Hydrolastic/Hydragas repair.

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- 18G703 tabulated data and repair/overhaul information

    - Mini - various
    - 1100, 1300, 1500, Nomad - all
    - Apache, Victoria, America - all
    - 1800 - all
    - Metro - all 4 cylinder models
    - MG-F - most
    - Maxi - all
    - Allegro - all
    - Princess 2200 - all
    - and many, many more...

Of all the vehicle manufacturer's that have ventured down the fluid suspension path, only one got it right and that's Citroen. Runner up is BMC and its descendants with Moulton Hydrolastic and Hydragas. Citroen's hydro-pneumatic on a bad day is usually compared to good Hydrolastic. It can probably be argued that BMC et al did manage to provide the car of the future (which floats on fluid) to the masses. All the rest, which includes Ferrari, Mercedes Benz, Jaguar and others, had their own array of short and long term problems. Other manufacturer's forays into air suspension have been just as successful.

Much has been written about Hydrolastic and Hydragas. A lot of which is more fantasy than fact. Hydrolastic and Hydragas are nothing new and in no way complex. The following pages are essentially a collation of information that I've found useful over the years. Useful to DIY owner/repairers, potential car buyers and owners wanting/needing to have their vehicle fixed. This paper does not represent repair procedures for any specific vehicle. In every instance, refer to the correct workshop manual for your vehicle before commencing repairs!

Service units:

There are three basic designs of genuine service unit;

A. original 18G703 (Dalek) including the Australian version 18GA703, pressure and vacuum, both no longer available (NLA) new,
B. portable service unit 18G685 (grease gun), pressure only, NLA new,
C. the 1980s replacement 18G703V (rectangular box that sits on floor with one lever on top and a foothold), pressure and vacuum, NLA new,

three after market;

D. typically looks like a cylinder on the floor with a lever on top (Alba), pressure only, also seems to have been sold under at least one other brand name (Taskmaster and possibly UNIPART)
E. essentially a copy of 'C' made by Liquid Levers, available as either pressure, or pressure and vacuum (Hydravac),
F. other proprietary brands such as ENCO, Sterling Hydraulics, Scope Engineering...

and;

G. whatever homebrew creations countless people have knocked up over the years, typically pressure only,

plus;

H. other proprietary equipment that can be used or readily adapted for the task such as; RIGID type 1425 pump.

‘A’ is pretty well as pictured in most BMC workshop manuals. Typically in black, grain finish exterior (Marviplate) and sold through V.L. Churchill. Except for the Australian version, these units are portable. The four legs plug in and are secured by 3/16 bolts and nuts. Once removed, the unit becomes surprisingly compact and remains fully functional. Operating levers (in front) for pressure and vacuum also unscrew for stowage. The Australian version (hammer finish blue) has a local frame with fixed legs and usually two wheels. Gauges are typically by Floyd. Internal workings are UK made, essentially allowing for local content to be applied to the external structure. I suspect these were created by AUSTALOY (Healing Industries), as they were the BMC Australia contracted tool supplier of the time. Some do in fact bare an Austaloy label. Both imported and local versions were sold in Australia.

The 18G703 Dalek design is current through to the early 1980s with the introduction of Minimetro. Within UK production all Daleks are not exactly the same. This is probably indicative of different production runs. Gauge colour, ID plates and specification placards are some of the obvious differences.

‘B’ is decidedly rare. Essentially a grease gun in appearance and operation. However the pump plunger is considerably larger than that of any grease gun. The head assembly also includes a pressure relief valve. These are set to a notional 230 psi. Therefore limiting the unmodified tool to an onsite, emergency role.

‘C’ is a big tin rectangle that sits on the floor. No legs, all controls on top and black finish. From memory, the original item was a Churchill product. Notable in only having one vertical lever and one hose as a result of redesigned valve controls on the main body. Operation is more like that of a Tirfor winch.

