History to Houdaille Shocks



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Maurice Houdaille (1880 - 1953) invented the double-action rotary shock absorber that bears his name. Exactly when he began his experimental work is unclear, but we do know that he was far enough along in 1907 to patent the two-vane pressure-balanced rotor. (Possibly because of this patent, some competitive shocks used unbalanced rotors as illustrated here.)

The concentric fluid reservoir, sealed against working pressure by a check valve, was patented two years later. The last definitive patent was issued in 1914 for the striated plugs that vent the working chambers.

The remarkable thing is that the shocks employ no high pressure seals, either at the rotor/body interfaces or at rotor shaft. Sealing is a entirely a function of the precision of mechanical fit. In comparison, a piston-type pump represents a much easier sealing problem, since the piston can be fitted with expansion rings or, as in the case of diesel injection pumps and some model aircraft engines, lapped to fit. It is interesting that the modern Kayaba rotary shock, used on certain Suzuki motorcycles, seals the rotor with elastomer pads.

Designers of most pre-1914 passenger cars assumed that the friction between spring leaves gave adequate damping at the moderate speeds these vehicles were capable of. Sports and racing cars generally were fitted with friction shocks, such as the American Hartford. Frequent adjustments were required to compensate for pad wear and changing driving conditions. Once set, the amount of damping was constant, regardless of the rate of suspension acceleration.

Hydraulic shocks appeared early and, according to one account, were fitted on the Mors car that was declared winner of the aborted 1903 Paris-Madrid race. Some form of sophisticated shock absorber would have been appropriate: the giant 10-liter machine average 65.3 mph for 342 miles before authorities intervened to halt the race. By then, more than a dozen spectators had been killed. In view of its late starting position and the frequent stops for tire changes, the Mors probably achieved burst speeds of 90 mph.

Factory racing teams were among the Houdaille's first customers. The Sunbeam that won the 1915 Isle of Man event and the Benz that took honors in the Paris-Moscow race helped to publicize the new dampers. The French army used them on ambulances and staff cars. By the late 1920's, Houdaille dominated the domestic market. Rolls Royce, which tested its vehicles on the excellent French road system, fitted the shocks

on certain export models. A world-wide network of agents was established to serve the aftermarket. Even the lowly Model T could be retrofitted with the hydraulic shocks.

Today the automotive market has been lost, but Houdaille Lelaurin continues to manufacture rotary dampers for railcars, industrial washing machines and military applications. The Paris-based company also rebuilds shocks for vintage cars.

American Houdaille

Domestic manufacture began in 1915 with OEM shocks for Mercer and Cunningham cars, but soon ended because of the shortage of alloy steel resulting from America's entry into the First World War. A. B. Shutz, a well-known automotive engineer of the period, purchased the rights and resumed limited production in 1919 at his Houde Engineering plant in Buffalo, New York. The first major breakthrough came in 1923 with a contract to supply Lincoln. Pierce-Arrow, Jordan and Sterns-Knight followed.

In 1927 Henry Ford electrified the automotive world by announcing that these sophisticated appliances would be standard on the upcoming Model A. This order alone was worth an estimated 21.5 million units. Another 2 million or so Houdailles would used on the front axles of Model B and V-8 Fords until 1934 The great majority were built by Houde Engineering, although both National and Spicer made complete units and may have supplied wing shafts and other parts.

The Ford contract was followed by orders from Chrysler, Studebaker, Graham Paige, Hudson and Nash.

There are no interchangeable parts in a Houdaille shock, which probably makes it the first mass-produced automotive component to be built in this expensive and, in one sense, retrograde fashion. Rebuilding Houdaille shocks with their custom-tailored parts was not theoretically possible, although some Ford dealers tried.

Houde Engineering conducted a sophisticated marketing campaign that equated shock absorbers with social status. "And you, " said one of the magazine ads reprinted by George Sprotte The Restorer for May-June 1979, "can have this amazing liquid-smooth comfort -- formerly the privilege of the wealthy -- for less than the cost of many make-shift devices." Another company promotion exclaims that Houdailles give "the elite a taste of riding comfort as it ought to be!"

