It should be borne in mind that in no case should a lap joint be used for joining plates more than ½ in. in thickness, except in the case of circumferential joints.

Riveted Butt and Double Strap Joints

Double riveted butt joints are especially recommended for longitudinal seams where joint efficiency is not a prime factor, but where watertightness is essential. This is evident from the fact that the narrow strap has a well supported caulking edge, the pitch of rivets in the second row being much less than in either the double or triple riveted lap joints, as can be seen from the accompanying tables. In all butt strap joints, the narrow strap should be placed on the outside of the pipe. While both straps may be caulked, the narrow strap is the principal one in making the joint water tight, and must be accessible for recaulking in case a leak develops in testing.

Triple riveted butt joints are used in longitudinal seams where the required efficiency cannot be satisfied by any of the simpler joints; or they should be used in the smaller diameter pipes where the increased cost of a quadruple riveted butt joint is more than the saving in the metal effected by its higher efficiency.

TABLE 1—SINGLE RIVETED LAP JOINTS*

Thickness of Plate	Diameter of Rivet Holes	Efficiency %	Pitch	A	Method of Failure
¼"	11/16"	60.7	1¾"	1 1/16"	T.P.
9/32"	11/16"	60.3	1¾"	1 1/16"	S.R.
5/16"	13/16"	59.4	2"	1¼"	T.P.
11/32"	13/16"	59.4	2"	1¼"	T.P.
⅜"	15/16"	58.3	2¼"	1 7/16"	T.P.
13/32"	15/16"	58.3	2¼"	1 7/16"	T.P.
7/16"	1 1/16"	57.5	2½"	1⅝"	T.P.
15/32"	1 1/16"	57.5	2½"	1⅝"	T.P.
½"	1 1/16"	56.7	2½"	1⅝"	S.R.

*Joint efficiencies in Tables 1 to 6 are computed upon the following basis:—Tensile strength of plate = 55,000 lbs. per sq. in.; resistance to crushing of plate = 95,000 lbs. per sq. in.; strength of rivets in single shear = 44,000 lbs. per sq. in. In the columns headed "Method of Failure," T.P. indicates that the joint will fail by tearing the plate in the net section between rivet holes, and S.R. means that the failure will be due to shearing of rivets.

TABLE 2—DOUBLE RIVETED LAP JOINTS

Thickness of Plate	Diameter of Rivet Holes	Efficiency %	Pitch	A	B	Method of Failure
¼"	11/16"	69.5	2¼"	1 1/16"	1¾"	T.P.
9/32"	11/16"	69.5	2¼"	1 1/16"	1¾"	T.P.
5/16"	13/16"	69.1	2⅝"	1¼"	1⅞"	T.P.
11/32"	13/16"	69.1	2⅝"	1¼"	1⅞"	T.P.
⅜"	15/16"	68.9	3"	1 7/16"	2"	T.P.
13/32"	15/16"	68.9	3"	1 7/16"	2"	T.P.
7/16"	1 1/16"	68.5	3⅜"	1⅝"	2⅛"	T.P.
15/32"	1 1/16"	68.5	3⅜"	1⅝"	2⅛"	T.P.
½"	1 1/16"	68.5	3⅜"	1⅝"	2⅛"	T.P.

Quadruple riveted butt joints are used where maximum efficiency is required in the longitudinal seams of pipes having a diameter of 4½ ft. or more. For smaller diameters, it would be advisable to compute the cost of pipe per foot of length for both quadruple and triple riveted butt joints, and for very small diameters it would be well to consider also the double riveted butt joint.

Occasionally resort is made to quintuple riveted butt joints where a very high efficiency is essential, due to a necessary limit to the thickness of plate used, but on account of higher cost and increased resistance to the flow of water, their use in pipe should be avoided if possible. They may be found economical for use in the joints of tanks and standpipes, where friction is a negligible factor.

Another type of joint coming into more general use, especially for girth seams, is the single strap double riveted butt joint. The strap is made the same thickness as the main plates, and its mathematical treatment is the same as that of a double riveted lap joint. Its particular advantages lie in the smooth surface it presents on the inside of the pipe and, in girth seams, in the use of pipe sections having constant diameter.

Joint Efficiency Principal Consideration

The principal consideration entering into the design of a riveted joint is the determination of joint efficiency. Joint efficiency may be defined as the ratio of the strength of the joint to the strength of the uncut plate, and is usually expressed in percentage. The following formulæ may be used to determine the efficiency of the different types of joints:—

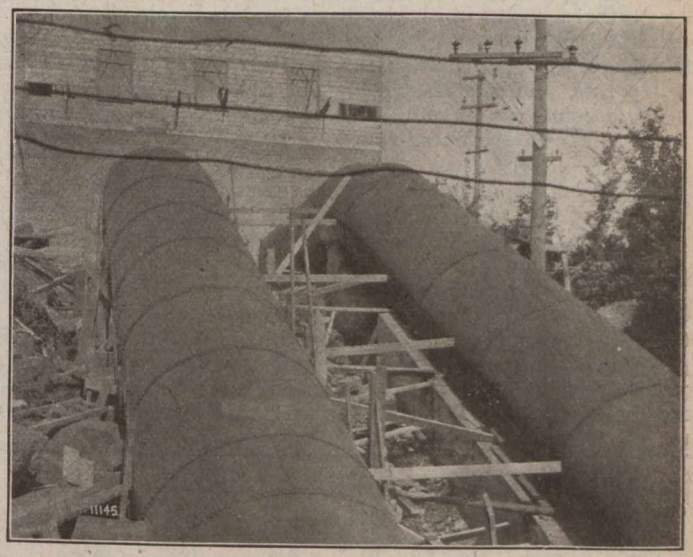

FIG. 5—BIG CHUTE PENSTOCK, 9-FT. DIAMETER, WITH SINGLE AND DOUBLE-RIVETED LAP JOINTS

Formulæ for Riveted Lap Joints

A = Strength of solid plate.
= Ptf.
B = Strength of plate between rivet holes.
= $(P-d)tf$.
C = Shearing strength of one rivet in single shear for single-riveted, of two rivets in single shear for double-riveted, or of three rivets in single shear for triple-riveted.
= nsa.
D = Crushing strength of plate in front of one rivet for single-riveted, of two rivets for double-riveted, or of three rivets for triple-riveted.
= $ndtc$.

To obtain the joint efficiency, divide B, C or D, whichever is the least, by A.

Formulæ for Riveted Butt and Double Strap Joints

A = Strength of solid plate.
= Ptf.
B = Strength of plate between rivet holes in the outer row.
= $(P-d)tf$.
C = Shearing strength of two rivets in double shear for double-riveted, of four rivets in double shear for triple-riveted, or of eight rivets in double shear for quadruple-riveted, plus the shearing strength of one rivet in single shear for double and triple riveted and three rivets in single shear for quadruple riveted.
= $NSa+nsa$.
D = Strength of plate between rivet holes in the second row, plus the shearing strength of one rivet in single shear in the outer row.
= $(P-2d)tf+nsa$.