The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE STANDARD

SAE J1153

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An American National Standard

HYDRAULIC MASTER CYLINDERS FOR MOTOR VEHICLE BRAKES TEST PROCEDURE

1. ***Scope—***This SAE Standard specifies the test procedure to determine minimum performance and durability characteristics for master cylinder assemblies of current established designs, components of which conform to SAE Standards. It is applicable to new assemblies from commercial production and remanufacture (factory rebuild).

The minimum performance and durability requirements are specified in SAE J1154.

1.1 **Type—**This document applies to both single and dual output master cylinder assemblies used In hydraulically operated brake systems of highway vehicles. It covers such cylinders where they are employed in passenger car, truck, bus, and like brake systems utilizing motor vehicle brake fluids which conform to SAE J1703.

2. ***References***

2.1 **Applicable Publications—**The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

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

SAE J1154—Hydraulic Master Cylinders for Motor Vehicle Brakes- Performance Requirements Test Apparatus

3. ***Displacement Mechanism—***The basic apparatus shall be that shown and as arranged in Figure I or equivalent. All hydraulic lines and fittings shall be of sufficient size as to permit unrestricted flow to and from test master cylinder(s). The apparatus shall operate per the following description and as called for in Section 5. It is desirable to have the test apparatus portable to facilitate cold, hot, and room temperature bench testing.

3.1 The displacement mechanism(s) connected to the master cylinder outlet(s) shall restrict the master cylinder(s) output performance to the shaded area of Figure 2. In addition, the heel of the pressure cup(s) on the piston(s) shall be past the vent port(s) before a pressure of 345 kPa (50.0 psi) is attained. The master cylinder outlet pressure(s) shall rise smoothly to a maximum of 6900 kPa ± 690 (1000 psi ± 100) within 60 to 80% of total piston travel.

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3.2 Stroking Mechanism—The stroking mechanism shall contain a mounting plate to which the master cylinder can be attached. The actuating push rod shall be compatible with the master cylinder piston socket and shall operate coaxially within 2 degrees of the master cylinder bore longitudinal axis. The fixture shall be constructed such that full release of the master cylinder piston is obtained. The stroking mechanism may accommodate multiple master cylinders, if desired.

Means must be provided for the stroking mechanism to stroke the master cylinder both singly and cyclically. For single stroke operation, the means must be capable of generating a minimum 20 680 kPa (3000 psi) pressure in the master cylinder.

