OTTAWA September 5th, 1940.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 894.

Report on Comparison of Tools Submitted for Examination by the Department of National Defence, Ottawa, Ontario, on August 19th, 1940.

BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

O T T A W A   September 5th, 1940.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 894.

Report on Comparison of Tools Submitted for Examination by the Department of National Defence, Ottawa, Ontario, on August 19th, 1940.

Origin of Work and Nature of Investigation:

The office of the D.C.I.A. (G), Department of National Defence, Ottawa, Ontario, submitted, on August 19th, 1940, some wrenches and wrench socket adaptors made by four different manufacturers. A report was requested which would give comparative measurements of their quality.

Macro-Examination:

The adaptors are steel cylinders. One end has a square hole made to fit the ratchet wrench. The other end has a 12-cornered hole made to fit a standard hexagonal nut.

The flat wrenches or spanners have U-shaped jaws set at about 17° from the handle. The cross-section of the handle varies with the different makes, thus,

The "Blue Point" is a flattened oval; the "Master Alloy" is a dumb-bell shape; and the "Gray Dreadnaught" is a flattened oval.

The MASTER ALLOY tools had defects of manufacture, as follows:

(1) The socket adaptor had a forging "lap" or cavity.

(2) The MASTER ALLOY flat spanner had one end ground out to a larger size. This grinding had been done by hand.

Appearance and surface finish of the BLUE-POINT wrench were superior to those of the MASTER ALLOY tools and the GRAY spanner.

Socket Adaptors:

A "Snap-On" adaptor for a $\frac{5}{8}$-inch bolt was cut in half and the thin collar with the 12-cornered hole was compressed. Fracture occurred in four places at 90° intervals. There did not appear to be any distortion.

A MASTER ALLOY adaptor socket for a 1-1/16th inch

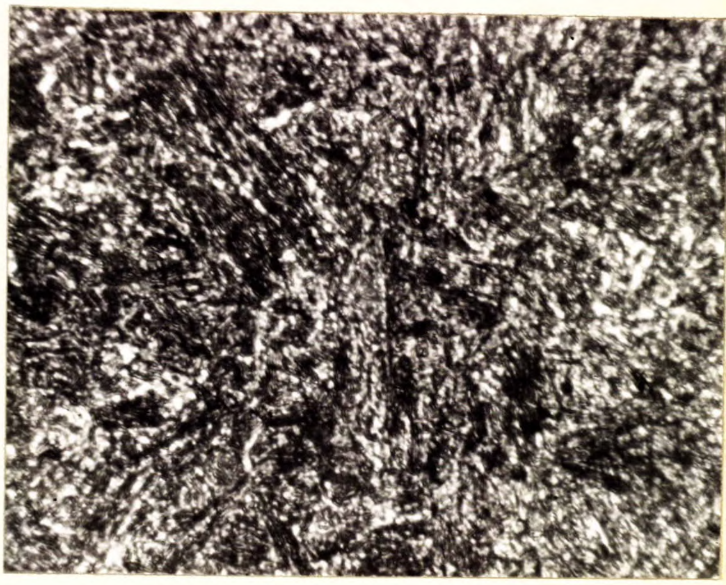
(Microstructure, cont'd) -

Figure 3.

1000X.
(Nital etched)

MASTER ALLOY adaptor.

Figure 4.



2000X.
(Nital etched)

SNAP-ON adaptor.

Hardness Tests:

BLUE-POINT flat spanner	-	546 Vickers H. N.
MASTER ALLOY " "	-	415 " " "
GRAY DREADNAUGHT "	-	444 Vickers H. N. (Core)
		157 " " " (Skin).

There was a soft decarburized skin on the GRAY wrench which was over 0.003 inch in thickness.

