TEST PROCEDURES FOR BRAKE SHOE AND LINING ADHESIVES AND BONDS-SAE J840

SAE Recommended Practice

Report of Brake Committee approved November 1962.

SCOPE -- This SAE Recommended Practice covers equipment and procedures for qualification and quality control tests of brake shoe and lining adhesives and bonds.

ADHESIVE TESTS

PURPOSE -- These tests are for determining adhesive characteristics of a specimen which has been prepared under specified conditions.

VISCOSITY

1. Viscosity is to be determined on a motor-driven spindle type viscosimeter.

2. The adhesive test container should be a one-quart, round, friction-top can, 4-1/2 in. dia, 4-7/8 in. high, with a 3-1/4 in. opening.

3. Temperature of the adhesive should be 77 ± 2 F.

4. The type and amount of agitation before measurement of viscosity should be agreed upon by the supplier and purchaser.

5. The reading should be taken after the viscosity has stabilized.

6. Spindle number, spindle speed and make and model of viscosimeter should be reported.

SOLIDS CONTENT

1. The solids content of an adhesive is obtained by weighing a sample of adhesive, heating it in an oven to evaporate the solvent and weighing it again after heating. Care must be exercised in obtaining the weight of the sample before heating as the solvent evaporates during weighing. The percent solids content is:

$$\frac{\text{Weight of sample after heating}}{\text{Weight of sample before heating}} \times 100$$

2. Approximately 5 g sample of adhesive should be used or as agreed upon by the supplier and purchaser.

3. The container should be a 3 oz ointment tin with cover, 2-3/8 in. dia.

4. Temperature should be according to the adhesive suppliers' recommendation. It should be high enough to remove all solvents.

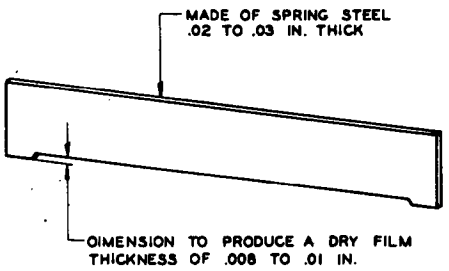


Fig. 1 - Doctor blade

5. Heating time should be a minimum of 2 hr, or sufficient to establish a constant weight sample.

6. The report should show: (a) total solids in percent, (b) time of heating, (c) temperature during heating, and (d) method of heating.

FLOW

Purpose -- The flow of the dried adhesive film under bonding or curing conditions indicates the wetability, penetration and pattern of the adhesive. Since bonding adhesives are thermosetting, they may advance under conditions of heat or aging. A flow test is a good indication of the condition of the adhesive.

Procedure

1. If the adhesive is a liquid, a dry film must be cast; if a tape, use as is.

2. Pour some of the liquid adhesive on a clean glass or metal plate covered with a polyethylene film or directly onto a polytetrafluroethylene coated plate.

3. Draw a doctor blade or a scraper bar (see Fig. 1) across the adhesive to cast a sufficiently thick wet film to give a dry film 0.008 to 0.01 in. thick.

4. Dry the film according to the adhesive supplier's specification. In the absence of such a specification, dry up to 6 hr at room temperature as required to obtain a smooth film. Follow by heating for 20 minutes at 175 ± 5 F.

5. Using a circular die, cut a 1.125 in. dia (1 sq in.) circle from the dried film and strip off the polyethylene film. Check the film thickness with a spring gauge or a paper micrometer.

6. Weigh the sample in milligrams on an analytical, a torsion, or other suitably sensitive balance. One square inch of 0.01 in. dry film weighs approximately 200 mg; the weight varies with the specific gravity of the compound.

7. Place a 2 in. dia circle of untreated heat resistant cellophane over a clean 3 x 3 in. steel panel. Place the 1 sq in. sample of dry film in the middle of the panel. Cover