The manufacturer boasted that the "modern perfected Houdaille" with its "watch-like precision" was "hardly improved beyond its basic design." In other words, the product, which had hardly changed since 1915, was too good to require development.

According to a brochure published by Houde in 1929, Maurice Houdaille "went to work in 1909 as an experimental engineer for the Rochet-Schneider Words. His hydraulic device for eliminating the recoil shock on the great 75 mm French cannons

was an idea he further developed for use as a shock absorber on motor cars." The supposed connection was reiterated in magazine advertising.

It is quite possible that M. Houdaille contributed to the later development of the weapon: he was an hydraulics expert and active during the period when France was rearming. But he could hardly have invented the technology, since the field piece was adopted in 1893, when Maurice was still a school boy. Nor does his rotary shock absorber have much in common with the double-piston, air-over-oil muzzle brake. The mention of Rochet-Schneider in the material quoted above may also be misleading, since it would be easy enough for readers to confuse the Lyons-based auto manufacturer with Schneider-Creusot, which did indeed make weaponry. As far as I can determine, there was no connection between these two companies other than the coincidence of their names. Until reorganized in 1908, Rochet-Schneider had been owned by British investors, which makes it even less likely to have been part of the French military-industrial complex.

The brochure concludes with a brief description of the manufacturing process, which was the center of gravity of the whole operation. The immediacy of the account makes one think that some production veteran sat down with the writer and explained what had been done and at what cost:

The simplicity of the Houdaille instrument might erroneously imply simplicity of manufacture. It is a fairly easy task for a good mechanic to complete a piece of work to very accurate measurements, but it takes genius to make another one just like it. And Houdaille production has progressed from a dozen a day to thousands an hour.

Houdaille manufacturing is accomplished by methods and largely with equipment perfected and adopted exclusively to the production of this instrument.... Much of the machinery has been designed by Houdaille engineers. Houdaille's tool-making department is a factory in itself!

A small second floor tool room first housed the lathes, drills and grinders necessary to turn out a few Houdailles. The progress from a dozen instruments to thousands an hour has been logical, steady and inevitable.

The challenge faced by management was to get millions of the high-precision instruments out the door in the shortest possible time. That required organization and dedicated tooling. By the late 1940s, when the market for rotary shocks dried up, the Buffalo plant was able to use its expertise to transform itself into a manufacturer of specialized machine tools.

The emphasis on production probably explains why the endemic leaks were never fixed, why steel-on-steel rotor bushings continued to be used, and why shocks were shipped with glycerin after hydraulic oils became available.

How Houdailles Work

The term "Shock absorber" is a misnomer, since the springs do that whenever a wheel hits a bump. Left to their own devices, the springs would release the absorbed energy in a series of oscillations. Shock absorbers dampen these oscillations by converting the energy stored in the springs to heat.



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The Houdaille absorbs energy by pumping hydraulic fluid across a restriction that simultaneously generates a pressure head and causes the fluid to heat. Most of the heat passes through the shock body mounting flange and into the vehicle frame.

The rotor and stator divide the cavity in the shock body into four chambers, one on each side of the two rotor vanes. Operation consists of pumping oil between two full and partially empty working chambers. The oil passes through ports cross-drilled in the rotor hub and past a the restriction imposed by an adjustable needle valve.

The shock works in both directions of rotation to dampen spring oscillations on joust and rebound. Unless some additional hardware is included, the dampening force is equal in both directions.



Most Houdailles produce more damping force in one direction of rotor rotation than in the other. Model A differential-action shocks generate about 60% of the total damping during suspension rebound and 40% during initial joust.

The pressure differential is accomplished by check valves that open to bypass the needle restriction. < shock P rebound. on close and joust during open valves the have to is idea The rotation. anti-clockwise or clockwise check application, upon Depending>



Differential action gives a marginally better ride, although the improvement is marginal. Few vintage car owners are able sense the difference between 60/40 and 50/50 shocks. At any rate, biasing shock action toward rebound, when the springs extend at their natural and predetermined rate, imparts consistency to the process. Nearly any combination of spring deflection and axle velocity can occur upon initial joust.