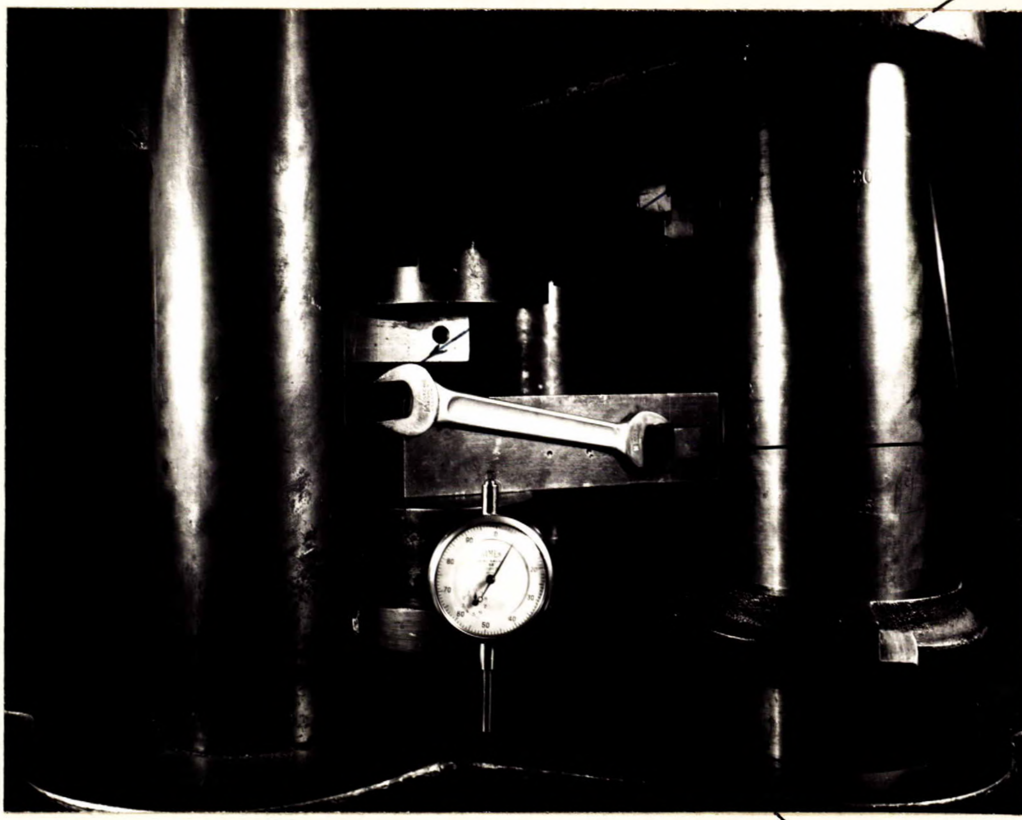
Physical Tests:

In order to duplicate service conditions, the wrenches were tested in a fixture as shown in Figure 5.

(Continued on next page)

(Physical Tests, cont'd) -

Figure 5.



Wrench-testing fixture:

(A) Hardened mandrel.
(B) Point of loading.
(C) Deformation gauge.

With this equipment it was possible to measure the force and the distance through which it was exerted before failure of the wrench. In order to find out how much energy is required to cause failure in a wrench, the following equation is used:

$$\frac{\text{Max. load}}{2} \times \frac{\text{Ins. deflection}}{12} = \text{Foot pounds.}$$

The results obtained are tabulated below:

(Continued on next page)

(Physical Tests, cont'd) -

Tool.		Maximum foot pounds absorbed without any damage to wrench.	Type of failure.
BLUE-POINT	--	34 foot pounds.	Fracture at base of jaw.
MASTER ALLOY, No. 1	--	15 " "	Deformed jaw.
MASTER ALLOY, No. 2	--	11 " "	" "
GRAY DREADNAUGHT	--	7 " "	" "

(Note: Load and deflection curves for these wrenches are shown in Figures 6, 7, 8, and 9.)

