April 1944.

TESTS ON METALOCKED JOINTS OF STEEL PLATE

Results -

When Metalocks are used to repair a broken piece of equipment made from medium strength steel, the minimum length lock used should never be less than five lugs long. Tests numbers 3, 5 and 6, indicate that the compressive and shear strength of the Metalock is about equal to the steel and that when five lugs are used, the lock is at a critical point where failure might occur from either shear of the lugs or from tensile failure of the lock. If seven lugs are used, the full strength of the Metalock will positively be developed even if the workmanship of the job is a little below average.

Tests numbers 8 and 9 indicate that the outward thrust developed by the lugs of the locks against the restrictions in the steel being repaired produce a moment sufficient to bend the metal outward when the center of the lock is placed one inch or closer to the edge. If the lock is placed slightly over one inch from the edge, this moment becomes greater than the ultimate strength of the lock and consequently the lock will fail.

In actual practice, the lock never is inserted completely through the metal being repaired, therefore, the lock can be placed at such distance from the edge where the moment of inertia of the cross section of metal through the area between the lock and the edge is equal to or greater than the moment of inertia of the condition previously stated.

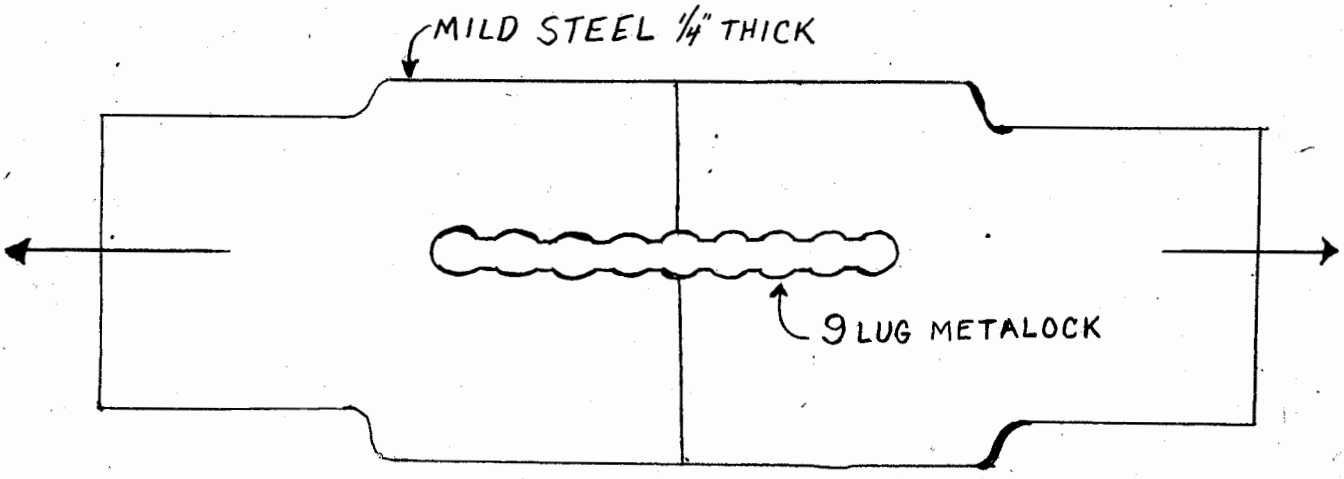
When two or more locks are used, the joint is no stronger than the weakest lock, for when the weakest one fails its load is added to the others. Tests not included in this report indicate that an average enlisted man with but several days practice can produce a Metalocked Joint greater than 85% of the ultimate strength of a perfect job. Therefore, men of minimum experience can use this Metal Repair process and still produce a reasonable satisfactory job.

TEST NO. 1

1 Metalock 1/4" x 1/4" - 9 lugs.

Tensile Load - Lb.	Spread at Joint - In.
2500	.00
3000	.00
3500	.00
4000	.01
4500	.01
5000	.02
5250	.06#

Elongation of the lock at this load caused the joint to spread to.15 ins. at which time the lock broke.



