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SAE INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

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Superseding J782 AUG76

(R) MOTOR VEHICLE SEATING MANUAL

Foreword—This Document has also changed to comply with the new SAE Technical Standards Board format.

1. Scope

2. References

2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the lastest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J826b JAN74—Devices for Use in Defining and Measuring Vehicle Seating Accommodation
SAE J879b JUL68—Motor Vehicle Seating Systems
SAE J1010 FEB73—Emission Control Hose

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D2406
ASTM D1692 MVSS 302
ASTM D1229—Test Method for Rubber Property—Compression Set at Low Temperatures

3. Motor Vehicle Seats

3.1 Front Seats—The motor vehicle seat is a structure engineered to seat the driver and passengers comfortably for short, as well as extended, periods of time with a minimum of fatigue. It must position the occupants at their proper locations to assure the desired:

a. Proximity of driver to steering wheel, brake pedal, accelerator pedal, and instrument panel controls
b. Head and leg room
c. Field of vision

In addition, modern automotive seating requires an appealing appearance as well as versatility such as folding for entrance or egress. Today's seating may encompass such things as reclining seat backs, swivel seats, arm rests, lumbar supports, and head restraints of add-on or built-in variety. Some of the typical front seats available today are shown in Figure 1 (A-G).

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3.2 Rear Seats—The rear seats may take many different shapes; the most basic seats are the four-door, two-door, and station wagon second and third seats.

In general, four-door and two-door seats are supported by the floor pan and are not adjustable. Seats may be side facing, front facing, or rear facing. Most station wagon seats fold to give a level loading area. A number of typical rear seats are shown in Figure 2 (A-C).

4. Seat Adjusters

4.1 Definition—A seat adjuster is a device which, when suitably anchored to the vehicle structure, supports the seat frame assembly and provides adjustments by manual or power actuating assemblies.

4.2 Purpose—The purpose of a seat adjuster is to enable the driver to readily adjust the seat position to suit his individual requirements.

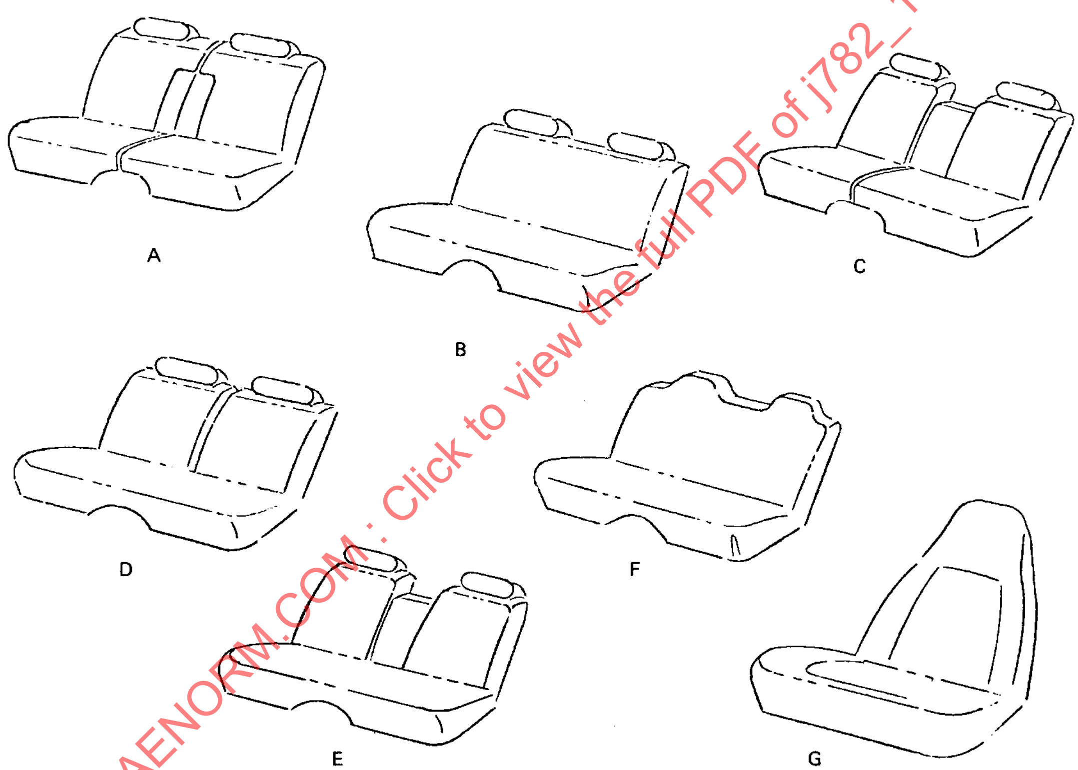

FIGURE 1—TYPICAL FRONT SEATS (A) 50/50 BENCH WITH ARM RESTS (B) FOUR-DOOR BENCH (C) 60/40 BENCH WITH A CENTER ARM REST (D) TWO-DOOR BENCH (E) TWO-DOOR OR FOUR-DOOR BENCH WITH CENTER ARM REST (F) FOUR-DOOR BENCH WITH INTEGRAL HEAD RESTRAINT (G) BUCKET SEAT WITH INTEGRAL HEAD RESTRAINT

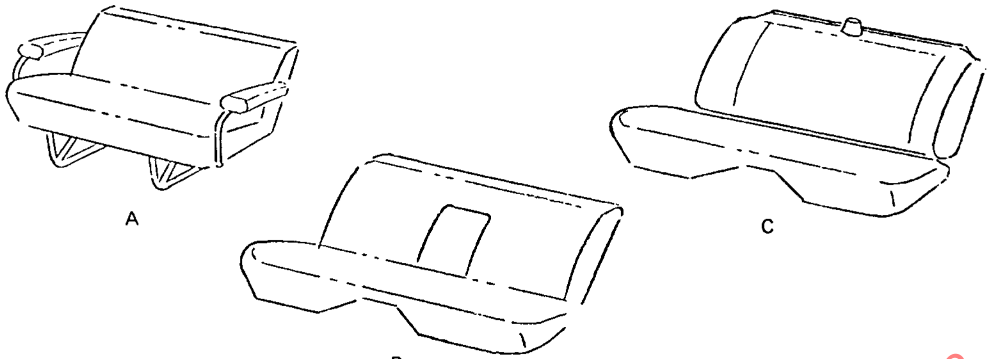

FIGURE 2—TYPICAL REAR SEATS (A) VAN TYPE PASSENGER SEAT (B) TYPICAL PASSENGER CAR REAR SEAT (C) FOLDING BACK SEAT FOR SUBURBANS AND SPECIAL SPACE PACKAGE VEHICLES

4.3 Design Requirements

4.3.1 The usual adjustment range fore and aft is between 3 1/2 (90 mm) and 6 in (152 mm), in increments of about 1/2 (13 mm)—5/8 in (16 mm), or an infinite number of positions as in the case of the power-operated adjuster.

4.3.2 The usual range of maximum vertical adjustments is between 1 1/4 (30 mm) and 2 1/2 in (65 mm), in increments of about 1/4 in (6 mm) or an infinite number of positions as in the case of the power-operated adjuster.

4.3.3 The usual range of angular adjustment is between 5 deg = (0.087 rad) and 10 deg = (0.174 rad) from the horizontal plane, in increments of about 1/2 deg = (0.009 rad) or an infinite number of positions as in the case of the power-operated adjuster.

4.3.4 The adjuster should provide a safe locking device which should not fail under normal operation. Impact loadings should also be considered.

4.3.5 It should operate with minimum effort.

4.4 Typical Types of Adjusters

4.4.1 A two-way straight adjuster, providing level fore-and-aft movement of the seat (Figure 3).

4.4.2 A two-way inclined straight adjuster combining the elevation with forward movement of the seat (Figure 4).

4.4.3 A two-way curved adjuster combining forward tilt and elevation with forward movement of the seat (Figure 5 and 6).

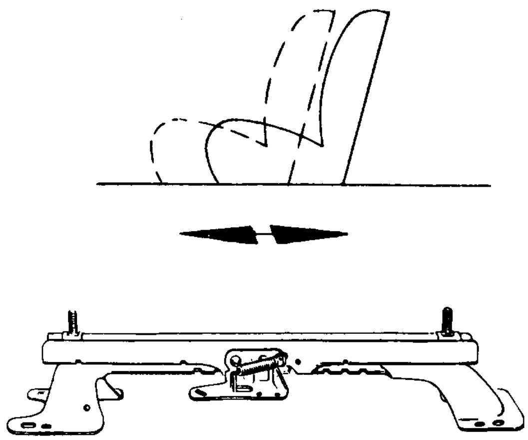

FIGURE 3—TWO-WAY STRAIGHT ADJUSTER

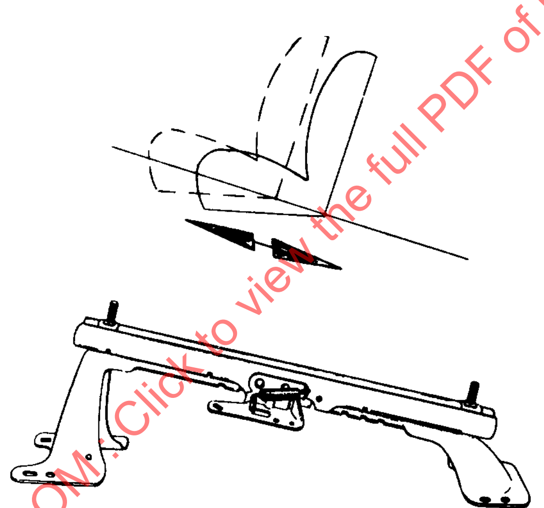

FIGURE 4—TWO-WAY INCLINED STRAIGHT ADJUSTER

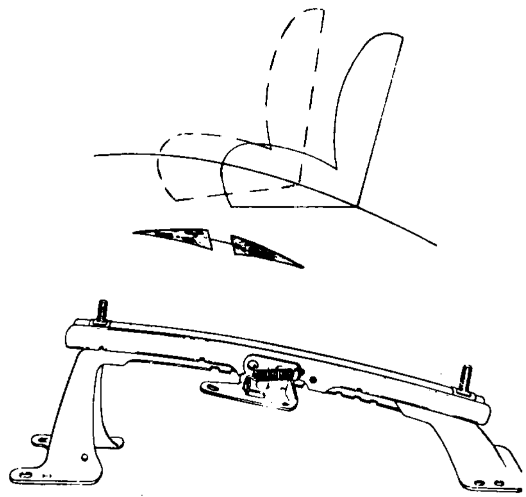

FIGURE 5—TWO-WAY CURVED ADJUSTER

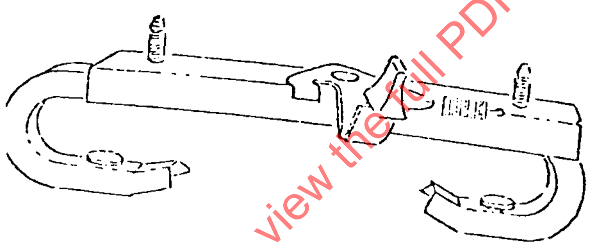

FIGURE 6—TWO-WAY CURVED ADJUSTER

4.4.4 A four-way elevating adjuster consisting of a mechanism for independently raising the seat in addition to the fore-and-aft movement of the basic type adjusters. (See Figures 3 - 5.) The vertical elevation is sometimes combined with a movement tilting the seat forward as it is raised (Figure 6).

