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Memorandum

To: H. M. Martin

Denver, Colorado
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From: J. W. Ball

Subject: Laboratory tests of jet pumps made from standard pipe fittings

AUTHOR

Limited tests were conducted in the Hydraulic Laboratory to determine if operable jet pumps could be made from standard pipe fittings. On the basis of tests made with fittings up to 2 inches in size, it was found that such pumps could be built and that fair performance could be obtained from them.

The test program was undertaken in part, to answer the many inquiries that the Bureau has received concerning jet pumps. In particular, the program was undertaken to determine if a suitable pipe-fitting pump could be made for recirculating the water in the fish screen model at Tracy Pumping Plant, California. Another type of pump was selected for the model before the jet pump studies were well advanced, and the studies were continued only long enough to establish some basic design principles, and to obtain rough performance figures.

The initial tests were made using a 1-1/2 x 2-inch elbow with a 1-inch heel outlet (Figure 1). A 2-inch pipe 5 feet long formed the mixing tube and outlet line, a 1-1/2-inch pipe formed the suction line, and a valve-controlled 1-inch pipe attached to a high-pressure water supply formed the driving nozzle. Almost no pumping was obtained with this design. When the size of the driving nozzle was reduced to 1/2 inch, slightly better performance was obtained.

An analysis of the flow conditions within the pump indicated that the nozzle stream expanded too far upstream in the pump body (elbow) to produce the interchange of energy in the mixing tube required for a pumping action. The nozzle was placed in a more favorable position in the body by running standard threading dies several inches up the nozzle tube and then screwing the tube into the 1/2- by 1-inch bushing until the threads became tight. Much better pumping occurred, but the pump was handicapped by difficulty in making the 2-inch-diameter mixing tube flow full. More favorable results occurred when the pipe was replaced with 1-1/2-inch line 22 inches long. With the nozzle extended so as to be 2-7/16, 1-1/8, and 1/8 inches from the upstream end of the mixing tube (Figure 1), pumping ratios (water pumped, Q_p ÷ nozzle discharge, Q_n) of 0.47, 0.47, and 0.59 were obtained. These pumping figures were low, primarily due to