It should also be remembered that Houdailles are velocity sensitive because of the turbulent flow across the needle-valve restriction. That is, damping increases in some non-linear fashion with the rate of suspension acceleration. A violent upward movement of the suspension will result in a large damping force even though internal check valves snap open. By the same token, the springs are free of parasitic shock-absorber loads during gentle dislocations. Because body roll occurs fairly slowly, the shocks do little to control it.

Notes on Components

- The threaded lock ring permits the reservoir cover to be positioned correctly and tightened against leaks.
- The adjustable needle valve compensates for minor wear and gives the operator some control over ride quality.
- Fluid leaking around the rotor shaft returns to reservoir via a port in the side of the shaft-bearing boss. Consequently, the reservoir seal has little pressure on it.
- The replenishing valve in inner cover opens automatically to top off the associated working chamber.
- Two bleed plugs in inner cover vent air and gas-off from working chambers into the reservoir. These plugs may function as pressure-relief valves.
- X-pattern oil passages in the rotor equalize pressures on both “wings” to reduce bearing wear.
- One or two check valves, usually mounted in the stator, provide differential action.

Nominal Direction of Rotation

Reservoir covers are marked “CW” or “AC” to indicate the direction of rotor rotation that causes the check valves to open. When viewed from the front, as if mounted on the car, the CW rotors turn clockwise during the upward, and less damped, movement of the axle. The same upward axle movement causes AC rotors to turn anti-clockwise.

CW and AC shock bodies and stators do not interchange, although it is not unusual to find the wrong cover installed or the rotor 180° out of phase. The table below should help clarify matters, at least for Model A's.

Code on Reservoir Cover	**Direction Rotor Turns During Joust**	**Stator/Rotor Check Valve Status**	**Approx. Pinch Bolt Orientation**	**Filler Plug Orientation**	**Shock Installed Location**
CW	Clockwise	Open for reduced damping	9 o’clock	40 deg left of vertical	Right front, left rear

AC	Anti-clockwise	Open for reduced damping	3 o'clock	40 deg right of vertical	Left front, right rear

Houdaille Disassembly

Nearly all Houdaille shocks used glycerin as the working fluid. Think about what it means to apply intense heat to a container filled with glycerin, the oxygen-bearing constitutent of nitro-glycerin.

Thanks to the hydroscopic working fluid, the fine threads and decades of exposure to the elements, most Houdailles require radical, heat-intensive methods of disassembly.

This is unfortunate, both because of its effect upon the metal and because of the real hazards involved.

At least one Houdaille restorer suffered second and third-degree burns when the reservoir cover exploded off a shock he was heating with a torch.

To minimize risk, we have developed the following guidelines. They are offered without a guarantee: in other words, you can do exactly as we say and still get hurt.

- If possible, remove the reservoir cover (sometimes called the outer cover or reservoir cup) before proceeding.
- If you cannot undo the cover, by all means remove the filler plug. Drill out the plug if you have to.
- Loosen the rotor so that it turns a few degrees on its bearing. This should improve the odds that the working chambers vent.
- Wear eye protection and protective clothing.
- Do not heat an assembled shock with a torch. Instead, place the shock in a brazier, barbeque pit, a charcoal-filled hole in the ground, etc., and retreat to a safe distance.

We "cook" the partially disassembled shock in a charcoal fire for three or four hours to burn out the seals and glycerin. Then, following the example of Houston-area shock builder Brian Perkins, we drop the shock into a pail of cold water. Within seconds, a loud "burp" signals that water has gotten inside the unit. The shock is retrieved and, while still too hot to touch, disassembled.

Heating shocks releases noxious fumes. Work in a well ventilated area.

Holding Fixture

You should take the time to fabricate a holding fixture. The fixture, based on a design by George Sprotte, should be mounted with the shock vertical, so that disassembly forces pass down through the vise to the floor. Mounting it horizontally can result in a broken vise. We know.