4.4.5 A multipositioning adjuster provides the seat with angular tilting and elevating as well as any combination of these and the normal fore-and-aft movements (Figure 7).

The coordination of the movements between the right-hand and the left-hand seat adjusters may be accomplished by torque bars, cables, seat frame, or some other mechanical interlocking device so that whatever motion is imparted to one side of the seat is transmitted to the opposite side.

4.5 Methods of Test

4.5.1 GENERAL REQUIREMENTS

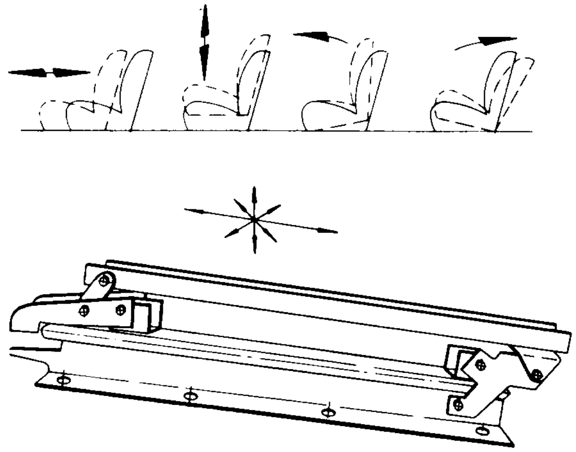

FIGURE 7—SIX-WAY ADJUSTER

4.5.1.1 *Manual Seat Adjusters*—The seat adjuster mechanism must be capable of giving trouble-free operation throughout the design range of travel. The locking mechanism should operate with the application of no more than 15 lb (67 N) horizontally and 25 lb (111 N) vertically to release. Adequate structural strength must be provided to sustain vertical and lateral loading. Ease of operation is essential and forces required to operate the seat should not exceed 80 lb (356 N) in the rearward direction and 45 lb (200 N) in the forward direction.

4.5.1.2 *Power Seat Adjusters*—Power seat adjusters, in addition to the requirements in Section 4.3, should be capable of traveling in the fore-and-aft direction at the rate of 0.4 in (10 mm)/s—1.5 in (40 mm)/s with a load of 600 lb (2669 N) (bench seat) and 325 lb (1446 N) (bucket seat) while capable of raising 700 lb (3114 N) (bench) and 350 lb (1557 N) (bucket) through one cycle without impairment.

4.5.2 OPERATION TEST

4.5.2.1 *Manual Seat Adjusters*—For this test, the seat adjuster is mounted in car position with a seat frame or equivalent structure and loaded to 156 lb (71 kg) per passenger, properly distributed, in addition to the normal weight of the seat. A mechanism to cycle the seat adjuster between the extremes of its travel must be provided. The locking mechanism may be activated if desired. The seat is operated 5000—10 000 cycles with periodic inspection for wear during the cycling test. The periodic inspection normally consists of an examination of the wearing surfaces and measurements of the force required to move the adjusters and the locking mechanism control. A suggested procedure for conducting this test is shown in Figure 8.

4.5.2.2 *Power Seat Adjusters*—Power seat adjusters are normally set up and loaded in a manner similar to the manual seat adjusters and operated through the extremes of travel on a cyclic basis, such as forward, up, rearward, and down for 5000—10 000 cycles. Time delays are ordinarily required between each change of direction of motion in the cycle to prevent the overheating of the drive mechanism. Periodically during this test, the adjuster is examined for wear and operating characteristics, such as the time of cycling, power requirements, etc. Measurement of power is ordinarily a good indication of the wear characteristics in testing a power seat adjuster.

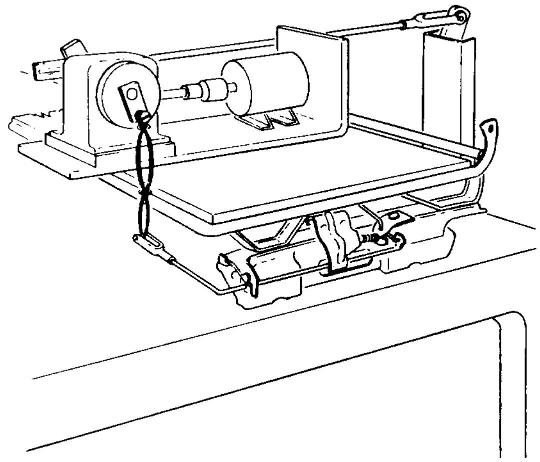

FIGURE 8—OPERATION TEST OF SEAT ADJUSTER

4.5.3 STATIC TEST

4.5.3.1 *Manual and Power Seat Adjuster*—Static tests on seat adjusters are normally of the proof load type. Adjusters are not required to be operable after proof loading, but must have no separation of mating parts, per SAE J879b (July, 1968). These tests require that the seat adjuster withstand the test loading in any adjustable position. Typical seat adjuster tests are:

a. Vertical Loading—A vertical load of 500 lb (2224 N) per passenger is applied to seat frame. Indicators installed to determine the relative movement of the seat adjuster to the base under this load application. See Figure 9.
b. Occupant (Rearward) and Inertia Loading—As outlined in SAE J879b. See Figure 9.
c. Lateral Loading—A lateral load of 100 lb (445 N) is applied midway between the seat frame attachments, and corresponding measurements are taken at the seat frame attachment relative to the base. The load is applied first to the left and then to the right, giving the total displacement on the indicators. Typical setup is shown in Figure 10. This test is conducted with no vertical load on the seat frame.
d. Fore-and-Aft Chucking Load—A load of 100 lb (445 N) is applied in both the fore-and-aft direction at the center of the seat frame, and measurements of the fore-and-aft movement of the seat adjuster slide are made relative to the base. Deflections for this loading should be a minimum to avoid noise and chuck problems. A typical setup for this test is shown in Figure 11.

4.5.4 OTHER MISCELLANEOUS TESTS—Other tests are conducted for specific studies on seat adjusters. However, these tests are not ordinarily performed in all instances. It is sometimes desirable to study the brinelling characteristics of the rollers or balls by subjecting the seat to a vibration test.

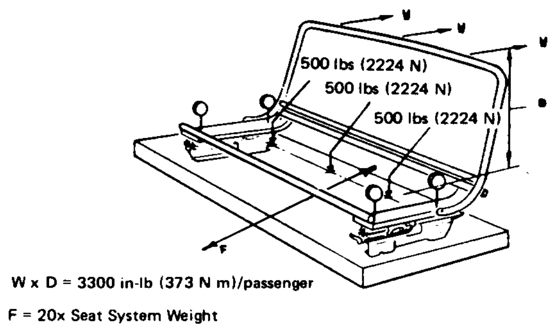

FIGURE 9—STATIC VERTICAL LOAD TEST OF SEAT ADJUSTER

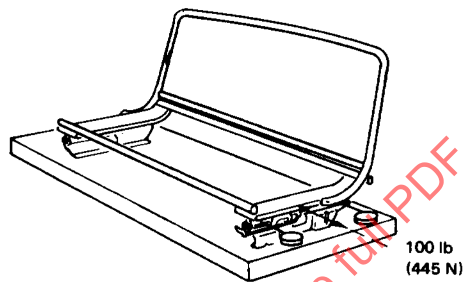

FIGURE 10—STATIC LATERAL LOAD TEST OF SEAT ADJUSTER

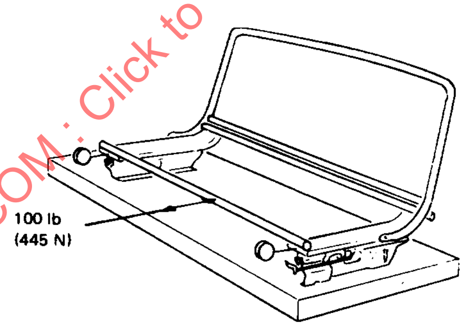

FIGURE 11—STATIC FORE AND AFT CHUCKING TEST OF SEAT ADJUSTER

5. Motor Vehicle Seat Frames

5.1 Definition—The term seat frame refers to the structural portion of a seat assembly. The seat frame may be constructed with springs attached to the structural frame or may support padding such as urethane foam, which can be applied or molded onto the frame.

5.2 Purpose—The purpose of the seat frame is to provide shape and support for the cushioning members and trim covers.

It provides an attachment to the vehicle structure and maintains the occupant in the proper seating attitude.

5.3 Structural Classification—The frames are generally classified structurally as follows:

a. Tubular
b. Stamped or rolled sections
c. Wire or sheet metal assemblies
d. Combinations of a, b, and c
e. Fiberboard
f. Reinforced plastics
g. Wood

5.4 Design Requirements

5.4.1 Structurally, the seat frame should be strong enough to withstand the design load requirements without excessive permanent set. The load requirements vary with the number of passengers and vehicle use.

5.4.2 The seat frame is constructed to provide a means of attaching trim, ornamentation accessories, and possibly occupant restraint systems.