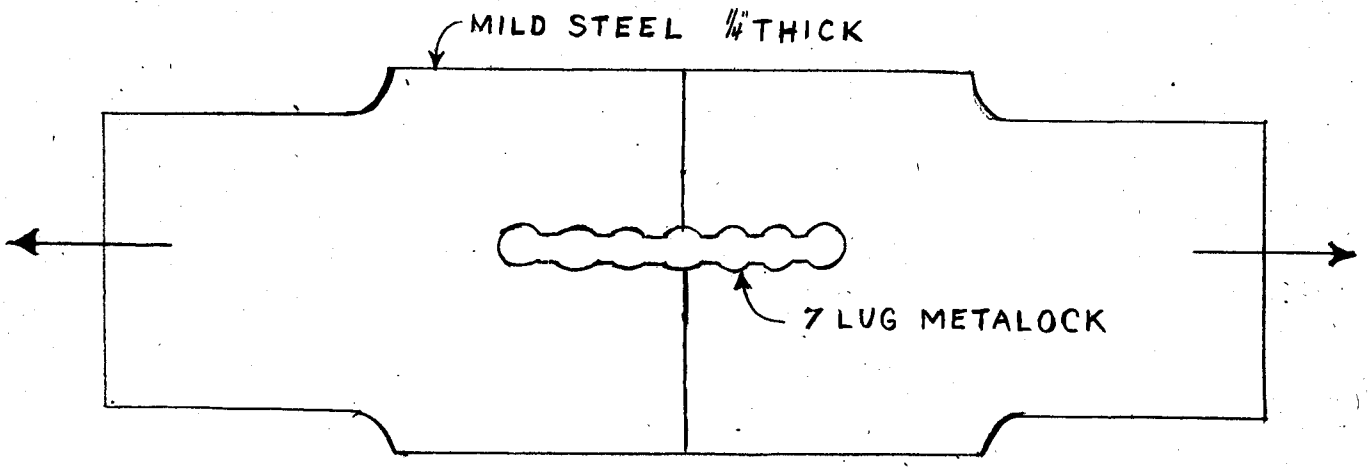
Comment - The restrictions and lugs of the metalock held firmly in place within the mild steel plate and no preceptible movement occurred between the lock and the plate.

TEST NO. 2

1 Metalock 1/4" x 1/4" - 7 Lugs

Tensile Load - Lb.	Spread at Joint - In.
2500	.01
3000	.01
3500	.01
4000	.02
4500	.02
5000	.02
5900	.03#

Elongation of the lock at this load caused the joint to spread to .11 in. at which time the lock broke.



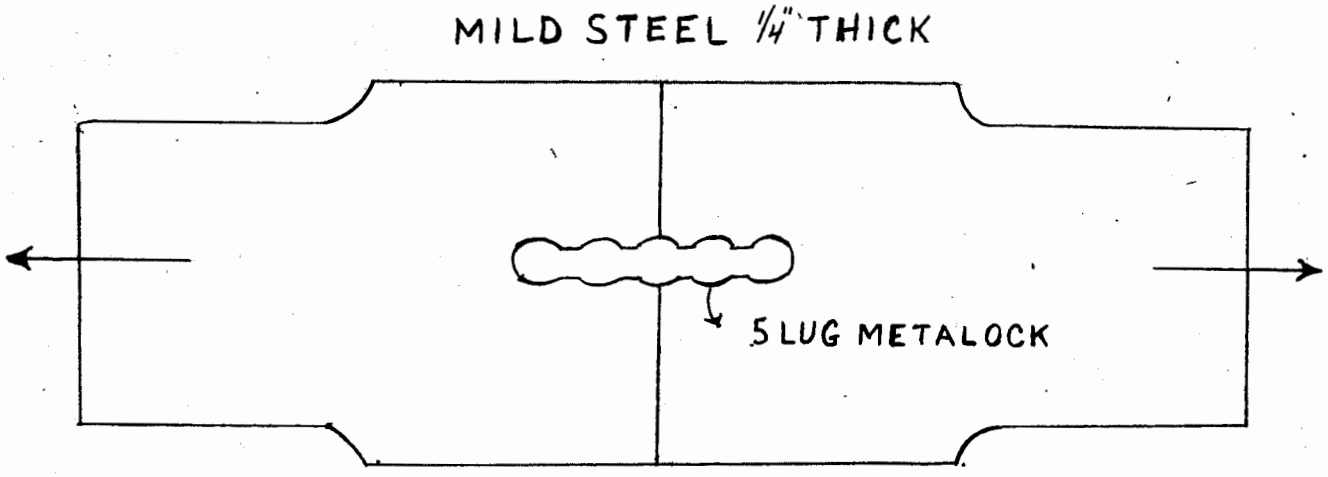
Comment - The restrictions and lugs of the metalock held firmly in place within the mild steel plate and no perceptible movement occurred between the lock and the plate. The ultimate tensile strength was beyond the average (5400 lbs.) for a 1/4" x 1/4" metalock due to good workmanship and a very strong lock.