Reservoir Cover (Outer Cover)

Unscrew the reservoir cover by turning it counter-clockwise with a strap wrench. Apply penetrating oil and lightly tap the part in the vicinity of the threads as it is unscrewed. The lock ring is drilled for a spanner-wrench, although a chain wrench works as well.

Inner Cover (Bushing Nut)

If you look closely, you will see a dimple cast into the inner cover between the two bleed valve plugs. File a notch on the shock body threads adjacent to the dimple as an assembly guide. Upon further disassembly, you will see that the dimple is centered over the stator, with the bleed plugs above adjacent working chambers.

Some inner covers may have four or even six bleed plugs. One theory is that the covers were cannibalized in the field and redrilled to fit. It is also possible that tolerance mismatches forced Houde inspectors to redrill some covers.

The standard inner cover incorporates hex for wrench purchase. You will need a 1 9/16” socket, possibly relieved by grinding to clear the square end of the rotor shaft, a 3/4”- drive wrench and cheater bar combination. We usually get by with a five-foot-long cheater, although there is no rule against using a longer one.

If the rotor is frozen, coax it free by turning it a few degrees in either direction with a large Crescent wrench. Otherwise the rotor may break when the inner cover is unscrewed.

Now the grunt part: with the shock mounted vertically in the fixture, try to undo the inner cover. Have a helper heat the area adjacent to the threads with a propane torch as you apply torque. In extreme cases, it will be necessary to repeat the “cook and quench” process.

Once the cover is off, support the inner cover on a soft wood block and punch the two bleed plugs down and out. Try not to damage the staking that anchors the plugs against chamber pressure. Note the shallow groove in each plug that extends from the lower (tapered) end to the top. Plugs install with the grooves adjacent to the near edge of the inner cover. By some miracle of French engineering, these grooves vent air and gas-off without loss of fluid.

The replenishing valve, which transfers fluid from the reservoir to the working chambers, is integral with the cover. Careful examination should reveal the small drilled port on top of the cover, about 180° from the bleed plugs. A retaining pin, the end of which is visible on the threaded edge of the cover, holds the 5/32 inch check ball in place.

The underside of the inner cover directly above the stator should be unworn and relatively free of pitting. A comparison between this area and the surface swept by the rotor gives an idea of the amount of wear.

Rotor (Wing Shaft)

Lift out the rotor and note any damage or other anomalies. Most exhibit pronounced wear at the wing tips and hub/stator interface. Exposure to water results in local pitting and may etch a deep groove at the reservoir seal. Many rotors are solid steel, probably forged by Houde. Hollowed-out, skeletal wings appear to be castings that may have been sourced from outside suppliers.

Shock Body

Shock bodies vary somewhat by model year and supplier. A cursory inspection will reveal if corrosion and/or wear on the ID and floor require machine work to correct.

Differential-Action Check Valves. At least three styles of internal check valves are encountered:

- The most common check valve consists of
- Some late production Houdailles incorporate check valves in the rotor.
- Contract-built units sometimes employ a cartridge-type check valves mounted horizontally in the stator wings.



Stator (Stationary Wing)

The stator should remain undisturbed, unless the shock body needs machine work or cartridge-type check valves are to be replaced. Most rebuilders let these sleeping dogs lie, since few vehicle owners can detect the slight ride improvement afforded by working check valves.

Usual Houde practice was to mount the stator to the shock body with pins. Some contract-built units used tongue-and-groove joints, spot-brazed for security. In all cases, the joint formed by the ends of the stator and the shock-body cavity was made pressure-tight by packing it with lead after assembly.

Either of two methods can be used to extract the stator:

- Drill a 1/8-inch hole in the back of the shock body under each pin. Using a small punch, drive the pins up and out. Holes must be filled with weld prior to returning the unit to service.
- Pull the stator with a pair of 8-inch Vise-Grips with a slide hammer extension welded to the end of the adjustment screw. This method works reasonably well if you soak the area with penetrating oil for a few days prior to disassembly.

The stator footprint gives an excellent indication of wear on the shock-body floor.

