

PEENING INTENSITY MEASUREMENT  
MARCH 1, 1945

PURPOSE

THIS MEMORANDUM SERVES TO SUMMARIZE INFORMATION AT THIS DATE PERTAINING TO STANDARD APPARATUS FOR MEASURING SHOT PEENING INTENSITY AS ADOPTED BY RESEARCH LABORATORIES DIVISION, GENERAL MOTORS CORP. IT IS A TECHNICAL BULLETIN ON THE PRESENT STATUS OF DEVELOPMENT OF SUCH APPARATUS AND ITS USE.

INTRODUCTION

THE PROCESS OF SHOT PEENING REQUIRES CONTROL JUST AS DO OTHER METAL TREATING PROCESSES.

AMONG THE ELEMENTS TO BE CONTROLLED IS THE CAPACITY OF THE BLAST OF SHOT TO DO PEENING. THIS CAPACITY OR PROPERTY IS CALLED "INTENSITY" OF PEENING. IT MAY BE LIKENED TO TEMPERATURE IN A HEAT TREATING PROCESS OR TO INTENSITY OF LIGHT IN PHOTOGRAPHIC WORK. IT SHOULD BE NOTED THAT INTENSITY IS A PROPERTY OF THE BLAST OF SHOT ITSELF AND THAT THE SAME BLAST WOULD HAVE DIFFERENT EFFECTS ON DIFFERENT METALS.

THE MEASUREMENT OF THE INTENSITY OF A BLAST OF SHOT MAY BE ACCOMPLISHED BY DETERMINING ITS EFFECT ON A STANDARD SAMPLE. THIS METHOD MAY BE DESCRIBED IN PRINCIPLE AS FOLLOWS: SUPPOSE A FLAT STEEL STRIP IS CLAMPED TO A SOLID BASE AND THE OUTER SURFACE OF THE STRIP IS EXPOSED TO THE BLAST OF SHOT. WHEN THE STRIP IS UNCLAMPED AND REMOVED FROM THE BASE, IT WILL BE FOUND THAT THE STRIP HAS CHANGED ITS SHAPE - IT WILL NOW BE CURVED WITH THE SHOT PEENED SURFACE CONVEX. THIS IS AN INDICATION THAT THE PEENING INTRODUCES A RESIDUAL COMPRESSIVE STRESS IN THE PEENED SURFACE MATERIAL. THE MAGNITUDE OF THE CURVATURE DEPENDS UPON THE TIME OF EXPOSURE AND UPON THE INTENSITY OF THE BLAST OF SHOT. BY EXPOSING A SERIES OF TEST STRIPS, EACH FOR A DIFFERENT TIME OF EXPOSURE, THE INTENSITY OF A BLAST MAY BE DETERMINED.

MAKING USE OF THIS PRINCIPLE, STEEL STRIPS AND A GAGE FOR MEASURING CURVATURE HAVE BEEN STANDARDIZED AND SPECIFICATIONS ARE PRESENTED HEREWITH. THE USE OF THIS APPARATUS IS EXPLAINED, A STANDARD DESIGNATION OF INTENSITY PRESENTED AND SOURCES OF SUPPLY OF THE APPARATUS GIVEN.

NO SPECIFICATION CHANGES HAVE BEEN MADE IN THE APPARATUS SINCE JUNE 1, 1944, THE

DATE OF THE PREVIOUS ISSUE OF THIS MEMORANDUM (S-200-9B). THE PRESENT ISSUE GIVES MORE CAREFUL CONSIDERATION TO TIME OF EXPOSURE AND INCLUDES INFORMATION PERTAINING TO THE CORRELATION OF "A" AND "C" SIZE TEST STRIPS. THE ALMEN NO. 1 GAGE IS NOT INCLUDED SINCE IT HAS NOW BEEN EFFECTIVELY SUPERSEDED BY THE ALMEN NO. 2 GAGE. THE CORRELATION CHART BETWEEN THE NO. 1 GAGE AND THE NO. 2 GAGE IS INCLUDED, HOWEVER, FOR REFERENCE.

#### TEST STRIPS AND HOLDING FIXTURES

SPECIFICATIONS HAVE BEEN ESTABLISHED FOR TWO SIZES OF TEST STRIPS AND THEIR HOLDING FIXTURE. TEST STRIP "A" IS SHOWN BY S-200-2A, TEST STRIP "C" BY S-200-4A, THE HOLDING FIXTURE BY S-200-2B, AND THE ASSEMBLY BY S-200-3, ON PAGES 7 AND 8.

IT WILL BE NOTED THAT SPECIFICATIONS FOR THE TEST STRIPS DO NOT DEFINE THE MATERIAL TO BE USED. THE MATERIAL SPECIFICATION IS PURPOSELY OMITTED BECAUSE THE METHOD OF ROLLING AND POSSIBLY OTHER FACTORS MAY INFLUENCE THE RESPONSE OF THE STRIP TO THE BLAST OF SHOT. IT IS CONSIDERED MORE DEPENDABLE TO APPROVE SEPARATELY EACH SOURCE OF SUPPLY. THE APPROVAL WILL BE BASED ON TESTS BY RESEARCH LABORATORIES DIVISION, GENERAL MOTORS CORP., TO DETERMINE WHETHER OR NOT THE STRIPS RESPOND TO SHOT PEENING IN THE SAME MANNER AS THOSE NOW USED.