5.4.3 Forward and rearward facing seats having folding seat backs must be provided with a latching mechanism that meets the requirements of SAE J879b (July, 1968).

5.5 Methods of Test—Seats are subjected to a variety of tests. Tests must be performed as outlined in SAE J879b (July, 1968).

In addition, other tests for fatigue strength of springs and frames, frame parallelogramming, cushion and back permanent set, and spring damping are sometimes performed for specific investigations.

5.6 Typical Types of Seat Frames

5.6.1 Front Seat Spring And Frame Assemblies

5.6.1.1 Two-door full width cushion spring assembly—folding split backs designed for full volume foam pads (Figure 12).

5.6.1.2 Four-door full width cushion—full width back. Both components are designed for full volume foam pads (Figure 13).

5.6.1.3 Individual cushion and back designed for full volume foam pads (Figure 14).

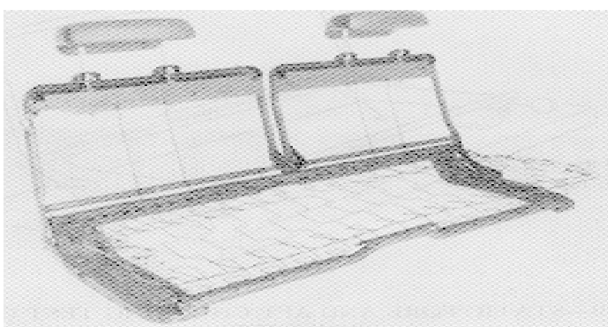

FIGURE 12—

FIGURE 13—

FIGURE 14—

5.6.1.4 Bucket type cushion and back designed for full volume foam pads with integral head restraints (Figure 15).

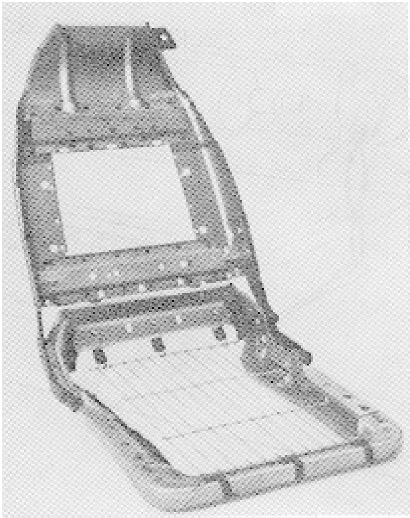

FIGURE 15—

5.6.1.5 Bucket type cushion and back. Back frame molded integral with foam pad (Figure 16).

FIGURE 16—

5.6.1.6 Truck bucket seat (Figure 17).

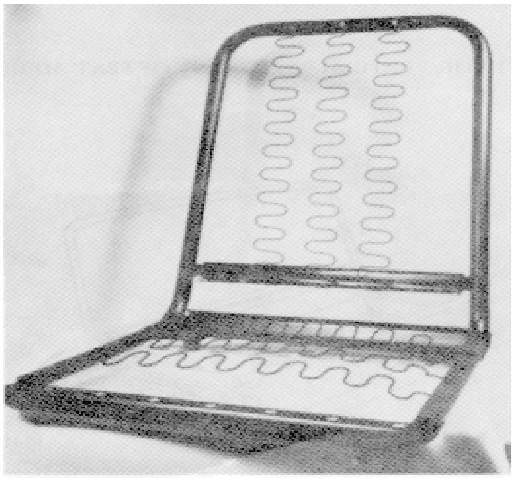

FIGURE 17—

5.6.2 Rear Seat Spring And Frame Assemblies

5.6.2.1 Full width cushion spring—full width back spring (Figure 18).

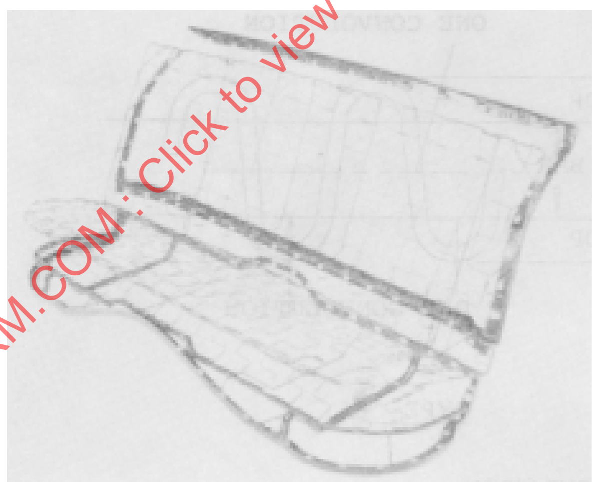

FIGURE 18—

5.6.2.2 Full width cushion frame—full width back fiberboard frame—both designed for full volume foam pads (Figure 19).

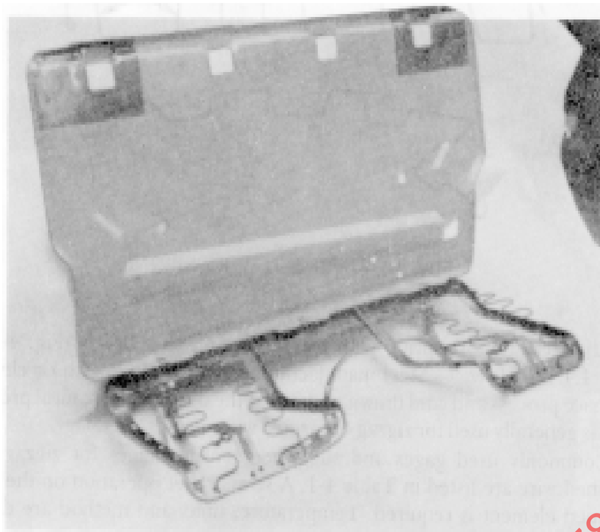

FIGURE 19—

5.6.2.3 Second seat cushion with folding cargo panel back frame (Figure 20).

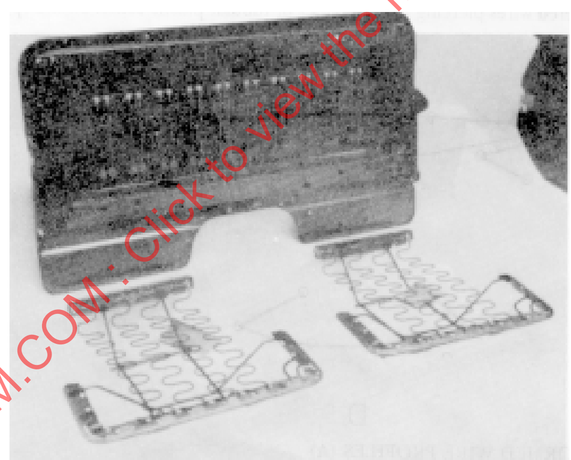

FIGURE 20—

5.6.2.4 Van type passenger bench seat spring assembly (Figure 21).

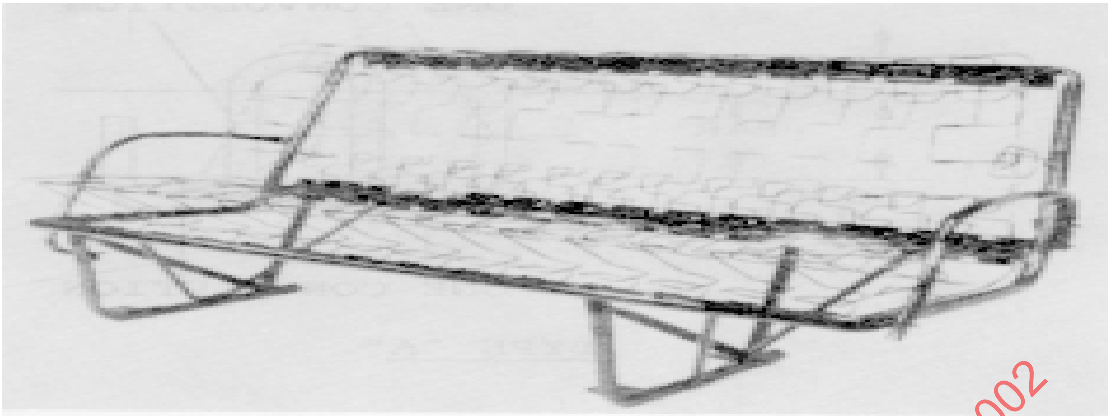

FIGURE 21—

6. Seat Spring Assemblies

6.1 Definition—A seat spring assembly is that part of a seat which distributes the load of the occupant to a seat frame or substructure mounted on or within a seat frame or other structural member.

6.2 Purpose—The purpose of the seat spring assembly is to absorb shock and vibration and support the occupant with a maximum of comfort and safety.

6.3 Design Requirements—Seat cushion and back spring assemblies are designed within the limitations of the body. This accounts for the many variations and combinations. The basic requirements of a good seat spring assembly are as follows:

a. It should support the occupant.
b. It should provide comfortable pressure distribution.
c. It should have acceptable service life and minimum set.
d. It should be noiseless.
e. It should have good dampening characteristics to absorb shock and vibrations.
f. The outside edges of the spring assembly should provide sufficient support to hold the occupant and maintain the trim contour.

6.4 Spring Element Types

6.4.1 ZIGZAG AND FORMED WIRE TYPE SPRING ELEMENTS

6.4.1.1 Definitions and Terms—The zigzag and formed wire spring element provides a load-supporting span by being formed (two-dimensionally) into a ribbon-like flat pattern which is anchored at or near each end. Spring action results from the twist of the torsion bars and the flexing of the radii joining them. Additional springing results from crowning the ribbon element, high near the middle. However, the most pronounced spring action is created when bends are placed in the surface near the front (and sometimes rear).

a. Zigzag Springs—The wire is formed into a pattern of constant width having parallel bars connected by constant radii which are alternating. Common terms to define sections of the spring are:

1. Convolution—The distance from any one point on the spring to the next corresponding or exact same point in the series of formations making up the spring (Figure 22).
2. Bar—The center, or straight portion, of the formation making up the spring (Figure 22).
3. Loop—The outer, curved portion of the formation making up the spring (Figure 22).

b. Formed Wire Spring Elements—The wire is formed into a flat ribbon having nonuniform torque and spacer bars connected by radii (Figure 23). Commonly used terms to define sections of the spring are:

1. Torque Bar (Transverse Bar)—That section of wire lying in a transverse direction to the longitudinal axis of the formation which, when deflected, has a torsional action under load.
2. Spacer Bar (Longitudinal Bar)—That section of wire lying parallel to the axis of the formation.

