NBSIR 75-913

Structural Test Procedures for Bicycles

Donald E. Marlowe

Engineering Mechanics Section
Mechanics Division
Institute for Basic Standards
National Bureau of Standards
Washington, D. C. 20234

October 1975

Final

Prepared for

Office of Consumer Product Safety
Center for Consumer Product Technology
Institute for Applied Technology
National Bureau of Standards
Washington, D. C. 20234

NBSIR 75-913

STRUCTURAL TEST PROCEDURES FOR BICYCLES

Donald E. Marlowe

Engineering Mechanics Section
Mechanics Division
Institute for Basic Standards
National Bureau of Standards
Washington, D. C. 20234

October 1975

Final

Prepared for
Office of Consumer Product Safety
Center for Consumer Product Technology
Institute for Applied Technology
National Bureau of Standards
Washington, D. C. 20234

U.S. DEPARTMENT OF COMMERCE, Rogers C.B. Morton, *Secretary*
James A. Baker, III, *Under Secretary*
Dr. Betsy Ancker-Johnson, *Assistant Secretary for Science and Technology*

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Acting Director*

TABLE OF CONTENTS

Table of Contents (Con't.) page

STRUCTURAL TEST PROCEDURES FOR BICYCLES

Donald E. Marlowe

Tests for several structural performance criteria have been included in a mandatory regulation on bicycle safety which has been proposed by the Consumer Product Safety Commission. The apparatus and procedures developed to conduct these tests and results from 15 representative bicycles are described. Several of the bicycles tested failed to meet the requirements for the seat and handlebar stem friction clamp strength.

Key Words: Bicycle, consumer safety, regulations, safety, structural testing.

1. SCOPE

Accident reports received by the Consumer Product Safety Commission (CPSC) list many injuries to children as a result of accidents involving bicycles. Many of these injuries result from failure of the structural components of the bicycle during normal use. As a result, the CPSC has included a set of structural performance criteria in the proposed mandatory regulations [1] on bicycle safety. This report describes the apparatus and procedures developed at the National Bureau of Standards for the performance of tests to measure the structural properties of bicycles in accordance with the mandatory regulation and its proposed amendments.

1.1 Test Purpose

The purpose of the tests described here is to verify the technical feasibility of the tests as proposed in the regulation and to exercise the test apparatus which was designed at NBS for CPSC.

The tests included in the program and the paragraphs of the regulation to which they refer are as follows:

1) Drive chain strength	(1512.8)
2) Handlebar strength	(1512.18 (h))
3) Seat clamp strength	(1512.18 (l))
4) Handlebar stem strength	(1512.18 (g))
5) Frame strength	(1512.18 (k)(2))
6) Fork strength	(1512.18 (k)(1))
7) Rear hub retention strength, and	(1512.12 (a)(1))
8) Wheel rim strength	(1512.18 (j))

2. TEST EQUIPMENT

The equipment used for these tests included a universal testing machine with a 11100 N (2500 lbf) range which complied with the calibration requirements of ASTM E-4 [2], spring force gages with capacities of 450 N (100 lbf) and 900 N (200 lbf), a loading frame equipped with a load cell, deflectometer and an X-Y plotter, and several specialized test jigs which will be described in conjunction with particular tests in later sections of this report.

2.1 Load-Deflection Recorder

This instrumentation was used for all tests which were conducted in the loading frame. The complete package includes an X-Y plotter, control box, load cell, and deflection transducer.

Operation: For operation and maintenance of the recorder, see the instruction manual [3] provided with the recorder.

Load Channel: An electrical signal proportional to load is provided for recording on the Y-axis of the recorder. Load is sensed with 2200 N (500-lbf) capacity load cell. The load scale is adjusted to 220 N/cm of record (50 lbf/in of record) when the recorder multiplier switch is set at 1 mV/in and the push to calibrate button results in a deflection of 22.4 cm (8.80 in).

Deflection Channel: An electrical signal proportional to deflection is provided for recording on the X-axis of the recorder. Deflection is sensed with a displacement transducer having a maximum range of 10 cm (4 in). The deflection scale is adjusted to 0.25 cm per cm (0.25 in per in) of record when the recorder multiplier switch is set at 100 mV/in and the push-to-calibrate button results in a pen deflection of 19.2 cm (7.55 in).

Schematic: A schematic of the control box circuit, which includes the load and displacement transducers, is shown in Figure 1.

2.2 Loading Frame

A loading frame, designed to supplement the use of a testing machine, was used in several of these tests. Its use will be illustrated for several tests in later sections of this report. The loading frame provides attachment points for the bicycle parts and the loading actuator employed. The actuator used was a double acting hydraulic cylinder and power supply. Drawings of this load frame are provided in Appendix A.

3. TEST PROCEDURE

3.1 Test Flow

Special attention must be given to the order in which tests are performed if a single bicycle is to be used for all the tests. If care is not taken, the loading and subsequent destruction of bicycle parts not under test may occur which will invalidate tests to be performed later in the program. One possible order for these tests is shown in Figure 2. It should be noted that no component tests can be conducted until all braking tests, probe tests, reflector tests and road tests have been completed.

3.2 Drive Chain Test (1512.8)

3.2.1 Test Equipment

The apparatus used for these tests is shown in Figure 3. The fixtures are mounted as shown in a universal testing machine having a loading range of 11100 N (2500 lbf) capacity. The detailed drawings of the test fixtures are given in Appendix A.

3.2.2 Procedure

The chain grips (Figure 4) were suspended in the testing machine using the testing machine pull rods. The drive chain was removed from the bicycle and installed in the grips. This was done by inserting the chain onto the sprocket wheel such that the test section of the chain was on the axis of the testing machine and the chain was wrapped around the sprocket until the last link rested in the tooth adjacent to the hole through the sprocket. A light gage wire was then inserted through the hole and wrapped around the chain or inserted through the hole in the last chain link (Figure 4). After placing the fly mesh screen around the specimen to contain all broken chain pieces, load was applied until chain failure (1512.8).

3.3 Handlebar Stem to Fork Clamp (1512.18 (h)(1))

3.3.1 Test Equipment

The apparatus used to conduct this test is shown in Figure 5. It includes a load bar clamped to the handlebar and a spring force gage attached to the load bar a measured distance from the stem clamp axis.

3.3.2 Test Procedure

The front fork was restrained from rotating by clamping it against a stationary object. The load bar was clamped to the handlebar. The

distance from the stem axis to the loading point on the loading bar was measured. A gradually increasing load was applied through the force gage until a torque on the clamp of 47.2 N-m (35 ft-lb) was reached or the stem began to turn in the fork (1512.18(h)(1)).

3.4 Handlebar Strength (1512.18 (h)(2))

3.4.1 Test Equipment

The apparatus used to conduct this test is shown in Figure 6. It includes a fixture to hold the handlebar stem in the testing machine, and a loading jig to apply loads to the ends of the handlebar. The test was conducted in a testing machine for convenience only and could have been done with the stem inserted in the bicycle. The detailed drawings of these test fixtures are given in Appendix A.

3.4.2 Test Procedure

The stem was removed from the bicycle, inserted in the holding fixture and the stem clamp tightened. Adjustments were made to the fixture to level the portions of the handlebar near the ends where load would be applied. The fixture was placed in a testing machine. The loading yoke was placed on the handlebar ends and load slowly applied by the machine until a load of 445 N (100 lbf) was reached, or an energy of 22.6 J (200 in-lb) was absorbed in handlebar bending, or the handlebar slipped in the clamp (1512.18(h)(2)).

3.5 Handlebar Stem Test (1512.18 (g))

3.5.1 Test Equipment

This test was performed in a testing machine which complies with the requirements of ASTM designation E4-72. The apparatus used for this test is shown in Figure 7. This test fixture fulfills the requirements of paragraph 1512.18 (g)(1) and Figure 2 of the proposed regulation. A detailed drawing of this fixture is given in Appendix A.

3.5.2 Test Procedure

The handlebar was removed from the stem and a solid bar inserted in the stem in its place. The handlebar clamp was retightened. The stem was placed in the stem loading fixture at its minimum insertion mark and the stem bolt tightened. For stems which did not have a minimum insertion mark, the diameter of the stem was measured and the stem was inserted into the fixture to a depth of 2.5 diameters. Gradually increasing loads were applied in the testing machine through the loading yoke in a direction as shown in Figure 2 of the regulation until a load of 2000 N (450 lbf) was reached (1512.18(g)(1)). The load was removed. The stem was removed from the fixture and checked visually for cracks.

3.6 Seat Clamp Tests (1512.18 (1))

3.6.1 Test Equipment

For this test a 900 N (200 lbf) spring force gage was used as shown in Figure 8.

3.6.2 Test Procedure

With the bicycle frame restrained from movement by clamping its frame to the frame of a testing machine, 668 N (150 lbf) was applied downward, 25 mm (1 in) from the seat front and then 25 mm (1 in) from the seat back so as to test the seat clamps in pitch. A load of 222 N (50 lbf) was then applied horizontally at these same distances from the seat front and back so as to test the seat clamps in yaw (1512.18(1)(1)).

3.7 Rear Hub Retention Test (1512.12 (a)(1)

3.7.1 Test Equipment

The equipment needed for this test is shown in Figure 9. This equipment included a hydraulic ram and load cell for applying and measuring the load, the connectors needed to grip the bicycle frame and rear axle, and a reaction frame.

3.7.2 Test Procedure

For this test, the front wheel was removed from the bicycle. The test fixtures for holding the frame and axle were attached to the bicycle (Figure 10). The fixtures were attached to the reaction frame and hydraulic ram such that the applied load was in the direction of the axle adjustment slot in the frame. Force was gradually applied to the axle-frame coupling until 1780 N (400 lbf) had been reached or until the axle moved in the frame.

3.8 Rim Test (1512.18 (j))

3.8.1 Test Equipment

The test apparatus used in this test is shown in Figure 11. This equipment included the masks for each tire size, a hydraulic ram to apply the load, a load cell and indicator to measure the load, a coupling for each bicycle axle, and a reaction frame. The mask rested on the frame and supported the rim through the tire around its entire circumference. A coupling which fitted the threads of the axle and a chain (Figure 12) was used to connect the loading ram to the wheel.

3.8.2 Test Procedure

Wheel rims were tested in accordance with paragraph 1512.18 (j) of the regulation. If both wheels of the bicycle were symmetric about the plane of the tire, only one was to be tested. If, however, the wheel hub was offset, as occurred when a multiple drive sprocket was used on the rear axle both wheels were tested. For the wheel with the offset, load was applied in the direction of the offset.

After the wheel to be tested was removed from the bicycle, the tire was inflated to the pressure recommended by its manufacturer. The axle coupling was installed, and the wheel was placed on the mask in the reaction frame with the mask supporting only the tire. The chain was attached to the loading ram and the axle coupling. A gradually increasing load was applied to 2000 N (450 lbf). This load was held for 30 seconds and removed. The wheel was then reinstalled on the bicycle according to the manufacturers instructions and tested for alinement in accordance with paragraph 1512.11 of the regulation.

3.9 Frame Test (1512.18 (k)(2))

3.9.1 Test Equipment

The equipment needed for this test is shown in Figure 13. It includes a reaction frame, load cell and deflectometer for measuring load and deflection, the X-Y plotter, and a hydraulic ram for applying the load.

3.9.2 Test Procedure

After the wheels were removed from the bicycle, the rear fender brackets were removed. The frame was inserted in the reaction frame as shown in Figures 13 and 14. Shown in Figure 14a is the positioning of the deflectometer to measure frame deformations. As the load was applied using the hydraulic ram, a plot of load versus deflection was made. Load was gradually applied until a force of 890 N (200 lbf) was reached or 39.5 J (350 in-lb) of energy was absorbed in frame deflection, whichever resulted in the greater force (1512.18(k)(2)). After the load had been released, the frame was removed from the test fixture and the front wheel reinstalled on the bicycle and checks were made to determine if the steering of the bicycle had been affected.

3.10 Fork Test (1512.18 (k)(1))

3.10.1 Test Equipment

The equipment needed for this test is shown in Figure 15. This fixture complies with the requirements of paragraph 1512.18 (k)(1)(i) and Figure 1 of the proposed regulation. Also required for this test

is a testing machine, a deflectometer and the X-Y plotter. A drawing of the apparatus used in the test is given in Appendix A.

3.10.2 Test Procedure

After the results of the frame test had been evaluated, the fork was removed from the bicycle and all bearings, hardened shoulders and any cable fittings were removed. A hardened steel roller wheel was installed at the axle attachment point (Figure 15). The fork was placed in the fixture with the fork yoke hard against the V block. The deflectometer was adjusted to measure fork deflection. The X-Y plotter was connected to the load readout of the testing machine and to the deflectometer and the spans adjusted to a convenient value. Gradually increasing loads were applied through the roller wheel until a deflection of 64 mm (2.5 in) was reached. The area under the force deflection curve was computed to find the energy absorbed. The Regulation required that a minimum of 39.5 J (350 in-lbf) of energy shall be absorbed in bending of the fork (1512.18(k)(1)).

4. RESULTS

All tests were conducted in a normal laboratory environment at room temperature. It is estimated that the errors did not exceed 1 percent for load measurement and 0.05 inches for deflection. Fifteen bicycles were tested to evaluate the regulation and the test equipment. These bicycles are described in Table 1. The results of the structural tests performed during this evaluation are given in Table 2. Typical load-deflection autographic recordings, from which the energy of deformation for the forks and frames are calculated, are shown in Figure 16 and 17.

Because no spare forks were submitted with these bicycles, the frame test (1512.18 (k)(2)) was performed before the fork test. The regulation provides that a second fork, identical to that tested in the fork test be installed in the bicycle for this test but that provision was not possible for these tests. Accordingly the fork, which was supplied on the bicycle at the time of purchase and which may have been deformed by the frame test, was tested.

5. DISCUSSION

As can be seen from Table 2, 11 of the 15 bicycles tested failed to pass one or more of the clamp tests. These clamps were tested in the "as received" condition, or as "assembled" in our laboratory before the bicycle was ridden during the braking system tests. No attempt was made to retighten and retest a clamp which had failed.

The apparatus and the procedures used for these tests are not unique. Several alternate ways of applying the necessary forces to the bicycle components could have been devised. One of the purposes of these tests was to exercise the test apparatus which was assembled at NBS for CPSC. This was done with only a few minor modifications to the test apparatus. The procedures used and the order in which the tests were performed were developed during this program.

6. CONCLUSIONS

The structural tests proposed in the mandatory regulation have been performed on 15 bicycles which represent many of the types and sizes which are currently available in the marketplace.

The greatest number of "failures" occurred during the testing of friction clamps such as are used in seats and handlebar stems. However the bicycles had been tested for brake performance before these tests and the clamps were adequately tight.

The testing of the bicycle forks in accordance with the regulation requires that a new fork, nominally identical to that provided with the bicycle, be the test object. Many of the sources of bicycles, such as department stores, large drug stores, hardware retail stores, etc., may be unable to supply the part at the time the bicycle is procured for testing. Some consideration should be given to the meaning of a test performed on an already damaged fork.

7. REFERENCES

1. Requirements for Bicycles, Part 1512, Federal Register, Vol. 39, No. 137, July 16, 1974, as amended; Federal Register, Vol. 40, No. 4, January 7, 1975, as amended; Federal Register, Vol. 40, No. 116, June 16, 1975.