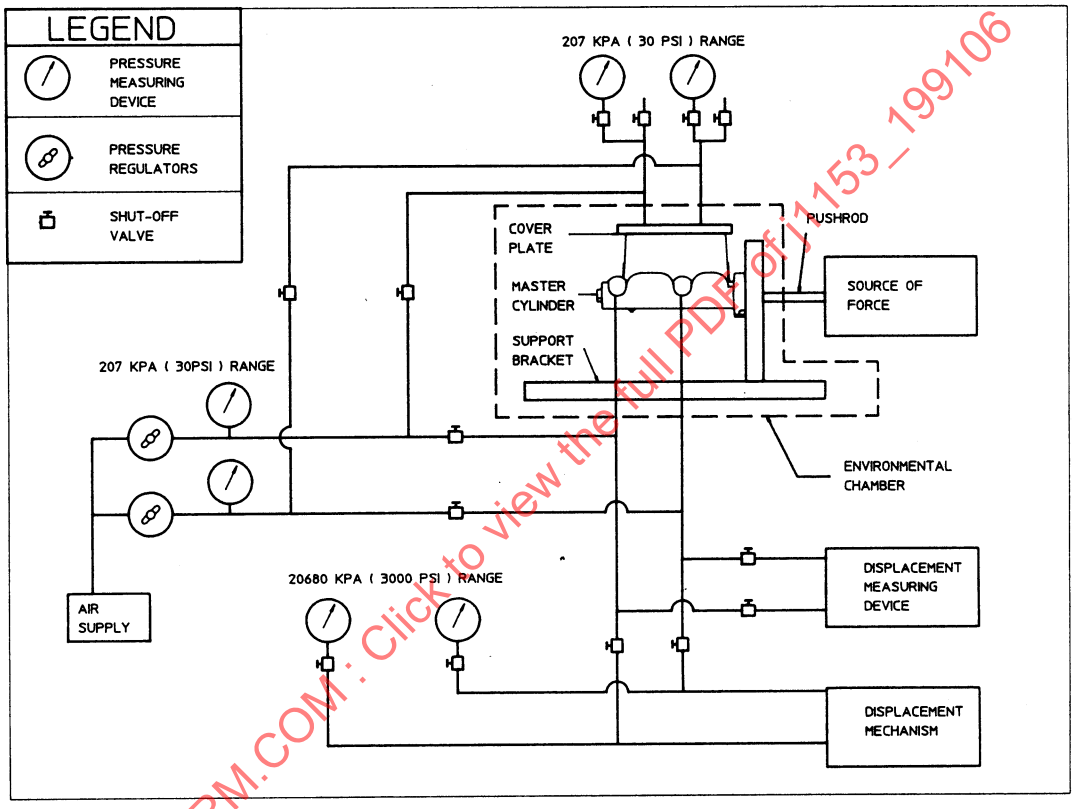

FIGURE 1—TEST APPARATUS

The means shall also be capable of applying the push rod to generate pressure that will provide for full master cylinder stroke and allow holding of a fixed stroke position. For cyclic operation, the stroking mechanism shall be capable of applying the push rod to generate 10 340 kPa ± 690 (1500 psi ± 100), at a rate that can be adjustable from 250 to 1000 cycles/h. The push rod shall be stroked forward at a smooth rate and allow the piston(s) to return rapidly to the retracted position(s). The time cycle shall be adjusted to allow maximum time for forward stroking while insuring that the piston(s) returns to the fully retracted position before the start of the next forward stroke. Means must also be provided for a 207 kPa ± 7 (30 psi ± 1) air pressure source to be applied to the outlet port(s).

3.3 Instrumentation

3.3.1 Two hydraulic pressure measuring devices shall be employed for each outlet port. One shall have a range of 0 to 207 kPa (0 to 30.0 psi) and the other shall have a range of 0 to 20 680 kPa (0 to 3000 psi). Both shall be of a type which require small hydraulic displacement and are equipped with a bleeder and a shut-off valve. Pressure measuring device(s) accuracy shall be ± 0.5% or better.

3.3.2 Suitable displacement measuring equipment shall be provided, accurate to 0.1 cm^3 or better.

3.3.3 Short lengths of tubing with suitable connections shall be provided in order to bleed flow fluid from outlet(s) into reservoir(s).

3.3.4 Proper air fittings with pressure measuring device(s) and shut-off valves shall be provided.

3.3.5 Suitable graduated cylinder shall be provided capable of measuring fluid volumes, accurate to 1 cm^3 or better.

3.4 Environmental Equipment

3.4.1 HEATED AIR BATH CABINET—An insulated oven or cabinet shall be provided having sufficient capacity to house test apparatus fixtures. A suitable thermostatically controlled heating system is required to maintain a temperature of 120 °C ± 3 (248 °F ± 5). Heaters shall be shielded to prevent direct radiation to master cylinder.

3.4.2 COLD CHAMBER—A cold chamber shall be provided having sufficient capacity to house test apparatus. It shall be capable of maintaining a uniform atmosphere of cold dry air at –40 to –42.8 °C (–40 to –45 °F).

3.4.3 HUMIDITY CABINET—A humidity cabinet shall be provided having sufficient capacity to house test apparatus fixtures. It shall be capable of maintaining a relative humidity between 80 and 90% at 21 °C ± 3 (70 °F ± 5) and 46.1 °C ± 3 (115 °F ± 5).

3.5 Test Fittings and Material—Test hydraulic fluid shall conform to SAE J1703. The compatibility fluid of SAE J1703 is recommended.[1] The hydraulic connector to the master cylinder shall be of the type used by the vehicle manufacturer.

4. Test Sample—The master cylinder shall come from one of the sources described in Section 2. It shall not have been used after manufacture or rebuild, and it shall not be disassembled prior to testing.

5. Test Setup and Procedure—Tests shall be conducted in the sequence shown and at room temperature except where otherwise specified. The master cylinder shall not be disassembled until after all tests are completed or unless testing is discontinued.