‘D’ and **‘E’** are as previously described. At the time of writing both are still available. The brand name problem arises for ‘D’ and as yet I haven’t had chance for close up inspection or serious research in order to ascertain the actual manufacturer. ‘C’ or probably the Liquid Levers version ‘E’, would have been in Australia as a mandatory tool for MG-Rover dealerships selling MG-F. Product evolution is present for Liquid Levers and I believe they no longer support earlier models. They also produce an entry level pressure only version. Essentially the same unit, less the vacuum components. To add a little more confusion, the pressure and vacuum unit only has one hose, two gauges and a gearshift to switch between functions.

‘F’, ENCO is a rectangular floor unit similar to Liquid Levers’ ‘E’. Both the other stated brands (Sterling, Scope) offered an upright box on legs arrangement, with single (jack or grease gun handle) lever on top or to the side and one flexible line.

‘H’ includes equipment that was designed for pressure vessel testing or hydraulic repairs. Typically a manual lever operated pump, gauge and an open trough reservoir. Alternately, aircraft maintenance equipment such as those from Tronair. A variety of small trolley mounted devices with reservoir, gauge and hand pump. Very similar in concept to 18G703.

A, B, C, D, E and F are suitable for use with Hydragas and Hydrolastic. A and B use a quick disconnect (QD) fitting on the pressure side. This makes system repair dramatically easier. I suspect this part may have been custom made by or for V.L. Churchill, as I've not located anything close. Air conditioning QDs (for R12) possess the right concept but are considerably bulkier and don't always have the valve core depression screw. What are generally used today are American made, aircraft grade fittings, with a screw thread connection. Connecting to the system is problematic due to the fine Schrader thread and general valve access. This current design now makes a spanner a mandatory part of the service tool. Whereas earlier units were truly standalone.

The vacuum side of 'A' is also QD but of a different design. Essentially like the flip-lever arrangement found on most domestic tyre pump chucks. The original part clamps on to the valve stem for better sealing. A twist base applies or releases the clamping force. The flip lever only controls the core of the Schrader valve.

Which service unit to buy?

Despite the international nature of Hydrolastic/Hydragas and the wide diversity of applications, there is little support today for the service equipment. Essentially it's everyone for themselves. Some people have claimed to offer certain parts as direct replacements but in most cases this is little more than hype. Major service (seal) kits are NLA and no one has created replacements. As per service bulletin ST 41 (29 June 1964);

- Major repair kit for pumps, 18G703A
- Minor repair kit for connectors, 18G703B

For today's user and prospective buyer; age and neglect usually mean that the vacuum side will not be working. Most sundry fittings will also be broken or missing. Any example of 'A' you locate today will probably be knackered. You have more chance of being struck by lightning than finding a fully functional 18G703. Primary pump seals for the vacuum and pressure sides of 18G703 can be found from specialty seal and pump outlets. However to fit correctly, the brass retaining plates of both pumps need to be machined, or replaced with bespoke items. Essentially the crush depth of the new seals is different. Just trying to locate inch measure Dowty washers (not metric sold as inch, which don't seal), can be a time wasting endeavour. Excessive linkage wear, corrosion and perished reservoirs are also common features of surviving 18G703 units. There is a considerable amount of plastic in each unit. Plastic that doesn't like a protracted environment of alcohol, oily hands and UV light exposure. Liquid levers still offer parts for their later products and a rebuild service within the U.K. Though I doubt too many people have the forethought to be acquiring reserve parts stock for the future.

Having serviced and rebuilt genuine V.L. Churchill units in the past, I can clearly state that the would-be buyer is better off saving up for a brand new Liquid Levers item. This even includes the cost of international freight. Trying to properly repair most of what's wrong with the average classic unit is extremely expensive. For all pump designs, sedimentation of the fluid (essentially contamination) will cause filter

blockages. Certain fluids have more floaty-bits than others. To make it worse, what comes out of many older cars isn't always bright green. I now have two pumps; one for my own cars and one for everyday dogs-body Hydrolastic vehicles. My 18G703 and 18GA703 both contain several new, inline fuel filters;

- one on each of the two return lines in to the reservoir and,
- one on each of the two outlet lines from the reservoir.

I also keep spares on hand in case of blockage. If the hose is not translucent then the filters need to be clear. I'd further suggest removing the factory gauze strainer at the bottom of the reservoir. They are a bugger to access at the best of times. Hence, you may well encounter older units which have most of their panel work missing. Internal repairs are not complex but they are time consuming.