2. Standard Methods of Verification of Testing Machines, ASTM E4-72, American Society for Testing and Materials, Philadelphia, Pennsylvania.

3. Instruction Manual, Series 2000 Omnigraphia X-Y Recorder, Houston Instrument Co., Bellaire, Texas.

Table 1 - Test Specimen Parameters

Bicycle No.	Brake Type	Number of Speeds	Maximum Gear Ratio	Wheel Size		Bicycle Mass		Wheel Base		Frame Size[d]	
				mm	in	kg	lb	mm	in	mm	in
1	Coaster and Single Caliper	1	40/16	508	20	14.1	31.1	887.7	34.95	349.2	13.75[a]
2	Double Caliper[e]	10	52/14	686	27	11.8	26.0	1027.7	40.46	527.0	20.25
3	Double Caliper	3	48/20	660	26	18.2	40.1	1051.6	41.40	527.0	20.75
4	Double Caliper	10	52/14	686	27	13.9	30.5	1088.6	42.86	635.0	25.00
5	Double Caliper with Extension Levers	10	50/14	686	27	13.4	29.5	1025.6	40.38	485.6	19.12[a]
6	Double Caliper with Extension Levers	10	52/14	660	26	15.0	33.1	1041.4	41.00	552.5	21.75
7	Double Caliper	10	50/14	686	27	18.4	40.4	1071.1	42.17	508	20.00
8	Double Caliper	10	52/14	686	27	16.8	37.0	1055.4	41.55	552.5	21.75
9	Double Caliper	10	52/14	660	26	15.2	33.5	1044.4	41.12	552.5	21.75
10	Double Caliper	5	50/14	686	27	16.6	36.6	1058.2	41.66	590.5	23.25
11	Coaster	1	36/16	508	20	13.9	30.5	894.6	35.22	352.3	13.87

(continued)

Table 2 - Structural Test Results for Bicycles

Bicycle No.	Drive Chain Failure Load	Handlebar				Seat Clamp		Rear Hub Locking Device	Wheel Rim		Frame Test			Fork Test		
		Stem[b] Clamp	Stem Strength	Strength Load	Strength Defl	Pitch[b]	Yaw[b]		Front	Rear	Load	Defl[e]	Energy	Load	Defl[e]	Energy
	N		N	N	mm	N	N	N	N	N	N	mm	J	N	mm	J
1	7740	32	2000	445	3.17	668	222	(c)	2000	(c)	1560	47	55.4	1310	64	67.3
2	9520	38	2000	445	3.17	668	164	1780	2000	2000	1330	60	68.6	1180	64	55.4
3	7760	65	2000	445	3.17	668	196	1780	2000	(c)	1560	57	60.7	1530	64	73.6
4	9760	61	2000	445	2.54	668	151	1780	2000	2000	1250	57	53.1	1070	64	54.4
5	7760	47	2000	445	(c)	668	222	1780	2000	2000	1290	57	50.4	1220	64	25.2
6	9350	47	2000	445	3.17	668	160	1780	2000	2000	1380	60	58.8	1360	64	74.2
7	9440	27	2000	445	4.32	668	222	1780	2000	2000	1780	47	46.4	1620	64	73.4
8	10090	49	2000	445	3.17	668	222	1780	2000	2000	1470	57	65.8	1200	64	24.5
9	9950	49	2000	445	2.54	668	156	1780	2000	2000	1380	44	47.1	1220	64	67.7
10	9270	41	2000	445	3.17	668	222	(c)	2000	2000	1670	51	51.6	1690	64	55.4
11	8230	26	2000	445	4.75	668	222	(c)	2000	(c)	2220[f]	25	28.2	1670	22	55.8
12	9040	49	2000	445	2.54	668	222	1780	2000	2000	1850	51	60.7	2560	64	50.0
13[a]	8330	(c)	(c)	(c)	(c)	(c)	222	1110	2000[d]	(c)	1600	64	56.8	(c)	(c)	(c)
14[a]	8740	38	1200	445	3.17	668	222	1780	2000	(c)	1730	44	47.7	1850	64	89.3
15	4870	34	2000	445	3.17	668	147	1780	2000	2000	1580	54	60.0	1090	64	54.8
REQUIREMENTS																
Bicycles	8010	47	2000	445	76	668	222	1780	2000	2000	890		39.5		64	39.5
Sidewalk Bicycles	6230	20	1000	445	76	334	111	1780	2000	2000	890		39.5		64	39.5

[a] Sidewalk Bicycle

[b] Tested in as received condition

[c] Data not recorded

[d] Non-inflated tire rolls off the rim while under test

[e] Total deflection while under load. A large portion of this is recovered upon unloading.

[f] This frame exceeded the capacity of the testing apparatus. Therefore the absorbed energy is not indicative of the actual capacity of this frame.

Table 2a - Structural Test Results for Bicycles

Bicycle No.	Drive Chain Failure Load	Handlebar				Seat Clamp		Rear Hub Locking Device	Wheel Rim		Frame Test			Fork Test		
		Stem[b] Clamp	Stem Strength	Strength		Pitch[b]	Yaw[b]		Front	Rear	Load	Defl[e]	Energy	Load	Defl[e]	Energy
	lbf	lbf-ft	lbf	lbf	in	lbf	lbf	lbf	lbf	lbf	lbf	in	in-lbf	lbf	in	in-lbf
1	1740	24	450	100	0.125	150	50	(c)	450	(c)	350	1.87	490	295	2.5	596
2	2140	28	450	100	.125	150	37	400	450	450	300	2.37	607	265	2.5	490
3	1744	48	450	100	.125	150	44	400	450	(c)	350	2.25	537	345	2.5	651
4	2195	45	450	100	.100	150	34	400	450	450	280	2.25	470	240	2.5	481
5	1745	35	450	100	(c)	150	50	400	450	450	290	2.25	446	275	2.5	223
6	2101	35	450	100	.125	150	36	400	450	450	310	2.37	520	305	2.5	657
7	2122	20	450	100	.170	150	50	400	450	450	400	1.87	411	365	2.5	650
8	2269	36	450	100	.125	150	50	400	450	450	330	2.25	582	270	2.5	217
9	2238	36	450	100	.100	150	35	400	450	450	310	1.75	417	275	2.5	599
10	2084	30	450	100	.125	150	50	(c)	450	450	375	2.00	457	380	2.5	490
11	1850	19	450	100	.187	150	50	(c)	450	(c)	500(f)	1.00	250	375	0.87	494
12	2033	36	450	100	.100	150	50	400	450	450	415	2.00	537	575	2.5	442
13(a)	1873	(c)	(c)	(c)	(c)	(c)	50	250	450(d)	(c)	360	2.50	503	(c)	(c)	(c)
14(a)	1964	28	270	100	.125	150	50	400	450	(c)	390	1.75	422	415	2.5	790
15	1095	25	450	100	.125	150	33	400	450	450	355	2.12	530	245	2.5	485
REQUIREMENTS																
Bicycles	1800	35	450	100	<3.0	150	50	400	450	450	200		350		2.5	350
Sidewalk Bicycles	1400	15	225	100	<3.0	75	25	400	450	450	200		350		2.5	350

(a) Sidewalk Bicycle

(b) Tested in as received condition

(c) Data not recorded

(d) Non-inflated tire rolls off the rim while under test

(e) Total deflection while under load. A large portion of this is recovered upon unloading.

(f) This frame exceeded the capacity of the testing apparatus. Therefore the absorbed energy is not indicative of the actual capacity of this frame.