NOTE 1—When outlet ports are pressurized on dual master cylinders, both ports must be pressurized simultaneously.

NOTE 2—When fully stroking master cylinders which do not incorporate internal stroke limiting means, care shall be exercised to avoid damage to spring(s), retainer(s), cup(s), etc.

5.1 Unrestricted Apply and Release—Remove shipping plug(s) from master cylinder outlet port(s) and stroke the piston through full design stroke five times and allow it to return by the return spring load.

1. Compatibility fluid may be obtained from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warendale, PA 15096-0001.

5.2 Venting—install the master cylinder on the mounting plate and tighten mounting bolts. Make certain that the push rod is properly aligned with the cylinder bore longitudinal axis within 2 degrees. Adjust push rod to allow piston(s) to return to normal release position.

5.2.1 Connect a 207 kPa ± 7 (30.0 psi ± 1) air supply to the outlet port(s). Bore venting will be indicated by air flow from the vent port(s).

5.2.2 Without changing the setup in procedure 5.2.1, stroke the input push rod a minimum of 5.1 mm (0.200 in). Apply 207 kPa ±7 (30.0 psi ± 1) air pressure to the outlet port(s) and observe that no air is flowing from the vent port(s).

5.3 Residual Pressure Valve— For master cylinders with residual check valve(s) only. Release the push rod to allow piston(s) to return to the normal release position.

5.3.1 Cap (both) reservoir(s), apply 207 kPa ± 7 (30.0 psi ± 1) maximum air through cap with outlet port(s) open.

5.3.2 Open (both) reservoir(s) and apply air pressure to outlet port(s) as specified in manufacturer's data for residual valve operation check.

5.4 Applied Leakage—Stroke piston(s) a minimum of 5.1 mm (0.200 in) such that the vent port(s) is (are) closed and mechanically restrain piston(s) from releasing. Apply 207 kPa ± 7 (30.0 psi ± 1) constant air pressure to the outlet port(s). Cap reservoir(s) with pressure measuring device(s) mounted through cap.

5.4.1 Stroke the pistons once to full design stroke at no more than 6.35 mm/s (0.250 in/s) and allow to return to starting restrained position. Record reservoir pressure measuring device(s) pressure after 30 ± 1 s stabilization period,

5.4.2 Remove piston restraint and disconnect air pressure source from outlet port(s). Connect low pressure hydraulic pressure measuring device(s). Fill the test setup with new clean brake fluid to the manufacturer's recommended level and bleed air from master cylinder and pressure measuring device(s) by stroking until the exiting fluid stream is free of bubbles. If bleed screws are present, open for required bleeding then tighten to nominal torque specified by the manufacturer.

NOTE— During the following procedures, 5.4.3 and 5.4.4, allow 15 to 20 s such that the pressure shall stabilize and then record pressure at the beginning and end of a 30 s ± I interval. If the specified pressure cannot be obtained simultaneously in both pressure chambers on any one application of a dual master cylinder, repeat the procedure to obtain the specified pressure for each individual chamber.

5.4.3 Apply master cylinder to build up 138 kPa ± 14 (20.0 psi ± 2) pressure. Hold push rod in applied position(s) and observe pressure measuring device(s) for pressure drop.

5.4.4 Replace low pressure measuring device(s) with high pressure measuring device(s) and bleed. Stroke piston(s) sufficiently for seal(s) to pass vent holes at approximately atmospheric pressure and restrain piston(s). Repeat procedure 5.4.3 for high pressure test of 6900 kPa ± 690 (1000 psi :k 100).

5.5 Fluid Displacement—Suitable fluid displacement measuring equipment shall be connected to cylinder outlet port(s) with shut-off valve(s) between measuring equipment and outlet(s). The cylinder and equipment shall be bled of air before starting test measurements. The cylinder shall be stroked to Its full design stroke for five full applications at 2.5 mm/s (0.1 in/s) maximum velocity with a minimum of 5 s interval between strokes. Close shut-off valve(s) at end of each application and while cylinder is being returned to release position. Make-up fluid may be added to the reservoir(s). The fluid volume discharge from the outlet(s) at the end of each stroke shall be recorded. Calculate and record the average of all trials.

