

Hydraulic Electromagnetic Magnetostrictive Actuator

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Operations Manual

Document

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Figure 1. Magnetostriuctive hydraulic actuator

Description

The purpose of the magnetostriuctive hydraulic actuator is to produce a minute stroke that can be applied to aircraft valve systems. The device utilizes the magnetostriuctive material Terfenol-D, which elongates when exposed to an external magnetic field. In this design, a solenoid is used to generate a sufficient magnetic field. Because the elongation of the Terfenol-D is microscopic, it is amplified through a hydraulic volume manipulation system to be useful.

Safety Precautions

- Do not exceed a voltage source of over 250 volts. The solenoid was designed for 250 volts, however it is recommended that a voltage of 120 volts is used if testing is conducted over an extended period of time.
- Do not handle the iron core-solenoid by hand after immediate use. The amperage running through the solenoid causes the iron core setup to heat up to temperatures that can cause burns.
- Do not touch any exposed wires while the external power source is on to prevent electrical burns
- Check the resistance across the solenoid leads before activating the device. If a resistance of less than 90 ohms is measured, DO NOT activate the device. A resistance below 90 ohms indicates that the circuit is shorted, this short must be identified and corrected before connecting the device to a power supply.
- Do not use near water or any liquid that can conduct electricity

- ❑ Do not pressurize hydraulic chamber past 500 psi to ensure proper results and the smaller piston at end of actuator may project out at a fast enough speed to harm someone past 500 psi.

Assembly

1. The Terfenol-D rod is fitted into the solenoid with the iron core stops on either side.
2. The solenoid (with the Terfenol-D and the core stops inside) is then fitted inside the iron cylinder.
3. The iron endcap is placed on the open end of the iron cylinder over the portion of the solenoid which is still visible. While attaching the endcap, ensure that the leads of the solenoid are fed through the groove in the iron endcap.
4. Place the iron cylinder on the aluminum endcap shelf and simultaneously feed the solenoid leads through the electrically insulated hole in the aluminum endcap. The pre-stress bolts surround the core setup going through two of the unused holes in the aluminum endcap.
5. The large piston is placed on the opposite side of the iron cylinder, away from the aluminum endcap. Make sure that the impact plate is installed into the large piston. The rightmost core stop will be making contact with this impact plate. Once in place, the brass bolts can be threaded into the large piston. This will put pressure on the core stops and hold all of the core components together.
6. This entire setup is then slid into the aluminum housing. The core setup will be slid as far in as possible, where the bleeder valve is placed and the hydraulic chamber is filled.
7. Next the bleeder valve can be threaded in and the hydraulic chamber can be filled with hydraulic fluid.
8. The small piston is the last component to be placed on the device in order to create an airtight fluid chamber. The small piston must be installed in a way which removes ALL air bubbles from inside the fluid chamber.