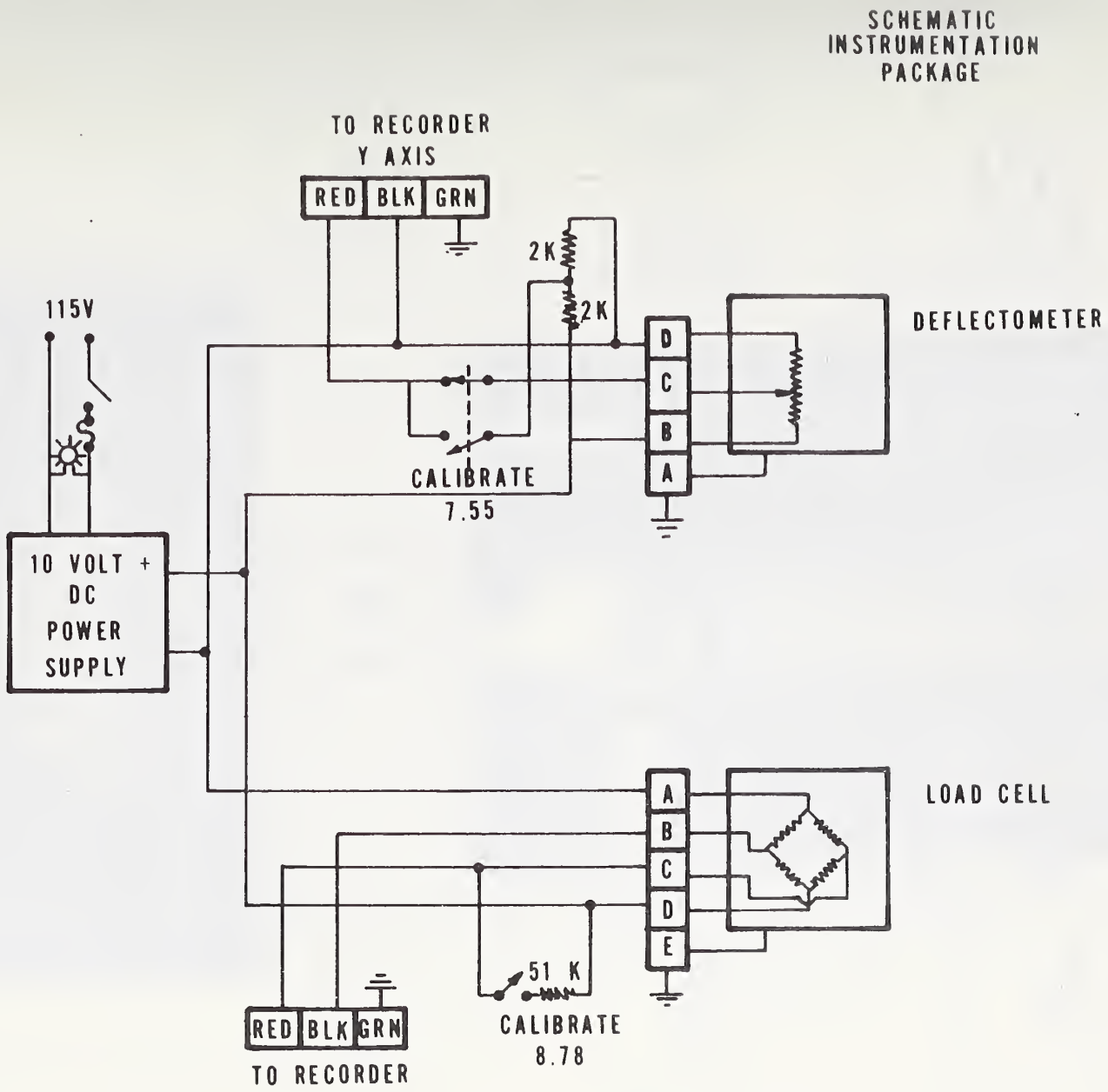


Figure 1 - Schematic of the load-deflection instrumentation

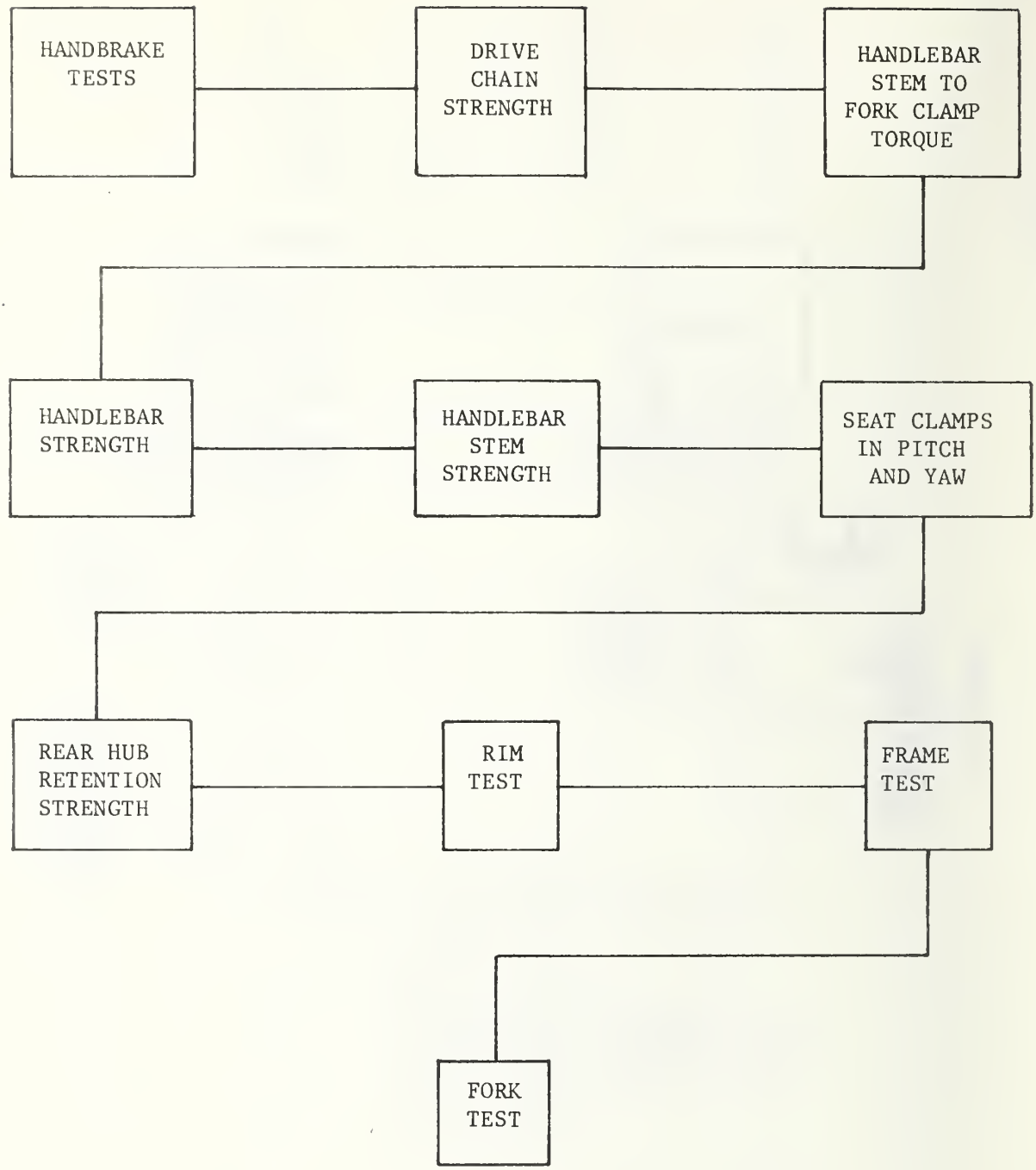


Figure 2 - Flow Diagram for Bicycle Performance Tests

Figure 3 - Drive Chain Test Apparatus

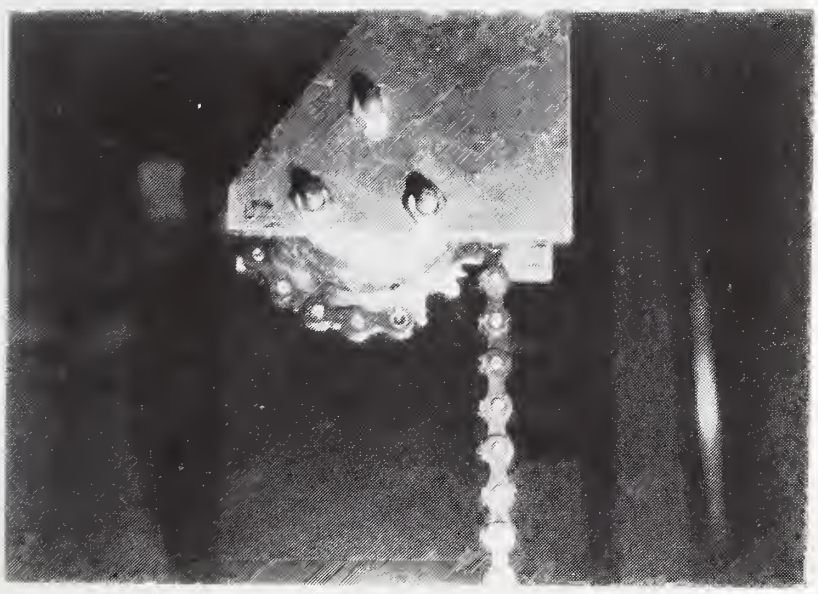


Figure 4 - Drive Chain Test Loading Fixture

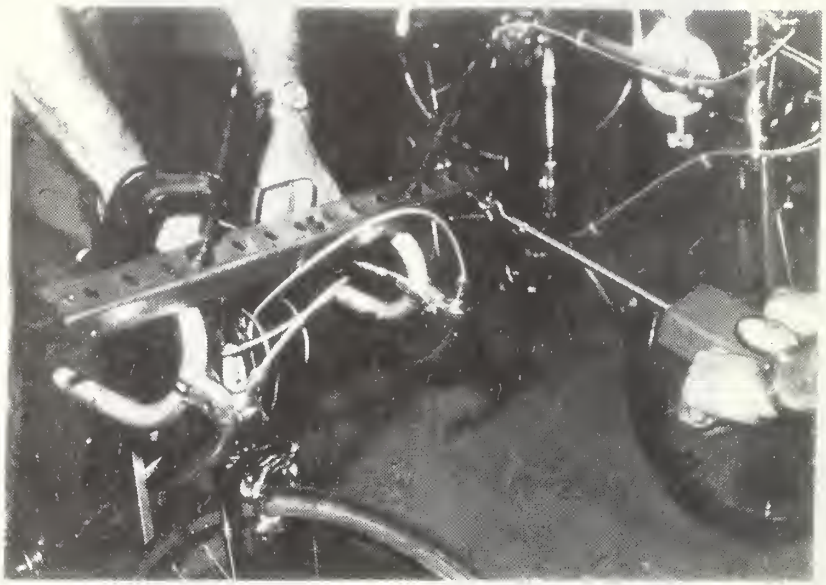


Figure 5 - Handlebar Stem-to-Fork Clamp Test

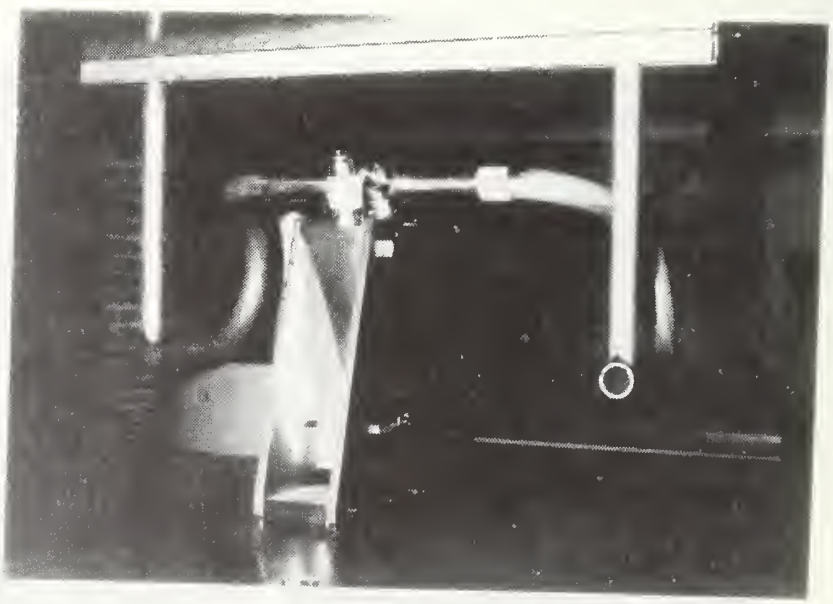


Figure 6 - Handlebar Strength Test Fixture

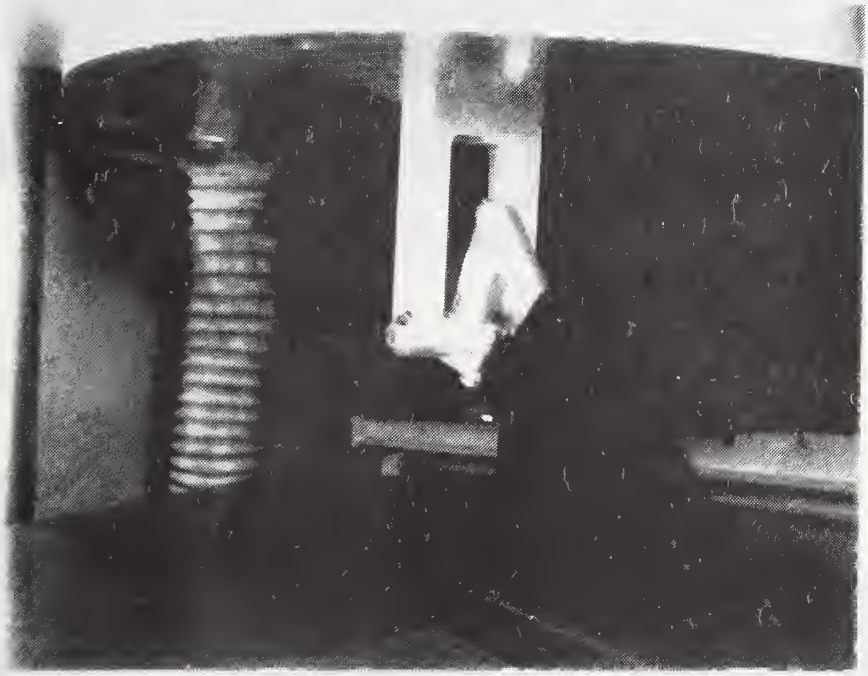


Figure 7 - Stem Test Fixture

Figure 8 - Seat Clamp Test

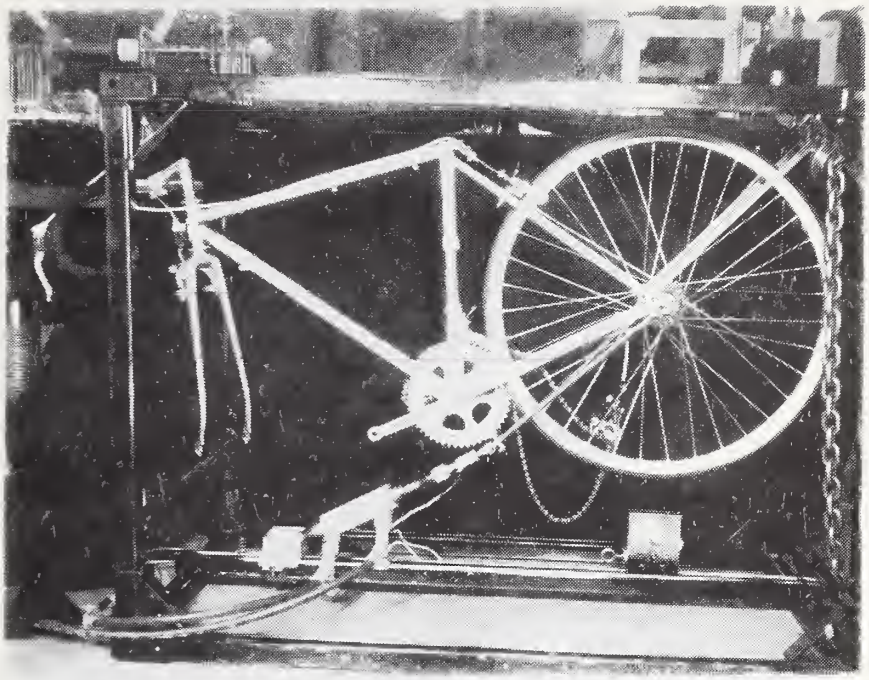


Figure 9 - Rear Hub Retention Test

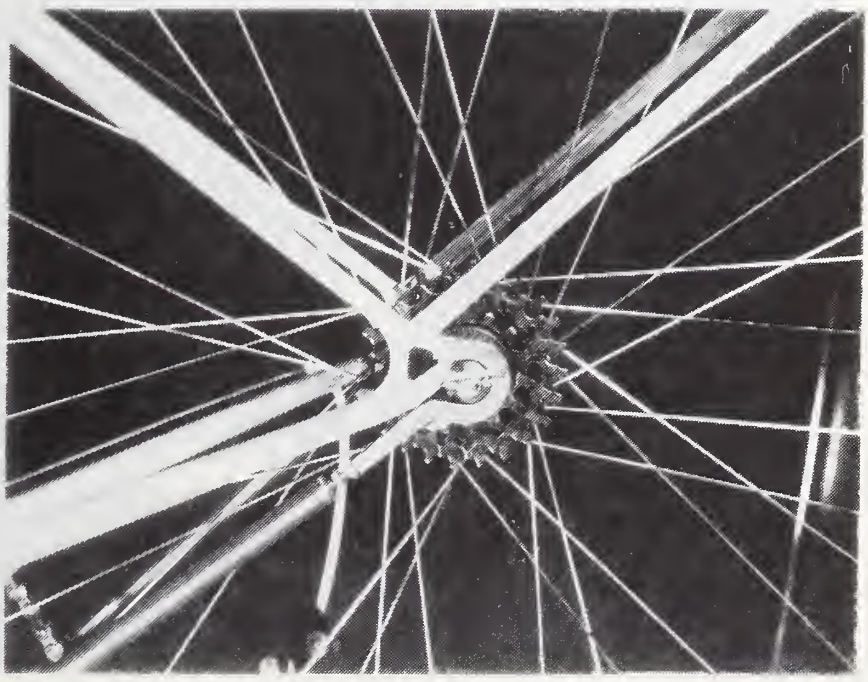


Figure 10 - Rear Hub Retention Test - Close-up of Axle Attachment

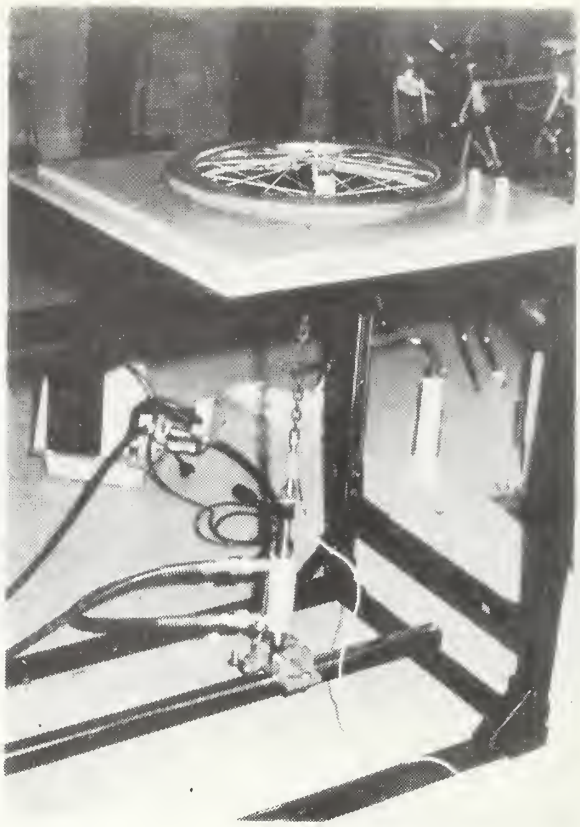