SINCE THE PREVIOUS ISSUE OF THIS MEMORANDUM, TEST DATA HAVE BEEN OBTAINED PERTAINING TO THE RELATIONSHIP BETWEEN THE "A" AND THE "C" SIZE TEST STRIPS. THE RESULTS ARE PRESENTED BY CHART S-200-13 ON PAGE 11. EACH POINT ON THIS CURVE WAS ESTABLISHED BY EXPOSING "A" AND "C" SIZE TEST STRIPS TO THE SAME BLAST OF A PARTICULAR INTENSITY. THIS CORRELATION IS BASED ON THE USE OF THE ALMEN NO. 2 GAGE ONLY.

#### GAGES

TWO TYPES OF GAGES HAVE BEEN DESIGNED TO MEASURE THE AMOUNT OF CURVATURE OF EXPOSED TEST STRIPS. THE ALMEN NO. 2 GAGE (S-200-7) IS SHOWN ON PAGE 9. DETAILS PERTAINING TO THE ALMEN NO. 1 GAGE (S-200-6) ARE OMITTED SINCE THIS GAGE HAS BEEN SUPERSEDED BY THE ALMEN NO. 2 GAGE. THE ALMEN NO. 2 GAGE MEASURES COMBINED LONGITUDINAL AND TRANSVERSE CURVATURE BY MEASURING THE DISPLACEMENT OF A CENTRAL POINT ON THE NON-PEENED SURFACE FROM THE PLANE OF FOUR BALLS FORMING THE CORNERS OF A PARTICULAR RECTANGLE.

SINCE THE TWO GAGES GIVE DIFFERENT READINGS FOR THE SAME PEENED TEST STRIP, THE CORRELATION CURVE (S-200-10) SHOWN ON PAGE 10 WAS ESTABLISHED. THIS IS GIVEN FOR

REFERENCE. SUCH A CURVE WAS NEVER ESTABLISHED FOR THE "C" SIZE TEST STRIP.

TO USE ALMEN NO. 2 GAGE, THE TEST STRIP IS LOCATED SO THAT THE INDICATOR POINTER BEARS AGAINST THE NON-PEENED SURFACE AS SHOWN BY FIG. 1, PAGE 12.

THE ZERO POSITION OF THE GAGES MUST BE FREQUENTLY CHECKED AND ADJUSTED IF NECESSARY.

(THE ALMEN GAGE NO. 2 WAS DEVELOPED BECAUSE THE ALMEN NO. 1 GAGE WAS NOT SATISFACTORY FOR THE MEASUREMENT OF THOSE STRIPS WHICH HAVE BEEN EXPOSED TO HIGH INTENSITIES BECAUSE OF TRANSVERSE CURVATURE AND/OR THOSE ON WHICH THE PEENED SURFACE IS RELATIVELY ROUGH SO AS TO AFFECT THE READING. SINCE THE NO. 2 GAGE READS A COMBINATION OF BOTH TRANSVERSE AND LONGITUDINAL CURVATURES, IT IS BELIEVED TO BE A BETTER INDEX OF PEENING INTENSITY.)

#### USE OF THIS APPARATUS

AT PRESENT THE "A" SIZE TEST STRIP IS USED FOR INTENSITIES UP TO .024A2 (SEE PEENING INTENSITY DESIGNATION, PAGE 5) AND FOR GREATER INTENSITIES, THE "C" STRIP IS USED.

THE PROCEDURE TO BE FOLLOWED IN MAKING INTENSITY MEASUREMENTS VARIES WITH THE CONDITIONS. ACCORDINGLY, THREE PROCEDURES ARE OUTLINED BELOW: (1) GENERAL PROCEDURE (2) PRODUCTION SET-UP PROCEDURE AND (3) PRODUCTION CONTROL PROCEDURE.

#### (1) GENERAL PROCEDURE - INTENSITY MEASUREMENT

THE GENERAL PROCEDURE TO BE USED IN MAKING MEASUREMENTS OF INTENSITY MAY BE OUTLINED AS FOLLOWS:

1. FASTEN THE STRIP, S-200-2A OR S-200-4A, TIGHTLY AND CENTRALLY TO THE HOLDING FIXTURE, S-200-2B.
2. EXPOSE THE SURFACE "X" (S-200-3) OF THE STRIP TO THE BLAST TO BE MEASURED. RECORD THE TIME OF EXPOSURE.
3. REMOVE THE STRIP FROM ITS HOLDING BLOCK AND MEASURE THE CURVATURE ON ALMEN NO. 2 GAGE (S-200-7).
4. USING DIFFERENT EXPOSURE TIMES REPEAT 1, 2 AND 3 SUFFICIENTLY TO DETERMINE A CURVE OF THE TYPE SHOWN BY FIG. 2 ON PAGE 13. FROM 5 TO 12 TEST POINTS ARE NECESSARY.
5. THE GAGE READING CORRESPONDING WITH THE POINT A WHERE THE CURVE FLATTENS OUT IS TAKEN TO BE THE INTENSITY OF THE PARTICULAR BLAST.

