zation. We have the "Board of Directors" but have no adequate engineering organization.

Bridges must not be built too small to provide sufficient waterway for passing the run-off from the watershed above them, and in the interest of economy neither should they be made too large.

An example of the result of providing a waterway too small is known. The structure was a 50-foot arch bridge built in 1910. The cost to the county was about $3,000.00. Two years later, or in 1912, the structure collapsed during a freshet, and after the water had gone down it was found that the current had widened the channel by cutting behind the west abutment. As this was a patented type bridge which used the earth pressure behind the abutments to help support the arch, and which has shallow foundations as one of its characteristic features, the result of washing out the fill was the collapse of the structure.

As an example of building bridges too large for the demands of the drainage area, the bridge shown in Fig. 1 is a good illustration. Here a forty-foot riveted steel span with concrete floor and concrete abutments eighteen feet high was placed over a stream having a total drainage area of sixty-nine acres. This bridge cost the county $5,187, when the run-off from the watershed could have been carried by a 4-ft. x 4-ft. box culvert costing about $500. The county in which the bridge is located has an approximate area of 440,000 acres, and at the rate shown above it would cost $32,700,000 to bridge the entire county. The bridge fund in this county is about $30,000 per year, or at the above rate it would require the entire bridge fund for 1,100 years to get once over the county with so-called permanent bridges.

Under the systems usually used in the counties, the general design and the location of the structures are left to the supervisors and to the bridge company's foreman. The majority of supervisors are not trained bridge men, and the bridge company's foreman is not working for the county. As a result there are many examples of improper locations and designs. Bridges are often located several feet above the proper position. In a number of cases we have found concrete bridges located high upon the bank at one side of the stream, and with the pavement or floor six or ten feet above the stream bed. In other cases bridges are so located as to require excessive length of wing walls. In one case, a forty-foot span steel bridge with concrete abutments and three wing walls cost $2,925. This bridge was so located that the other wing wall was made 50 feet long, and the price paid for this wing was $2,262, or an amount nearly as great as the cost of the remainder of the bridge. Another bridge in the same county has one wing wall 80 feet long. This wing extended out into the field, and does not hold up any fill or serve any other purpose which would justify the expenditure of so much money.

In most cases, no estimates are prepared showing the labor and material required to build a given piece of work and when the work is completed the bill presented is allowed by the board without question. This is well illustrated by the record in one county where bills amounting to $57,000 and covering a whole year's work were allowed by the board at one session which lasted not more than three hours. Apparently none of these bills were checked against the structures built as evidenced by the following:—

One of the bills contained the item—

"Building concrete abutments and 2 wings, $737.10."

Investigation disclosed the fact that only one abutment had been built, and that it contained only 15.91 cubic yards of concrete, or the price paid was $46.33 per cubic yard. Another bill for construction on the bridge shown in Fig. 3, contained the item,

"One-half contract price for building concrete bulkheads 16 ft. x 20 ft. long on 48-in. steel culvert 36 ft. long ..... $390.00"

The bridge is located on the line between two counties and hence the bill was presumably approved by two boards of supervisors. The bill apparently included only the building of the concrete bulkheads.

Investigation showed that the two bulkheads contained only 15.45 cubic yards of concrete or the price paid was at the rate of $50.48 per cubic yard. According to the engineer who made these investigations, a fair cost for the concrete in each of these jobs would be $12.50 per cubic yard. Another example of the loose system under which the bridge business is handled in many counties is shown by the following invoice:

To one 14-ft. span with 12-ft. foundations.....	$	720.00
Less acct. abutments 8 ft. deep 8 ft. at $9.00		72.00
	$	648.00
Lattice railing	$	28.00
One 16-ft. wing, one 10-ft. and two 8-ft. wings.....		382.00
		$1,058.00

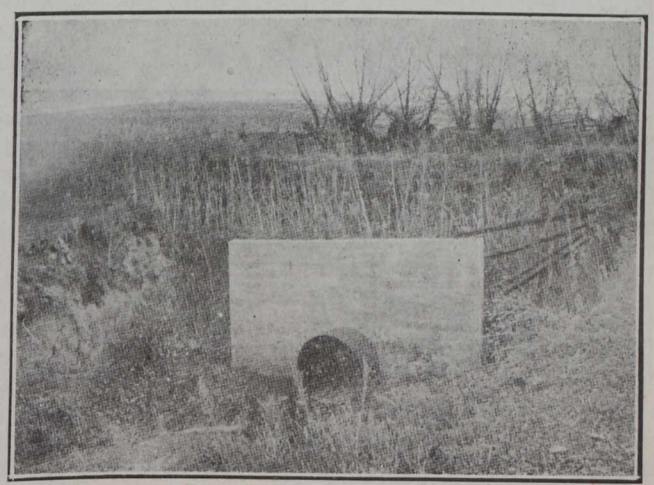

Fig. 3.—The Concrete in This Culvert Cost $50 per Cu. Yd.

When this bridge was examined it was found that the charge of $28 for lattice railing was a double charge, as the railing had already been paid for in the charge of $720 for the first item.

Quite often bridges are built which provide roadways entirely out of proportion to the requirements of present or anticipated future traffic. This was well illustrated in one county where a bridge was found with a 40-foot roadway. The location was such that an addition of filling over the culvert at some future date was impractical. The fact that the bridge was upon a road seldom frequented made this width of roadway very excessive. Not a mile from this bridge, on an adjacent road with a great deal more traffic was another bridge with an available roadway of less than twelve feet. Had a study been made of present and future traffic conditions on these structures, they would never have been built as we found them.

Frequently it is possible to relocate a road and thus avoid building one or more bridges. The following is given as a typical example. In one of the counties, a new road about three-quarters of a mile long was established in such a location that two forty-foot bridges, costing over $2,000 each, were required, when, by a slight relocation of this road, such as any engineer would make, both of these bridges