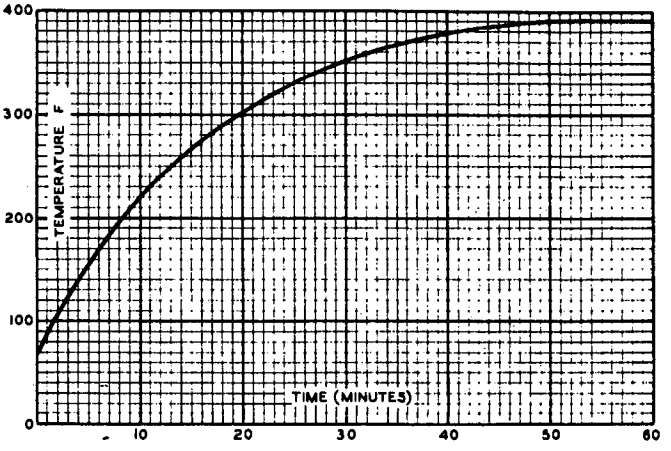


Fig. 2 - Rate of heating curve-flow test

this with another 2 in. dia circle of cellophane, then lay another 3 x 3 in. clean steel panel over this.

8. Place the assembly in the standard SAE disk bonding press (see Fig. 4) or in a spring-loaded fixture if an oven is to be used for heating. Load to 100 psi pressure. Heat at the temperature and time cycle recommended by the adhesive supplier. In the absence of such a recommendation, use rate shown in Fig. 2. (As a supplemental test, the pressure and rate of heating could be the same as that used in the SAE disk bonding press.)

9. Remove from the press or oven and cool to room temperature. Remove the top steel panel. The new area will be visible through the cellophane.

10. Determine the area.

11. Calculate the increase in area per milligram of adhesive by:

$$\frac{\text{Measured area} - 1}{\text{Weight, milligrams}} = \text{increase in square inches per mg}$$

Alternate method:

10. Soak disk in water to remove cellophane.
11. Check film thickness with a micrometer.
12. Calculate flow by:

$$\% \text{ flow} = \frac{\text{Original thickness} - \text{new thickness}}{\text{Original thickness}} \times 100$$

DISK SHEAR TEST

Equipment -- The testing machine shall be capable of compression loading and shall be so selected that the breaking load of the specimens falls between 15 and 85% of the full scale capacity. The testing machine shall be capable of maintaining a uniform rate of loading of 1200 psi per minute. This rate of loading will be approximately obtained by a free crosshead speed of 0.05 in. per minute.

The shear fixture, Fig. 3, consists of a semicircular anvil and a rectangular opening to receive the bonded test disk and strip. The fixture shall have a built-in, thermostated, electric heater.

A suitable press for bonding the disk shear specimens is shown in Fig. 4. It consists of upper and lower heated platens and an air cylinder for applying pressure during the bonding cycle. This press may also be used in making the flow test.

The bonding of the disk shear specimens may be done in any suitable manner which conforms with the bonding conditions specified by the supplier of the adhesive and which gives a uniform adhesive line thickness.

Test Specimens -- Disk and strip specimens shall conform to the shape and dimensions shown in Fig. 5. At least five bonded specimens shall be tested at ambient temperature and five at elevated temperature or as agreed upon by supplier and purchaser.

Preparations of Test Specimens

1. Test strips and disks shall be made of a mild steel; for example, SAE 1010. Both strips and disks shall be an initial thickness of 0.252 in. max. They shall be ground flat and parallel within 0.001 in. Disks and strips may be reused by removing the old adhesive and refinishing the surfaces as described, but the thickness shall not be reduced to less than 0.24 in.