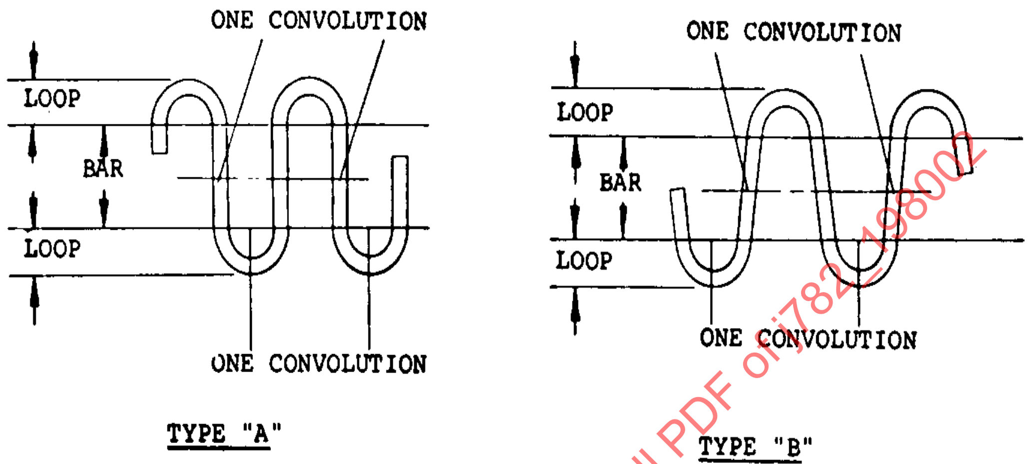

FIGURE 22—ZIGZAG CONFIGURATION

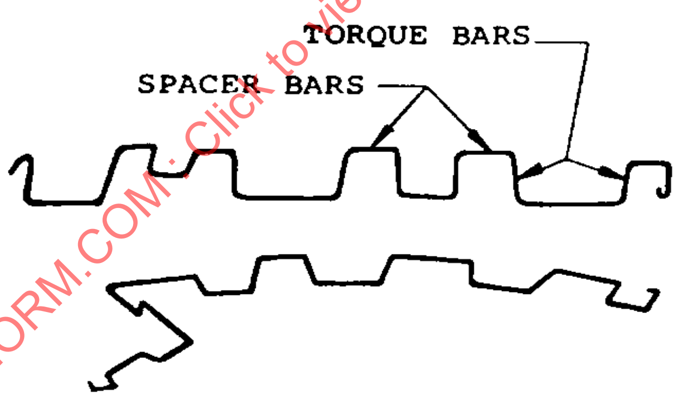

FIGURE 23—FORMED WIRE SPRINGS

6.4.1.2 Curvature

a. Zigzag spring elements can be readily fabricated with a predetermined constant arc or crown.
b. Formed wire spring elements are fabricated flat, and arc or crown is obtained by kinking spacer bars or twisting torsion bars.

6.4.1.3 Profiling—The zigzag and formed wire spring element ribbon is bent at the front (and sometimes rear) by twisting one or more torsion bars about their axis.

6.4.1.4 *Assembly*—Successive rows of nearly parallel zigzag and/or formed wire spring elements are mounted one after another and interconnected to form the assembled load-supporting surface. Component connecting parts are clipped to loops, spacer, and torsion bars of successive spring elements.

6.4.1.5 *Description of Units*—Zigzag of formed wire springs are classified by their usage and location in the assembly. The major classifications are back and cushion. These are subdivided into main and supporting, and can further be described as to profile, number, and types of bends. All units are described as being in car position. Typical zigzag or formed wire spring would, therefore, be described as:

a. Main back spring with double V or fishmouth at both ends (Figure 24(A)).
b. Main cushion spring with a spacer and fishmouth or V bend in front and an obtuse bend in the rear (Figure 24(B)).
c. Side cushion support spring with fishmouth or three V bends (Figure 24(C)).
d. Back support spring with fishmouth or two V bends (Figure 24(D)).

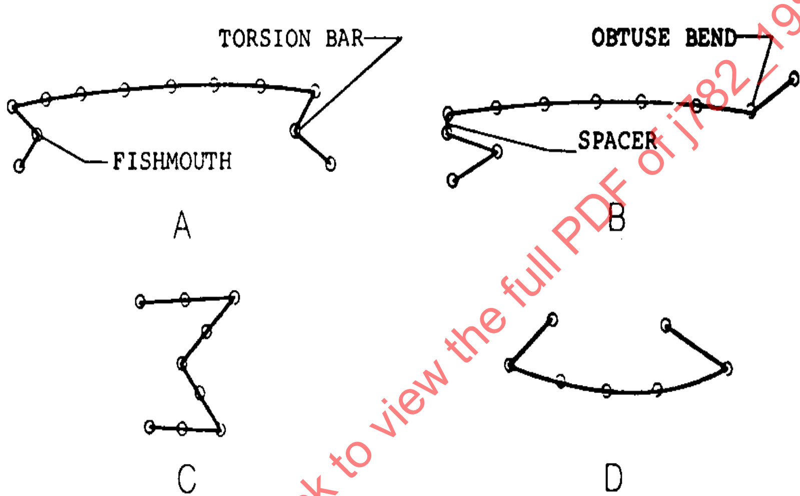

FIGURE 24—TYPES OF ZIGZAG OR FORMED WIRE PROFILES
(A) ZIGZAG OR FORMED WIRE PROFILE
(B) ZIGZAG OR FORMED WIRE PROFILE
(C) CUSHION SIDE SUPPORT
(D) BACK SUPPORT SPRING ZIGZAG OR FORMED WIRE

6.4.1.6 *Material*—Steel manufactured by the open hearth or electric furnace process and cold drawn to develop the desired mechanical properties is generally used for zigzag or formed wire springs.

Commonly used gages and suggested tensile ranges for zigzag and formed wire are listed in Table -1. A stress relief operation on the final formed element is required. Temperature, time, and method are determined by application.

TABLE 1—

W & M Gage	Nominal Dia, in	Nominal Dia, mm	Suggested Tensile Range, psi in thousands	Suggested Tensile Range, MPa
8	0.162	4.11	180–210	1242–1449
8–1/2	0.155	3.94	190–220	1311–1518
9	0.148	3.76	200–230	1380–1587
9–1/2	0.142	3.61	200–230	1380–1587
10	0.135	3.43	205–235	1415–1622
10–1/2	0.128	3.25	205–235	1415–1622
11	0.120	3.05	210–240	1449–1656
11–1/2	0.113	2.87	210–240	1449–1656
12	0.105	2.67	215–245	1484–1691
12–1/2	0.099	2.51	215–245	1484–1691
13	0.091	2.31	220–250	1518–1725

6.4.2 FLAT SPRING GRID

6.4.2.1 *Definition*—A wire grid suspended from two opposite seating frame members such as from side to side or front to back with the attachment to at least one frame member by means of helical extension springs. Shown in Figure 25.

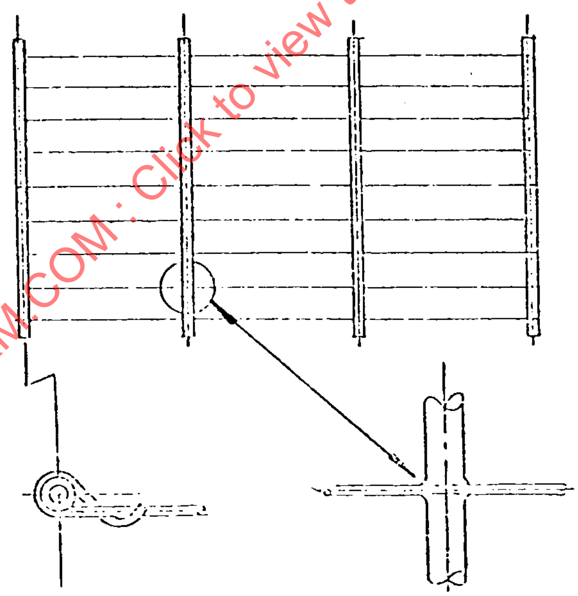

FIGURE 25—WIRE GRID

6.4.2.2 *Assembly*—Typically the grid is made with 18-gauge oil tempered wires piercing twisted paper or tubular plastic center strand spacers with the ends of the wires knotted around border strands comprised of paper or plastic covered 12 gauge, oil-tempered wire. The heavy border strands serve as the means of retaining tabs or with suspension elements such as helical tension springs shown in Figure 26. Some loose end coils are placed in pockets sewn in muslin (burlap) strips and successive rows of encased coils are hog ringed to adjacent rows at the top and to basic wire at the bottom. All coil spring assemblies are held in place with a peripheral top and bottom rim wire.

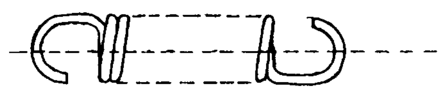

FIGURE 26—HELICAL TENSION SPRING

6.4.2.3 *Material*—Steel manufactured by the open hearth or electric furnace process and cold drawn to develop the desired mechanical properties is used for coil springs. (See Table 2). A stress relief operation on the final formed element is required. Temperature, time, and method are determined by application.

TABLE 2—

W & M Gage	Nominal Dia, in	Nominal Dia, mm	Suggested Tensile Range, psi in thousands	Suggested Tensile Range, MPa
9	0.148	3.76	185–215	1277–1484
10	0.135	3.43	190–220	1311–1518
10-1/2	0.128	3.25	190–220	1311–1518
11	0.120	3.05	195–225	1346–1553
11-1/2	0.113	2.87	195–225	1346–1553
12	0.105	2.67	200–230	1380–1587
12-1/2	0.099	2.51	200–230	1380–1587
13	0.091	2.31	210–245	1449–1691
14	0.080	2.03	225–260	1553–1794
15	0.072	1.83	230–265	1587–1829
16	0.062	1.57	235–270	1622–1863
17	0.054	1.37	240–280	1656–1932
18	0.047	1.19	245–285	1691–1967

6.4.3 JACK STRINGER (FLEXIBLE BASE ELEMENT)

6.4.3.1 *Definition*—A jack stringer is a formed piece of wire which acts as a flexible base element to which coils are mounted (Figure 26).