Cleaning

Bead-blasting may be the fastest, more labor efficient way to proceed. Lacking that equipment, we generally sandblast the heavy rust from the outside of the body casting and soak the body cavity and other parts in muraitic acid for several hours.

Rebuilding Houdaille Shocks

While it is possible to recreate workable shocks with the techniques described here, a better solution would be to redesign the rotor using modern elastomers as sealing elements.

I say this, yet people have rebuilt these shocks in the past. The photograph below is evidence of that.



As far as I can determine, modern rebuilders limit machining operations to installing a bushing in the inner cover. No attempts are made to refurbish the rotor impeller, stator and shock body, although some rebuilders may substitute parts cannibalized from other shocks. Cost of the service ranges from $60 to $125, which is not unreasonable, considering that the shocks must also be disassembled, cleaned, tested and repainted.

Bushing replacement should centralize the rotor, but does nothing to address wear on the pump elements. Perhaps 10% of the shocks floating around swap meets can be restored to service in this manner. The remainder are too far gone to develop a pressure head.

It is feasible, barely feasible, to recondition every wearing surface on almost any Houdaille. Whether it is economically practical, is another question. George Sprotte computes the cost of a shock built in this way at between $500 and $600. The emotional cost may be even higher, considering the refractory material, the side-tracks to build fixtures and special tooling, and the steep learning curve. Try this and Houdailles will haunt your dreams.

There are various approaches to the problem. In my case, I resolved to contain the madness by making no large investments in tooling or outside services. Metal spray and exotic plastic coatings were out. I would use what I had, which consisted of a 115v MIG welder, a South Bend lathe dating from FDR's second term, a 6-inch rotary table and a vertically challenged Chinese mill.

Basically the project amounted to recapitulating the Houdaille manufacturing process on a minuscule scale and with lightweight tooling. If A.B. Shultz and his Houde company built 20,000 shocks an hour, I hoped to build one a week. Four working shocks came out of the effort.

General

- Make things easy on yourself by selecting good cores, worn just beyond the useable limit. Unscrew the inner cover and try to move the rotor from side to side. Play should be limited to about 1/16 inch. Reject cores that are severely rusted or warped.
- Time spent building fixtures will not be wasted. At the very minimum, you will need a three- and four-jaw chuck adapter for the rotary table so you can switch operations between the lathe and mill without losing the setup.



- Initially I assumed that dimensions could be standardized as they are for rebuilt alternators or starters. This was not possible. Design variations and the mysterious "wandering center" make each shock unique. And thinking about it, it's presumptuous for a rebuilder to suppose he could achieve parts interchangeablility when the original manufacturer did not make that claim.
- Leave as much material in place as possible -- even at the expense of an occasional rust pit or other surface imperfection. Not only does aggressive metal removal increase the work load, at some point, one must become concerned for shock body integrity. A Houdaille is, after all, a pressure vessel
- Fairly loose shocks can develop decent levels of pressure with 50/50 mixture of STP and hydraulic oil. We aim for a sliding fit between adjacent surfaces with the inner cover torqued hard down.

Mounting Flange

The first step is to true the rough-cast mounting flange to establish a datum in that plane for subsequent machine work on the shock body and inner cover. A flat mounting surface should also eliminate distortion when the shock is bolted to the car frame and assist in heat transfer.

One's initial impulse might be to hold the shock body by the OD threads in a three-jaw chuck. Unfortunately, the threads are not even approximately normal to the mounting base, and must have been cut on a different setup than used at other stages in the manufacturing process.

After giving the problem some thought, I decided to make a fixture that would mount flush against the shoulder formed by the reduced diameter of the working chamber wall. The inner cover seats against this shoulder, which sees no wear or corrosion.

The fixture consists of a 2 7/8" disc cut from 1/2" steel plate and welded to a heavy bar. 20 TPI threads, undercut at the outboard end, match those on the shock body ID. A facing cut across the disk assures that the fixture seats flat against the shoulder.

A light skim cut should be enough to true the mounting flange. Do not attempt to clean

up deep corrosion pits or locally shallow areas.