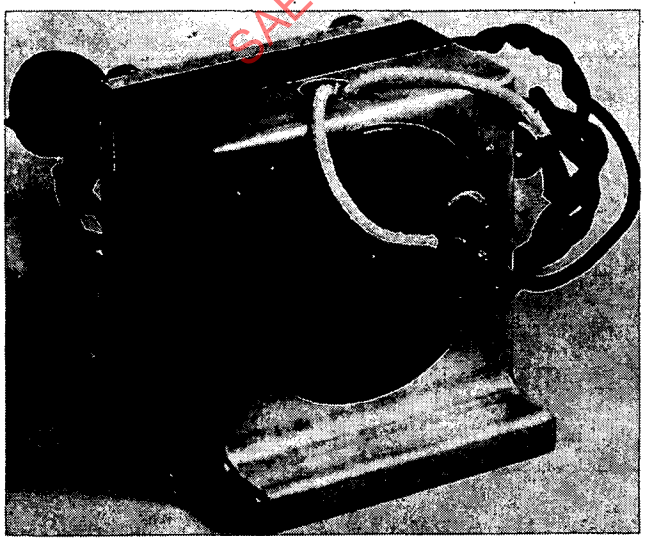


Fig. 3 - SAE disk shear fixture

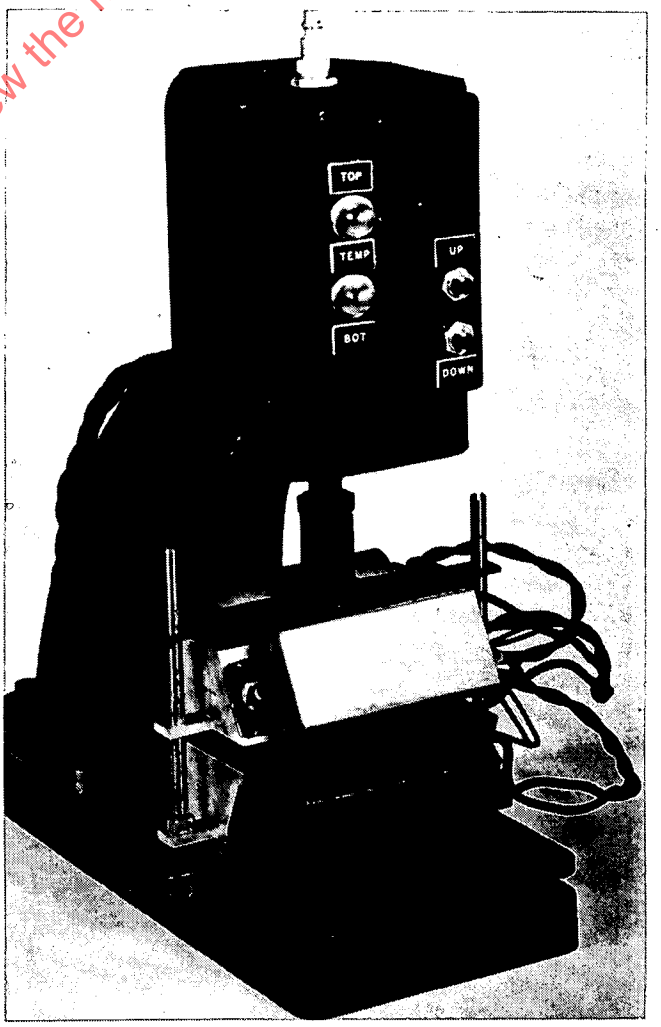


Fig. 4 - SAE disk bonding press

2. The bonding surfaces of the strips and disks shall be prepared as follows:

(a) Clean with a hot degreasing solvent such as trichlorethylene.

(b) The surface to be bonded shall be finished with 180 grit aluminum oxide cloth or grit blasted. (G 40 - grit has been found satisfactory).

(c) Follow by a Methyl-ethyl-ketone (MEK) rinse.

(d) Store in a desiccator until used. Prevent contamination of the clean surfaces.

3. The adhesive shall be applied as follows:

(a) If a dry film or tape adhesive is used, a 1-1/4 in. dia disk of adhesive shall be cut and placed between the disk and the strip. Record dry film thickness.

(b) If a liquid adhesive is used, the adhesive shall be spread on the surface of the strip only. The wet film thickness shall be sufficient to produce the dry film thickness recommended by the supplier.

The adhesive on the strip shall be air dried or oven dried as recommended by the supplier's specification. In the absence of such a specification, dry up to 6 hr at room temperature as required to obtain a smooth film. Follow by heating for 20 minutes at 175 ± 5 F, recording film thickness. The mating surfaces shall then be placed together.

4. The bonding procedure shall be as follows:

The specimens shall be bonded at the temperature, pressure, and bonding time recommended by the supplier. The thermostat shall be set to control the heat of the platens at the specified bonding temperature. The pressure regulator shall be set to give the specified pressure. The platens shall be preheated to the specified temperature before inserting the specimen. The lower platen shall be swung out and the specimen (disk down) placed on the locating pin in the lower platen; it shall immediately be swung back into position and pressure applied by actuating the air cylinder. After the specified bonding time has elapsed, the pressure shall be released, the lower platen swung out and the specimen removed. It shall be allowed to cool to room temperature before shear testing. Excessive adhesive squeezed out around the edge of the disk shall be removed with a knife or hole saw.

Procedure -- The bonded test specimen shall be inserted in the slot at the top of the shear fixture with the bottom of the disk resting on the semicircular anvil. The load shall be applied at a rate of 1200 psi per minute (± 5%) until failure occurs.