(See following pages for Figures 6, 7, 8, and 9)

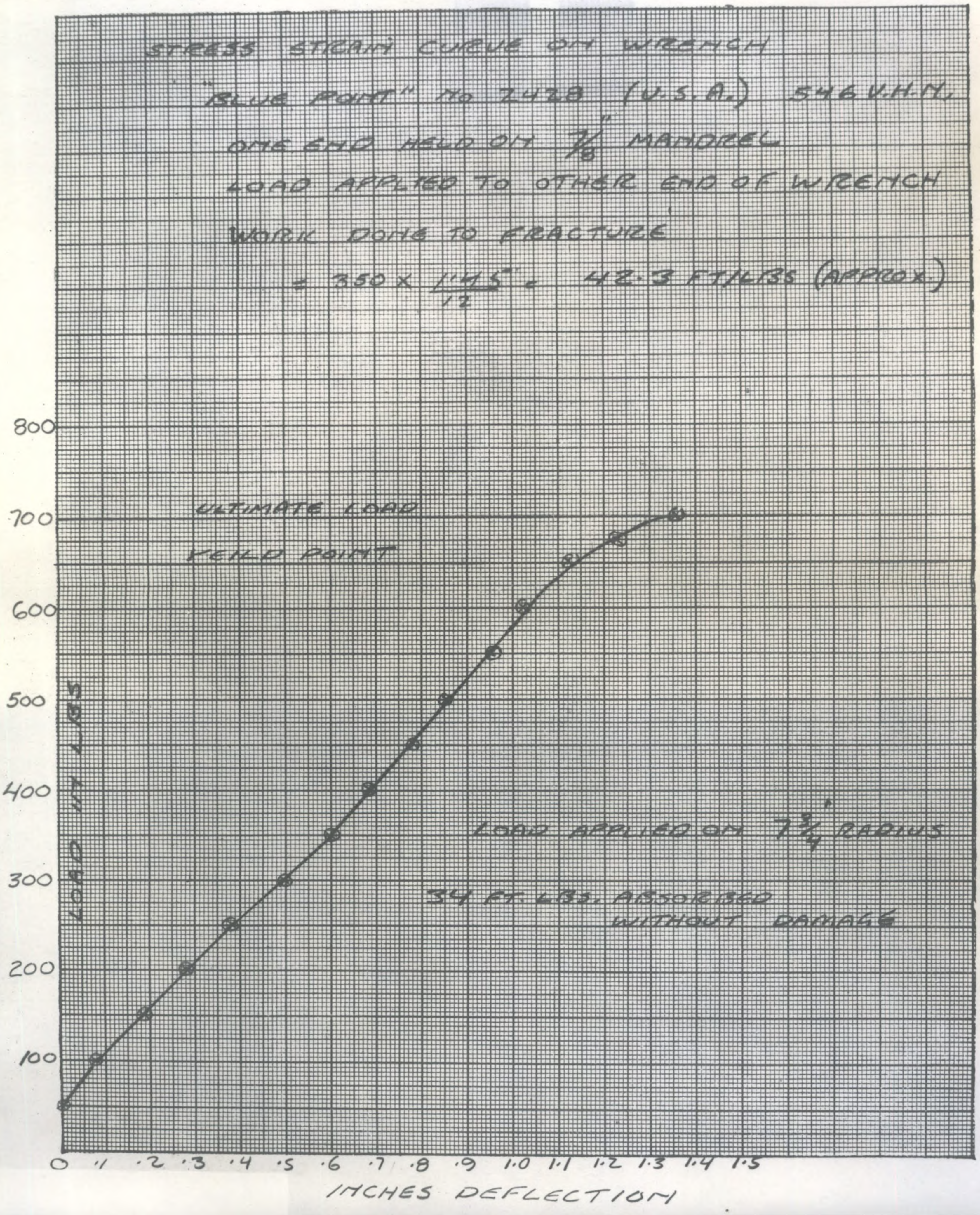
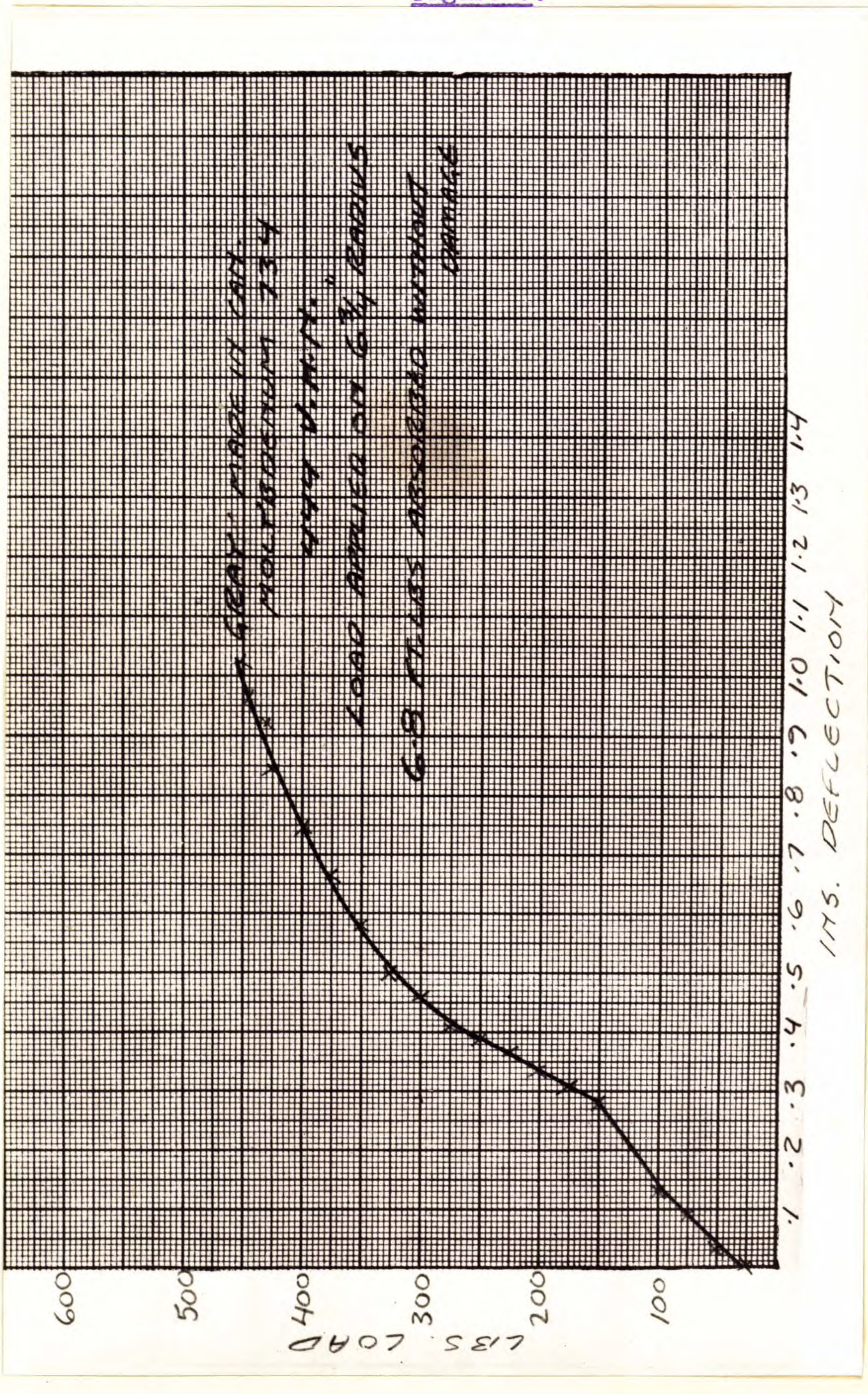