Exploded view

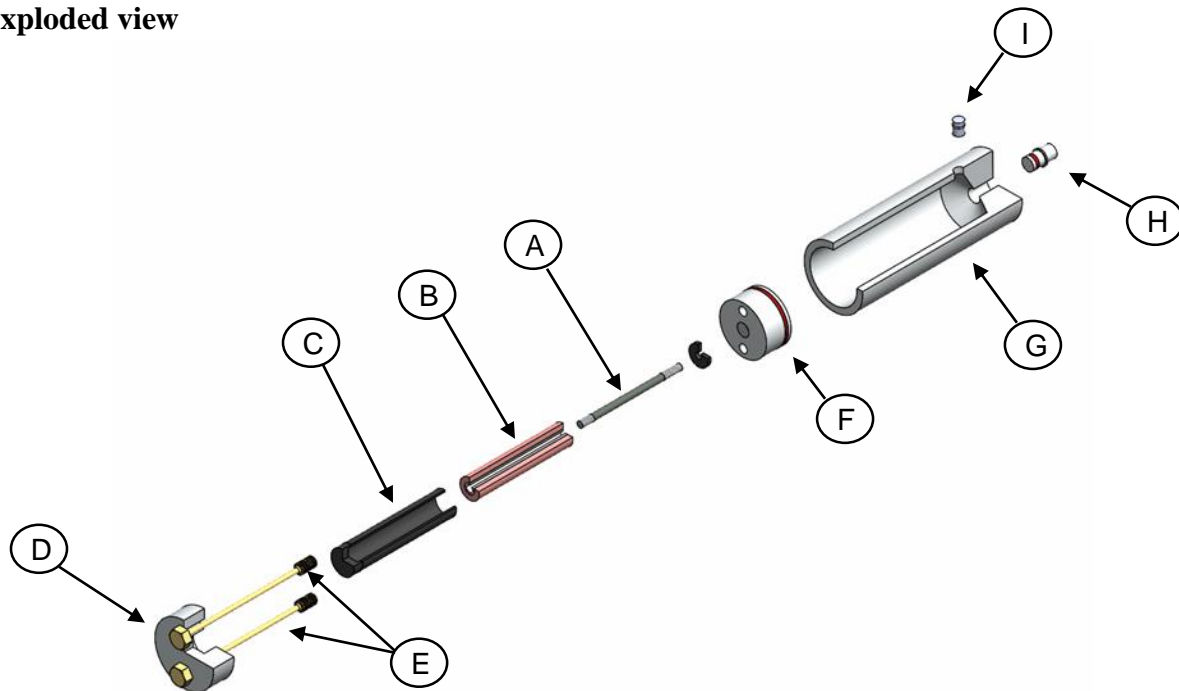


Figure 2. Exploded view of device

Description of Components

A. Terfenol-D & Core Stops - Experience magnetic field, concentrate the field and elongate to initiate actuation. Iron core stops translate pre-stress to the Terfenol-D, communicate the elongation to the large piston, and complete magnetic circuit. Placed inside the solenoid

B. Solenoid - Generates magnetic field when electrical current is applied placed inside iron cylinder

C. Iron Cylinder - Concentrates magnetic field generated by solenoid placed between aluminum endcaps

D. Endcap - Supports inner core assembly and pre-stress bolts

E. Pre-Stress Bolts - Adjustable bolts that compress Terfenol-D core

F. Large Piston - Experiences the initial stroke of the Terfenol-D core and translates it to the fluid chamber

G. Housing - Encloses the inner core assembly and fluid chamber

H. Small Piston - Experiences the stroke magnification and translates the actuation

I. Bleeder Valve - Allows excess air to evacuate when filling the fluid chamber

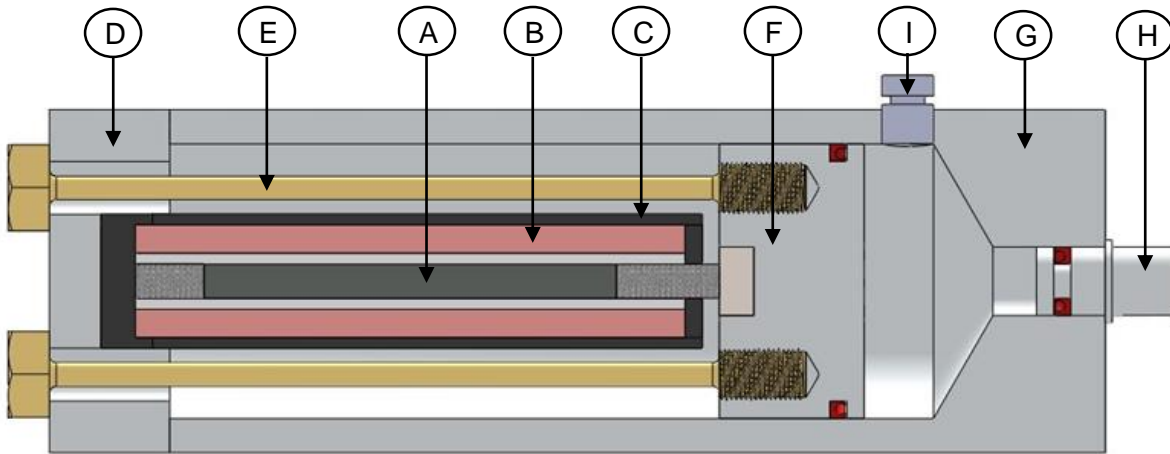


Figure 3. Side view of device

Operation Instructions

Open valve to allow for fluid flow. Place small piston and pressurize hydraulic chamber. Close bleeder valve to assert there is no air in the chamber. Connect leads to switch (which is connected to power source). Flip switch into ON position to experience actuation. DO NOT leave actuator on for more than 30 seconds per use.