For elevated temperature testing, the shear fixture shall be heated to the specified temperature before the specimen is inserted. Then the specimen shall be inserted and held at the specified temperature for 10 minutes before the load is applied. A thermocouple inserted in the disk may be used to check temperature.

Calculations -- All failing loads shall be expressed in pounds per square inch of shear area, calculated to the nearest 0.01 sq in. A 1-1/8 in. dia disk shall be reported as 1 sq in.

Report -- The report shall include the following, and shall be reported on a form as shown in Fig. 6.

1. Complete identification of adhesive tested, source including type, manufacturer's code number, date of manufacture, and test date.
2. Bonding apparatus used.
3. Metal preparation.

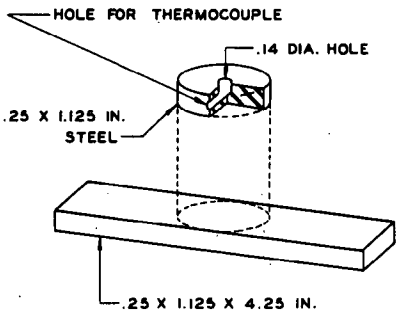


Fig. 5 - Steel disk and strip specimens

DATE _____

ADHESIVE SUPPLIER _____ COMPOUND _____ BATCH NO. _____

DATE MANUFACTURER _____ DATE TESTED _____

BONDING APPARATUS USED _____

METAL PREPARATION: SOLVENT _____ FINISH _____

AIR DRY _____ MINUTES ____ FORCE DRY ____ MINUTES AT _____ F.

DRY FILM OF TAPE THICKNESS ____ CURE ____ MIN. AT ____ F. AT ____ _____ PSI.

RATE OF CURE TIME - MINUTES VERSUS CURE TEMP. F.

MINUTES	2	4	6	8	10	12	14					
TEMP. F.												

TEST DATA

SPECIMEN NUMBER	TEST TEMP, F.	BOND THICKNESS	SHEAR STRESS P.S.I.	FAILURE	
				% COHESION	% ADHESION
1					
2					
3					
4					
5					

SHEAR STRESS: HIGH _____ LOW _____ AVERAGE _____

COMMENTS: _____

1					
2					
3					
4					
5					

SHEAR STRESS: HIGH _____ LOW _____ AVERAGE _____

COMMENTS _____

Fig. 6 - Report form

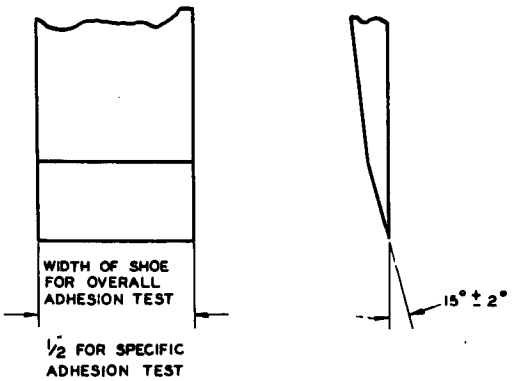


Fig. 7 - Chisel

4. Air or oven drying time and temperature.

5. Dry film thickness for each specimen to nearest 0.001 in.

6. Curing time, temperature and pressure.

7. Rate of curing (time - temperature curve).

8. Temperature at which shear test was performed.

9. Shear stress at failure for each specimen.

10. Nature of failure, including the average estimated percentage of failure in cohesion of the adhesive and adhesion to the adherents.

11. High, low, and average shear stress at failure (for 5 specimens).

OVERALL ADHESION CHISEL TEST

Purpose -- The purpose of this test is to determine the overall quality of lining to brake shoe adhesion with simple hand tools.

Equipment -- Suitable equipment for performing this test consists of a chisel as wide or wider than the brake lining, ground to a sharp edge as shown in Fig. 7, a hammer, and a vise.

Procedure -- The brake shoe and lining assembly shall be held in the vise and the lining removed from the shoe with the hammer and the wide chisel, starting from the end of the lining with the point of the chisel at the adhesive layer. It is important that the flat side of the chisel be held towards the brake shoe, and that the lining be removed from the brake shoe as close as possible to the adhesive line. During the operation, the exact plane of separation should be noted.