Using the Australian example, Hydrolastic ceased in 1972. New service units didn't reappear until the late 1990s with MG-F. Even then, they appear to have been limited to mandatory dealer purchase and nothing more. So far I haven't seen any of these in private hands. Other markets continued through these years with anything from Apache to Victoria. Thus new pumps continued to be available and evolve. Grandmother's pump, which she never used and polished every Sunday do pop up. Though it is more likely that you'll find; a well used, never maintained, ex-dealership unit that ended up in the local garage as a general purpose shelf for brake fluid bottles. In the case of my second Austaloy unit, a drill stand. The placard and top panel having multiple partially drilled holes.

What to buy today will most probably be influenced by why and how many times you want to use the unit.

A. 18G703 (any older genuine pump):

Personally I wouldn't turn down any reasonably priced genuine pump, if only to salvage for parts. However I recognise that I will be buying a problem and nothing more. As I already have an 18G703 I'd like to keep it alive, even if at the expense of other units.

B. 18G685:

Very few out there. Pressure only and really needs to have the limiting valve replaced with a gauge to improve usability.

E. Liquid Levers:

Expensive, unless you are in the UK. Factory rebuild service and parts support is a big plus. My choice would be to buy new, new or new. If you are considering used, then check with the manufacturer to see if it's a model they still cater for. Whatever you do, don't penny pinch and buy one without vacuum. Otherwise you could have bought an 18G685 copy.

The present day Hydravac (combined unit) can be a little disappointing to view. Especially if you remove the inspection cover. One common pump and a reservoir that looks like a screen wash bottle with a hole punched in the side.

One flat steel operating lever with sawn-off bolts and Nyloc nuts. All in a powder coated, folded tin case. The valve block is what's special. From the outside it's a miniature gear stick. Essentially a sliding/rotating shaft in a ported aluminium block acting as the valve body.

Presumably the non-vacuum version (a visually similar unit) has a straightforward valve or tap in place of the valve block.

G. Home-made (with the exception of recent 18G685 copies):

I haven't encountered any home-made unit that hasn't been a; one-off, scrap iron, improvised, pressure only, 'creation'. If they are such a god-send and not a penny pinching short cut, why did no one start producing them? Take from this what you will.

Home-made 18G685 (typically advertised on the internet in recent years):

So surprising that no one was doing this sooner. If you intend to use this more than once then expect to spend another $200 AUD replacing all the cheaper parts (gauge, flexible line, end fitting...). Not a bad 'get out of trouble' answer but no vacuum. I take one of these on long trips. If the system is empty, expect to spend quite some time pumping before pressure even indicates on the gauge. Grease gun pistons tend to be rather small and displace little volume. Whereas the real 18G685 piston isn't far off that of 18G703.

There are some excellent electric vacuum pumps available today as a result of automotive air conditioning. Affordable, efficient and many have a trolley mount option with reservoirs. Many of which could be readily adapted to the wet suspension role. Further adaptation with a pressure pump could make a modern, all in one vehicle service unit. The fact that such affordable options are ignored, typifies why most home-made pumps are generalised under the one-off, scrap iron title.

The ingenuity and operational simplicity of modern air conditioning service units really addresses all the problems of filling fluid suspension;

- the need for vacuum as already mentioned,
- one reservoir for new fluid,
- one reservoir for what fluid's in the vehicle,
- a scrubber unit to try and reuse what's come out of the vehicle,
- waste collection for what can't be reused, and
- a straightforward control system to switch between all these areas.

Concepts, problems and equipment which are ignored. Again reinforcing why most home-made units are generalised under the one-off, scrap iron title.

Instructions:

Despite over thirty years of production, it would seem that Rover Group never standardised procedures for wet suspension. Typically, later training publications consolidated the diversified instructions for various vehicles or components, into one generic approach. Fluid suspension appears to be the exception. Mini shop manuals don't cover pump maintenance whereas Maxi does. F and Metro (K Series) introduces the concept of settling time and ambient temperature variations. Fluid types continue to evolve as the years pass by... but still no reflective approach to a common design. Not even a compiled specifications chart to hang off the side of a dealership pump.