(2) PRODUCTION SET-UP PROCEDURE - INTENSITY MEASUREMENT

THE PROCEDURE TO BE USED IN MAKING A PRODUCTION SET-UP IN WHICH A SETTING OF THE MACHINE IS TO BE DETERMINED FOR A SPECIFIED INTENSITY OF PEENING MAY BE DESCRIBED AS FOLLOWS:

1. PROVIDE A FIXTURE TO SUPPORT THE TEST STRIP IN A MANNER SUCH THAT IT SIMULATES THE MOST CRITICAL SURFACES OF THE PART. IN CASES WHERE MORE THAN ONE CRITICAL SURFACE IS TO BE PEENED, THE FIXTURE SHOULD PROVIDE FOR THE MOUNTING OF THE REQUIRED ADDITIONAL TEST STRIPS.

2. WITH AN ESTIMATED SETTING OF THE MACHINE (SHOT FLOW RATE AND SHOT VELOCITY), A SERIES OF TEST STRIPS ARE TO BE EXPOSED EACH FOR A DIFFERENT TIME OF EXPOSURE SO THAT A CURVE SUCH AS SHOWN BY FIG. 2 ON PAGE 13 MAY BE ESTABLISHED.

3. IF THE MEASUREMENT OF INTENSITY AS OBTAINED DOES NOT FALL WITHIN SPECIFICATIONS, MACHINE SETTINGS MUST BE CHANGED. IF A HIGHER INTENSITY IS REQUIRED, HIGHER SHOT VELOCITY IS NECESSARY. IF LOWER INTENSITY IS REQUIRED, A LOWER SHOT VELOCITY IS NEEDED. (SHOT SIZE WILL ALSO AFFECT INTENSITY. FOR CONSTANT VELOCITY THE INTENSITY INCREASES AS THE SHOT SIZE IS INCREASED.) THESE VELOCITY CHANGES MAY BE MADE BY CHANGING WHEEL SPEED OR AIR PRESSURE. IN CERTAIN CASES AN ADJUSTMENT CAN BE MADE IN THE DIRECTION OF THE SHOT BLAST SO AS TO REDUCE OR INCREASE THE COMPONENT OF VELOCITY NORMAL TO THE TEST STRIP. THE ABRADING CHARACTERISTICS OF THE BLAST ARE ALSO FUNCTIONS OF THE ANGLE OF BLAST AND SHOULD BE CONSIDERED. IT IS CONTENDED THAT BEST PEENING IS OBTAINED WITH THE DIRECTION OF THE BLAST JUST OFF THE NORMAL TO THE SURFACE BEING PEENED.

4. AFTER NEW SETTINGS ARE MADE THE CORRESPONDING INTENSITY IS MEASURED AS DESCRIBED IN 2 ABOVE.

5. SUPPOSE WITH THE FIRST TRIAL THE CURVE B OF FIG. 3, PAGE 13, WAS OBTAINED AND THE DESIRED INTENSITY IS AS INDICATED BY THE HORIZONTAL LINE. THE SHOT VELOCITY IS, ACCORDINGLY, TOO GREAT AND MUST BE REDUCED. THE SECOND TRIAL RESULTED IN THE CURVE C. HERE THE VELOCITY OF THE SHOT PARTICLES IS TOO LOW. PERHAPS A THIRD TRIAL WOULD RESULT IN CURVE D WHICH IS THE CORRECT ONE FOR THE REQUIRED INTENSITY. ACCORDINGLY, CHANGES IN THE MACHINE SETTINGS ARE MADE UNTIL THE DESIRED INTENSITY CURVE IS OBTAINED.

6. WHEN THE MACHINE SETTINGS ARE FOUND THAT YIELD THE DESIRED INTENSITY OF PEENING, THE TIME OF EXPOSURE OF THE PART IS ALSO INDICATED. FOR EXAMPLE, ON

CURVE D, FIG. 3, THE TIME OF EXPOSURE T CORRESPONDING WITH POINT Q ON THE CURVE IS BELIEVED TO BE THE CORRECT ONE FOR MATERIAL OF THE SAME HARDNESS AS THE TEST STRIP. IT IS BELIEVED THAT EXPOSURE TIMES SHORTER THAN THIS WOULD YIELD ONLY A PARTLY PEENED SURFACE AND, ACCORDINGLY, MAY BE HARMFUL; WHEREAS EXPOSURE FOR LONGER PERIODS MAY BE BENEFICIAL. IF THE PART IS SOFTER THAN ROCKWELL C 47, SLIGHTLY SHORTER TIMES OF EXPOSURE MAY BE SATISFACTORY. IF THE PART IS HARDER THAN ROCKWELL C 47, THE LONGER TIMES OF EXPOSURE ARE PREFERRED. ACCORDINGLY, EXPOSURE TIMES FOR THE PART CAN BE ESTIMATED FROM THE INTENSITY DETERMINATION CURVES.