Results -- Suggested Standard Classification for reporting Bond Fracture.

Fig. 8 shows the seven possible planes of fracture between the brake lining and the brake shoe. Each of these planes is assigned a number from 1 to 7. The results of this test should report the type or types of fractures encountered, by indicating the appropriate number from 1 to 7, together with the relative areas of each fracture type, expressed as a percentage of the total area, in decreasing order.

SPECIFIC ADHESION CHISEL TEST

Purpose -- The purpose of this test is to determine the physical condition of the adhesive itself in the bonded brake shoe and lining assembly.

Equipment -- The equipment for performing this test consists of a chisel 1/2 in. wide, ground to a sharp edge as shown in Fig. 7, a hammer, a vise, a rough cut file, a stiff wire brush, and a suitable solvent to be agreed upon between purchaser and supplier.

Procedure -- This test may be done as a separate test or it may follow the Overall Adhesion Chisel Test, using the same sample.

All traces of brake lining shall be removed from the adhesive layer in a lateral strip, approximately 1 in. wide, using the chisel, the file, and finally the wire brush. The condition of the adhesive layer should be noted. A finger moistened in the suitable solvent should be rubbed over the adhesive until all of the solvent has evaporated. Any tackiness of the layer should be reported.

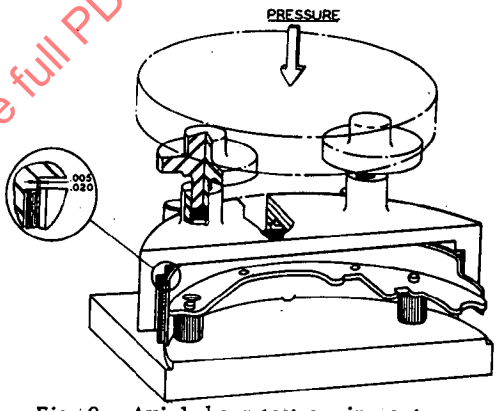
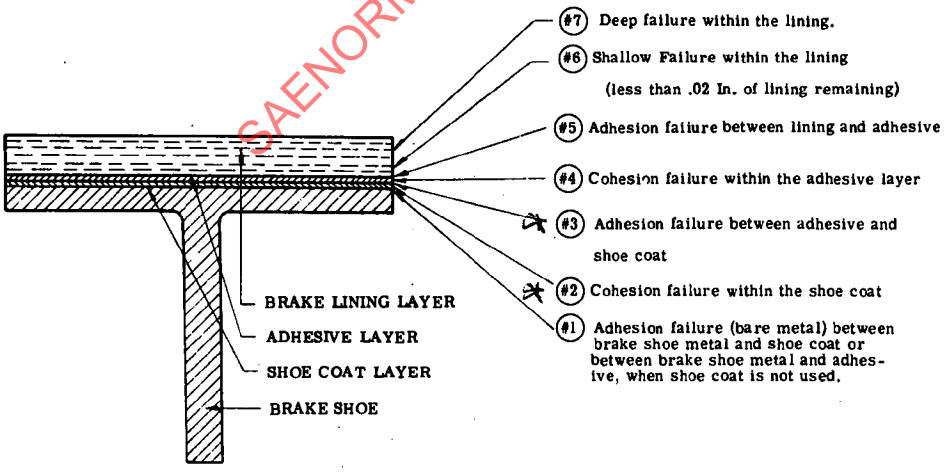


Fig. 9 - Axial shear test equipment



*Eliminate when shoe coat is not used.

To report fracture pattern, examine the destroyed bond to determine exactly where the fracture took place, ie. between the adhesive and the shoe coat (#3), or between the lining and the adhesive (#5).

Should the examination show more than one type of fracture, report, in decreasing order, all of the different types that are present, and indicate their approximate percentage of the total area, ie. 60 #6, 40 #2, or 50 #1, 30 #3, 20 #4.

Fig. 8 - Fracture pattern reporting

Results -- The physical condition of the layer should be reported as to its amount of flow, its wetting to the metal, its continuity or sponginess, and its reaction to the solvency test.

AXIAL SHEAR TEST

Purpose -- The purpose of this test is to determine the lining to brake shoe adhesion under controlled laboratory conditions for the purposes of production control, analysis, and comparison.

