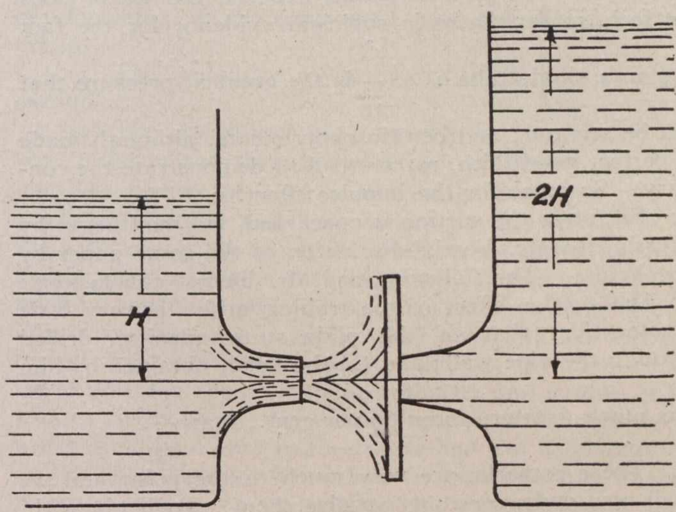

Fig. 4.

uniform blade-like cross-section. By means of suitable stuffing boxes the rod was made to pass completely through and extend on both sides of the pipe; so that traversing the pipe meant merely shifting the position of the orifice, and not, as in other rods, the immersion of an additional portion of the rod proper. Under these conditions the traverse curve was materially different from the one usually obtained from such small pipe (4-inch). The curve was visibly more symmetrical and thus proved, beyond doubt, the experimenters' point.

The fact has been long established in theory and confirmed by experiments of all kinds, that the *force* (*not* the pressure per square inch) due to an impulse of a jet is $M \times V$, mass times velocity, where the mass is the second-weight divided by 32.2 and the velocity is in feet per second, so that the result is in *pounds*. This immediately leads to $h = \frac{v^2}{g}$, in other words, to the conception of *twice the head generated by the velocity.*

That $M \times V$ is the actual force, due to an impulse, can be clearly proved by an experiment, similar to that described in Professor Merriman's *Hydraulics*, in the