6.4.3.2 *Assembly*—Jack stringer elements are mounted to a substructure by clipping or other means as required.

6.4.3.3 *Material*—Steel manufactured by the open hearth or electric furnace process and cold drawn to develop the desired mechanical properties is used for jack stringers. (See Table 3.) A stress relief operation on the final formed element is required. Temperature, time, and method are determined by application.

TABLE 3—

W & M Gage	Nominal Dia, in	Nominal Dia, mm	Suggested Tensile Range, psi in thousands	Suggested Tensile Range, MPa
6	0.192	4.88	170–200	1173–1380
7	0.177	4.50	175–205	1208–1415
8	0.162	4.11	180–210	1242–1449

6.5 Component Parts of Hard Drawn Wire

6.5.1 STABILIZER BRACE

6.5.1.1 *Definition*—That unit connecting one surface with another to stabilize or give support to surface (usually a wire used in compression or tension). (See Figure 27).

FIGURE 27—STABILIZER WIRE

6.5.1.2 *Material*—Steel manufactured by the open hearth or electric furnace process and cold drawn to develop the desired mechanical properties. (See Table 4.). A stress relief operation on final formed element is required. Temperature, time, and method are determined by application.

TABLE 4—

W & M Gage	Nominal Dia, in	Nominal Dia, mm	Suggested Tensile Range, psi in thousands	Suggested Tensile Range, MPa
7	0.177	4.50	160–190	1104–1311
8 (1)	0.162	4.11	165–195	1139–1346
9[1]	0.148	3.76	165–200	1139–1380
10	0.135	3.43	170–205	1173–1415

1. 8 and 9 gages may be roll flattened to finishised sizes 0.095 x 0.210 in and 0.082 x 0.197 in, respectively. Tensile strength increases by approximately 10 000 psi.

6.5.2 BORDER WIRE

6.5.2.1 *Definition*—That unit which defines the perimeter and shape of the spring assembly and serves to connect individual spring elements into an integrated unit. Descriptive adjectives may be used to designate specific uses and locations, such as upper, lower, single, double, etc. The wire may be round or flattened as desired, as shown in Figure 28.

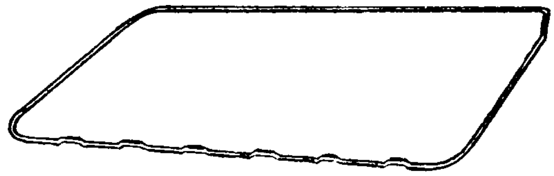

FIGURE 28—BORDER WIRE

6.5.2.2 *Material*—Same as stabilizer brace.

6.5.3 ARCH WIRE

6.5.3.1 *Definition*—A supplemental support used in conjunction with the border wire. An arch wire may be used to support padding as well as the border wire itself (Figure 29).

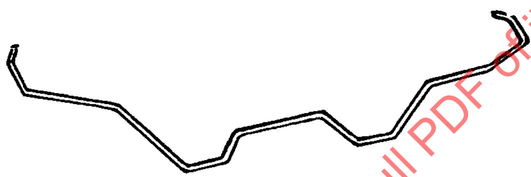

FIGURE 29—ARCH WIRE

6.5.3.2 *Material*—Same as stabilizer brace.

6.5.4 HELICAL COILS (CLOSE OR OPEN WOUND)

6.5.4.1 *Definition*—Used to bridge between coil spring elements or to lace elements into an integrated spring assembly (Figure 30).

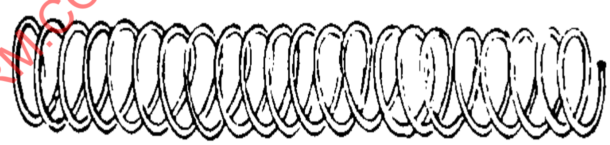

FIGURE 30—HELICAL COIL TIE SPRING

6.5.4.2 *Material*—Steel manufactured by the open hearth or electric furnace process and cold drawn to develop the desired mechanical properties (Table 5).

TABLE 5—

W & M Gage	Nominal Dia, in	Nominal Dia, mm	Suggested Tensile Range, psi in thousands	Suggested Tensile Range, MPa
18	0.047	1.19	215–255	1484–1760
19	0.041	1.04	220–260	1518–1794
20	0.035	0.89	220–260	1515–1794

6.5.5 LOOP TIES (HAIR PINS)

6.5.5.1 Definition—A formed piece of wire for stabilizing or tying spring units together (Figure 31).

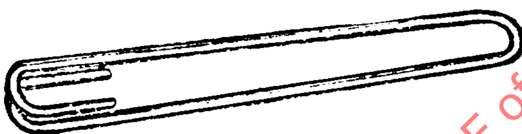

FIGURE 31—LOOP TIE

6.5.5.2 Material—Hard drawn steel wire made by the open hearth or electric furnace process (Table 6).

TABLE 6—

W & M Gage	Nominal Dia, in	Nominal Dia, mm	Suggested Tensile Range, psi in thousands	Suggested Tensile Range, MPa
14	0.080	2.03	225–260	1553–1794
15	0.072	1.83	230–265	1587–1829

6.6 Miscellaneous Component Parts

6.6.1 HOG RINGS

6.6.1.1 Definition—A wire clip used to fasten listings to border wire, coils, or other miscellaneous parts (Figure 32).

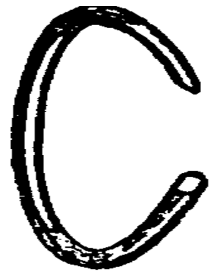

FIGURE 32—HOG RING

6.6.1.2 *Material*—Low carbon steel wire made by the open hearth or electric furnace process (Table 7).

TABLE 7—

W & M Gage	Nominal Dia, in	Nominal Dia, mm	Suggested Tensile Range, psi in thousands	Suggested Tensile Range, MPa
14	0.080	2.03	100–125	690–863
15	0.072	1.83	100–125	690–863
16	0.062	1.57	100–125	690–863

6.6.2 CLIPS

6.6.2.1 *Definition*—A preformed piece of metal used to attach spring elements or component parts together (Figure 33).

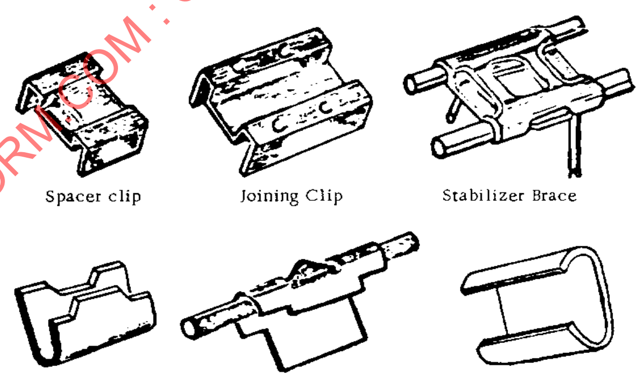

FIGURE 33—CLIPS

6.6.2.2 *Material*—Low carbon cold rolled strip steel (SAE J1010 (February, 1973)).

6.6.3 SPRING RETAINERS

6.6.3.1 *Definition*—Sheet metal of a preformed shape used to stabilize, locate, or hold spring elements in a definite position (Figure 34).

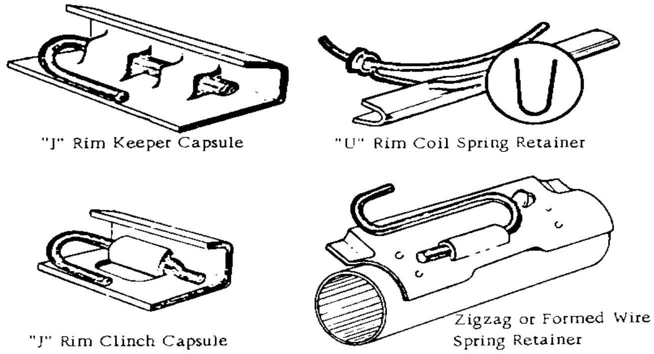

FIGURE 34—SPRING RETAINERS

6.6.3.2 *Material*—Usually a low carbon steel with gage and type as specified by ultimate user.

6.6.4 LISTINGS

6.6.4.1 *Definition*—A flexible member used to restrict or space spring units and/or support padding (Figure 35).

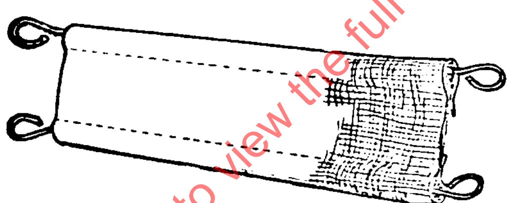

FIGURE 35—LISTING

7. ***Seat Spring Assembly Test Methods***—In order to determine the physical characteristics of seat assembly, such as comfort, package, and durability life, unique measurement and test methods have been devised. Although the final evaluation is dependent on in-vehicle performance, preliminary evaluation is conducted on the seat assembly under a controlled laboratory standard. This is usually done on a comparative basis utilizing either a specific seat as a design image or with the evaluation standard based on accumulative data obtained from previous experience.

7.1 Measurement

7.1.1 FREE CONTOUR—The seat assembly is placed on a rigid fixture simulating vehicle position. A template with adjustable fingers is placed over the seat. The fingers are then adjusted to meet the seat surface and locked. The template is removed and placed on the full size package drawing whereby the contact points are plotted to indicate actual contour (Figure 36).