I would certainly recommend having the period correct shop manual for your vehicle. However this needs to be supplemented with the later in-service changes to specifications. Such information continues to evolve, even after vehicle production ceased. Service bulletins are usually the best source of updated data.

Owner's handbook for your vehicle:

READ IT! What more can be said. The amount of owner dramas that have been caused by owners failing to take the simplest of actions cannot be comprehended. The handbook includes at what speed and distance the car can be driven, in the case of suspension failure. There is no need to abandon the car in the extremely rare instance a problem occurs.

Service:

Apart from checking trim height and inspecting the system for damage, there are no scheduled service procedures for Hydrolastic or Hydragas.

Pre-repair inspection:

This is usually where the whole thing falls down. Most wet suspension faults are owner diagnosed. With the misconception that 'pumping the car up' will fix everything, they book the car in. Few repairers actually challenge 'owner logic' and usually just add fluid and take the money. What should occur is a full inspection of the steering suspension and brakes. Most ride faults will be found in the remainder of the suspension and not specifically within the fluid/gas components. Common 'actual' faults are usually in the knuckle joints and suspension arms. These components are covered well in Death through Dehydration (Paget, 2010).

Repair:

Any mechanical faults need to be addressed first. This may well require the system to be deflated to enable repairs. In which case you'll need a service unit to complete the repair but not to start or perform them. If this work involves anything to do with the knuckle joints, then you should look at applying shims in order to reduce the final operating pressure (refer to your shop manual or service bulletins).

The reuse of old displacers is always a gamble. No guarantees can be made before, during or after. This is one of several age related issues that aren't covered in the manuals or subsequently reviewed by BMC et al or Moulton. If you are pressurising

for a client you may need to beat this into them beforehand, lest they start pointing the finger of accusation afterwards. Just getting up the street on the test drive is a gamble.

The rest comes down to common sense and therefore commonly ignored. Anything to do with a Hydrolastic displacer, then have spare dust boots on hand. Not so much a problem with Hydragas but early Metros (Minimetros) aren't equipped and should be. So retrofit where required.

Anything to do with displacers then expect the knuckle joint. Anything to do with knuckle joints then expect the arm. New knuckle joints should always be inspected for grease content before installation. Their stem should be plastered with an anti-seize compound. This is now moving into the solely mechanical area, so refer to the other material as referenced and/or you workshop manual. Age and previous ignorance may well see the job blowing out, so be prepared from the outset!

Wear PPE, at least latex gloves and glasses. I also use two clean, cotton sheets for every repair. For Mini this gives you something to lie on. With everything else you now have guard and paint protection. These are washed after every use. They are specifically not manky, contaminated, never cleaned, foam backed plastic guard covers that many workshops typically leave lying around, if they have anything at all.

Sudden leaks (catastrophic failure):

Most of us notice immediately when our car droops and start looking for leaks straight away. We may not spot the exact point but can narrow down the general area; open the bonnet, look under the car, front, rear, left, right... The system contains several pints of chemical and corrosion enriched fluid to spray out over the vehicle and ground. A look at workshop manual pictures can further narrow the likely cause if still not obvious.

Some of us do seem to be able to not notice their car listing for a week or three after failure. Stains from the fluid will still remain. Though not dripping in front of you, tell-tale marks can still be followed back to their source. One way to confirm the fault is to re-pressurize the system and observe for leaks. You may not possess a service tool but can get around this with a tyre pump. Unless you have a constant supply of air, find someone else to keep pumping while you look. Air and any remaining fluid should be expelled from the opening.

Knowing where the leak is can help predict required parts, down time and cost. Being prepared means being back on the road quicker and keeping your car alive for many more years. As expressed elsewhere, expecting the bare minimum is a false economy. Standing around admiring how half full the glass is doesn't stop the leak, it just reserves your spot for viewing the next problem.

Evacuation:

In addition to what your workshop manual states, I have found the following useful. Wear gloves and safety glasses! Due to the contamination issue, I have;

- an old clear plastic bottle,
- length of fuel hose,
- several old fuel filters that still flow, and

- a conventional tyre chuck, assembled in that order as one tool.