5.6 Replenishing— From the results obtained in procedure 5.5, calculate the variation between each application and the average obtained in procedure 5.5 and determine percentage.

5.7 Physical Strength—Connect high pressure measuring device(s) to outlet port(s). Apply force to develop 20 680 kPa ± 1030 (3000 psi ± 150) pressure for 15 s ± 5.

Observe pressure measuring device(s) for an abrupt decline in pressure and master cylinder for fluid leakage.

5.8 Humidity Operation—Place stroking mechanism with master cylinder mounted and filled with brake fluid to the manufacturer's recommended level into the temperature-humidity cabinet. Connect the displacement mechanism(s) to the outlet port(s) of the cylinder. The system shall be bled and carefully dried of fluid. Set the stroking mechanism to cycle at 1000 apply/release cycles/h ± 100 (3.27 to 4.00 s/cycle). Adjust the input force to the master cylinder and/or adjust the displacement mechanism(s) to stroke (each) master cylinder piston 60 to 80% of its full stroke at output pressures of 6900 kPa ± 690 (11000 psi ± 100). The rate of pressure rise versus travel shall fall within the shaded limits of Figure 2. Stroke 8 h at 46.1 °C ± 3 (115 °F ± 5) temperature and 80 to 90% relative humidity. Cease stroking for 16 h while at room temperature and resultant relative humidity. Repeat this sequence.

5.8.1 Periodically observe master cylinder for fluid disturbance in the reservoir(s) as an indication of venting

NOTE—On dual output cylinders, often only one chamber will give fluid disturbance during venting.

5.8.2 Remove master cylinder from humidity cabinet at the end of the second day (16 000 apply/release cycles and 32 h static).

5.8.3 Remove the pressure line(s) from the cylinder outlet port(s) to the displacement mechanism(s), and attach bleeder loop(s) from the cylinder outlet port(s) into the reservoir(s). Stroke piston(s) five times to full design stroke and allow to return, observing smoothness of stroke and returnability.

5.8.4 Remove bleeder loop(s) and reinstall pressure line(s) from the cylinder outlet port(s) to the displacement mechanism(s). Repeat procedure 5.4.3.

5.8.5 Repeat procedure 5.4.4.

5.9 High Temperature Durability— Place stroking mechanism with master cylinder mounted and filled with brake fluid to the manufacturer's recommended level into the heated air bath cabinet. Connect the displacement mechanism(s) to the outlet port(s) of the cylinder.

The system shall be bled and carefully dried of fluid. Set the stroking mechanism to cycle at 1000 apply/release cycles/h ± 100 (3.27 to 4.00 s/cycle). Adjust the input force to the master cylinder and/or adjust the displacement mechanism(s) to stroke (each) master cylinder piston 60 to 80% of its full stroke at output pressure(s) of 6900 kPa ± 690 (1000 psi ± 100). The rate of pressure rise versus travel shall fall within the shaded limits of Figure 2. Place leak trap(s) under the entrance to the master cylinder bore(s) and commence stroking while raising the temperature of the cabinet to 120 °C ± 3 (248 °F ± 5) within 2 to 6 h.

5.9.1 Periodically observe master cylinder for fluid disturbance in the reservoir(s) as an indication of bore venting. See Note in 5.8.1.

5.9.2 Discontinue stroking at the end of 70 h continuous apply/release cycles. Inspect master cylinder for external leakage.

5.9.3 Remove master cylinder from heated air bath chamber and immediately repeat procedure 5.4.3.

5.9.4 Immediately following procedure 5.9.3, repeat procedure 5.4.4.

5.10 Static Leakage

5.10.1 Immediately following procedure 5.9 (while master cylinder remains hot), disconnect displacement mechanism and plug outlet(s). Cylinder body and area(s) around outlet(s) and seal(s) shall be dry before starting test. Place master cylinder in design position, filled with brake fluid to manufacturer's recommended level for a minimum of 12 h. Observe and measure any fluid leakage.