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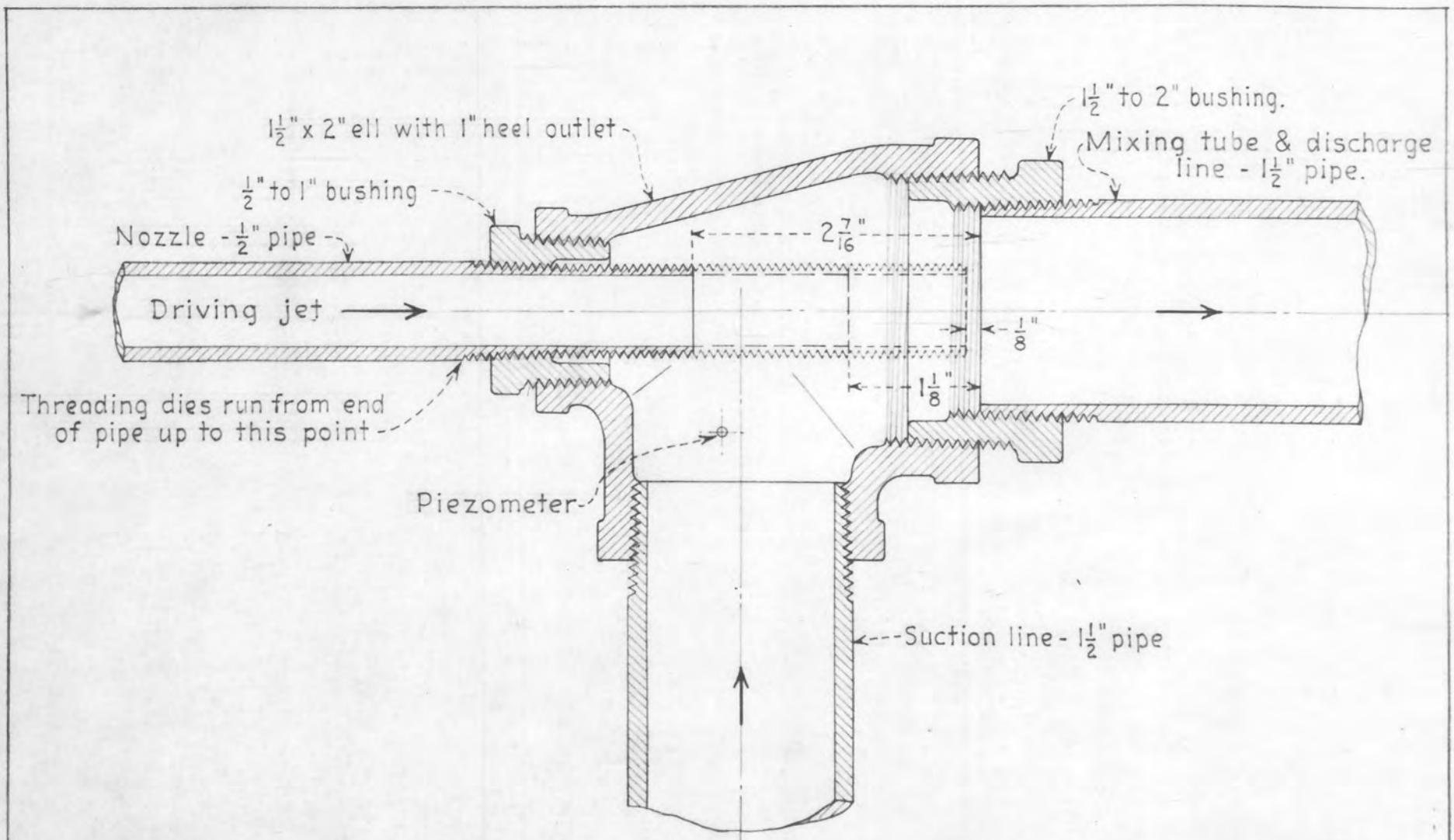
the restricted suction line which consisted of 12 feet of 1-1/4-inch hose, two 1-inch nipples, several other pipe fittings, and a 1-1/2-inch gate valve. In addition there was a vertical lift of 61 inches from the water supply to the pump center line.

The suction line and the water supply were changed to a 1-1/2-inch pipe 4 feet long feeding from a reservoir 7 inches below the pump center line. Considerably greater pumping ratios were obtained. Further improvement was made by removing the driving jet control valve from the 1/2-inch line a short distance above the pump and placing it in the larger pressure line further upstream. The final pumping ratio, $\frac{Q_p}{Q_n}$, with the nozzle at the 1/8-inch position (Figure 1) was 1.24 with a total driving head of 108 feet on the jet. A ratio of 1.07 was obtained with a 60-foot driving head. Actual cfs flow ratios were $\frac{0.110}{0.089}$ and $\frac{0.077}{0.072}$, respectively.