Figure 11 - Rim Test Fixture

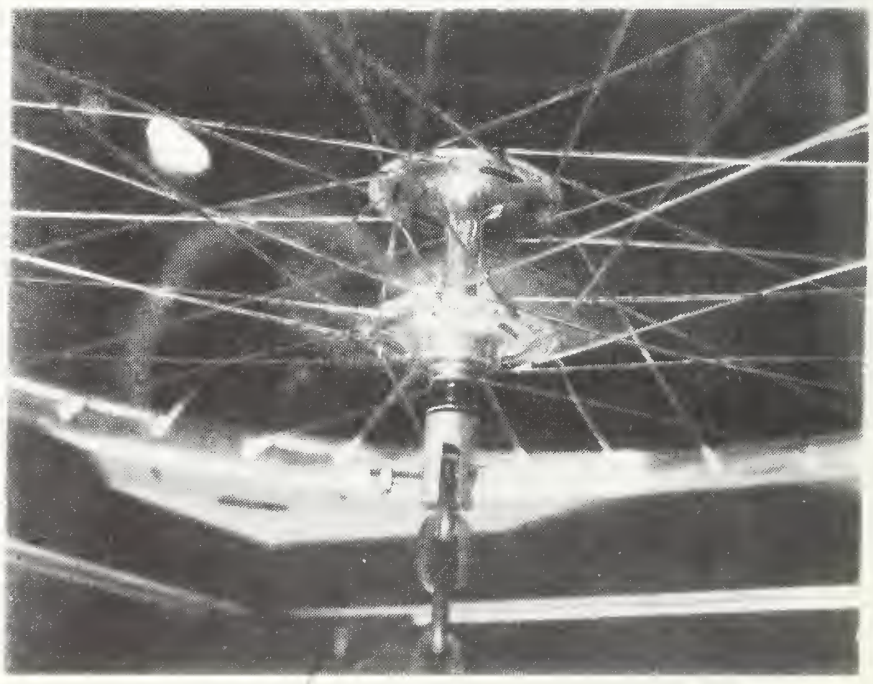


Figure 12 - Rim Test Fixture - Close-up of Axle Coupling

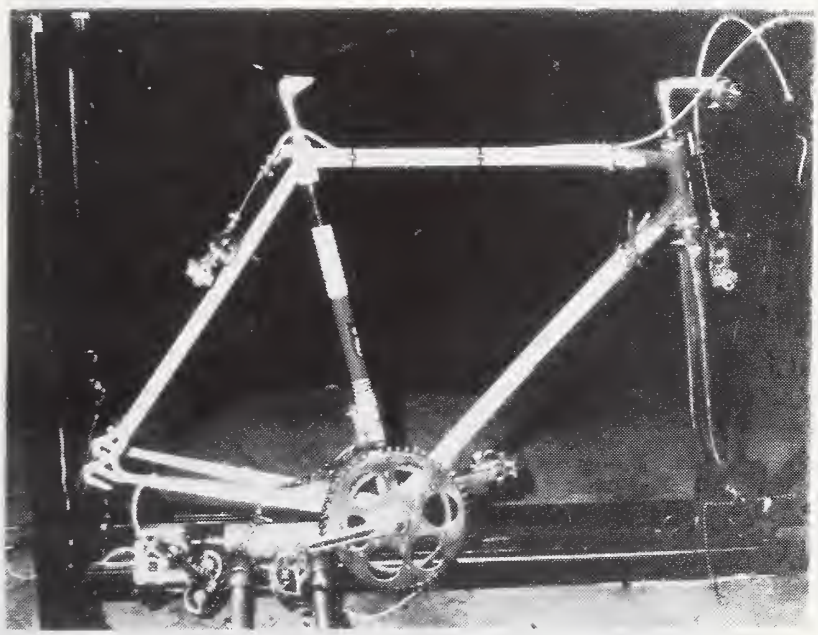


Figure 13 - Frame Test Fixture

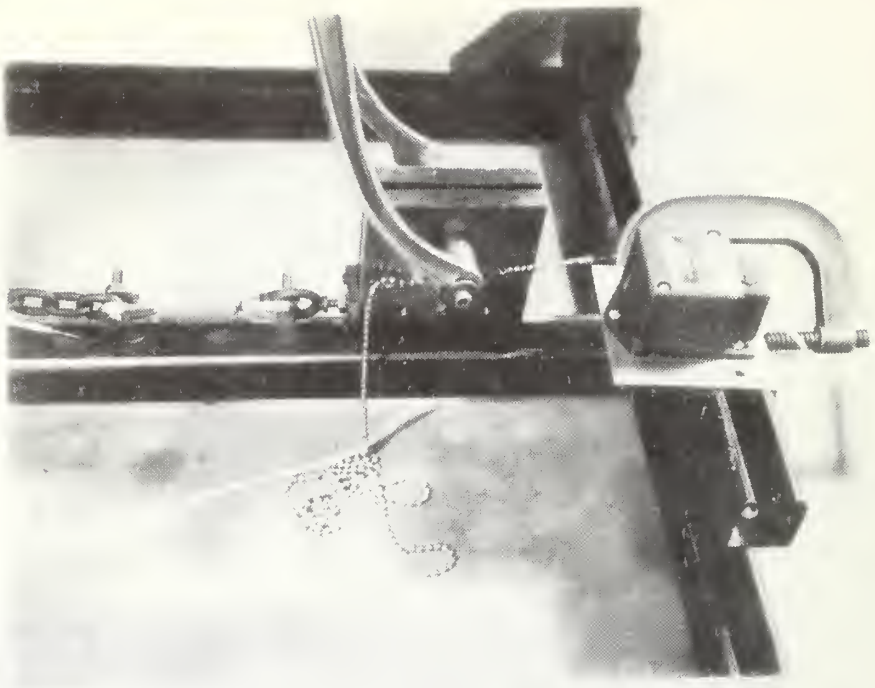


Figure 14a - Frame Test Fixture - Close-up of Front Attachment

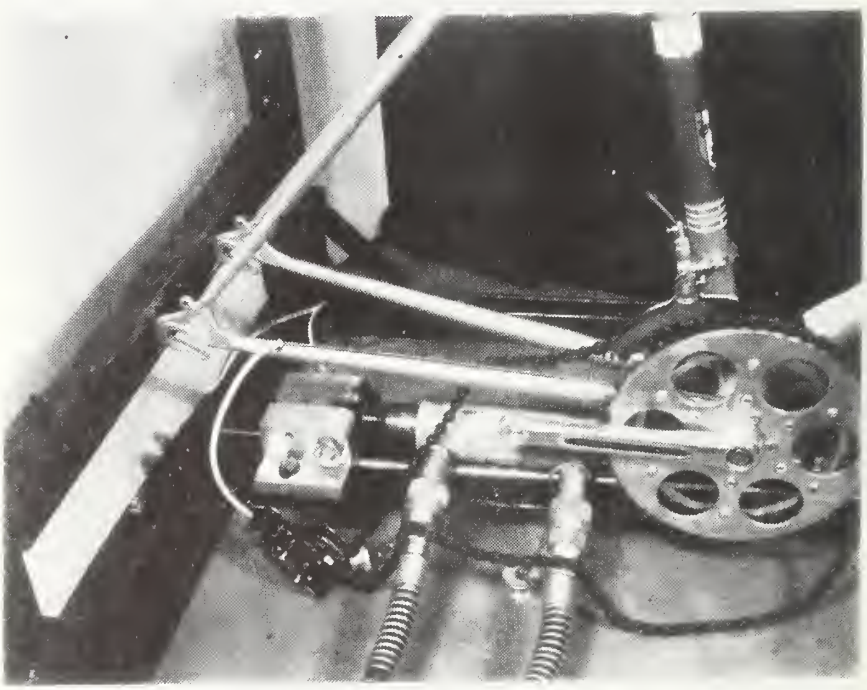


Figure 14b - Frame Test Fixture - Closeup of Rear Attachment

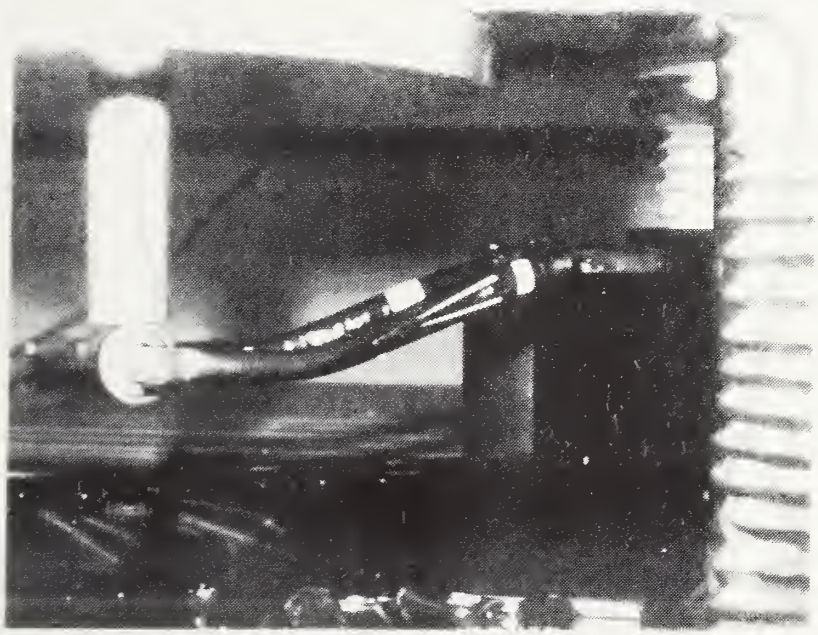


Figure 15 Fork Test Fixture

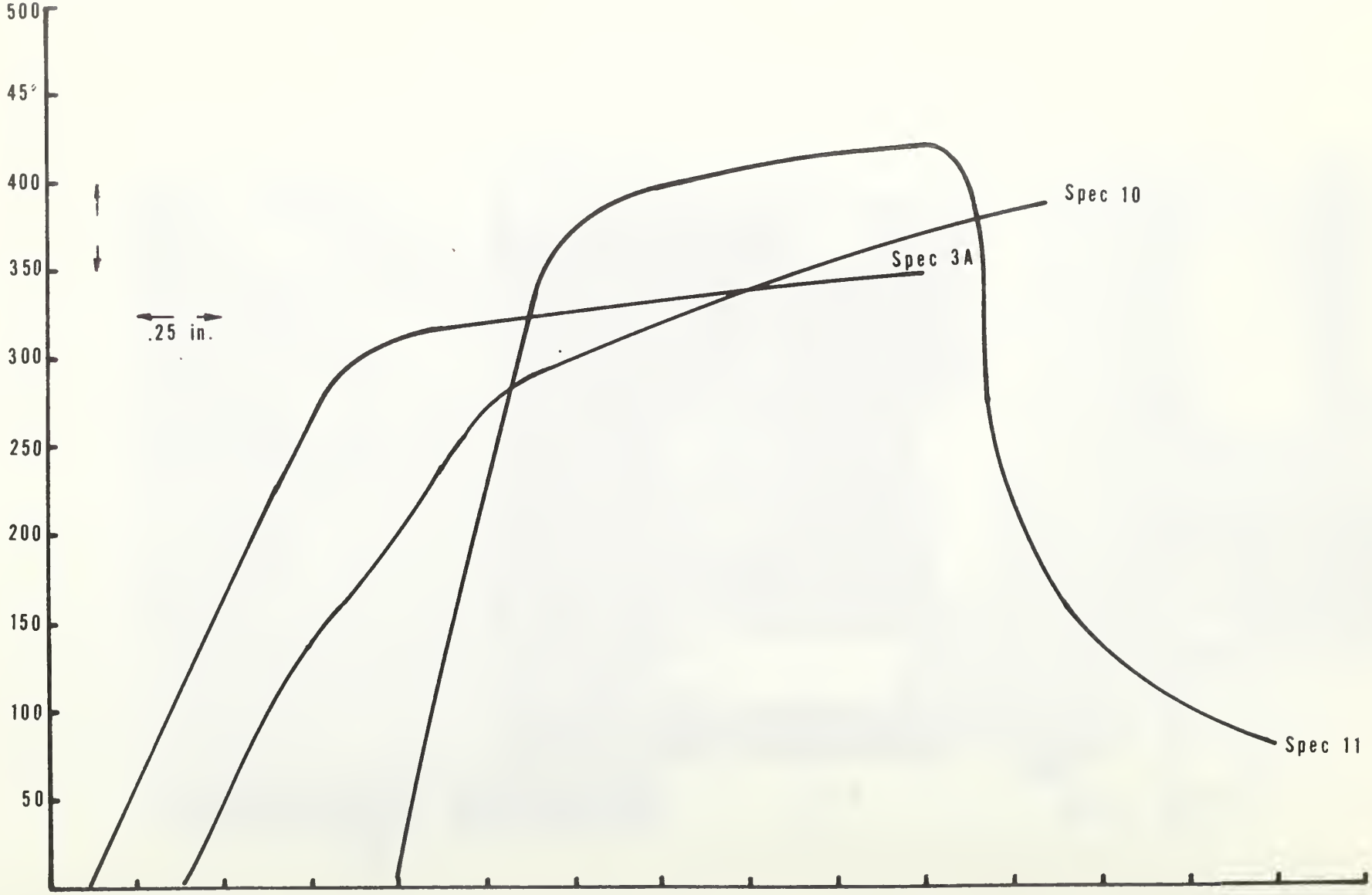


Figure 16 Typical Fork Test Load-Deflection Recordings

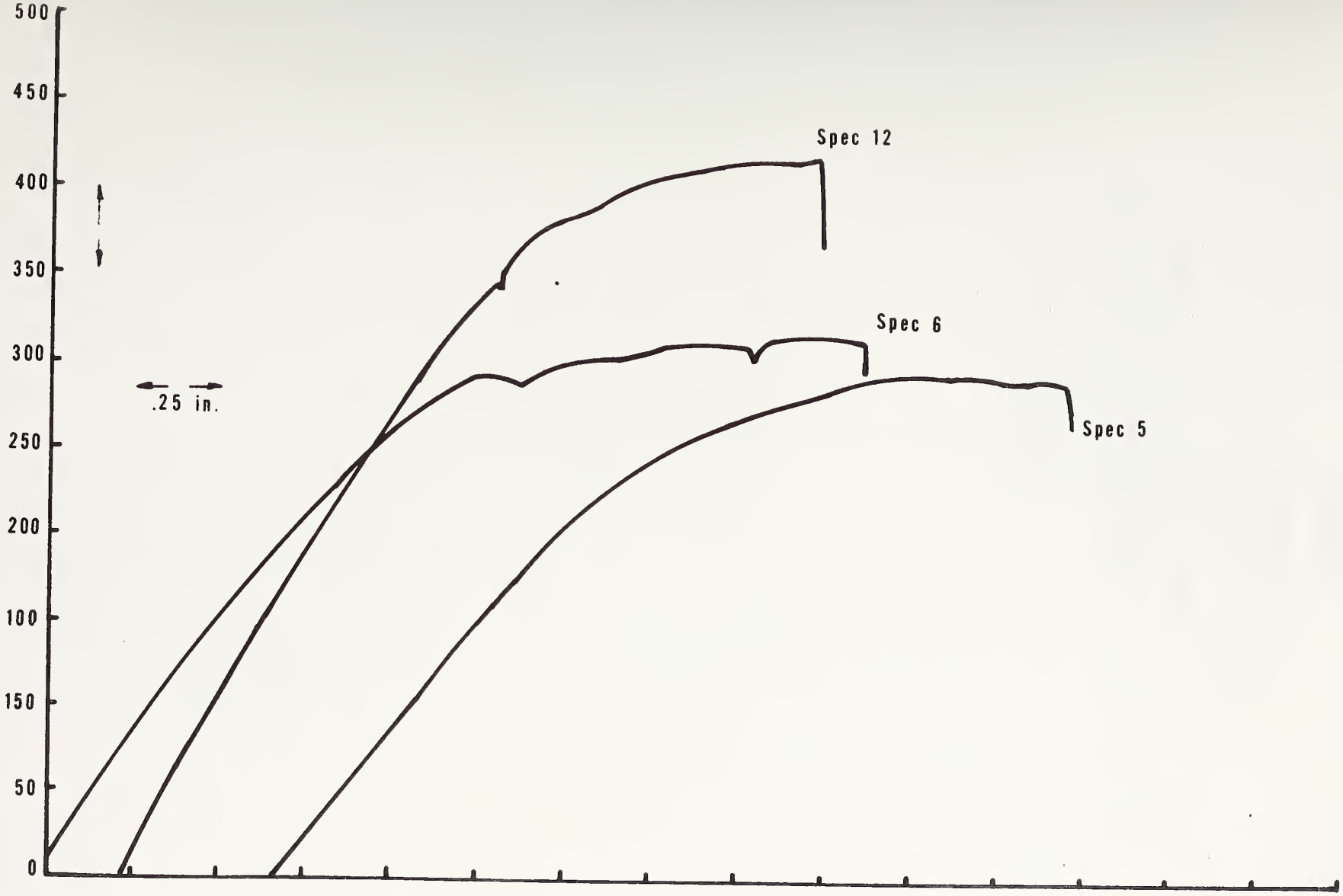


Figure 17 - Typical Frame Test Load-Deflection Recordings

Appendix A

Test Fixtures for Structural Tests on Bicycles

Detailed drawings for the fixtures used for the tests described in this report are given in Figures A-1 to A-18.