(3) PRODUCTION CONTROL PROCEDURE - INTENSITY MEASUREMENT

THE PROCEDURE TO BE USED IN PRODUCTION CONTROL OF THE INTENSITY OF PEENING MAY BE DESCRIBED AS FOLLOWS:

1. USING A FIXTURE FOR SUPPORTING THE TEST STRIPS JUST AS IN PARAGRAPH 1 UNDER "PRODUCTION SET-UP PROCEDURE" ABOVE, MOUNT NECESSARY TEST STRIP (OR STRIPS) AND PASS THROUGH PEENING MACHINE IN A MANNER IDENTICAL WITH THAT OF THE PART BEING PEENED.
2. REMOVE TEST STRIP FROM FIXTURE AND MEASURE CURVATURE.
3. IF THE RESULTING CURVATURE INDICATING INTENSITY IS WITHIN SPECIFICATIONS, THE MACHINE IS FUNCTIONING PROPERLY. IF NOT, ADJUSTMENTS MUST BE MADE.

DESIGNATION STANDARD OF PEENING INTENSITY

A STANDARD METHOD OF DESIGNATING PEENING INTENSITY HAS BEEN ADOPTED. THIS DESIGNATION INCLUDES THE FOLLOWING: THE GAGE READING, THE TEST STRIP USED, AND THE TYPE OF GAGE ON WHICH THE MEASUREMENT WAS MADE. IT MAY BE EXPLAINED BY THE FOLLOWING EXAMPLES:

.013A2

THIS EXAMPLE SIGNIFIES .013" GAGE READING ON AN "A" SIZE TEST STRIP MEASURED WITH ALMEN GAGE NO. 2.

.008C1

THIS SIGNIFIES .008" GAGE READING ON A "C" SIZE TEST STRIP MEASURED WITH ALMEN GAGE NO. 1.

TEST STRIP AND GAGE SUPPLIERS

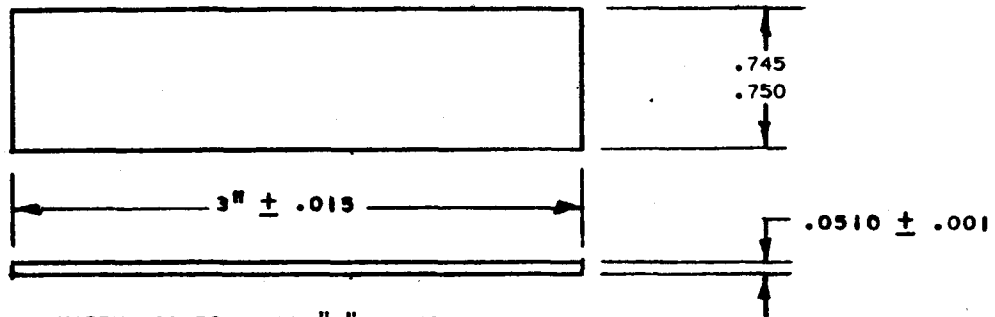
THE AMERICAN FOUNDRY EQUIPMENT COMPANY, MISHAWAKA, INDIANA, AND THE PANGBORN CORPORATION, HAGERSTOWN, MARYLAND, ARE PREPARED TO SUPPLY BOTH SIZES OF TEST STRIPS WHICH MEET STANDARD SPECIFICATIONS.

EACH OF THE ABOVE FIRMS IS IN A POSITION TO SUPPLY THE NO. 2 GAGE. THE NO. 1  
GAGE HAS BEEN DISCONTINUED.

MARCH 15, 1945.

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RESEARCH LABORATORIES DIVISION, G. M. CORP.

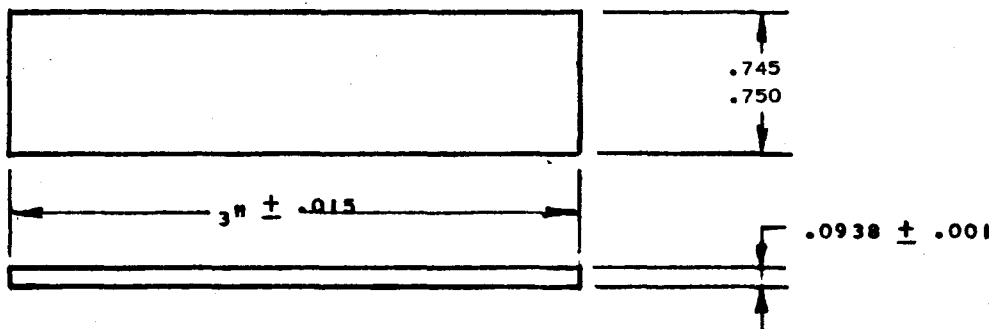
### TEST STRIP "A"



HARDNESS: ROCKWELL "C" 44-50  
FLATNESS:  $\pm .0015''$  ON ALMEN GAGE NO. 2  
ENDS ONLY MAY BE SHEAR FINISH.  
REMOVE BURRS AND BREAK CORNERS.