Bushing Installation

All Houdailles, even dummy units fitted to show cars, benefit from a proper shaft bushing.

Rotor Shaft (Wing Shaft) Reconditioning

1. Fill any corrosion pits on the shaft. A small MIG welder using .023" mild steel wire and C-25 shielding gas works well enough, but a DC stick machine would probably do a better job.
2. Chase the upper set of needle valve threads with a 1/2" x 20 TPI bottoming tap. Cut matching threads on a 1/2-inch-diameter aluminum rod about 2" long and install in the end of the rotor shaft. This rod will function as a false center.
3. Mount the rotor by the impeller end in a four-jaw lathe chuck and center to TIR +/- .001." Centering is easier and more secure, if you make a holding fixture. The rotor shaft will be worn out-of-round, which means that the flats the factory milled (however inaccurately) on the end of the shaft represent the best available dial-indicator register.



4. Carefully drill a center hole in the end of the aluminum rod that you previously threaded into the needle-valve boss. The centering hole will not be concentric with the rod OD since the needle-valve boss is never drilled on a true center. But the should be centered with the shaft flats. Recheck TIR.

If you have access to a tool post grinder, use it. Otherwise, take very light cuts with a sharp high-speed steel tool. Remove as little metal as necessary to restore concentricity. George Sprotte points out that the as-new shaft diameter ranges between .9250 - .9255 inch. Standard cylinder-type reservoir seals work for shaft diameters as small as .9000 inch; undersized seals are available for .8750-inch shafts. Maintain the original radius at the shaft/rotor interface.

Bushing Installation

I don't know how Houdaille centered the bushing bore over the working chambers, or how precisely it was centered. Bushing bores are neither concentric with inner-cover OD's nor with internal shock-body threads.

1. Mount the shock body in a four-jaw lathe chuck. A round fixture takes some of the hassle out of centering and is less likely to creep out of register during machining.
2. Center the shock body with a dial indicator. For want of a better surface, I place a dial indicator (fitted with a



mushroom tip) on the internal threads. The thread circle is guaranteed to be warped, and readings must be averaged to attain something approximating a TIR of +/-.001 inch.

3. Install and torque down the inner cover. When the cover can be tightened no further, the bleed plugs should be in the correct position and reference marks, made prior to disassembly, should align.
4. Bore the bushing boss to 1.000” to accommodate a slightly oversized 1-inch OD x 3/4-inch ID x 3/4 inch brass bushing, available from MSC and other tool houses.
5. Remove the inner cover from the shock body. Lightly oil the parts and, using a vise, press in a new bushing from the outboard end of the inner cover. Cut a chamfer on the lower end of the bushing to provide clearance for the shaft/wing radius.
6. Finish the bushing to size on a lathe, with the inner cover torqued down to the centered shock body. Bushing/rotor shaft clearance should be .0015 -.0020 inch.



7. Drill the 1/8-inch bleed port through one side of the bushing.
8. Cut a 1/-inch wide fluid collection groove to a depth of 0.015 inch in the bushing ID and in line with the bleed port.
9. Trim the excess length from the upper end of the bushing and chamfer the bushing to accommodate the shaft seal.

Inner Cover Refacing

Inner covers almost always exhibit some degree of corrosion and wear on the inboard face that forms the roof of the working chambers. But simply skimming the inner cover on a lathe will not do. There are complications:

- The resurfaced cover should torque down to its original position, with the bleed plugs up and flanking the stator. The 20 TPI pitch of the inner threads means that you can remove metal in .050-inch increments without upsetting the initial orientation.
  Note: as pointed out below in "Rotor Impeller and Stator" shock-body or inner-cover threads may have to be sacrificed for the inner cover to make up against the shoulder.
- Unfortunately, the pitting on many inner covers requires more than a single .050-inch cut to remove. Go deeper and you will cut away the retaining pin secures the replenishing-valve ball to the cover casting.

But, not to worry. George Sprotte developed a technique, detailed below, to adapt a grease fitting in place of the replenishing valve.