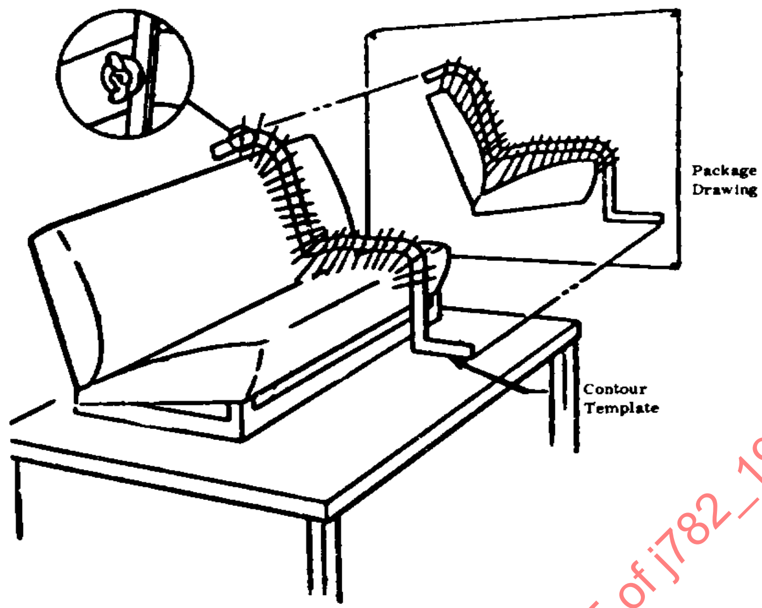

FIGURE 36—FREE CONTOUR SETUP

7.1.2 PACKAGE CHECK—The seat assembly is placed on a rigid fixture simulating vehicle position. The SAE manikin is placed and adjusted on the seat in accordance with the SAE J826b (January, 1974). The actual manikin position is obtained on a point-by-point basis with a rail mounted transit (horizontal) and bubble manometer (vertical) measurements made against a grid background. This procedure may also be performed with a seat installed in a vehicle (Figure 37).

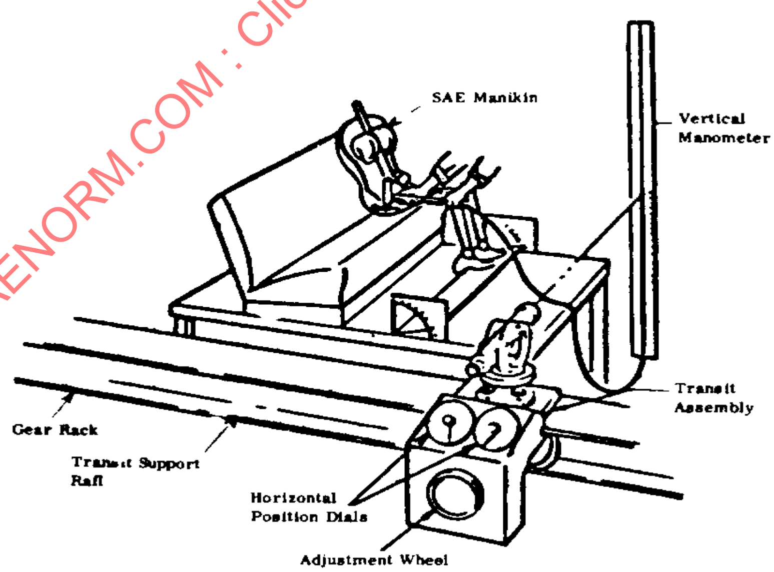

FIGURE 37—PACKAGE CHECK SETUP

7.1.3 LOAD DEFLECTION—TRIMMED SPRING ASSEMBLY

7.1.3.1 *Spring Assembly*—The trimmed back or cushion spring assembly is installed in the deflection fixture. A vertical saddle load is applied in 30 increments to 190 lb (845 N) for cushion spring assemblies and in 10 increments to 50 lb (222 N) for back spring assemblies. Load versus vertical saddle penetration is plotted. This procedure may also be conducted on an untrimmed spring assembly by placing an insulator and slab pad over it (Figure 38).

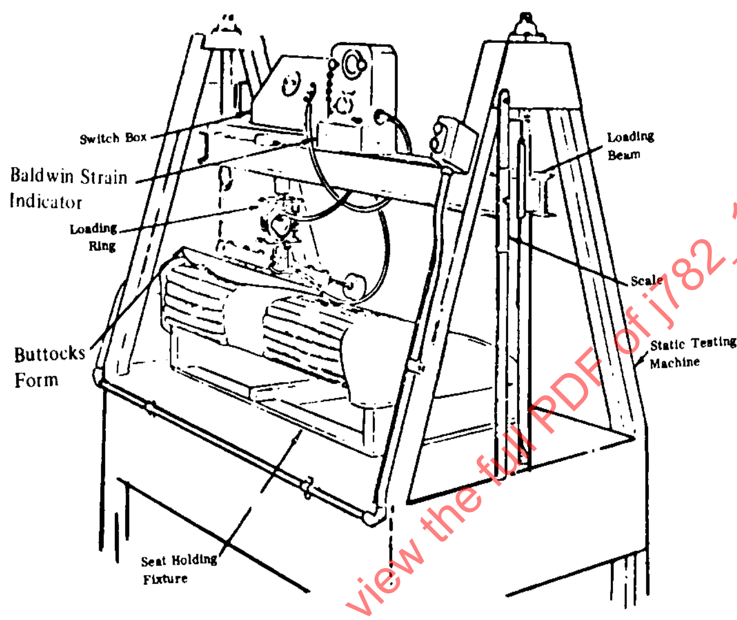

FIGURE 38—LOAD DISTRIBUTION TEST SETUP

7.1.3.2 *Individual Spring Element*—An individual element may be evaluated by placing it in a rigid fixture that duplicates its attachment to the seat frame. Each element bar is loaded with a dead weight whereby the loaded position of the element is measured against a grid background (Figure 39).

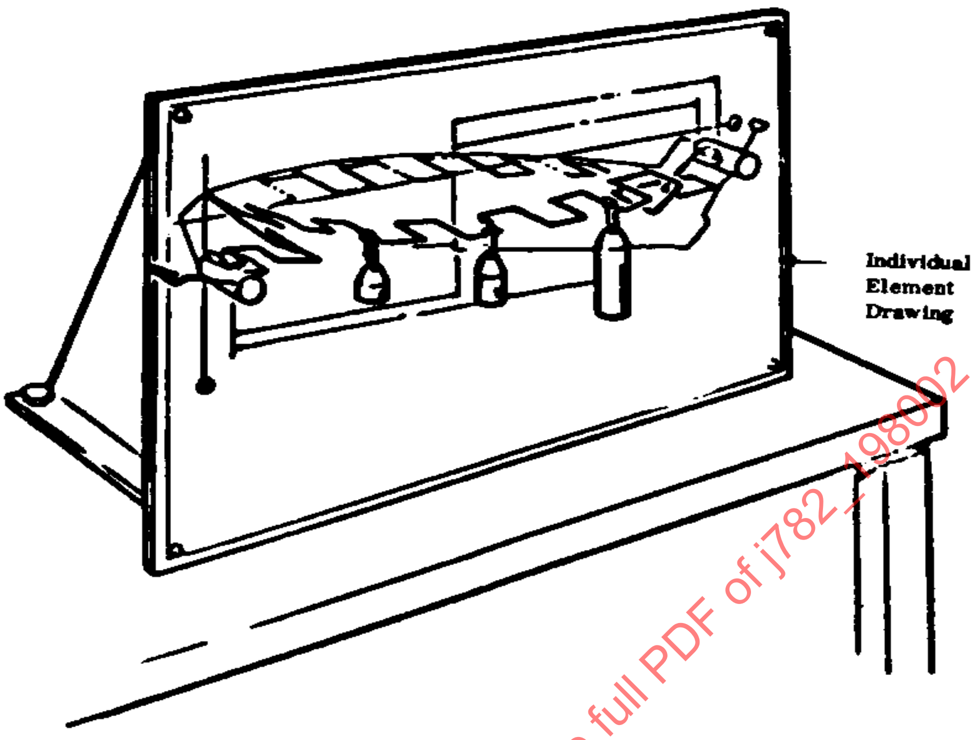

FIGURE 39—SINGLE ELEMENT LOAD DEFLECTION SETUP

7.1.4 LOAD DISTRIBUTION—The trimmed back or cushion spring assembly is placed in the test fixture. A special saddle having seven individually suspended segments is lowered into the spring assembly where the force applied to each saddle segment by the spring assembly is measured. The vertical saddle force versus the individual segment load response is shown in bar graph form in Figure 38.

7.2 Tests—Dynamic tests are conducted to determine natural frequency, damping coefficient, rebound rate, and durability fatigue life. The following test methods are utilized for that purpose:

7.2.1 SADDLE DROP TEST (CUSHION)—The test saddle is lowered into the cushion until a load of 215 (956 N) (conventional seats) or 250 lb (1112 N) (heavy-duty seats, for example, police and taxi fleet operations) has been reached. The saddle is raised 10 in (254 mm) above the static load position and released. A suitable device attached to the saddle support shaft records the depth of penetration and dynamic characteristics (Figure 40).

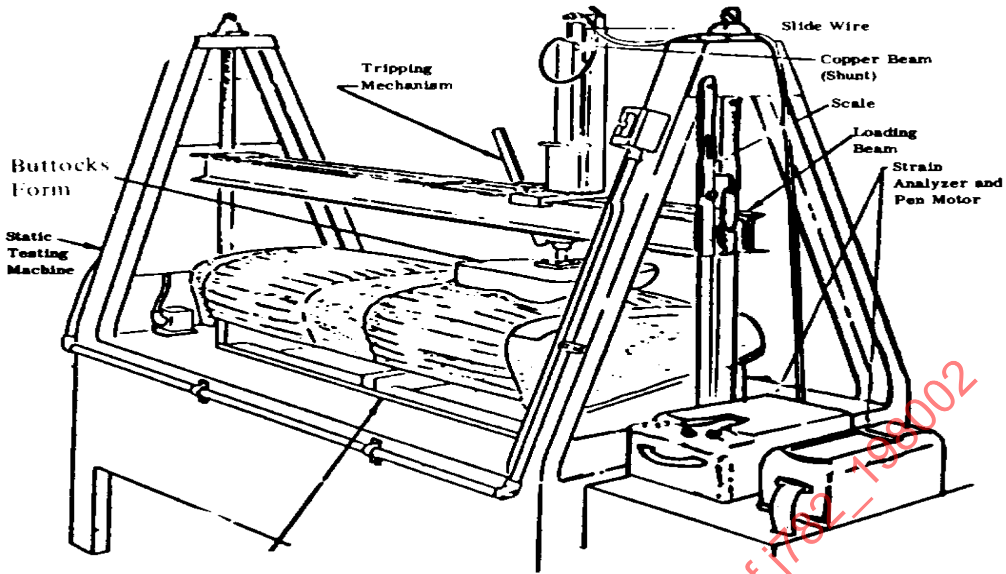

FIGURE 40—SEAT DROP TEST SETUP

7.2.2 FATIGUE TEST—CONSTANT DISPLACEMENT—The test saddle (150 lb (667 N) for cushions or 120 lb (534 N) for backs) is placed on the spring assembly and lowered into it an additional 2 in (51 mm) (conventional seats) to 3 in (76 mm) (heavy-duty seats). The saddle support arm is held rigid whereby the platform-supported spring assembly (vertically reciprocating) is cycled 100 000 times or until failure occurs (Figure 41).