Simply remove the valve cap, press the chuck into the stem and allow the car to deflate. Hold in position until no more escaping pressure is found (fluid or air). This will allow some of the contaminants to be removed. You can then decide whether you want to reuse the partially filtered fluid. I guarantee some clients won't be bothered.

The design of the Schrader valve should allow you to remove most of the fluid and air from the system with this method. The weight of the vehicle needs to be applied to all connected wheels at the same time for this to work. If you are intending to perform mechanical repairs, there is no need to create a void.

Vacuum:

In addition to what your workshop manual states, I have found the following useful;

- Wear gloves and safety glasses! Also,
- sample the system's contents before you connect.

Your service unit only has one reservoir! You may have filled it with nice new fluid but whatever is in the vehicle is about to be mixed in. Don't forget that the original Dalek design requires the top of the vacuum pump to be lubricated.

The pump should be filled with SAE10 oil through the filler hole with the pump piston at the top of its stroke (Svc. Bul. ST41). With a little practise you can get by without a vacuum pump. If you know air is in the system and don't have vacuum, fill the system as explained. Then rapidly deflate the system into a catch tank similar to what has been expressed in 'Evacuation'. Continuing to hold the chuck in place will let most of the air vent with the last of the fluid. Repeat as required.

Simply having all road wheels on the ground (displacers fully compressed) and holding the valve open (fully depressed) will vent most of the system. If you are still intent on purging the system without the factory service unit, then visit your local tool store or automotive parts supplier. Either can sell you an affordable, hand held, mechanical vacuum pump and a replacement hose for a tyre pump. The hose with its crimped-on, flip-lever connection can be readily adapted to the generic vacuum pump. It may take a little while but you will eventually purge the system.

The notable advantage with the genuine tool and some air-conditioning service units is the valve system. Once vacuum is established, the operator simply uses the valve to;

- close the vacuum circuit, while vacuum is maintained,
- open access to the reservoir and allow vacuum now in the vehicle, to draw in fluid.

Therefore when you disconnect at the vehicle's coupling, little or no air should be drawn in. You then disconnect the vacuum line, fit the pressure line, bleed the pressure line and begin filling/pressurizing.

If you've gone as far as purchasing a vacuum pump and connector, it doesn't take much more to plumb in valves and reservoir. Any clean, clear plastic container will suffice. It does become a handful but is certainly DIY achievable.

Flush:

This isn't a factory procedure but realistic considering the age of the average system. Wear gloves and safety glasses!

Follow 'evacuate' as above then pressurise with clean, clear methylated spirits. Evacuate again and inspect the expelled fluid. Repeat this process with clean fluid until you are happy with what's being expelled. At this point you can apply vacuum if available and then move on to pressurising the system with new suspension fluid. Clean, clear meths is compatible with either water or alcohol based suspension fluids.

After being driven you may find that the fluid has darkened with contamination. A certain amount of debris will have coated the insides of the displacer and has only started to dislodge with operation. A small amount of fluid also remains in the system regardless of how much vacuum is applied. Either drain and repeat the flush procedure or accept this as normal and wait for the next repair to flush and replace the fluid again.

If you are having your car repaired after major work or restoration, then consider paying extra and have the suspension flushed. Be realistic though. You will have to force your repairer to do so and this includes you supplying the ten to twenty litres of clear new meths, two clean buckets and a funnel. Remembering that an unmolested factory service unit contains one only gauze strainer. Even specialist workshops will typically have only one working unit.

Purging the pressure line:

The original pump and fittings allow you to purge the fill line before you inflate the vehicle. Otherwise you will force air into the system! A bleed screw (knurled knob or 'T' handle) is fitted just before the Schrader connector. This is covered in your shop manual.

If you have replacement line fittings such as the currently popular aircraft grade connector, the bleeder may not be present. Liquid Levers don't fit this to their pumps or replacement lines (though a screw is present). The alternatives are;

A. Holding your finger over the connector's end while pumping, should allow you to purge. Your finger acts as a one-way valve and pressure is not adequate to penetrate the skin. Once fluid flow is constant, quickly connect to the vehicle.