Resurfacing the inner cover in one of the final operations, done after work has been completed on the shock body.

1. Torque down the inner cover on the shock body (previously centered in a four-jaw chuck) and make a light cut on the raised rim at outboard face of the cover. This helps insure that the subsequent cut on the inboard face is square with the original or refaced shock-body shoulder.
2. Mount the internal cover, inboard surface out, by the hex in a three-jaw chuck. Back the cover into the chuck so that the previously squared surface registers against the chuck jaws.
3. Face off the inner surface of the cover. One revolution of cover threads = .050 inch. Some bronze welding may be required to fill deep pits.
4. Test fit the inner cover to the shock body, torquing it down snugly. Small, clockwise adjustments to bleed-plug orientation can be made with a belt sander. Serious misalignment is best dealt with by plugging and redrilling the bleed plug holes.
   *Note:*The fit of the inner cover will change if shoulder height is reduced to compensate for material removed from the shock floor and/or rotor faces.
5. In most instances, you will come out ahead by replacing the replenishing valve with a straight 1/8-inch pipe thread Zerk fitting. (I have not had much luck with standard 1/4-inch thread plugs.) Cut away the crimp at the bottom of the fitting threads, and extract the coil spring and ball. Turn a brass plug slightly larger than the fitting ID and centerdrill the port. Discard the spring, and assemble the fitting with the ball and plug. Drill and thread the inner cover in the original replenishing-valve position or, at any rate, near the bottom of the reservoir. Start the tap straight with a drill press. Fitting threads should be wrapped with Teflon tape.

Shock Body ID and Floor

Remove the stator as described under "Houdaille Disassembly."

Mount the shock body in a four-jaw chuck, preferably with the aid of a fixture. Register on the internal threads and aim for a TIR of +/-.001 inch. Readings should be averaged to compensate for the inevitable distortion of the thread circle.

The shock body cavity can be milled, although I prefer to use a lathe. A cemented carbide boring bar, applied with moderate cutting force, works for the ID. The floor responds best to sharp, single-pointed HSS tools mounted in right and lefthand holders.

As mentioned before, material removed from the shock body floor must be compensated for by lowering the shoulder, or ledge, which forms the seat for the inner cover. The ability of the inner-cover threads to hold oil pressure limits the amount of material that can be removed. Hogging out the ID may lead to sealing problems and can impact the stator stator mounting arrangement. Less is more, as far as shock bodies are concerned.

Rotor Impeller and Stator

The cleanest, most workmanlike solution to the many difficulties presented by the rotor would be to fabricate a new one from steel billet. Short of that, one must turn down the shaft to accept a new rotor bushing (described above) and render the impeller serviceable. All working surfaces -- upper and lower sides of the wings, wing tips, shaft end, hub OD and hub ID -- should be concentric with the body axis, parallel to the floor and positioned within .001 inch of adjacent parts.

Rotor rework involves use of two lathe chucks, transferred back and forth between the lathe and rotary table. The rotor is held in a three-jaw chuck; the shock body centered in a four-jaw. If the rotor is removed from the chuck for test fitting, its orientation relative to one of the numbered jaws is noted to reduce the effects of chuck runout.

Which parts to overlay with weld and which to machine undersized? My experience suggests that welding should be limited to the impeller wing tips, impeller hub ID (the tooth-like protuberances under the impeller), and the inboard ends of the stator wings. The hub OD and the disk-like pad upon which the rotor rides are milled undersize.