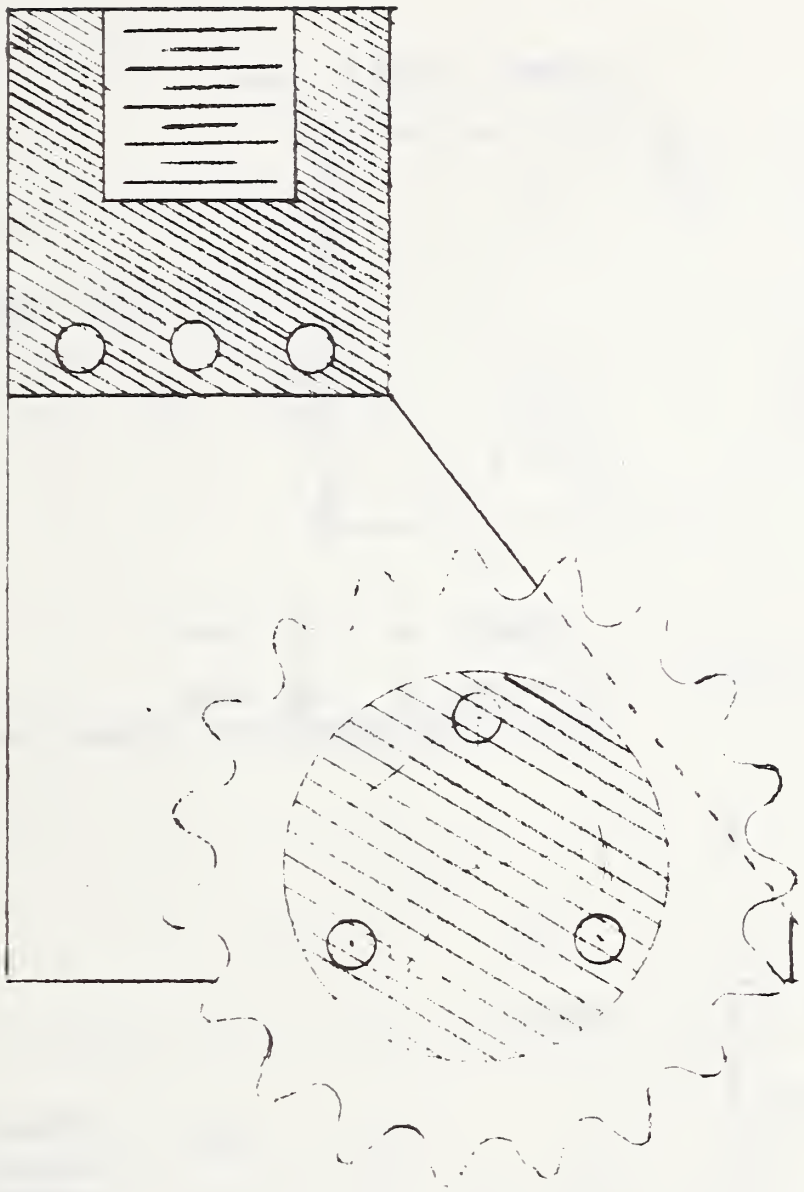
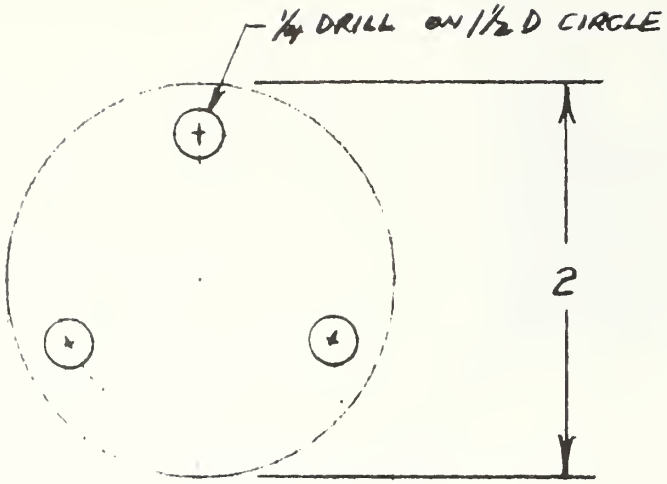


FIGURE A-1
CHAIN TEST JIG
2130442
ASSEMBLY
2 REQUIRED



SPACER A ½ LONG

SPACER B ⅞ LONG

WELD TO SPROCKET BEFORE DRILLING

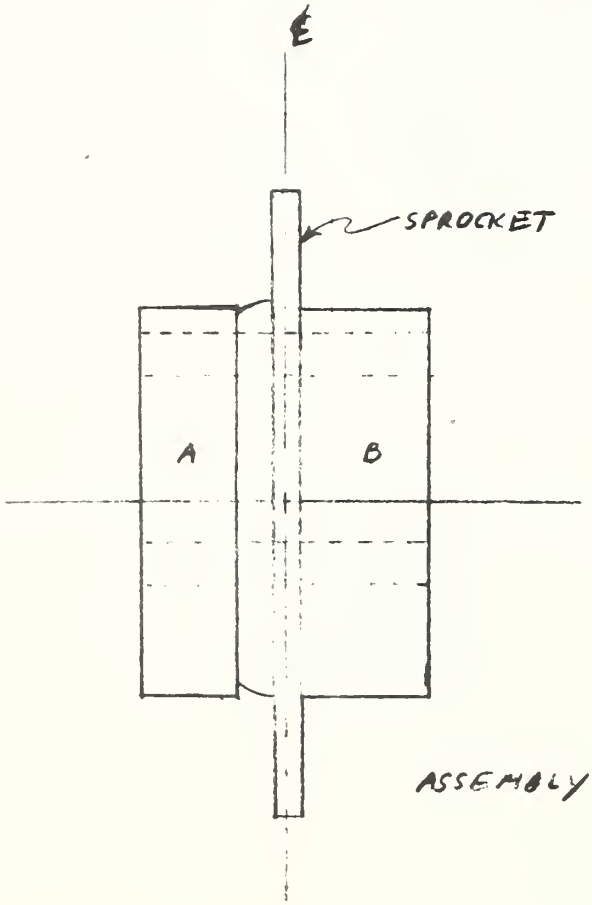


FIGURE A-2
CHAIN TEST
SPROCKET SPACER
2 REQ'D
MAT'L STEEL

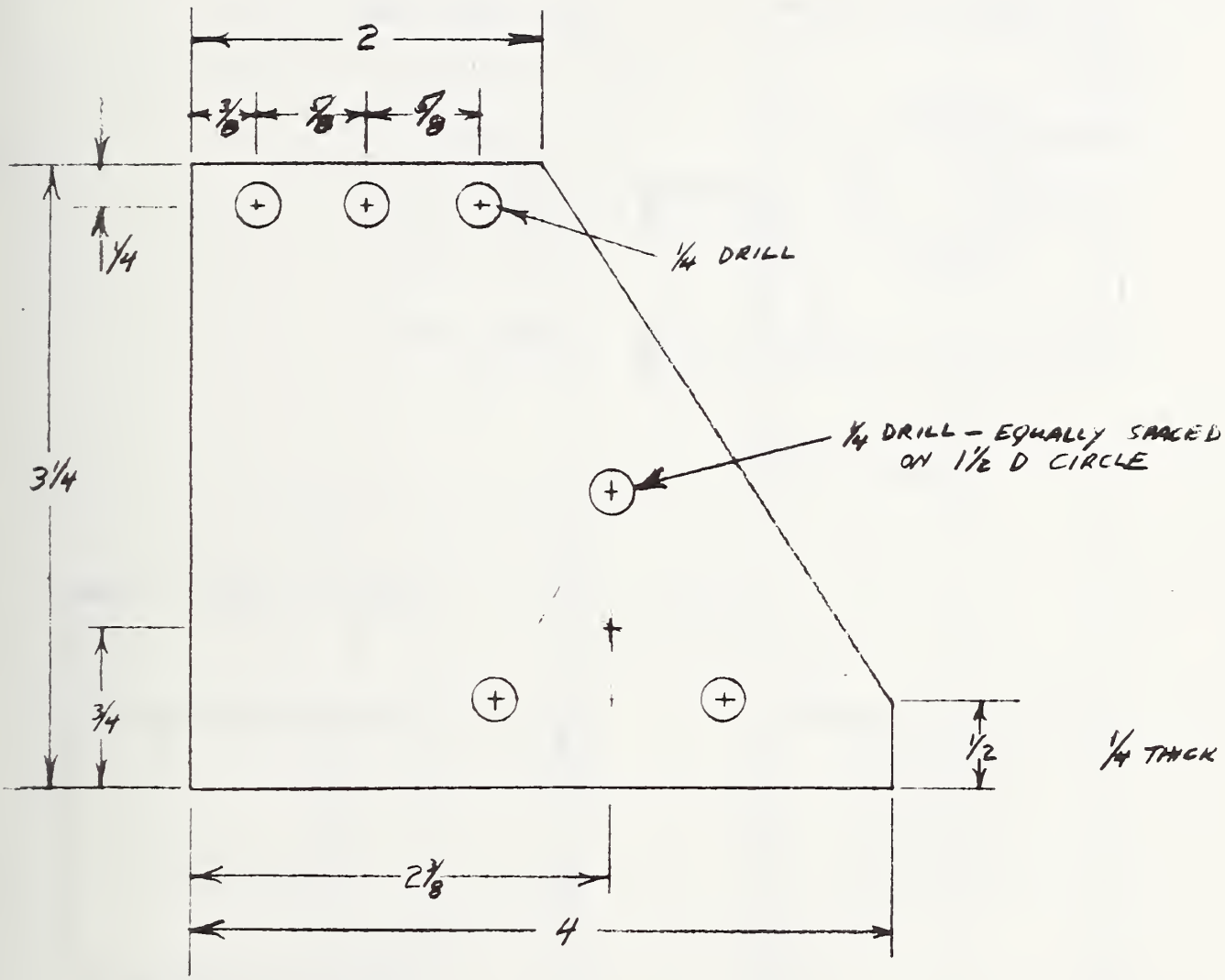
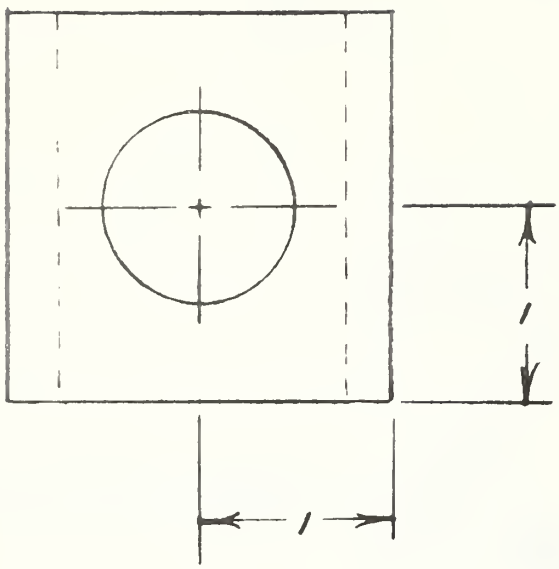