OR

B. With the screw-on type connector; unscrew the core depressor fully and connect to the Schrader stem by three turns. The majority of the connector should be obviously loose. Rapidly pump to purge the line, while fluid is still dribbling tighten the fitting to the Schrader valve's stem.

OR

C. If fluid pressure is still present in the vehicle; connect your line and open the pump's valve. Screw in the core depressor and allow the vehicle to purge the line in reverse. Close the pump valve while fluid is flowing.

Pressure:

In addition to what your workshop manual states, I have found the following useful;

- Wear gloves and safety glasses!
- Allowing for the age of the average vehicle I would have already put shims on each knuckle joint so as to reduce the final operating pressure (a mechanical repair not covered in this paper).
- Weight of the vehicle needs to be applied to each connected road wheel. Otherwise there is a possibility that some suspension components may disconnect while suspended and unpressurised.
- Confirm actual ride height and pressure specifications with the latest workshop manual/service bulletin before you start.
- A nominal amount of fluid and pressure will be lost as you disconnect from the system.
- If the ride height ends up notably higher than it was before you started, you will probably have upset the steering geometry. Therefore a wheel alignment will be required once you've finished.
    - Probably more representative of reality, if ride height is corrected from an owner fantasy to a correct measurement, then a wheel alignment will definitely be required.
    - In a front wheel drive application, toe will have changed from toe-in to notable toe out, tending to make steering overly sensitive.
    - Though entering a completely different area, if a wheel alignment is required, the OWNER should ensure that the steering rack, column, steering wheel and controls are centralised, before seeking alignment. Straightforward tasks that tend to be beyond the scope of many repairers.

If you have the original workshop manual for your car you may well find that the specifications are out of date. Most of the range has had in-service changes to specifications in subsequent years. Similarly, if there is a pressure placard on top of your 18G703, many quoted pressures were superseded before the pumps were delivered.

After mechanical repairs (including replacing a displacer), components may need to be guided in to place. Regardless of whether you have confirmed their position already, things can, do and will move. Of note are the knuckle joint's stem in to the foot of the displacer and flexible hoses against the body or frame.

Scragging:

This is a factory term you'll find in your service bulletins. Intended for when a new (unused) displacer is fitted so as to stretch the flexible components. Requiring the unit to

be over-pressurised to 350 PSI and left for at least sixty minutes. Then re-adjust pressure/trim height to normal readings before the test drive. This was in August 1966 for any vehicle and the notional overpressure may well have evolved as years passed.

Regardless of new or used components, the vehicle has to be flexed before taking measurements or passing judgement. Essentially grab the roof gutter with clean hands, midway alongside the car. Rock the car vigorously! This will allow the car to settle and let you to take trim height measurements. The vehicle needs to be on level ground with correct tyre pressures and normal kerb weight.

This is difficult on MG-F as there's nothing to grab hold of. In which case refer to the shop manual and roll the car forward and backwards.

Test drive:

If you have to slow down to negotiate your driveway then the car is too low. Go back and check the actual specifications for your vehicle!

After warming the engine and an initial timid drive to confirm all is OK, make the system work! Drive the car as hard as you possibly can with spirited acceleration, cornering and braking. Settle down before you return to the garage and try to glide to the final halt. Otherwise the last tab of the brakes may upset the car's resting position. Scragging or rolling the car backwards and forwards can be used to settle the car. At which point you need to recheck ride heights. If adjustment is needed then repeat the previous steps as required and recheck again. If all is good, then inspect for leaks and move to clean up.

Note, later manuals state the vehicle should be left for at least two hours to cool and settle. Then check trim height and correct as required. It is assumed but not stated that the floor needs to be absolutely level. This isn't being overly fastidious and shouldn't be disregarded. However allowing for the age and wear on the average car, you can be a little less precise. I would favour the level floor over cool off time in every instance.

Clean up:

Wear gloves and safety glasses! Fluids may cause staining/discolouration to vehicle paintwork. I fit clean cotton sheets to surrounding areas before commencing work. A bucket full of clean warm water and dishwashing liquid will deal with most spills. Having a clean rag and car polish on hand is also worthwhile. You will have at least left paw prints on the bodywork from trying to balance yourself while connecting to the system.