TEST NO. 3

1 Metalock 1/4" x 1/4" - 5 lugs.

Tensile Load - Lb.	Spread at Joint - In.
2500	.00
3000	.01
3500	.03
4000	.07
4150	.19#

The metalock lugs started to slide over the restrictions in the steel plate at this point. The joint finally failed by the metalock pulling out of the plate.



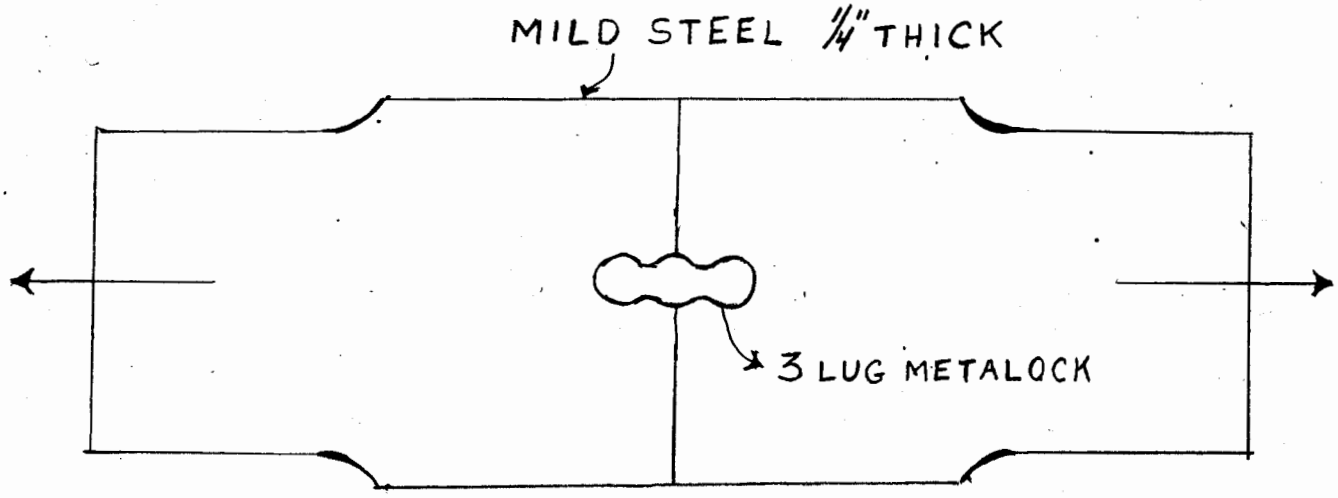
Comment - The failure occurred because the lugs of the metalock and the restrictions of the steel plate deformed under compression and shear. The lock therefore pulled out intact. Poor workmanship in forming the locking channel in the steel plate caused this failure below the ultimate strength of the lock.

TEST NO. 4

1 Metalock 1/4" x 1/4" - 3 lug.

Tensile Load - Lb.	Spread at Joint - In.
2000	#
2250	

The metalock started to pull out of the restrictions in the channel of the steel plate at this load and final failure occurred at 2250.