FIGURE A-3
CHAIN TEST
PIECE 2
MAT'L ALUM

FIGURE A-4
CHAIN TEST
PIECE 1
MAT'L ALUM



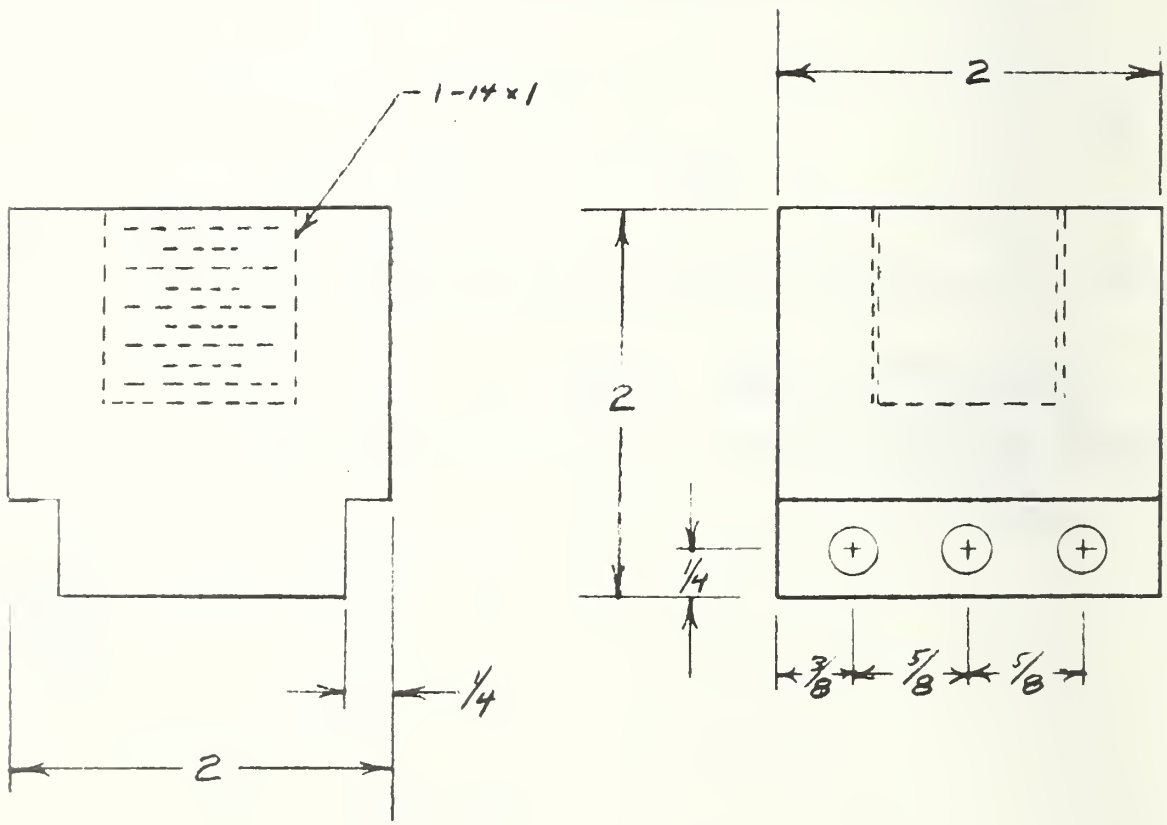


FIGURE A-5
HANDLEBAR TEST
PIECE 1
MAT'L: ALUM

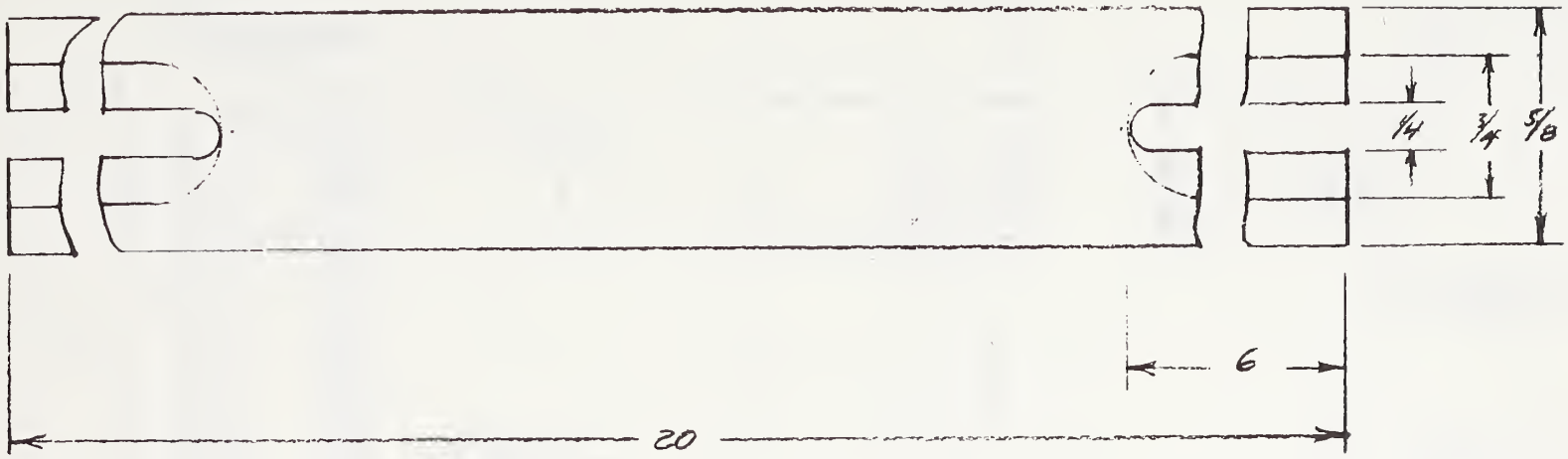
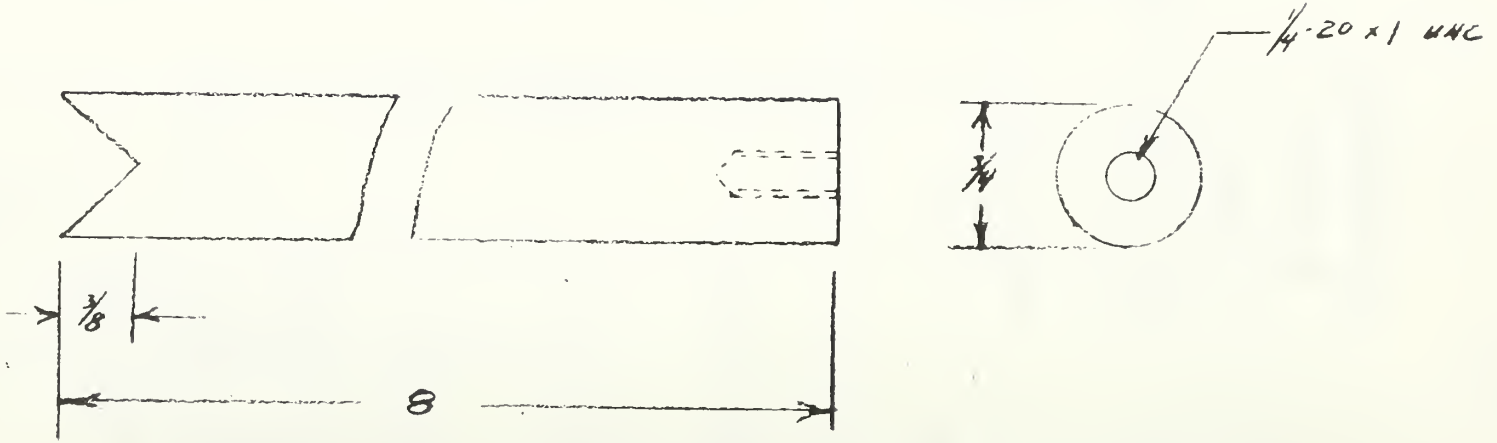
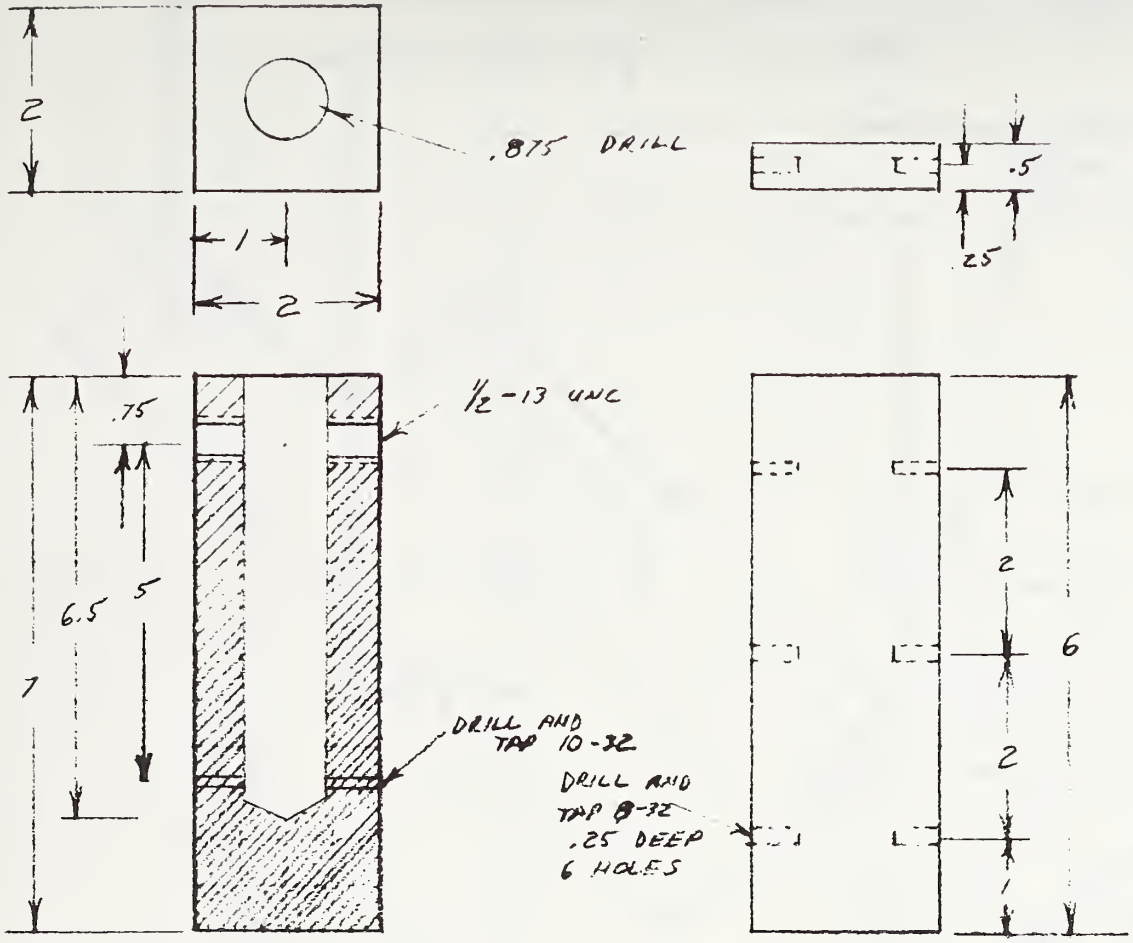