Fluid:

I haven't found any of the suppliers (including MG-Rover) providing MSDS with their products. Not that any of them should be overly hazardous to your person but I wouldn't go bathing in it. MG-Rover eventually made this information available through their website. While it's still available, I'll use and stock genuine, genuine and genuine parts.

Despite various published claims people have made about what the formula was, none acknowledge that there were several fluids. At one point BMC had two available at one time; one for normal use and another for competition. As with vehicle specifications, fluid evolved as the years passed. Add to this what the oil companies and other manufacturers were selling at various points in time and anywhere around the world. Most of the big names have ceased production, though the odd 'mystery brand' product still pops up. So back to my point, while genuine is still available... This isn't cheap and once you have a price you'll be less likely to want to mix your new fluid with the rancid muck that comes out of the average Hydrolastic vehicle. I have experience of two cars that were filled with brake fluid!

Some of what was available in Australia:

- BMC/BMC-A, (BL et al), fluids under various part numbers, all NLA,
    - SFY3 – Original Hydrolastic fluid (dyed blue) HYL2936
    - SFY3A – As above with extra lubricant (dyed blue)
    - SFY4 – Heavy duty fluid (dyed fluorescent green) HYL3478
    - Competition fluid – HYL3460
- Golden Fleece suspension fluid, NLA,
- Penrite suspension fluid, NLA unless you wish to order 10000 litres or more,
- The mysterious 'Suspension Fluid Type B', (green 20 litre drum) NLA,
- MG-Rover suspension fluid – clear concentrate (add water) NLA in Australia, and
- MG-Rover 4Lt (bright green fluid).

WARNING. Castrol manufacture a bright green hydraulic (oil) suspension fluid. This typically comes in a white plastic pint bottle with filler tube. This is a hydraulic oil for the ancillary hydraulic system in Jaguar XJ40. This does operate the suspension, brakes and steering in XJ40 but has nothing to do with Hydrolastic or Hydragas.

System faults:

Hydrolastic has one common problem throughout most of the range. This is an age related issue. Corrosion attacks the swaged connection between the flexible hose and the displacer. Quite literally the hose ends up blowing off. Due to the pressures involved, a high pressure hydraulic repair needs to be made. As this fitting (swage) typically sits in a recess, you need an offset chuck to install a new one. Such tools are rare. Surprisingly, a lot of hydraulic repairers are too narrow minded to see another option. The displacer can be threaded to accept screw-on fittings and a new flexible hose made to suit.

A swage is a tin ring, which is crimped (squished) in place with a big tool. This is not unlike how electrical terminals attach to wire. The rim (lip) at the top of the displacer stops the average tool from fitting in place.

Hydragas tends to fail between the upper and lower halves of the displacer casing. Though not immediately apparent there is a join in one of the folded recesses. Such a leak can cause a gradual or dramatic fluid loss. Slow leaks may even allow the car to be re-pressurized to normal ride height without an evident fail point. Given time of course…

It is also possible for any vulcanised part of a displacer to suffer sudden catastrophic failure but this is far from normal. Other problems are model specific such as front hoses on the 1800 range rubbing on the body. Age of course affects each and every displacer. Any assurances your supplier might give about a part being 'new' needs to be taken with a pinch of salt. You have a choice of used, used, or if you can find one, unused old stock. Production of Hydrolastic and Hydragas units ceased years ago. As the system ages, increased fluid pressure is required to attain the correct ride height. Hence the need perform proper inspections, mechanical repairs and shim procedures, to try and obtain the best compromise between pressure and ground clearance.

Displacers are also known to squeak. This is in addition to any noises the remainder of the suspension may have and there is no definitive cure. It will however need to be a pretty quiet car on a smooth road for you to notice.

It would be possible for someone to build a bench test unit for displacers but to what end? All this would achieve is a one off, static pressure test. The first bump the suspension encounters multiplies forces through the displacer. How many bumps before the bag goes bang is anybody's guess. Therefore a reasonable external examination is all that's possible. This again reinforces the need to have the client in the correct mind-set before committing to repairs.