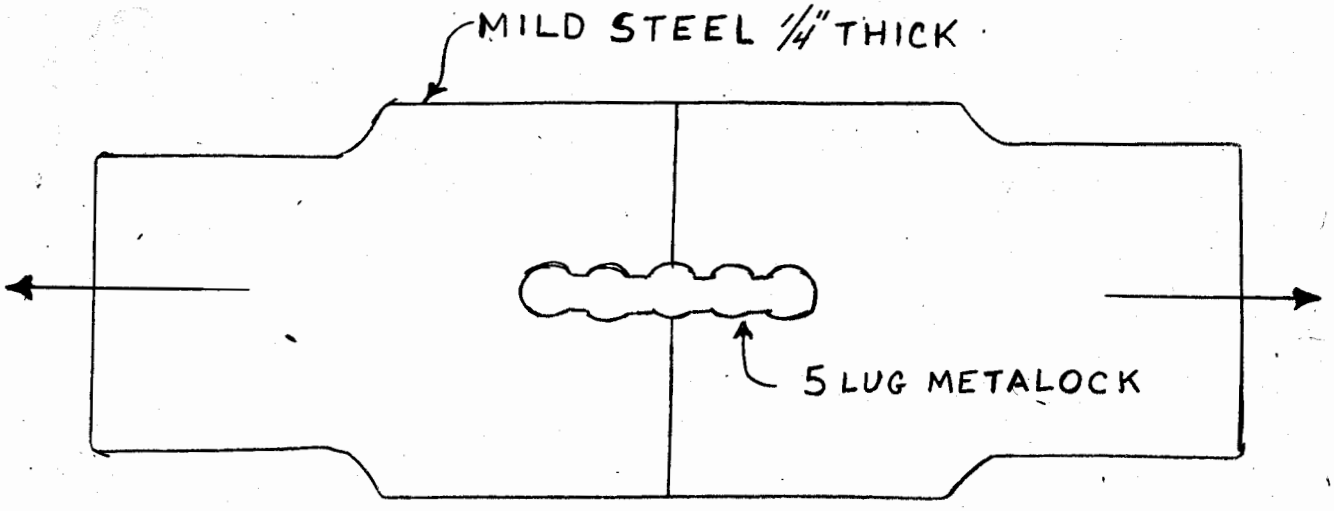
Comment - This test showed that a 3 lug lock will not give satisfactory holding strength for a metalock repair of any type.

TEST NO. 5

1 Metalock 1/4" x 1/4" - 5 lug

Tensile Load - Lb.	Spread at Joint - In.
2500	.00
3000	.01
3500	.01
4000	.02
4500	.02
4950	.03#

Elongation of the lock at this load caused the joint to spread to.12 in. at which time the lock broke.



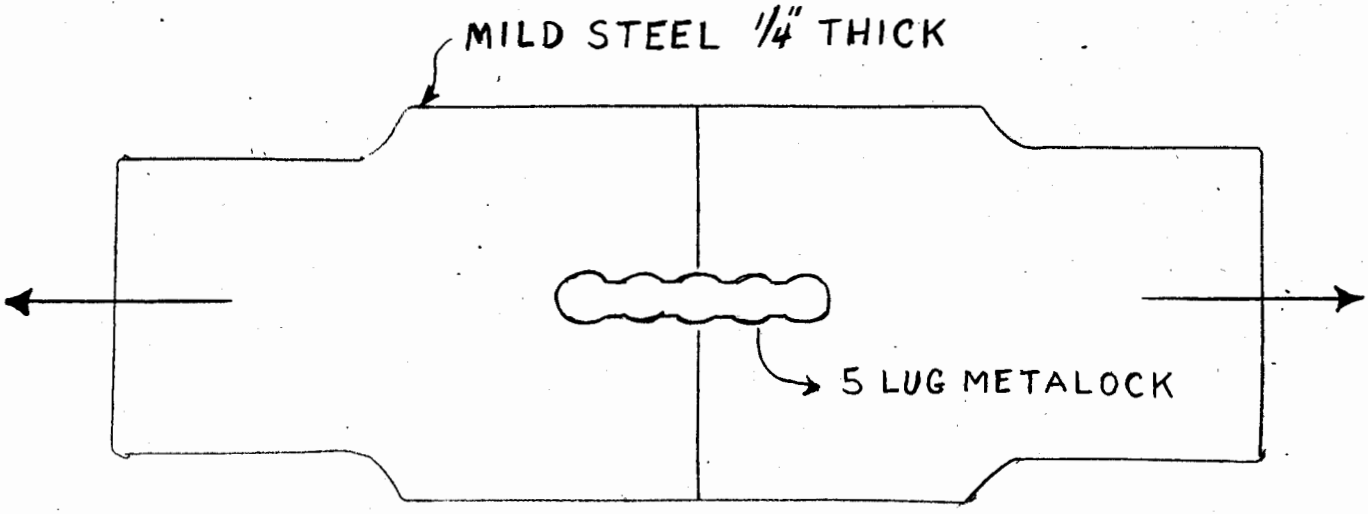
Comment - The restrictions and lugs of the metalock held firmly in place within the mild steel plate and no preceptible movement occurred between the lock and the plate. The ultimate tensile strength of the lock was below average (5400 lbs.)