Equipment -- The equipment for performing this test consists of a compression test machine of sufficient capacity to shear the lining from the shoe and a fixture adapted to load the edge of the lining for its full length within 0.005 - 0.02 in. of the shoe table or rim in an axial direction with respect to the shoe as shown in Fig. 9.

Procedure

1. It is recommended that 100% of production assemblies be proof-tested. The load shall be built up to the specified value after the ram is in contact with the lining and shall be maintained for a minimum of 1-1/2 sec. No movement of the lining relative to the shoe table or rim shall be permitted. The proof load shall be 150 lb per sq in. of bond area, except that it shall not be greater than 50% of the satisfactory destruction load, as determined in the shear test below. The edge of the lining shall show indented figures as evidence that the proof shear load has been applied.

2. A destruction shear test at room temperature shall be run according to statistical quality control sampling procedure. The shoe shall be suitably supported in a fixture such that the entire reaction load is taken on the table or rim edge when the load is being applied to the lining edge. The shoe shall be held firmly in the fixture so that there is a minimum of shift during the application of load.

The load shall be applied to the edge of the lining along the entire arc length, within 0.005 to 0.02 in. from the shoe table or rim. The punch member that applies the load must be able to pivot to allow load equalization, but lateral shift must be kept to a minimum.

The load shall be applied either hydraulically or mechanically in an axial direction with respect to the shoe.

In order to avoid an impact type of loading, after the punch is in contact with the lining edge, the load must be applied at the rate of 1000 lb per sec or 0.4 in. per minute (depending upon the type of machine), until failure.

3. The bond shall be considered satisfactory provided the following conditions are met:

The shear load shall be adequate as mutually agreed upon by the supplier and purchaser.

Not less than 70% of the intended bond area on the shoe table or rim shall be covered with lining residue of perceptible thickness (see Fig. 8, No. 6 or 7 fracture) or that the shear load is adequate as mutually agreed upon by the supplier and purchaser.

The adhesive is completely polymerized. This can be determined by a hot shear test or by wetting a small area of the adhesive on the shoe table or rim with a suitable solvent. If the adhesive does not become tacky to the touch or cannot be dissolved with the solvent, the adhesive is considered completely polymerized.

No more than 30% of the total intended bond area, nor more than 10% of the total intended bond area within 1/2 in. of each end of the lining, shows bare metal. (See Fig. 8, No. 1 fracture.)

DYNAMOMETER AND VEHICLE TESTS

PURPOSE -- The purpose of these tests is to determine the effectiveness of the bond for any combination of lining and adhesive when the brake shoes have been subjected to repeated rapid temperature changes and to the stresses of shock loading and heat, as may be encountered in vehicle service.

PREPARATION OF SPECIMENS -- Sufficient shoes for dynamometer and/or vehicle abuse tests shall be prepared. If the procedure is intended to be used as an acceptance test for a new adhesive, the heat-freeze cycle shall be 24 hr. If it is intended for a quality control test for a previously approved adhesive, it may be reduced to 2 hr.

The shoes shall be prepared as follows:

1. Soak shoe and lining assemblies in water at 180 ± 2 F for 2 or 24 hr, according to test requirements.

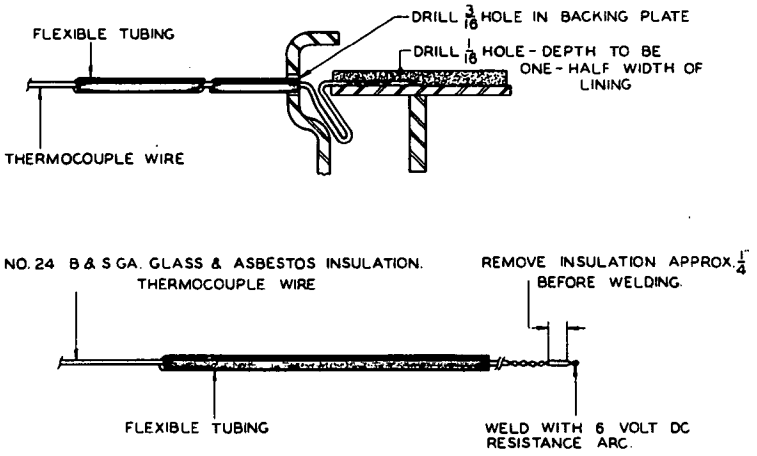


Fig. 10 - Thermocouple installation