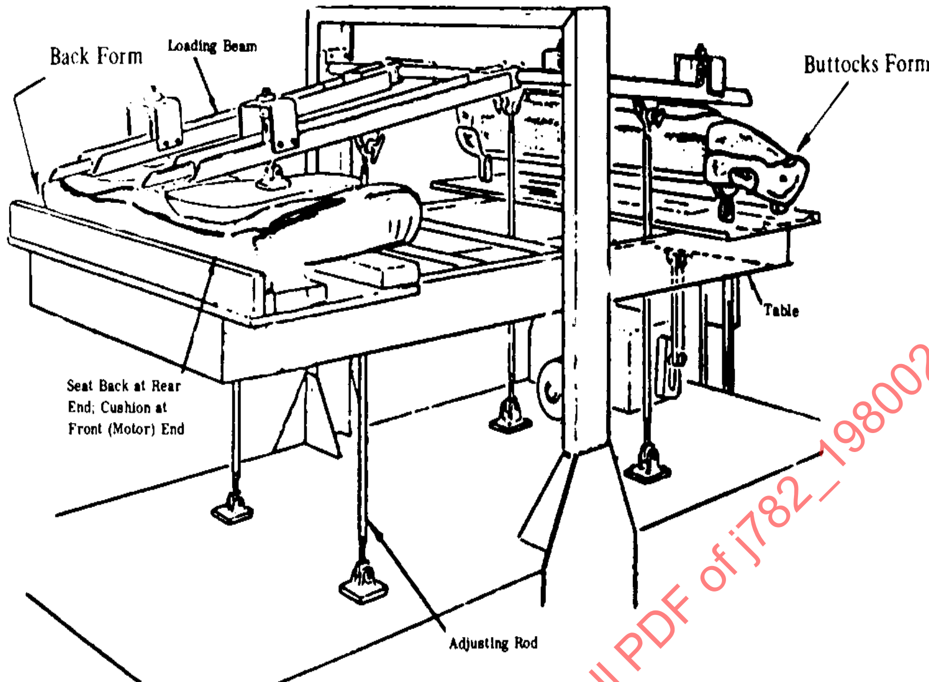

FIGURE 41—SEAT FATIGUE TEST SETUP (CONSTANT DEFLECTION OR CONSTANT WORK)

7.2.3 FATIGUE TEST—CONSTANT WORK—The constant work method involves a cycling procedure with the spring assembly mounted on a vertically reciprocating platform with two guided test saddles riding on the seat. The cushion saddle is mounted on the cushion per vehicle package position, while the back is cycles in a horizontal position. The test displacement, which is held constant throughout the test, is determined by the amount of penetration that results from a 280 lb (1246 N) static load for cushions and a 115 lb (512 N) load for backs. The cycle life requirements ranges 50 000—65 000 cycles depending on seat usage (Figure 42).

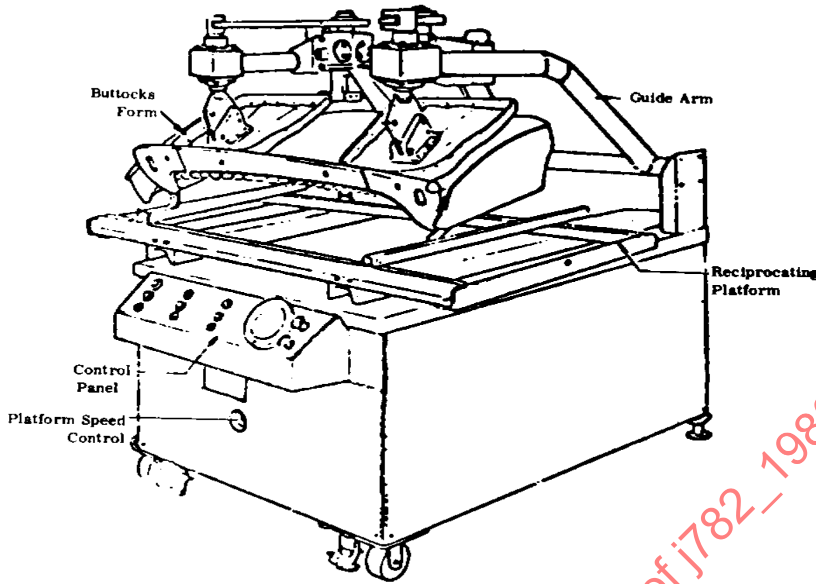

FIGURE 42—SEAT FATIGUE TEST SETUP (CONSTANT WORK)

8. Motor Vehicle Head Restraints

8.1 Definition—Head restraint is a device that limits rearward angular displacement of the occupant's head relative to his torso line. It may be in the form of integral seat structure or an applied device.

8.2 Purpose—The purpose of head restraints to to reduce the severity of head injuries in vehicular collisions.

8.3 Structural Classifications

8.3.1 Double post, applied (Figure 43).

8.3.2 Single post, applied (Figure 44).

8.3.3 Integral with seat frame (Figure 45).

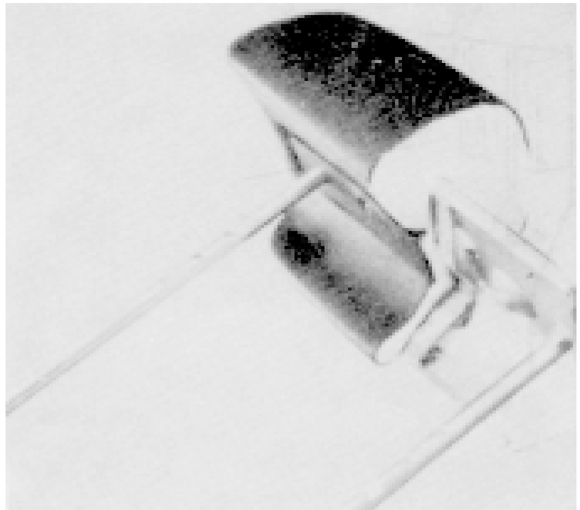

FIGURE 43—

FIGURE 44—

FIGURE 45—

8.4 Trim Variations of Applied Head Restraints

8.4.1 Foam pad and plastisol cover molded integral with support and post (Figure 43).

8.4.2 Foam pad molded integral with support with an applied sewn trim cover (Figure 44).

8.5 Methods of Test—Head restraints shall be tested in accordance with SAE J879b (July, 1968).

9. Padding

9.1 Definition—The term pad in motor vehicle seating usage refers to a soft and resilient material, such as urethane, generally in combination with a pad support installed between a frame or spring assembly and a seat trim covering. Pads are either slab, fabricated, or molded into a predetermined size, shape, and thickness.

9.2 Evolution of Padding—In the past padding has had many abrupt changes in form and composition. The following are the main types of padding materials and construction:

9.2.1 FIBROUS MATERIAL CONSTRUCTION—An early form of padding in which a layered construction was used.

1. Topper Pad—Composed of cotton felt; a fine grade of cotton fabricated to desired specification used directly under the cover.
2. Intermediate Pad—Composed of one of the following materials:

   a. Curled Hair—A blend of animal hair processed into a mat.
   b. Rubberized Curled Hair—Curled hair with rubber or neoprene latex sprayed through and cured to specified thickness and weight.
   c. Rubberized Tula, Wool, or Synthetic—Vegetable fiber, coarse wool, or plastic filaments with rubber or neoprene latex sprayed through as above.

3. Foundation Pad—Pad which is placed directly over the spring assembly composed of one of the following materials:

a. Dark cotton or colored cotton felt
b. Sisal Felt—Fibrous portion of sisal plant
c. Interlaced jute or sisal

9.2.2 LATEX TOPPER WITH LATEX INTERMEDIATE—As the name implies, two layers of latex foam between the foundation pad and the cover assembly.

9.2.3 FULL DEPTH LATEX PAD—A pad of sufficient thickness and proper compression of latex foam to cushion the occupant properly. A full depth pad can be used with either a rigid or flexible base.

9.2.4 URETHANE—Currently the most widely used motor vehicle padding material.

9.3 Design Guidelines—From a design viewpoint the basic guidelines of a good pad are as follows:

9.3.1 It should help maintain the seated occupant in the seating package. These guidelines are specified in initial design criteria for each vehicle style.

9.3.2 It should support any occupant equally across the pad with maximum lateral support.

9.3.3 It should, even in long use, not sag between the elements of the spring assembly or pocket excessively.

9.3.4 It should yield to compression and possess a certain amount of elasticity in both length and width. This means the pad should yield and conform to the shape of the contacting portion of the occupant's body. Some elasticity is required to prevent fractures or tears in the padding material when the weight of the seated occupant depresses the cushion surface, increasing the length and, to a lesser degree, the width of the pad suspended over the spring assembly.

9.3.5 It should have a satisfactory rate of recovery after normal use to its free height.

9.3.6 It should show little or no loss in thickness after normal use.

9.3.7 Back pads should provide proper lumbar support if there are no other supporting elements.

9.3.8 It should have uniformity, so that the designed contour of seat cushions and backs can be achieved in mass production.