TEST NO. 6

1 Metalock 1/4" x 1/4" - 5 lugs.

Tensile Load - Lb.	Spread at Joint - In.
2500	.03
3000	.03
3500	.04
4000	.04
4500	.04
5000	.05#
5400	.06

The metalock lugs started to slide over the restrictions in the steel plate at this point. The joint finally failed by the metalock pulling out of the plate.



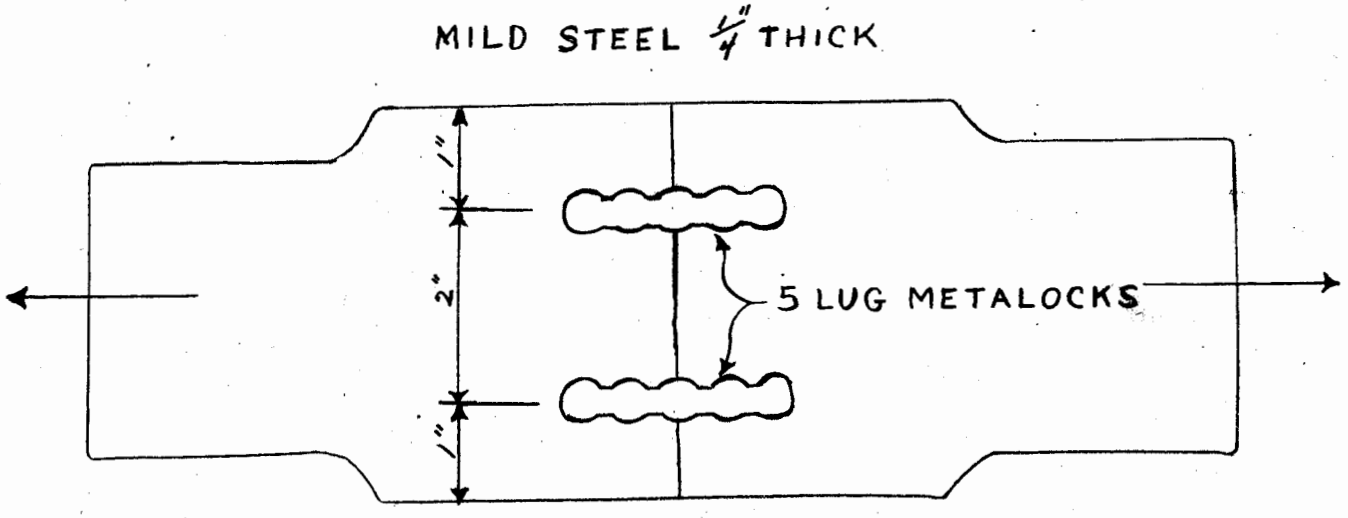
Comment - The failure occurred because the lugs of the metalock and the restrictions of the steel plate deformed under compression and shear. This joint failed at the average strength of the Metalock

TEST NO. 8

2 Metalocks 1/4" x 1/4" - 6 lugs each

Tensile Load - Lb.	Spread at Joint - In.
2000	0
4000	.003"#
6000	.013"
8000	.044"
8450	

The metalock lugs started to slide over the restrictions in the steel plate at this point. The joint finally failed by the metalock pulling out of the plate.