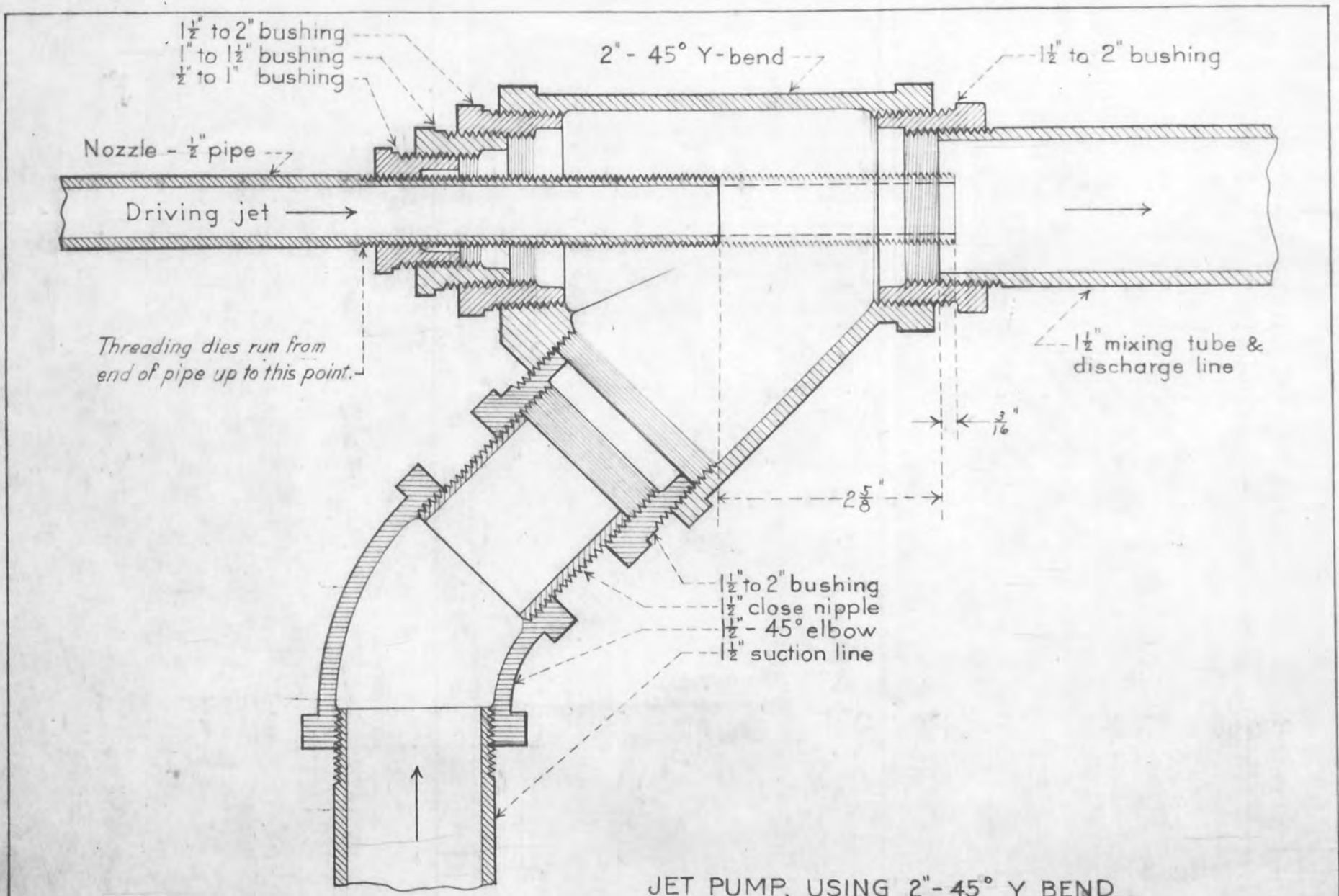
In the second series of tests, a 2-inch, 45° Y-branch was used for the body (Figure 2). The 1/2-inch nozzle was tested at two positions in the Y-branch; at a point midway through the fitting (2-5/8 inches), and at a point 3/16-inch inside the 1-1/2-inch-diameter mixing tube. Pumping ratios (Q_p/Q_n) of 0.90 and 1.02, respectively, were obtained with a 60-foot driving head. The same 1-1/2-inch suction line and reservoir were used as in the previous tests. When the size of the suction line was increased to 2 inches and the lift decreased to 6 inches, the pumping ratio increased to $\frac{0.107}{0.092}$ or 1.16 at the 60-foot driving head.

Several conclusions may be drawn from these limited tests. First, and most important, the discharge end of the driving nozzle must be located near the entrance to the mixing tube. This may be easily accomplished by running standard threading dies up the pipe for the required distance and then screwing the pipe in until the threads "make up." Second, the mixing tube must not be made so large that it will not flow full of its own accord. Third, all possible restrictions and sources of energy loss should be eliminated from the suction line.



JET PUMP USING 1½" x 2" ELL WITH 1" HEEL OUTLET

Figure 1



JET PUMP, USING 2" - 45° Y BEND

Figure 2