S-200-2A

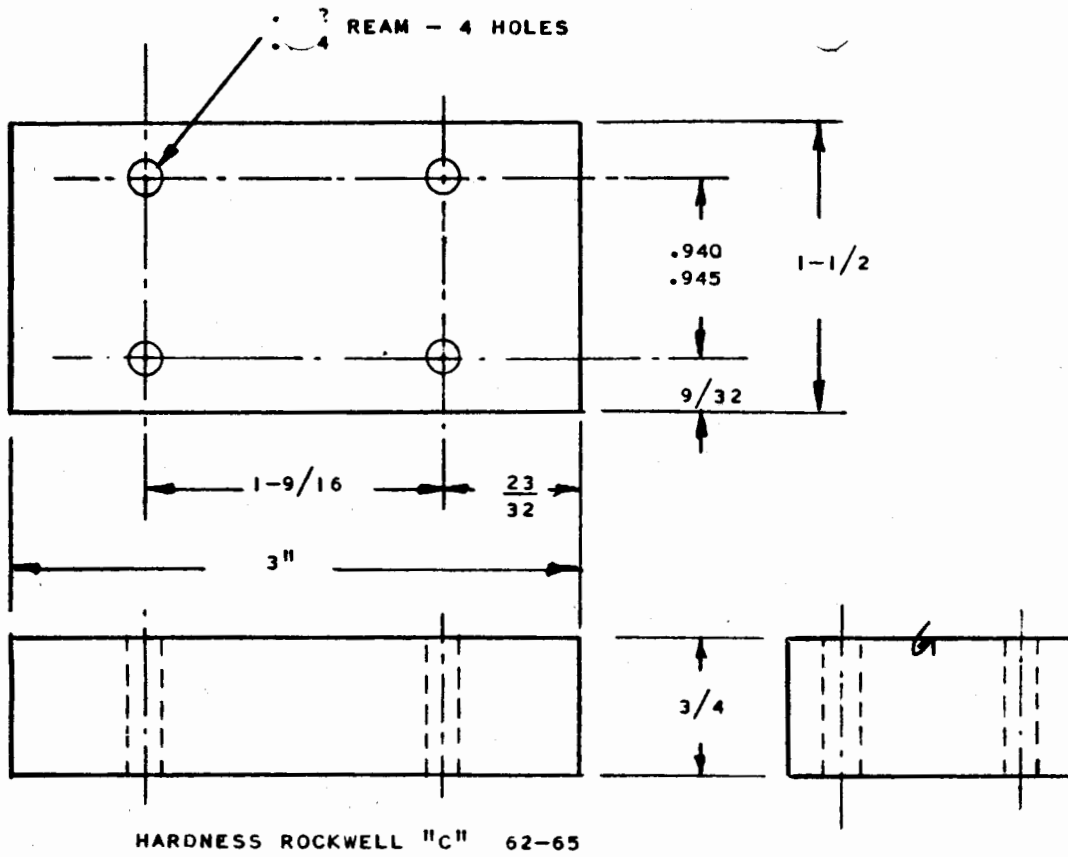
### TEST STRIP "C"



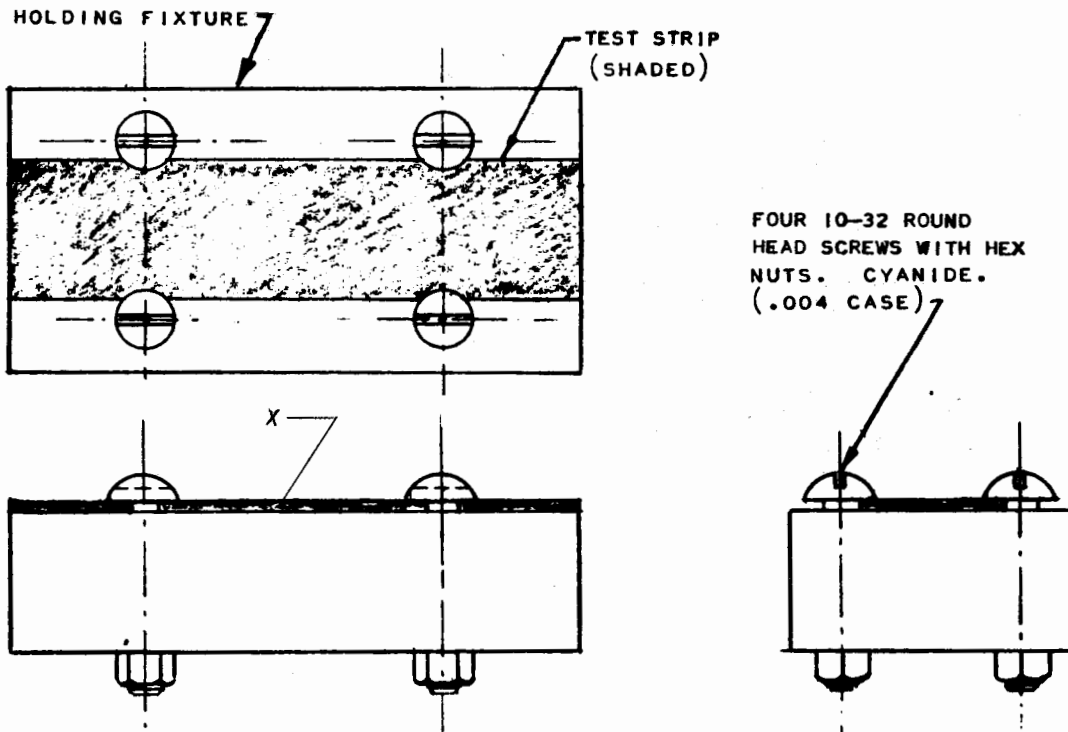
HARDNESS: ROCKWELL "C" 44-50  
FLATNESS:  $\pm .0015''$  ON ALMEN GAGE NO. 2  
ENDS ONLY MAY BE SHEAR FINISH.  
REMOVE BURRS AND BREAK CORNERS.