STRESS STRAIN CURVE ON WRENCH
"BLUE POINT" No 2428 (U.S.A.) 546 V.H.N.
ONE END HELD ON 7/8" MANDREL
LOAD APPLIED TO OTHER END OF WRENCH
WORK DONE TO FRACTURE
= 350 X 1.45"/12 = 42.3 FT/LBS (APPROX)
ULTIMATE LOAD
YEILD POINT
LOAD APPLIED ON 7 3/4" RADIUS
34 FT. LBS. ABSORBED WITHOUT DAMAGE
LOAD IN LBS
800
700
600
500
400
300
200
100
0
·1
·2
·3
·4
·5
·6
·7
·8
·9
1·0
1·1
1·2
1·3
1·4
1·5
INCHES DEFLECTION

Figure 6.

Figure 7.


GRAY. MADE IN CAN.
MOLYBDENUM 734
444 V.H.N.
LOAD APPLIED ON 6 3/4" RADIUS
6.8 FT.LBS ABSORBED WITHOUT DAMAGE
·1 ·2 ·3 ·4 ·5 ·6 ·7 ·8 ·9 1.0 1.1 1.2 1.3 1.4
INS. DEFLECTION
600
500
400
300
200
100
LBS. LOAD

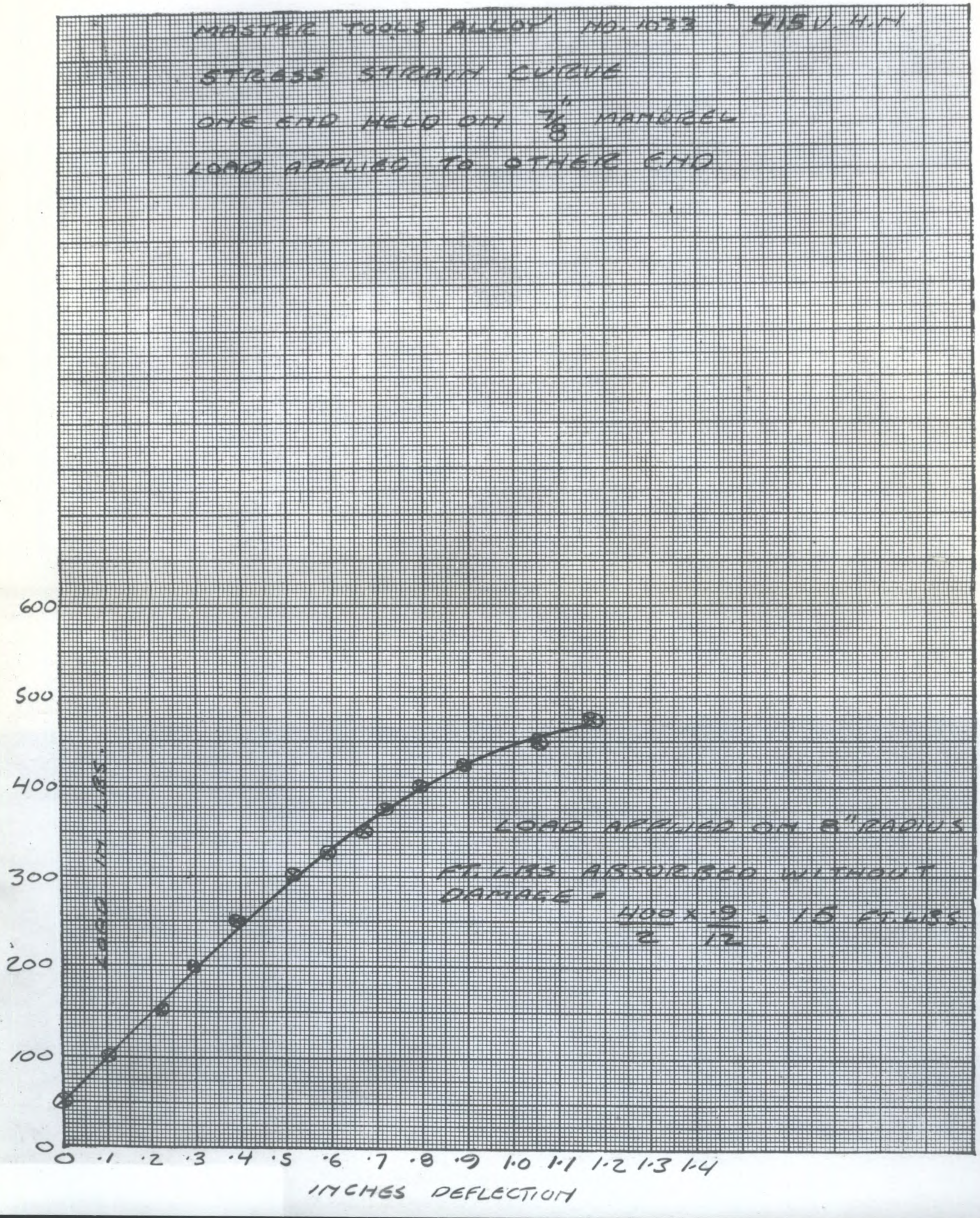
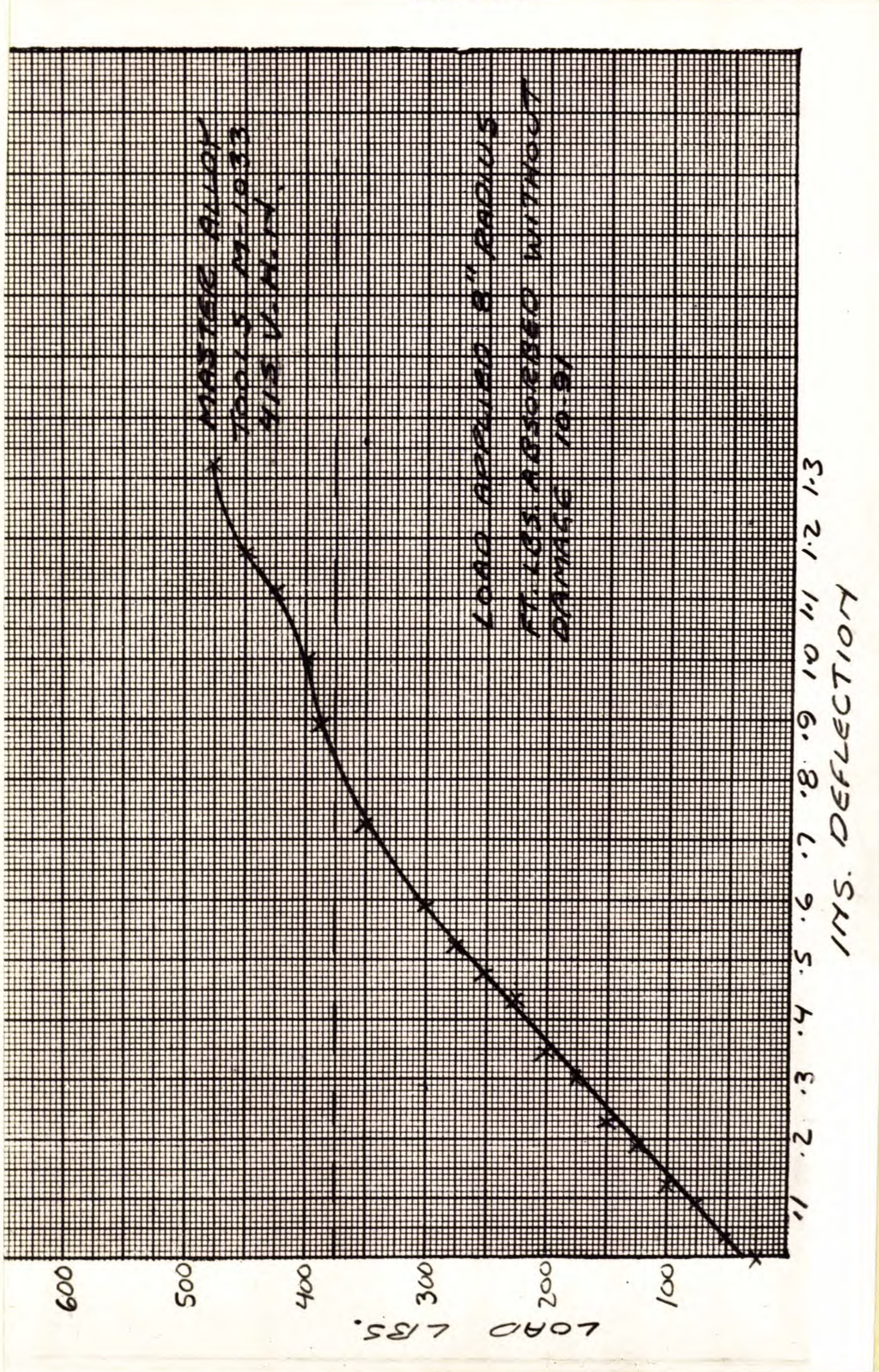