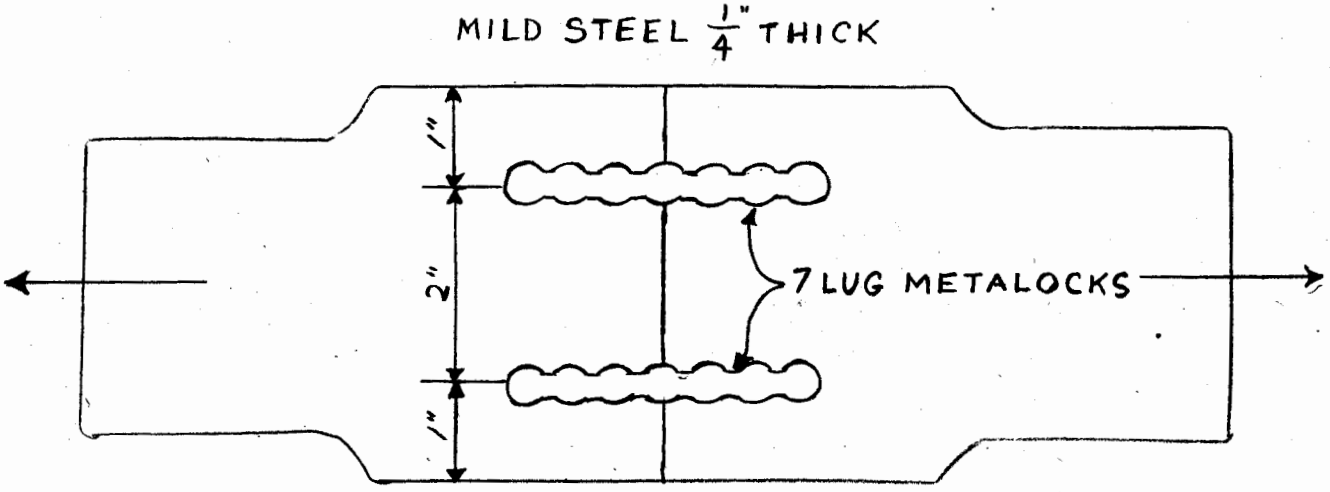
Comment - The failure occurred because the locks pulled out of the restrictions in the steel plate, the locks remaining intact. The side thrust caused by the pressure of the lugs against the restrictions in the steel plate developed a moment sufficient to bend out the side sections of the plate thereby releasing the metalock. This allowed a reduction in the ultimate strength of the joint.

TEST NO. 9

2 Metalock 1/4" x 1/4" - 7 lugs each.

Tensile Load - Lbs.	Spread at Joint - In.
2000	0
4000	.003"#
6000	.008"
8000	.014"
10,000	.054"
10,300	

The metalock lugs started to slide over the restrictions in the steel plate at this point. The joint finally failed by the metalock pulling out of the plate.



Comment - The failure occurred because the locks pulled out of the restrictions in the steel plate, the locks remaining intact. The side thrust caused by the pressure of the lugs against the restrictions in the steel plate developed the moment sufficient to bend out the side sections of the plate thereby releasing the metalock. This allowed a reduction in the ultimate strength of the joint.

TESTS ON SAMPLE BARS TAKEN FROM SAME STOCK AS PLATES LOCKED WITH METALOCKS

	SAMPLE NO. 1	SAMPLE NO. 2
Cross Section	.249" x.768"	.249" x .764"
Yield load	7,650 Lbs.	7,600 Lbs.
Ultimate load	12,300 Lbs.	11,750 Lbs.
Elongation in 2"	.65 in.	.65 in.
Reduction in cross section	.53" x .16"	.52" x .15"
Unit yield strength	40,100 P.S.I.	40,000 P.S.I.
Unit ultimate strength	64,400 P.S.I.	61,800 P.S.I.
% elongation in 2"	32.5%	32.5%
% reduction in area	53.5%	58.9%
Brinell hardness number	119	119

SIZES OF METALOCK AND TENSILE STRENGTH

Size of Metalocks	Tensile Strength per Lock - Lbs.	Shear Strength per Pair of Restrictions, Lbs. for 60,000 lbs. per Sq. In. Mild Steel *	Shear Strength per Pair of Restrictions, Lbs. for 20,000 lbs. per Sq. In. Cast Iron *
1/8" x 1/8"	1250	625	575
5/32" x 5/32"	1950	975	900
3/16" x 3/16"	2800	1400	1300
7/32" x 7/32"	3800	1900	1750
1/4" x 1/4"	5000	2500	2300
9/32" x 9/32"	6300	3150	2900
1/4" x 9/32"	5600	2800	2600
1/4" x 5/16"	6250	3100	2900
1/4" x 3/8"	7500	3750	3450
5/16" x 5/16"	7800	3900	3600

Dia. of Studs

1/8"

5/32"

3/16"

7/32"

1/4"

* These figures are given for an odd numbered lock. If an even numbered lock is used, then the shear strength on the restriction adjacent to the crack is reduced 30%.