5.10.2 MASTER CYLINDER IN INVERTED POSITION—Master cylinder with reservoir(s) sealed to the atmosphere shall be tested for reservoir seal leakage by mounting the master cylinder in an inverted position with the reservoir cover(s) on the bottom. Cylinder with vented reservoir cover(s) shall be tes by suitably plugging all cover vent(s). Mounting shall be such that the weight of the assembly external means shall not aid the reservoir sealing. Cylinder body and area(s) around outlet(s) a seal(s) shall be dry before starting test. Allow master cylinder to remain in inverted position filled with brake fluid for a minimum of 20 min. Observe and measure any fluid leakage.

5.11 Cold Temperature Operation—Place stroking mechanism with the master cylinder mounted and filled with brake fluid to the manufacturer's recommended level into the cold chamber. Connect the displacement mechanism(s) to the outlet port(s) of the cylinder. The system shall be bled and carefully dried of fluid. Set the stroking mechanism to cycle at 250 apply/release cycles/h ± 25 (13.1 to 16.0 s/cycle). Adjust the input force to the master cylinder and/or adjust the displacement mechanism(s) to stroke (each) master cylinder piston 60 to 80% of its full stroke at output pressure(s) of 6900 kPa ± 690 (1000 psi ± 100). The rate of pressure rise versus travel shall fall within the shaded limits of Figure 2 at ambient temperature. Place empty leak traps under the entrance to themaster cylinder bore(s), and lower the temperature of the chamber to -40 to –42.8 °C (–40 to –45 °F) within 18 h. Commence stroking after a minimum of 4 h soak at the test temperature.

5.11.1 Observe master cylinder for fluid disturbance in the reservoir(s) as an indication of venting. See Note in 5.8.1.

5.11.2 Discontinue stroking at the end of 20 apply/release cycles. Inspect master cylinder for external leakage.

5.11.3 Remove master cylinder from cold chamber and immediately repeat procedure 5.8.3.

5.11.4 Immediately following paragraph 5.11.3, repeat procedure 5.4.3.

5.11.5 Immediately following paragraph 5.11.4, repeat procedure 5.4.4.

5.11.6 Allow master cylinder to return to room temperature.

5.12 Storage Corrosion Resistance—Disconnect master cylinder at its outlet(s) and plug. With the master cylinder on its mounting plate and the piston(s) in release position, place empty leak trap(s) under entrance to cylinder bore(s) and store cylinder for 7 days at room temperature.

5.12.1 At end of 7 days, examine cylinder for visible leakage. Measure amount of fluid in leak trap(s).

5.12.2 Remove outlet plug(s) and install bleeder loop(s). Gradually increase force on input rod(s) until piston(s) starts to move. Measure and record this force.

5.12.3 Stroke the piston to full design stroke five times and allow it to return by the return spring load.

5.12.4 Repeat procedure 5.4.3.

5.12.5 Repeat procedure 5.4.4.

5.13 Reservoir Capacity—With the master cylinder located in design position, plug the outlet port(s) and remove the reservoir cover(s). Syphon, syringe, or otherwise remove all fluid from the reservoir(s) down to the level of the vent port opening(s). Retain the removed fluid in a suitable clean container for inspection purposes. Using a graduated cylinder, refill reservoir(s) to minimum design level using new clean brake fluid and measure the amount(s) required.

5.14 Reservoir Fluid Depletion—Mount master cylinder in the design position filled with brake fluid to recommended level. Attach line(s) to cylinder outlet port(s) which contain sufficient restriction to pump all usable fluid out of the reservoir(s). Immerse open end(s) of line(s) in a shallow level of clean new brake fluid in a clean container of sufficient capacity. Stroke cylinder until all usable reservoir fluid is pumped into container, saving fluid for inspection purposes. On master cylinder so equipped, remove cylinder cover(s) and gasket(s) and examine cover gasket diaphragm(s) for distention.

5.15 Push Rod Retention—For manual brake type master cylinders with integral push rod only. With master cylinder mounted in suitable fixture, apply a direct (non-angular, non-twisting) tension load to the push rod. This load shall be the minimum load specified by the manufacturer.

5.16 Examination—Remove master cylinder from test fixture, and carefully disassemble it.

5.16.1 Tighten tube nut(s) to the maximum as specified by the manufacturer. Measure and record minimum resulting diameter at smallest opening of hydraulic outlet(s).