9.3.9 Trim cover should be easy to assemble to the spring assembly.

9.3.10 It should have sufficient softness at light loads to provide *showroom feel*.

9.4 Purpose and Function—The specific purpose of a pad is to insulate the engaging portion of the seated occupant's body from the cushion or back springs and to provide a cushioning member while assisting in controlling occupants position relative to design requirements. A pad also affects the damping quality of the cushion and back assembly which may also be instrumental in providing the desired styling contour to the trimmed seat.

9.5 Pad Material

9.5.1 Urethane foam is an expanded cellular product resulting from two chemical reactions:

a. The reaction of an isocyanate with a polyol polyether to form urethane.
b. The reaction of the isocyanate with water to release carbon dioxide gas which is the blowing agent for the first reaction.

9.5.2 TYPES OF FOAM—There are three common types of urethane in use in industry.

a. Conventional—A urethane system which, under manufacturing conditions, requires molding temperatures in excess of 169 °C.
b. Hi-resilient—A relatively new urethane system using a different isocyanate and a higher molecular weight polyol than conventional urethane. This system is known as *cold cure* foam due to its lower curing temperatures (under 93 °C) in production. The main advantage of this urethane is its high sag factor giving the final product greater *showroom feel*.
c. Loaded—A urethane system using silica or other filler in the polyol. Its major use is in high load bearing applications.

9.6 Pad Construction

9.6.1 SLAB CONSTRUCTION—Urethane poured onto a moving conveyor in a long continuous bun. After curing, the urethane is then mechanically cut into various sizes and shapes. The main uses for slab pads are in:

a. Topper Pads—One to two inch flat pads assembled between the spring assemblies and trim covers in rear seat cushions and backs.
b. Seat Cover Inserts—Shaped filler pads sewn or bonded into trim cover assemblies to add contour to the completed seat.

9.6.2 MOLDED CONSTRUCTION—Urethane poured into closed sealed molds (generally aluminum) expanding to final part contour. Molded construction is used in both cushions and backs.

9.6.2.1 Molded Cushions—The following are the various types of molded cushions:

1. Topper Pads—1 1/2 in (38 mm) to 2 1/2 in (64 mm) thick pads with snap on feature for assembly over border wire in spring assembly.
2. Full Depth Foam Pads on Flexible Base—Border wires and bolster wires are generally molded into pad.
3. Full Depth Foam Pads on Solid Base—Pads are usually of greater thickness than when on a flexible base. These pads are supported by solid wood base or metal stamping and are generally used in truck applications.

9.6.2.2 Molded Backs—The following are the main types of molded backs:

1. Topper Pads—Same as in paragraph 9.6.2.1.(1)
2. Full Depth Foam Pads—Pads of sufficient thickness to replace spring assembly. These pads rest on stamped wire, or tube frames. In instances, where the frame is not a full stamping, cardboard is cemented to pad for greater support. Border wires may be molded into pads for high wing applications (bucket seat backs). The top of the front seat back is either molded together with the pad or cemented to the pad or frame in a separate operation.
3. Pads with Molded-In Frames—In some cases, advantages are obtained from molding the frames into the pads. The frames may be of the following types:

   a. Tube frame or partial stamped frame with elements attached. This type may have headrest pan attached.
   b. Wire grid frame—Generally used in truck and station wagon applications.

9.6.2.3 Cushion and back pads molded together with complete frame units. In applications, where the front seat back does not have to fold forward, it may be advantageous to mold the cushion and back together with a complete frame. Due to the physical size and weight of such an assembly only bucket seats are practical for use in this approach.

9.7 Pad Supports

9.7.1 A pad support is defined as a member placed on the top surface of a seat cushion or seat back spring assembly independently, cemented to the pad, or molded into the pad.

9.7.2 PURPOSE—The pad support is used to prevent the pad from sagging between open spaces in the spring assembly, to distribute the load more evenly to the springs, and to increase the life of the pad by preventing springs from penetrating same. It could be used as a stiffener where there is no spring assembly.

9.7.3 TYPES OF PAD SUPPORTS—Pad supports are made of various materials. Burlap or cotton netting were used exclusively with small gauge wires interwoven the length of the pad support in 1–2 in intervals. Spun bonded polyester scrim netting is used in many applications. In some foam pad applications, the above wires can be omitted.

9.8 ASTM Pad Test Procedures—The following are ASTM approved pad tests:

9.8.1 INDENTATION LOAD DEFLECTION—ASTM D2406 (Sec. 19–25)

9.8.2 COMPRESSION SET—ASTM D2406 (Sec. 12–18)

9.8.3 STEAM AUTOCLAVE (HUMID AGEING)—ASTM D2406 (Sec. 5–11)

9.8.4 TENSILE, TEAR, ELONGATION—ASTM D2406 (Sec. 68–81)

9.8.5 DENSITY—ASTM D2406 (Sec. 62–67)

9.8.6 LOW TEMPERATURE EVALUATION—ASTM D1229

9.8.7 HEAT AGEING—ASTM D2406 (Sec. 38–44)

9.8.8 FLEX FATIGUE—ASTM D2406 (Sec. 45–61)

9.8.9 FLAMMABILITY—ASTM D1692 MVSS 302

9.9 Pad Testing Parameters—There are a number of tests not specified by the ASTM for varying purposes.

a. Solvent resistance
b. Fogging
c. Staining
d. Odor
e. Cleanability
f. Fatigue deterioration
g. Life test
h. Cigarette test
i. Surface porosity

9.10 Types of Seat Pads and Pad Supports

9.10.1 FRONT SEAT BACK PADS

9.10.1.1 Typical molded pad construction for two- and four-door bench seat back with integral back of front seat back pad (Figure 46).

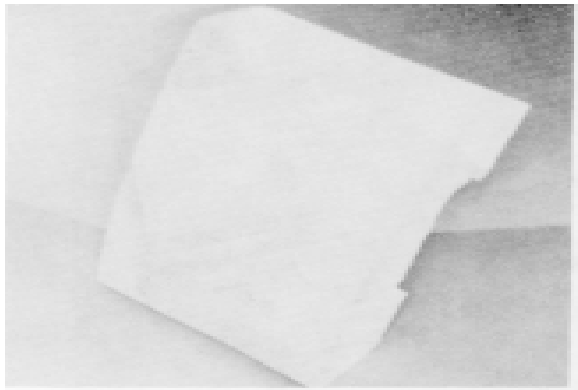

FIGURE 46—

9.10.1.2 Typical molded pad construction for two- and four-door bench seat backs with tapes for assembling pad to seat frame (Figure 47).

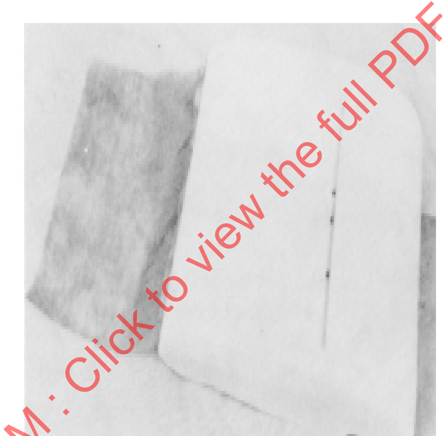

FIGURE 47—

9.10.1.3 *Individual seat*—Molded back pad with foundation board (Figure 48).

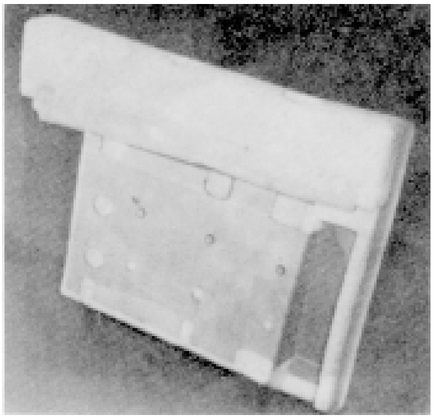

FIGURE 48—

9.10.1.4 Bucket seat molded back pad (Figure 49).

FIGURE 49—

9.10.1.5 Back pad molded integral with seat back frame (Figure 50).

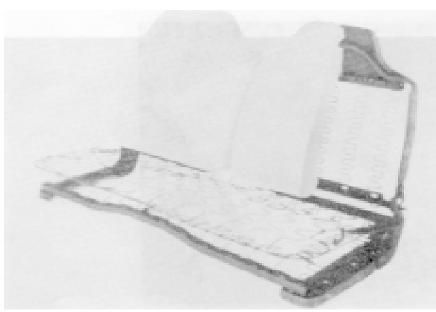

FIGURE 50—

9.10.2 FRONT SEAT CUSHION PADS

9.10.2.1 Typical molded full foam bench seat cushion pad (Figure 51).

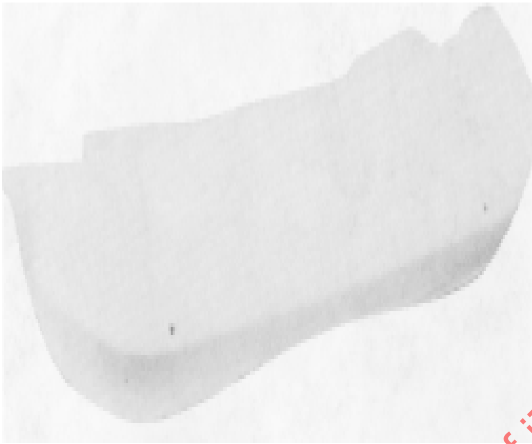

FIGURE 51—

9.10.2.2 Typical molded spring topper pad-bench seat (Figure 52).

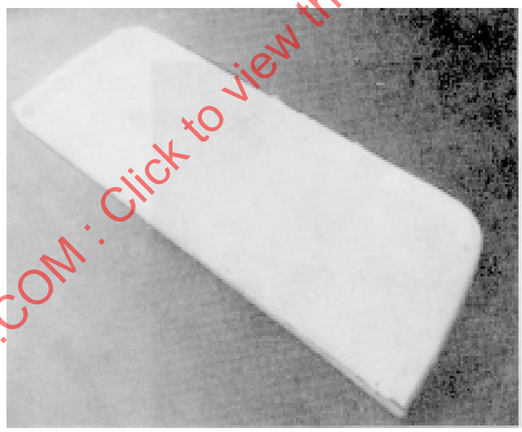

FIGURE 52—