S-200-4A

### TEST STRIP SPECIFICATIONS

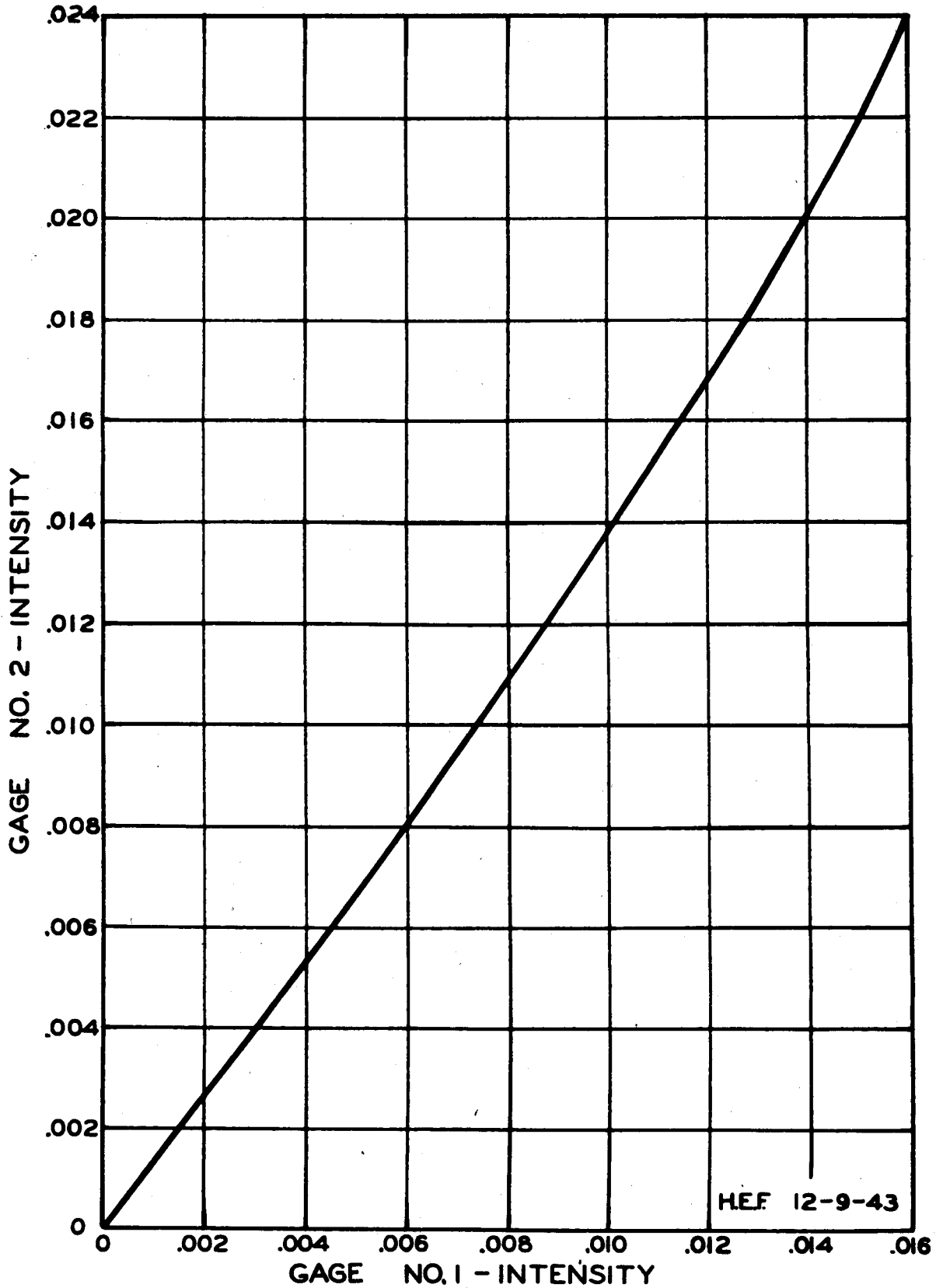


S-200-2B- HOLDING FIXTURE

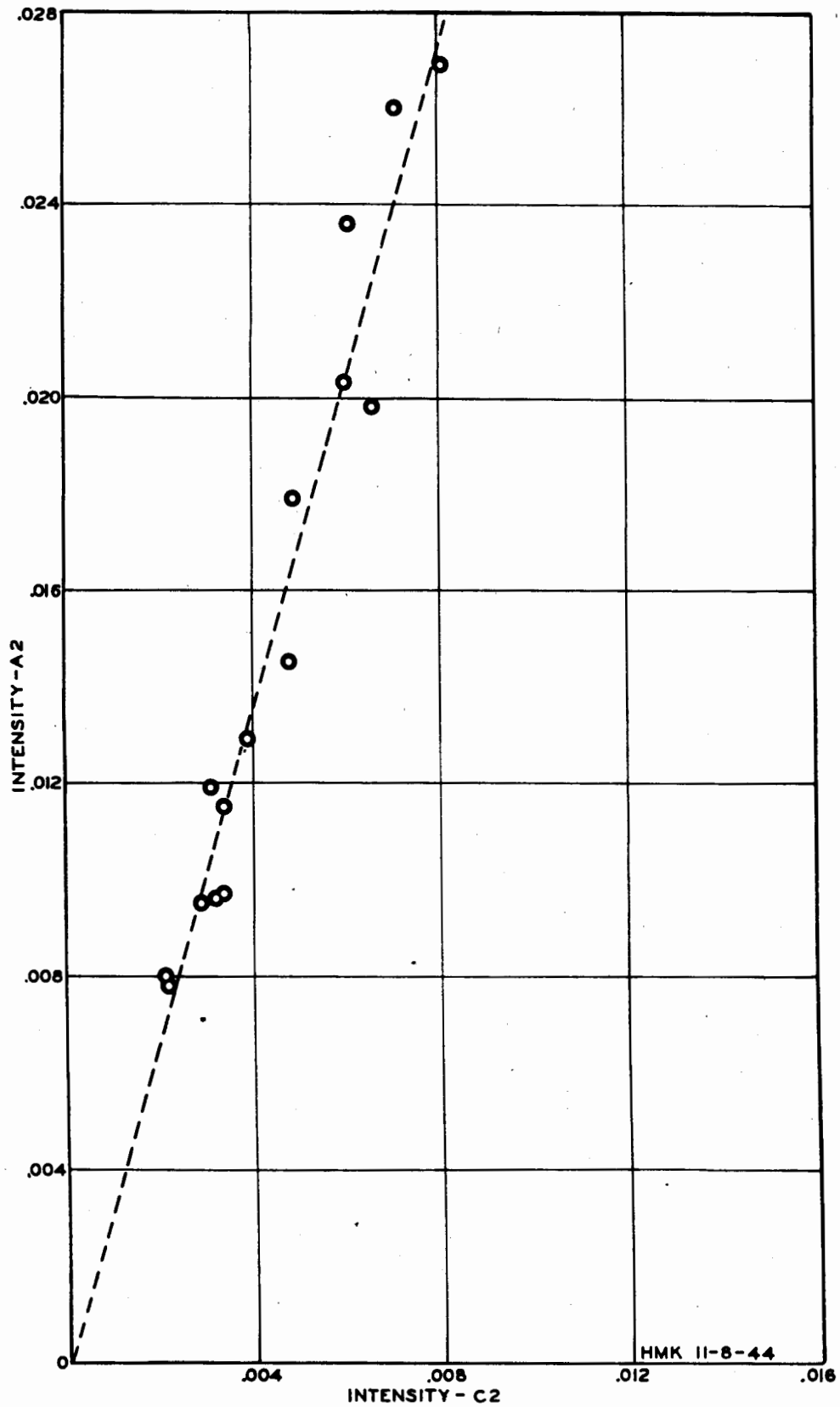


S-200-3- ASSEMBLED TEST STRIP AND HOLDING FIXTURE





S-200-10 - CORRELATION OF GAGE NO. 1 AND GAGE NO. 2.  
FOR "A" STRIP ONLY.



S-200-13-CORRELATION OF ALMEN "A" AND "C" STRIPS  
USING GAGE NO. 2.