5.16.2 Examine parts and fluid for evidence which would indicate imminent failure of the cylinder upon its continued usage in the vehicle. (This examination provides the tester with an indication of how far the test master cylinder would surpass minimum performance and durability requirements for satisfactory vehicle usage.)

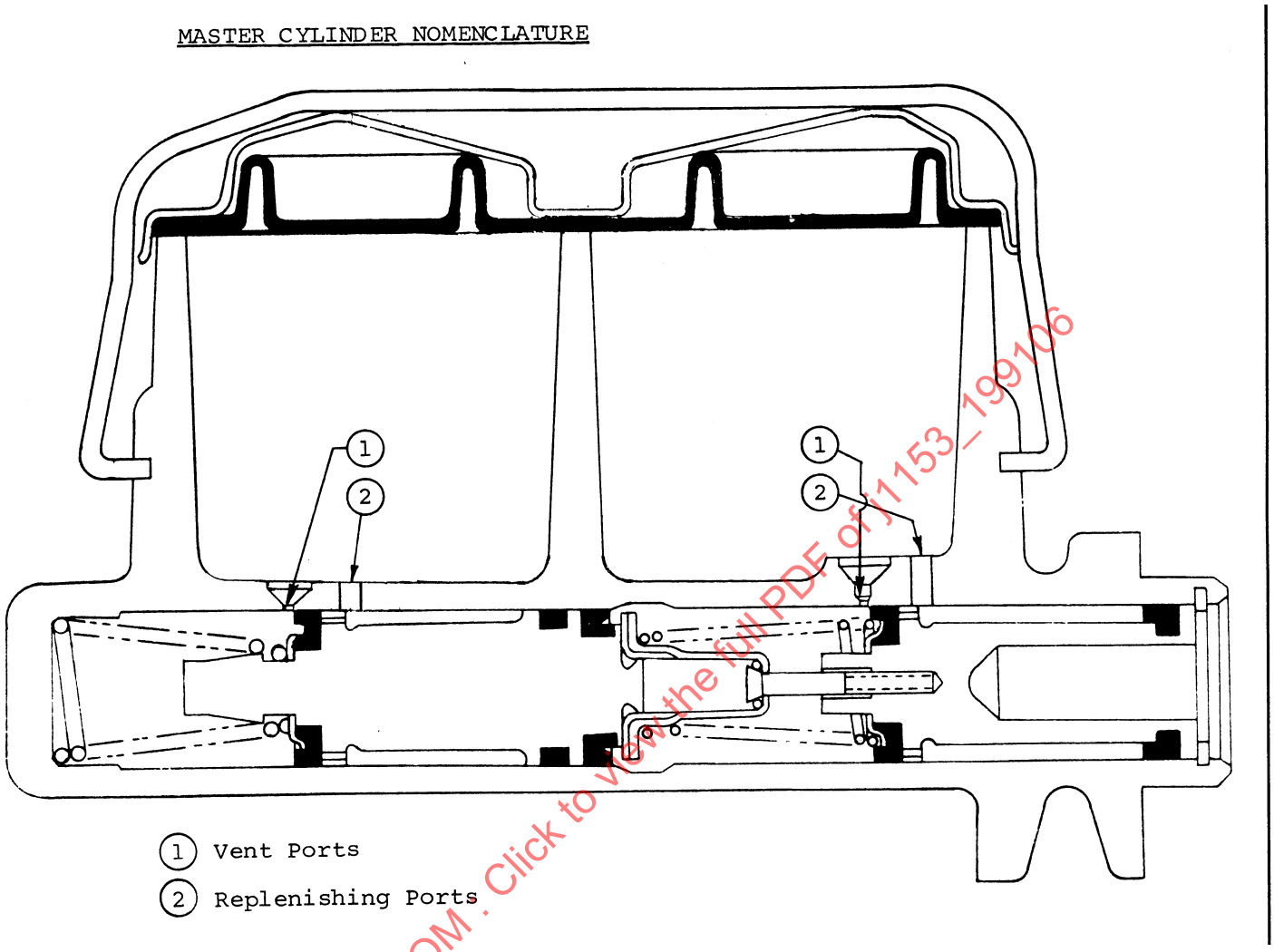

FIGURE 2—MASTER CYLINDER NOMENCLATURE