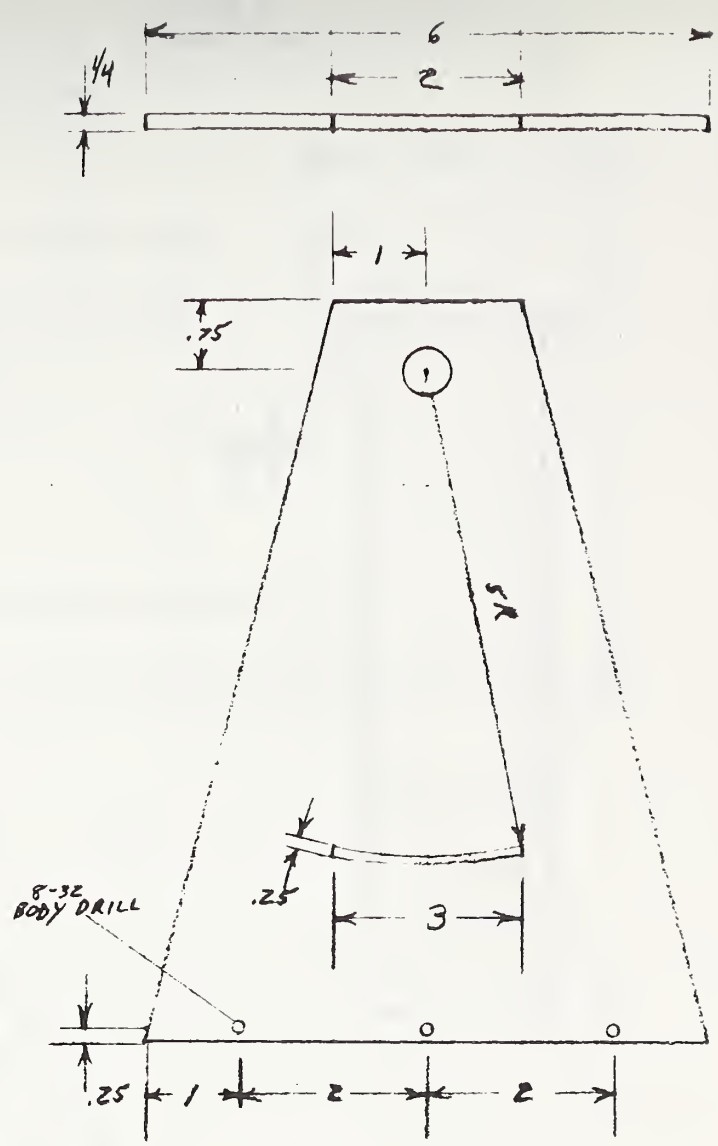
FIGURE A-6
HANDLE BAR TEST
MAT'L AL OR PLASTIC
2 REQ'D
PIECE 2





PIECE 3
MAT'L ALUM
1 REQ'D

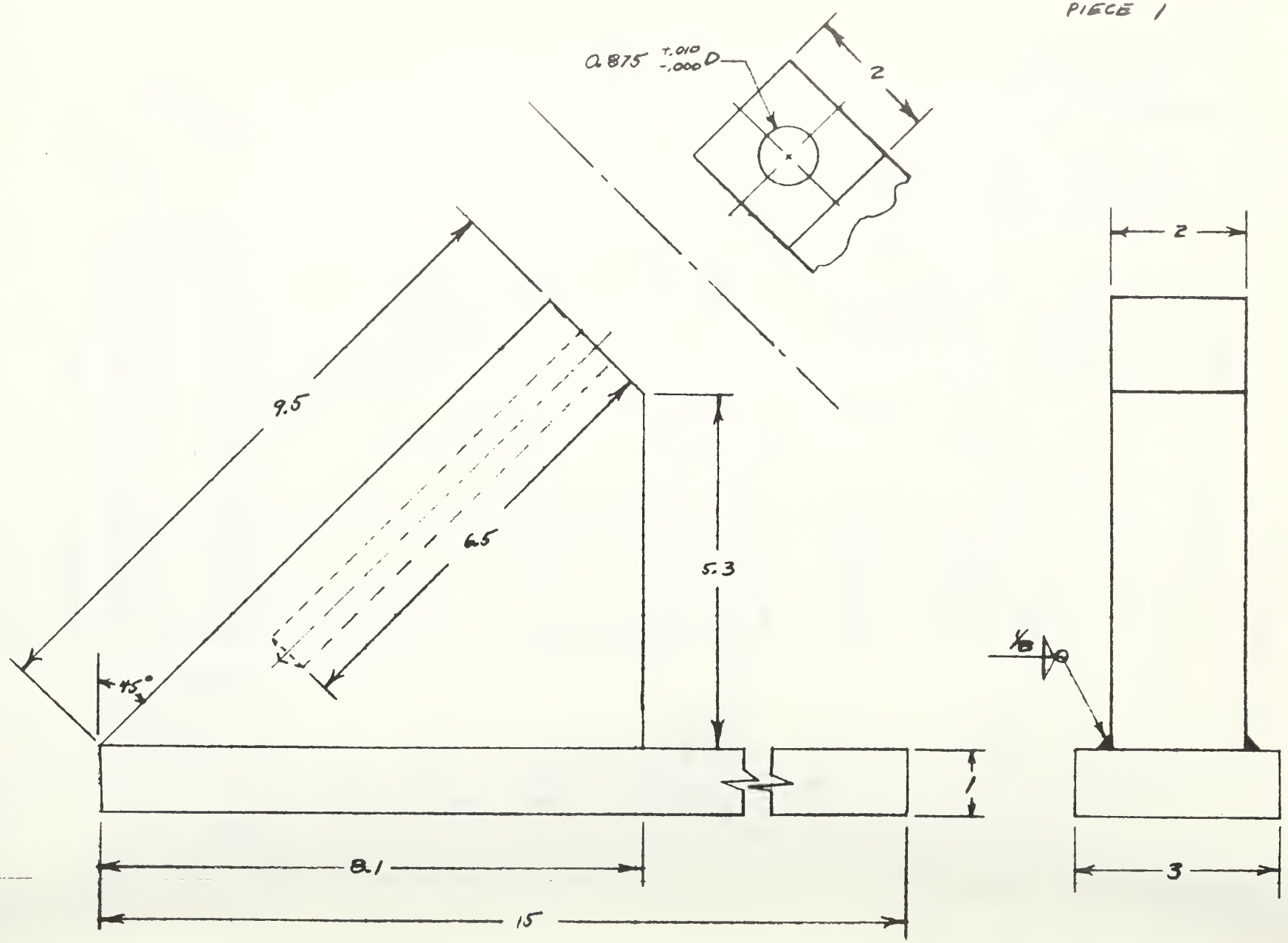
PIECE 4
MAT'L ALUMINUM
1 REQ'D

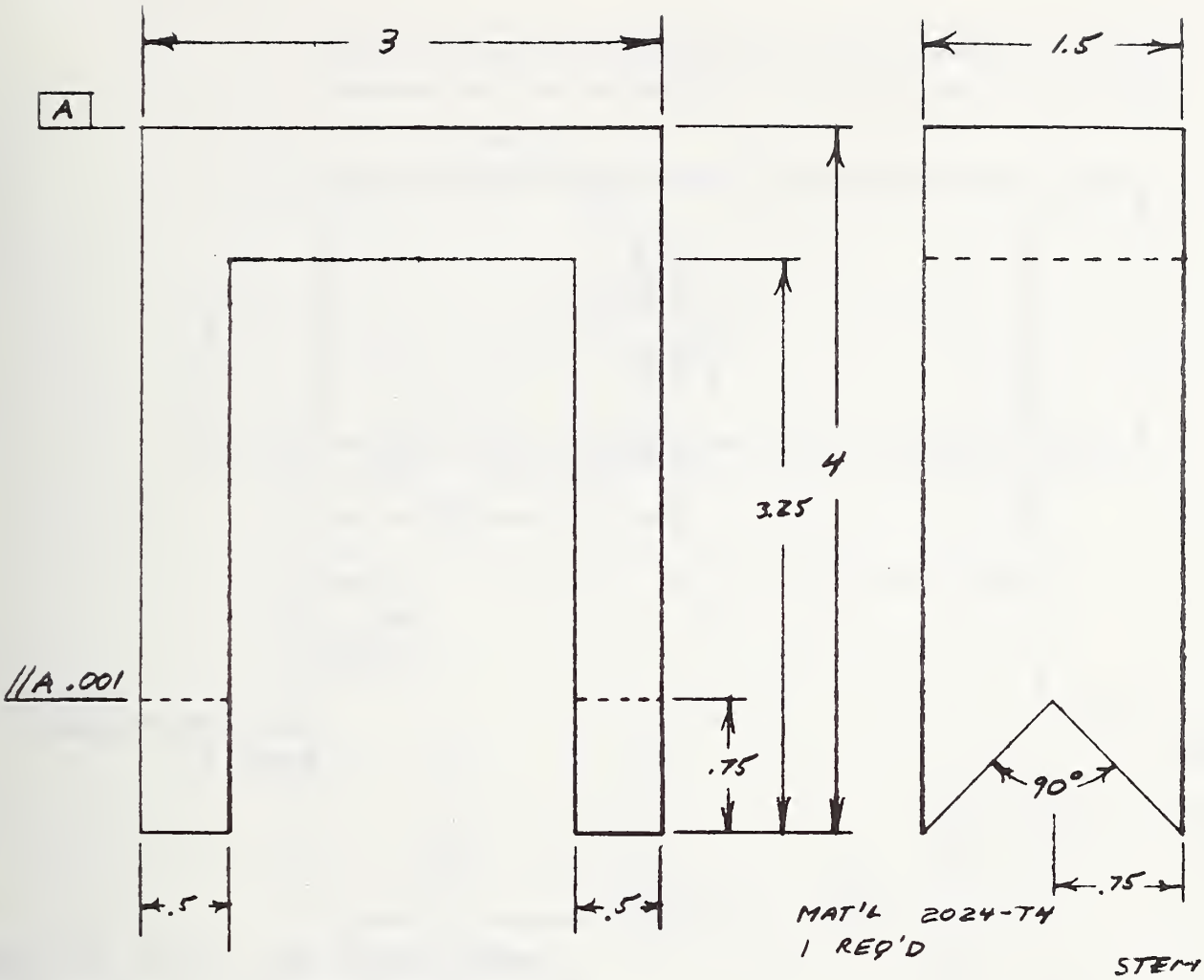


MAT'L ALUMINUM
2 REQ'D
PIECE 5

FIGURE A-7
HANDLE BAR TEST

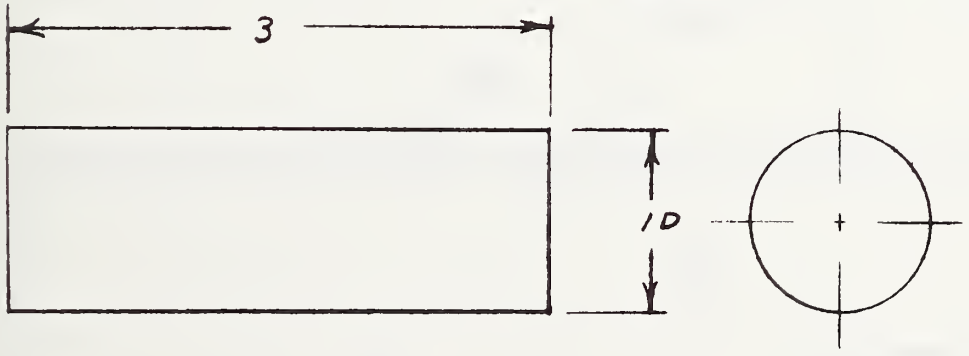
FIGURE A-8
STEM TEST JIG
PIECE 1





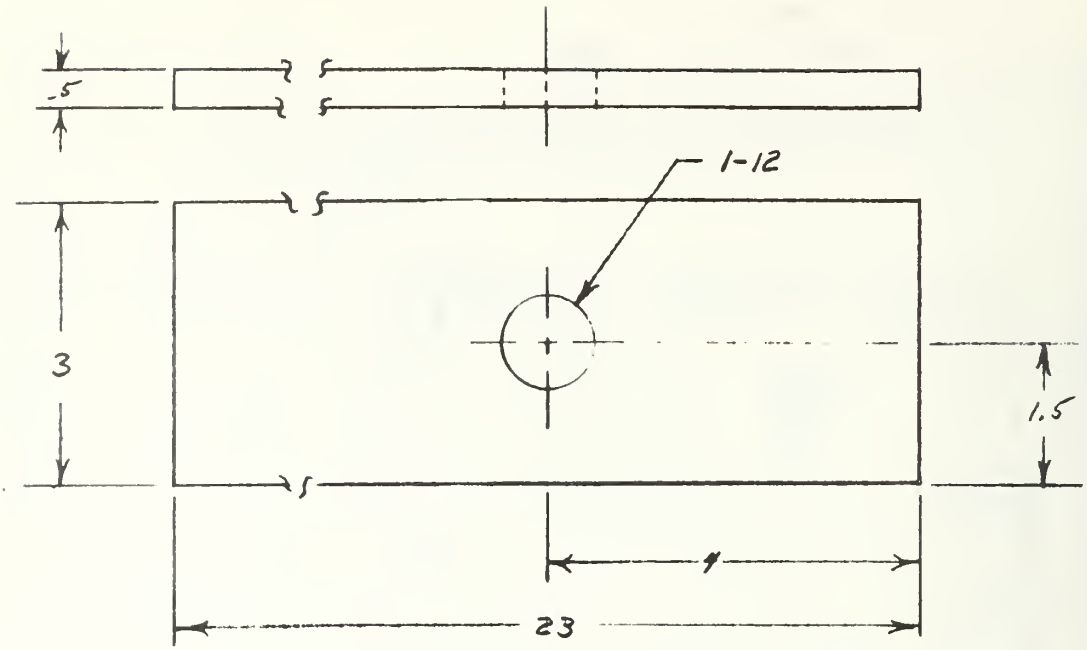
MAT'L 2024-T4
1 REQ'D

STEM TEST JIG
PIECE 2.