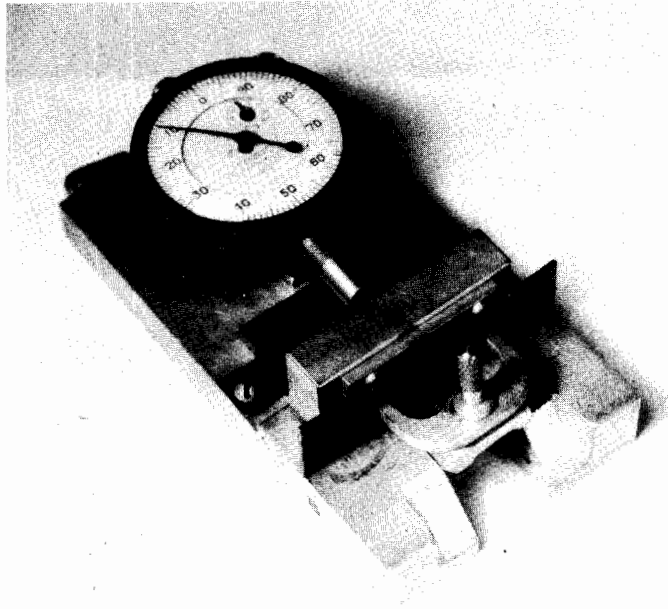
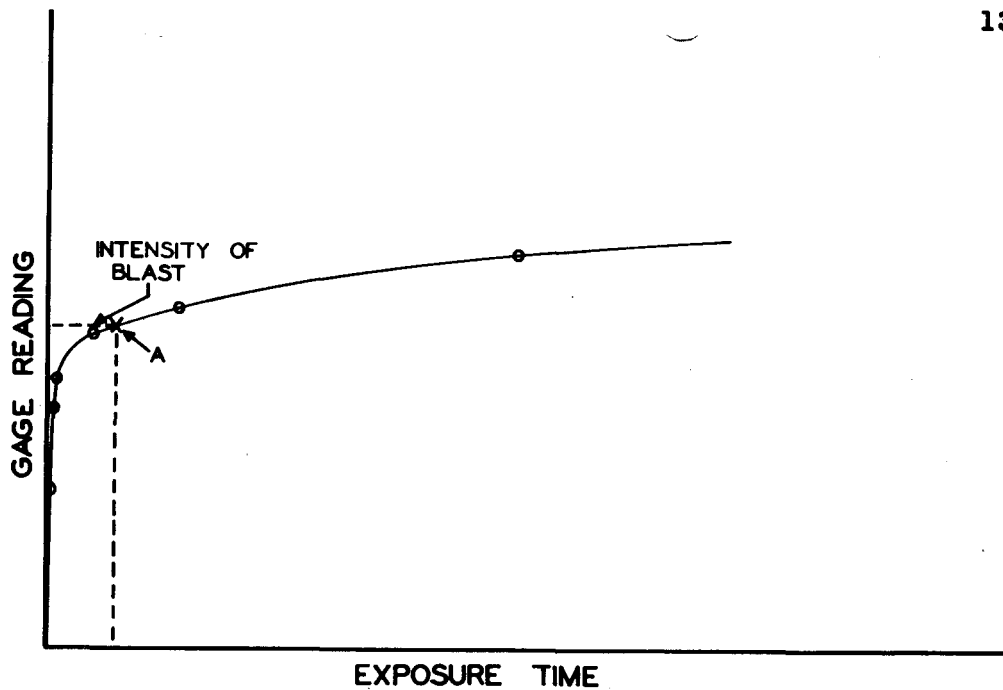
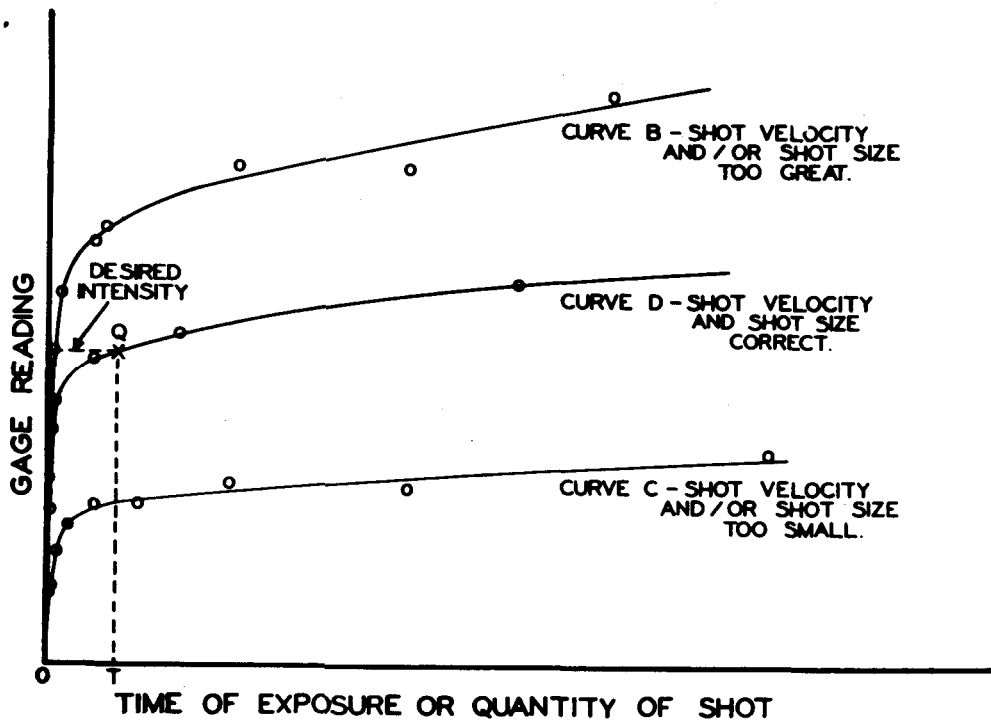


FIG.1- PHOTOGRAPH SHOWS TEST STRIP POSITION IN GAGE.



**FIG. 2- INTENSITY DETERMINATION CURVE**

GAGE READING VS. TEST STRIP EXPOSURE TIME WITH BLAST CONDITIONS CONSTANT. FOR DIFFERENT BLAST CONDITIONS, DIFFERENT CURVES OF THIS SAME TYPE WOULD BE OBTAINED.



**FIG. 3- INTENSITY DETERMINATION CURVES**

THESE CURVES ILLUSTRATE THE TYPE WHICH MIGHT BE OBTAINED IN ESTABLISHING A PROPER MACHINE SETTING FOR A PRODUCTION PEENING SET-UP.