1. Mount the rotor in a three-jaw chuck and make a clean-up cut on the hub ID. Wing tips can be prepared for welding with a tool post grinder or belt sander.
2. Apply a weld overlay. In the opinion of welding specialists consulted, a DC stick machine and any of several high-tech filler rods would give the best results. I tried the lowest-carbon mild steel MIG wire obtainable (good penetration and coverage, but hard) and gas brazing (difficult to apply, heat warped and annealed the impeller), before hitting upon silicon-bronze wire and C-25 shielding gas. Bronze gives good penetration and fair coverage on bright surfaces. Although quite tough, the bead can be machined with sharp tools. As a bonus, a bronze-lined shock will probably outwear every other friction surface on the car.
3. Mount the rotor in a three-jaw chuck and turn down the built-up rotor tips to within .001 inch of the refinished shock-body ID. Trial fit in the shock body and verify that the rotor turns through its full arc without binding. Don't forget to orient the pinch-bolt notch.
4. Without removing the rotor from the chuck, transfer the chuck to a rotary table centered under the mill. Using a 3/8-inch HSS cutter, mill enough material from the hub OD to restore concentricity. Measure hub diameter.
5. Move the chucked-up rotor back to the lathe and machine the weld overlay previously applied to the impeller hub ID. Measure this diameter.



6. Place a piece of abrasive paper on a machine work table and polish the underside of the stator to remove any high spots.



7. Install the stator in the shock body cavity and mill OD of the disc-shaped pad upon which the stator wings mount. We need to establish a .001-inch clearance with the impeller hub ID. Pad thickness

hub ID. Pad thickness will be adjusted later.
Note: Houde machined stator pads off-center, as can be demonstrated by using the shock body as a stator-holding fixture. The eccentricity may have assured correct rotor assembly. We save a little time by machining the pads on center.

8. Clean up the inboard ends of the stationary wings and apply a weld overlay.
9. Using the body cavity as a fixture, mill the overlay applied in the previous step to size. Test fit the rotor over the stator.
10. Verify that the stator seats flush against the shock-body floor. Stator ends may require notching to compensate for the reduction in floor height.
11. Make a vertical cut on top of the stator disc to restore surface finish.
12. Measure the installed thickness of the stator disc. Repeat this measurement on the lower end of the impeller to determine the clearance between the undersides of the rotor wings and body floor.
    Installed Pad Thickness - Rotor Undercut = Distance Rotor Stands Off From Floor
13. Mount the rotor in the lathe and square off the lower surface of the wings, removing metal until the rotor stands off .001 inch from the shock body floor.
14. Square off the upper surface of the rotor wings.
15. Place the rotor in the shock body and measure the distance from the shoulder to the upper surface of the wings. This distance, less .001 inch for running clearance, represents the amount to be removed from the ledge and stator top. I have found it easier to cut the ledge in a lathe and use a mill on the stator.
16. Once shoulder/stator height is correct, torque down the inner cover to verify that it makes up hard against the shoulder. You can use bearing blue to establish the pattern of contact. It may be necessary to compromise sealing by undercutting the inner-cover threads. A better approach (currently under test) might be to install a spacer between the cover and shoulder.
17. Because of the reduction in stator height, it will be necessary to redrill and groove one or both stationary wings for the top-side check valve(s). At present, we convert shocks with side-mounted check valves to 50/50 operation.

Needle Valve

It's a good idea to replace the needle valve and, in any event, to lap the valve tip against the seat with valve-grinding compound. A leaking needle valve invalidates any sort of test of shock action.

As of yet, we have not found it necessary to chase the lower set of needle valve threads, which appear to require a special 3/8" x 20 TPI tap.

Reservoir Cup

Some cups require light machining to restore the seal at the underside of the rotor-shaft hole. Elongated shaft holes can trued by boring, but the diameter of readily available o-rings or cylindrical-type seals limits the amount of material that can be removed.

Conclusion

Well, that's it. Assembly procedures are trivial by comparison. Seal the ends of the stator with epoxy (Houde packed the joint with lead), and top off the working chambers with a 50/50 mix of STP and hydraulic jack oil before installing the inner cover. We use Teflon tape on all threaded connections.

Cycle the rotor a few times before screwing on the reservoir cup to check for leaks at the inner cover, bleed plugs and replenishing valve. Install the reservoir cup, mount the shock vertically in the fixture, fill the reservoir to the level determined by the filler plug orientation, and test. We do not have quantitative data at this time: but a functional shock will bind almost solid with the needle valve seated.

In honesty, attempting to replicate the Houd approach, using the technology available to them, but with lighter and less precise tooling, has not been satisfactory. A better approach might be to redesign the shock internals.

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