MASTER TOOLS ALLOY NO. 1033 915 V.H.N
STRESS STRAIN CURVE
ONE END HELD ON 7/8" MANDREL
LOAD APPLIED TO OTHER END
LOAD APPLIED ON 8" RADIUS
FT. LBS ABSORBED WITHOUT DAMAGE =
400/2 x ·9/12 = 15 FT. LBS.
LOAD IN LBS.
600
500
400
300
200
100
0
0 ·1 ·2 ·3 ·4 ·5 ·6 ·7 ·8 ·9 1·0 1·1 1·2 1·3 1·4
INCHES DEFLECTION

Figure 8.

Figure 9.


MASTER ALLOY
TOOLS 13-1033
415 V.H.N.
LOAD APPLIED 8" RADIUS
FT. LBS. ABSORBED WITHOUT
DAMAGE 10.91
.1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2 1.3
INS. DEFLECTION
600
500
400
300
200
100
LOAD LBS.

Discussion of Results:

The MASTER ALLOY tools and the GRAY DREADNAUGHT tools are about half as good as the SNAP-ON tools. The MASTER ALLOY tools are not forged properly. The seam shown in Figures 1 and 2 indicates improper forging. The practice of grinding out the jaws by hand to a larger size results in rough, poorly fitting jaws.

GRAY DREADNAUGHT tools have a soft skin. Tools develop burrs and nicks through rough handling.

The BLUE-POINT wrench will absorb twice as much punishment as the MASTER ALLOY wrench and three times as much as the GRAY wrench before damage occurs.

Wrenches are required to be very tough and very hard. This condition is met best by the austempering type of heat treatment. The superiority of the American tools may be due in part to their heat treatment, which results in a structure similar to austempered structures.

The Canadian tools apparently were given a quench-and-draw treatment.

Descriptions of Heat Treatment Processes:

Austempering -

The steel is heated until it is completely austenitic. It is then plunged into a molten salt or low-melting alloy bath and held there for a definite length of time. Temperatures used range from 350° to 800° F. Time of quenching depends on temperature and type of steel.

Quench-and-Draw Process -

The steel is heated to some suitable tempera-

(Descriptions of Heat Treatment Processes, cont'd) -

ture above its "critical" range until it is completely austenitic. Next, it is quenched in water or oil, depending upon its mass and composition, to give an extremely hard martensitic structure. The steel is then tempered by re-heating to some temperature between 375° and 1,000° F. Control of properties of tempered steels is obtained by varying either tempering temperature or tempering time.

ooooooooooooooooo
ooooooooooo
ooo

HHF:PES.