"In the case of hydraulic models, it can be shown that homologous velocities in models of different size must be proportional to the square roots of homologous linear dimensions. When the quantities of water have been properly adjusted to comply with this requisite, it may be said that the mechanical and hydraulic conditions in the two models are mechanically and hydraulically similar, just as the configurations of fluids and solids in the models are geometrically similar."

He then states that experimenters with water-wheels have overlooked these relations and conditions, and have failed to make proper tests of model wheels.

Now, the writer thinks that the instances cited by Mr. Torrance and himself plainly refute the idea of simple and always uniform inter-relations and analogies. It is shown that, in a model of a static structure, additional load must be supplied to the extent of the weight of the model multiplied by the scale ratio. (A model bridge made by the writer had to be loaded with 350 lbs. before the individual members were stressed in proportion to the homologous stresses in the bridge represented.)

In the single case of the model dam, as the pressure (load) itself varies as the square of the depth, the behavior of the model and its prototype are the same; but in all cases where dynamic effects are involved, we cannot usually make the model and its prototype comparable or analogous by simple adjustments or contrivances.

Referring now to the experiments conducted by Mr. Groat, the writer would not presume to criticize the procedure or question the validity of the conclusions, so far as they relate to the particular object sought, and strictly under the conditions stated. No doubt, as the German experimenters found, useful lessons may be learned from "model" performances, but only under very special and tractable conditions. We have seen how their protracted and painstaking endeavors resulted in admitted failure to gain the full result sought. For one thing, changes in the model or miniature could be made with ease; but similar modifications under actual conditions might involve great labor and expense or develop unexpected forbidding conditions which the mere model would not suggest. (Like a plan "on paper" vs. a procedure necessitated in face of the working conditions.)

Engineers familiar with our northern rivers, even those flowing from north to south, and thus under more favorable conditions for getting rid of ice in the spring, know too well some of the extreme conditions that defy calculation. Although pieces of paraffin in a small stream may simulate ice carried under ordinary conditions of moderately high water, they are essentially different from ice. They will not freeze together as will ice after a thaw followed by a "cold snap"; they would not readily be subjected to the great side pressure which drives ice laterally into side channels and high up on sleeping banks; they would not so easily simulate the great jams which fill the entire channel, pile up high above it, and cause an excessive rise of the river, leading to destruction of dams, mill buildings, etc.; neither would the miniature contrivance be likely to produce baffling conditions of back-water which vex the souls of those who operate power plants. The writer's observations and experience on a river like the Upper Connecticut is that artificial furrows or transverse ridges in the bed of the river would be speedily obliterated in whole or in part, either by erosion or filling up; and such aids as jetties for con'rolling the flow, as proposed, must needs be of expensive construction to be permanent, and may easily be overtopped by high floods. The following instances illustrating the above stated points are only a few among many which might be cited.

At Summer's Falls a rocky barrier extends so obliquely across the river that its length is nearly double the direct width of the river. About 50 years ago at this site there was a dam, a canal lock and approach canal for river boats, and a very large saw-mill running seven saws. A spring flood brought down ice which jammed and froze; a second flood increased the jam, piled the ice high on the dam and against the banks, and finally carried the mill down stream, and wrecked the dam and lock, which were never rebuilt. The writer has seen (Engineering News, November 14th, 1912, p. 893) an impressive picture of blocks of ice up to 4 ft. thick (a man standing beside one) wedged together over an extent of many acres, on one side of the Lower Yellowstone dam, in Montana, as the result of a high flood. This suggests in part the possibilities of destruction by a spring flood carrying ice.

At the Vernon dam and power house the spillway is 650 ft. long, and the fall, without flash-boards, is 32 ft. The river just below widens to 1,200 ft., but below that is a short curved narrows, about 400 ft. wide. Yet the engineer reports that in a high flood the water below the dam has risen to within 0.8 ft. of the crest, so as to make it for a time practically a submerged dam. How could any model dam and section of this bay and gorge, extending actually a mile on the concave, have suggested this condition of back-water?

When we consider the demonstrated fact that the transporting power of a stream varies as the sixth power of the velocity; that the energy of the flowing water varies as the cube of the velocity; and know that, by geometrical necessity, any model on a reduced scale lacks weight and stability in itself to test its full capacity, under diminutive conditions, we are obliged to object to the quoted all-inclusive claim for the validity of model studies and experiment, especially where hydro-dynamic operations are involved.

A. F. Parker, M.Am.Soc.C.E.: The writer has been actively interested in the problem of canal intakes and keeping them clear. This paper mentions only the matter of ice and floating materials, and in large streams, presumably of not very great fall. Under conditions of ice flowing in such large rivers, and with only moderate velocity, the sub-diversion channels described may produce very good results; but, in smaller streams, of heavy fall, such as are usually found in mountainous districts, it is not so evident that the method presented would produce the results sought. In mountain streams it is usually necessary to build a diversion dam at each intake. Sometimes such dams may be permanent, and in other cases movable dams are necessary in order to pass the annual spring floods. In the case of a permanent dam, the basin back of it always fills up with silt, sand, and sometimes heavier drift materials, so that in time there is only a limited space of any considerable depth at the intake. Movable dams are erected only at low-water stages, and, when removed to pass the spring floods, the current sweeps the deposits accumulated in the basin cleanly away. Thus the action resulting from the use of either form of dam would evidently preclude the use of sub-diversion channels.

In such cases—and such conditions obtain almost everywhere in mountainous localities—it is always very difficult to keep intakes clear of ice. The main reliance must be placed on drawing the water from the greatest depth possible below the surface. The still water above the dam holds the ice flow, but sometimes the mush ice reaches nearly the full depth of the water. Usually, a large gang of men is required to keep the intake clear, and it is impossible to prevent considerable quantities of ice from entering it.