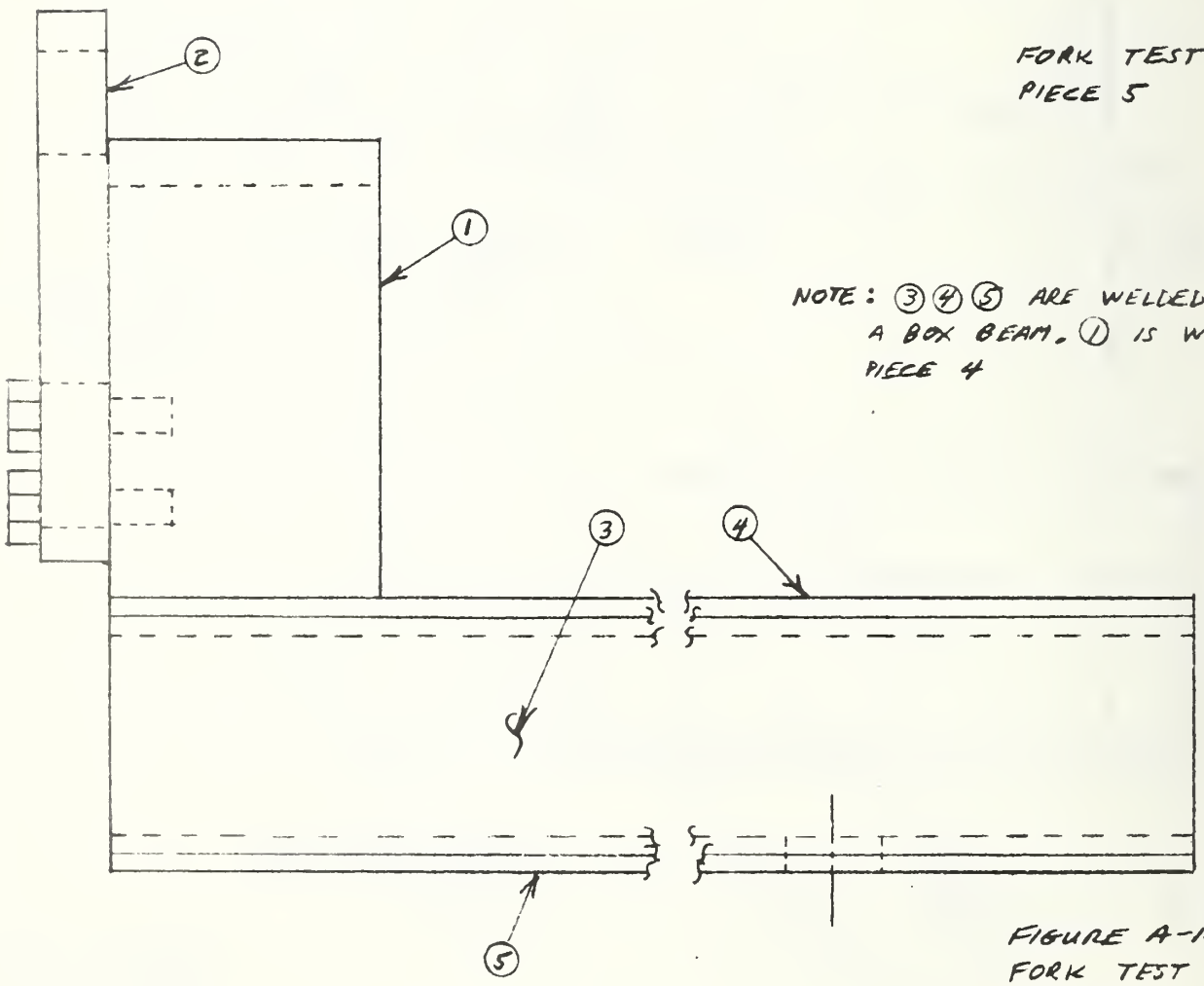
MAT'L DRILL ROD
1 REQ'D

FIGURE A-9
STEM TEST JIG
PIECE 3



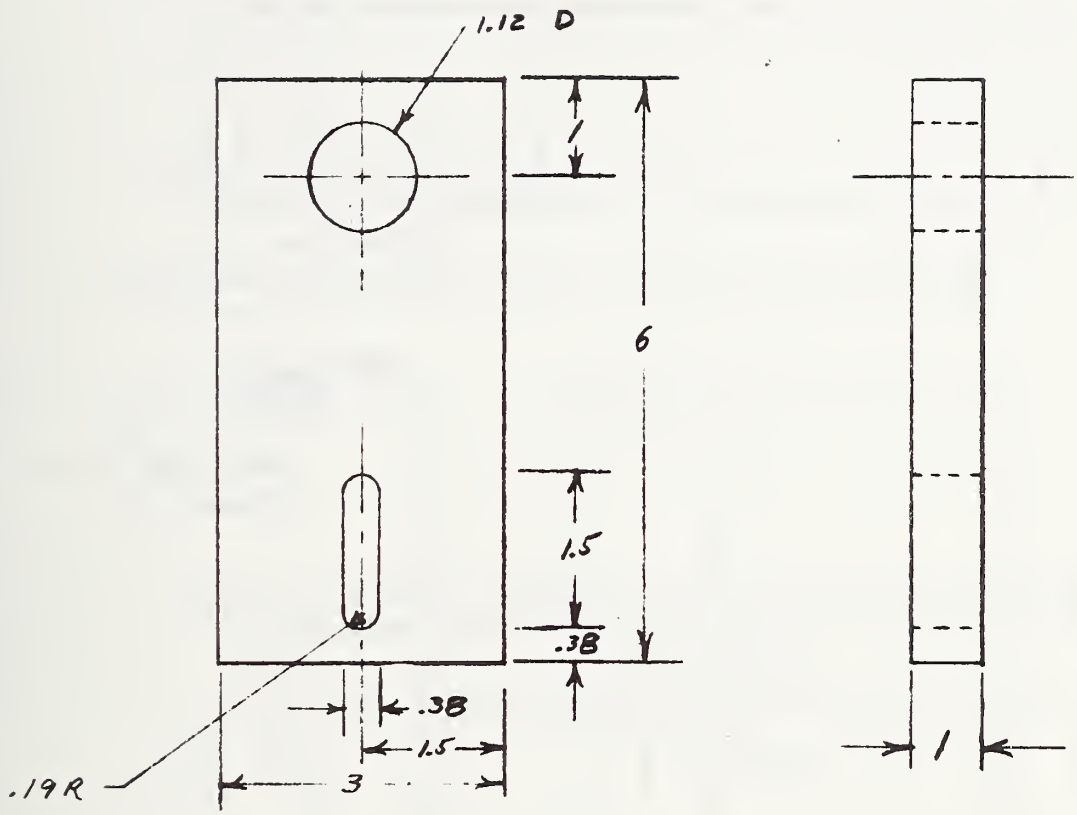
MAT'L CRS
1 REQ'D

FORK TEST JIG
PIECE 5



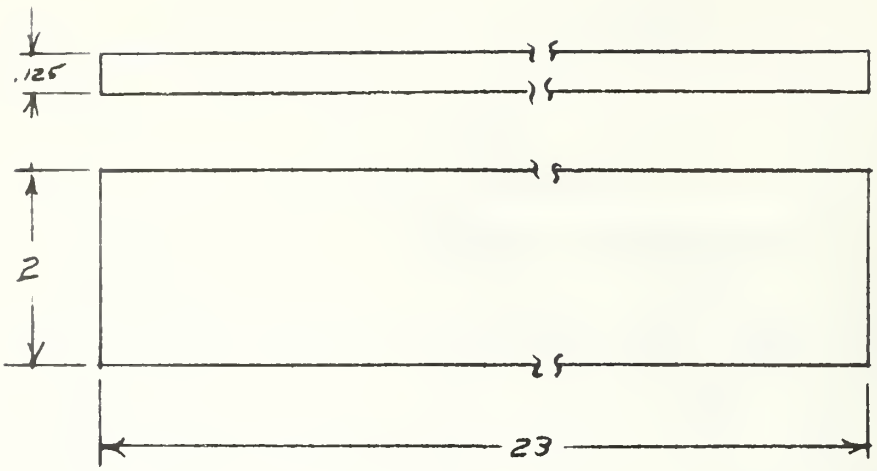
NOTE: ③④⑤ ARE WELDED TO FORM A BOX BEAM. ① IS WELDED TO PIECE 4

FIGURE A-10
FORK TEST JIG
ASSEMBLY



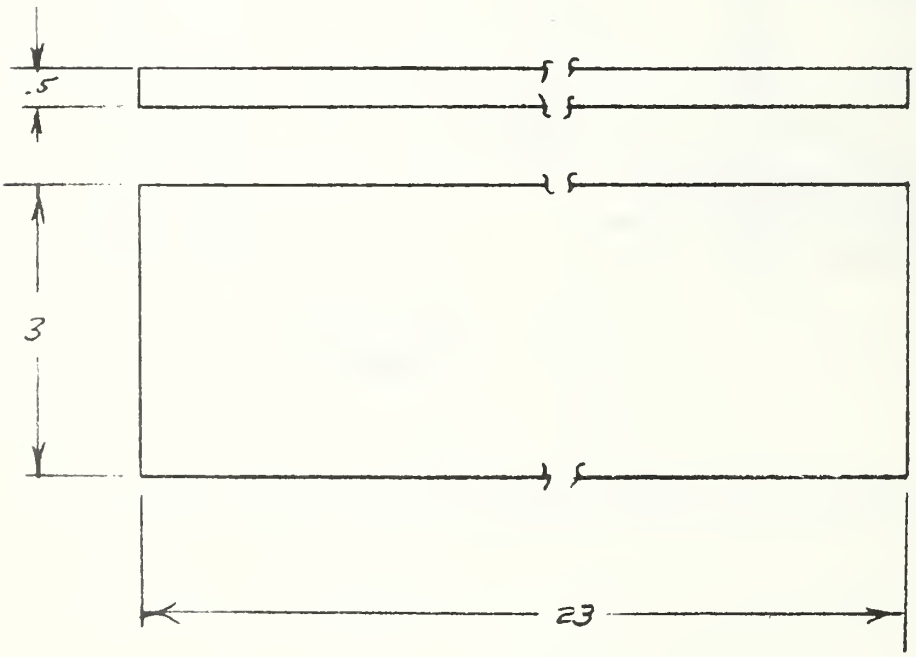
MAT'L CRS
1 REQ'D

FIGURE A-11
FORK TEST JIG
PIECE 2



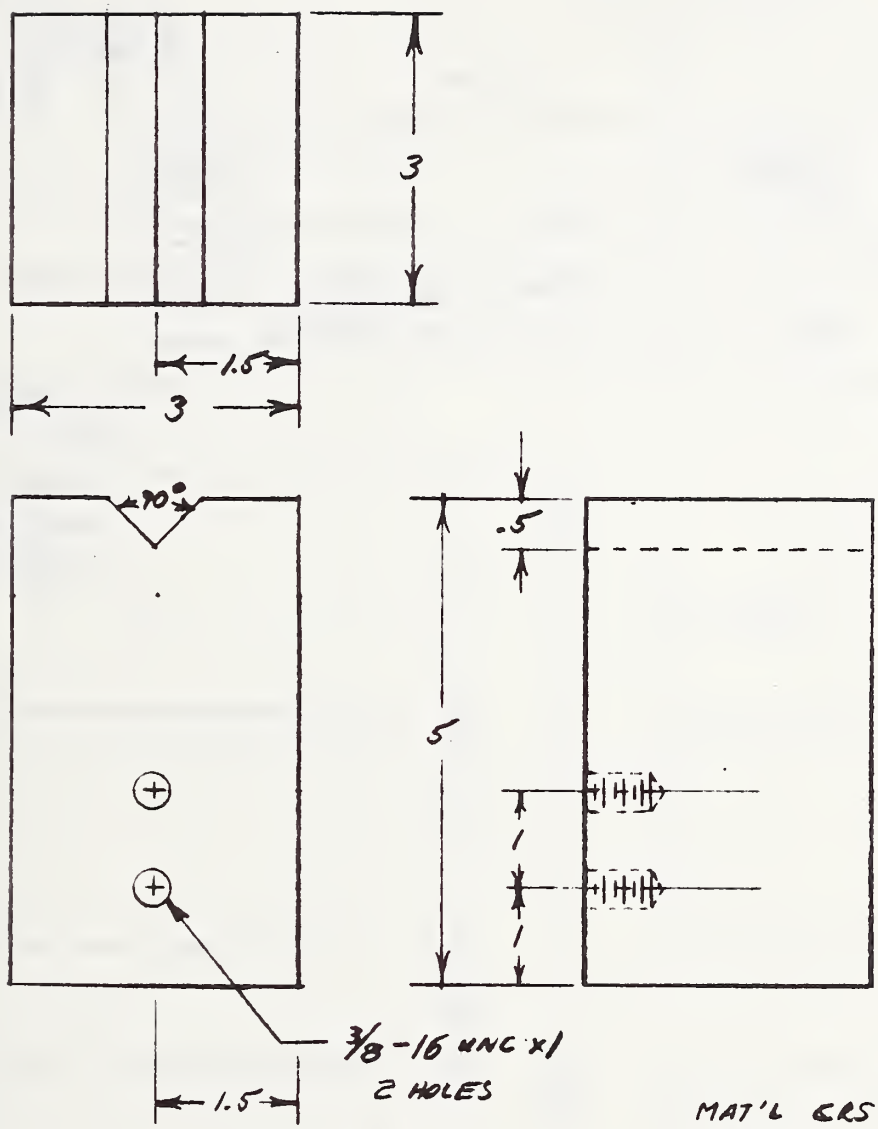
MAT'L CRS
2 REQ'D

FORK TEST JIG
PIECE 3



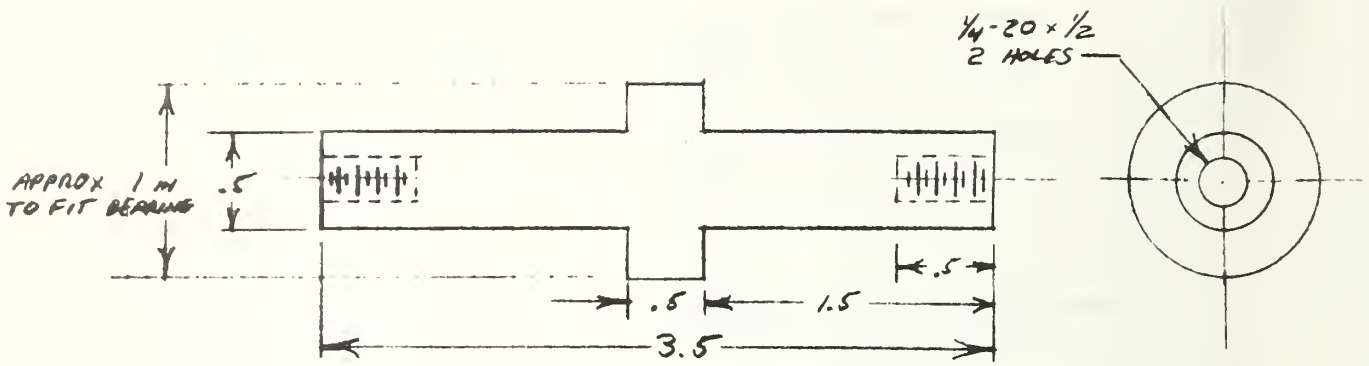
MAT'L CRS
1 REQ'D

FIGURE A-12
FORK TEST JIG
PIECE 4



MAT'L CRS
1 REQ'D

FIGURE A-13
FORK TEST JIG
PIECE 1



MAT'L DRILL ROD
1 REQ'D

FIGURE A-14
FORK TEST JIG
PIECE 6

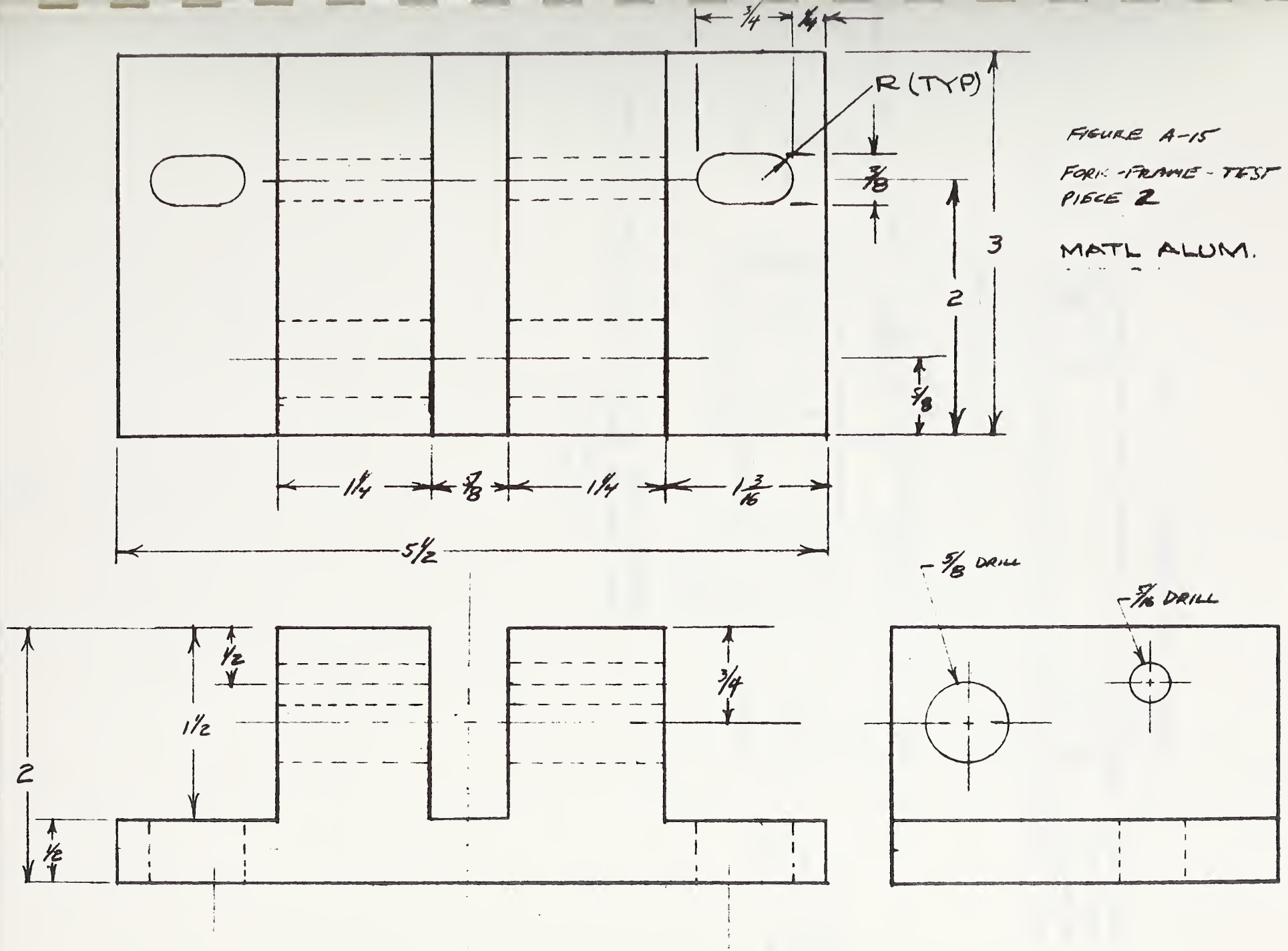


FIGURE A-15

FORM - FRAME - TEST PIECE 2

MATL ALUM.

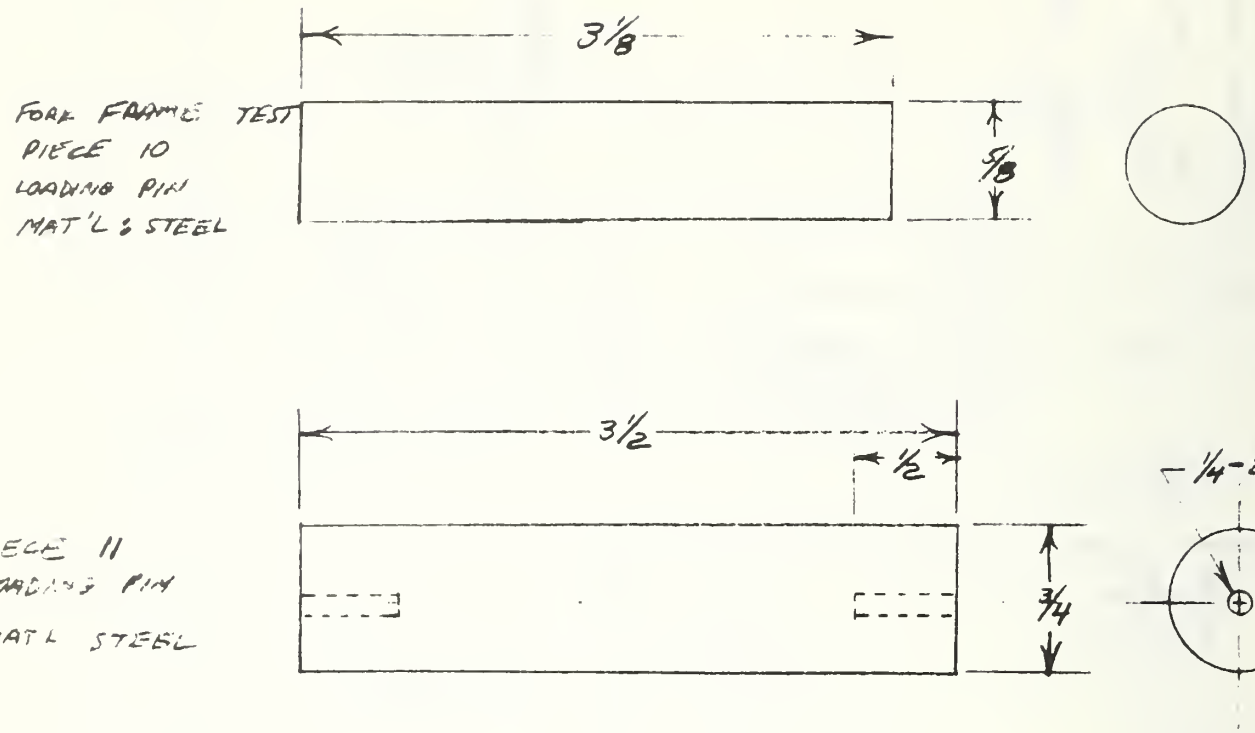
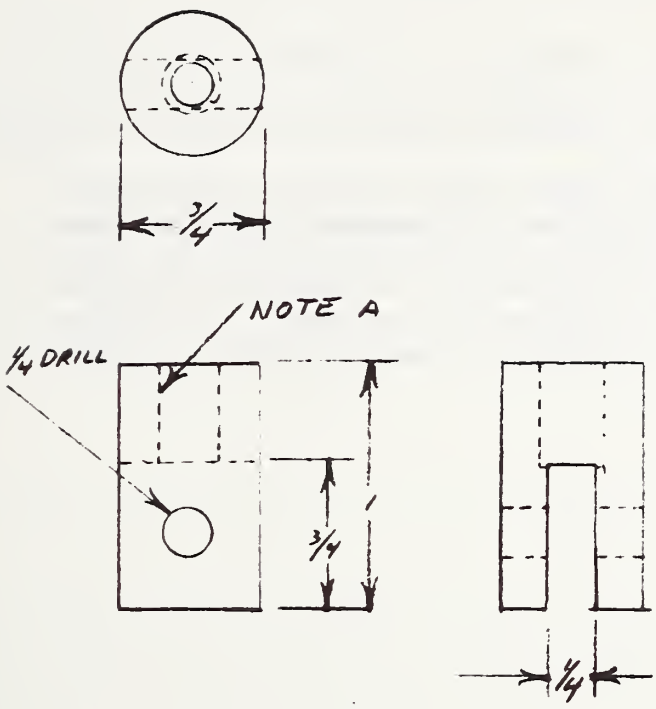


FIGURE A-16
FORK-FRAME TEST

FIGURE A-17
CLEVIS
RIM TEST
2130442
MAT'L ALUMINUM
3 REQ'D



NOTE A: THREAD SIZES 1) 5/16-24
2) M8×1.25
3) M10×1.5

Appendix B

Test Fixtures for Structural Tests on Bicycles

The operation manuals for equipment purchased to conduct the structural tests on bicycles include:

Dynamod Power Products Corp. (Power Supply)
American Design Components (Load Cell)
NBS Load Cell Calibrations - Ormond Cell No. 1196
Houston Instrument Co., Series 2000 XY Recorder
Research Inc. Displacement Transducer, Model 7101-4
Enerpac, Hydraulic Pump, Model PER 1541

NBS-114A (REV. 7-73)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBSIR 75-913	2. Gov't Accession No.	3. Recipient's Accession No.

4. TITLE AND SUBTITLE

Structural Test Procedures for Bicycles

5. Publication Date: October 1975

6. Performing Organization Code

7. AUTHOR(S): D. E. Marlowe

8. Performing Organ. Report No. NBSIR 75-913

9. PERFORMING ORGANIZATION NAME AND ADDRESS

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Complete Address *(Street, City, State, ZIP)*

Same as No. 9

13. Type of Report & Period Covered: Final

14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

Tests for several structural performance criteria have been included in a mandatory regulation on bicycle safety which has been proposed by Consumer Product Safety Commission. The apparatus and procedures developed to conduct these tests and results from 15 representative bicycles are described. Several of the bicycles tested failed to meet the requirements for the seat and handlebar stem friction clamp strength.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Bicycle; consumer safety; regulations; safety; structural testing.

18. AVAILABILITY

[XX] Unlimited

[ ] For Official Distribution. Do Not Release to NTIS

[ ] Order From Sup. of Doc., U.S. Government Printing Office Washington, D.C. 20402, SD Cat. No. C13

[X] Order From National Technical Information Service (NTIS) Springfield, Virginia 22151

19. SECURITY CLASS (THIS REPORT)	21. NO. OF PAGES
UNCLASSIFIED	47
20. SECURITY CLASS (THIS PAGE)	22. Price
UNCLASSIFIED	$ 4.00

USCOMM-DC 29042-P74


AMERICAN REVOLUTION BICENTENNIAL
1776-1976