Owner problems with reality, too frequently become repairer's problems with clients. Other silly problems occur with the simple nature of Schrader valves. Having a valve tool, cores and a bag of caps on hand, is well worthwhile.

Interconnection:

Where fitted, this will either be rigid or flexible lines. Early Hydrolastic cars are known to have encountered pipe damage on rare occasions. Rigid steel pipes typically run under the floor of the vehicle, exposed to any obstacles they may encounter. The rigid pipe is either pierced or crushed between road debris and the floor. Spot or small section repairs were and still are possible with the use of generic pipe couplings. Essentially a joiner, olives and nuts appropriate to the size of pipe used. A pipe cutter, smooth file and spanners are the major tools required to effect repair. Post 1968 Australian Minis were the only model to really address the matter of protection.

You are more likely to encounter pipe damage from poor panel repairs, corrosion or other workshop inflicted damage. In the case of Minimetro rear lines, they are no more difficult to manufacture than brake pipes. This line, complete with new fittings should be replaced whenever any damage is incurred. Most wet vehicles use significantly larger pipe diameters, however the manufacturing principles are the same. Exceptions are the Schrader connector on 1800 and other models. This 'T' piece appears to be silver soldered (or similar) in series with the line. Threaded joints are usually tapers and pipe fittings are fairly generic. There is no need for sealant but I would recommend some form of thread lubricant, especially with ageing components. Pipes are of course secured to the body and insulated at the same points.

Mystery brand lengths of high pressure plastic tube with loose fittings are sold as 'replacements' for the original steel pipes. Although this tubing is capable of achieving

gentle bends, how it is secured in place is somewhat unexplained. This is essentially a short cut repair for the cheaper owners who are unwilling to remove sub-frames and source or manufacture the correct steel item. MG-F relies on preformed semi-flexible lines. In the rare case of failure or damage, either purchase a new or used genuine part, or default to your nearest hydraulic shop to have a copy made.

Once more, tapered joints are present and these only have to be tight enough to seal and no more. MG-F uses a small ‘O’ ring at each displacer. These aren’t mentioned in the shop manual and don’t come with new displacers.

Advice:

What to do if you have, or are contemplating a vehicle with wet suspension?

1. Forget all the twaddle and nonsense people insist on proffering about wet suspension. I'm afraid that verbal opinions will probably lead you astray and are generally worth the paper they are written on. If you want to learn about Moulton suspension, then do your own proper research.
2. Perform a proper mechanical inspection as covered elsewhere in this paper.
3. Perform as proper an inspection as possible on the wet components. (If required, adjust the suspension settings to as correct as possible to allow the vehicle to be driven).
4. Test drive the vehicle and drive it as hard as you possibly can; hard acceleration, hard cornering, hard braking. There is NO Moulton equipped vehicle in good condition, that won't relish this driving style.

The car of the future floats on fluid. If you haven't driven or been a passenger in one before then go and find one. Contacting any relevant car club should get you a ride in a car with little effort. If the car you are offered can't comfortably drive at speed (not crawl) over any anti-tank obstacle your local authority uses for traffic calming, then politely ask for another. Anything from F to Princess won't have a problem if the suspension is in good condition.

One consistent comment I get from new/prospective owners is 'how hard the ride is'. My response is always; 'how many other wet cars have you driven?'. The reply is always 'none'. Which brings about the on going issue of the uninformed, comparing the features of their current model, everyday drive car, with the used classic. Suspension is always a compromise between handling and comfort. There is NO Moulton equipped vehicle that doesn't handle.

Rules of thumb:

As a quick check of ride height:

- Drive shafts should be horizontal and not on an upwards slope towards the outer CV joints.
- You should be able to easily slide one or more of your fingers between the upper bump stop and top front suspension arm.
- Using fingers as a unit of measure, you should be able to get a minimum of two between the top of the correct sized tyre and the wheel arch, at the engine end of the vehicle.
- If you have trouble negotiating your driveway or local traffic calming device, go back and check the ACTUAL specifications for the vehicle.

Wet vs. Dry:

Another area where fiction is more prevalent than fact. This option is only available to Mini or F.

In the case of F, steel coil springs were produced for F series racing in place of Hydragas. I'm not sure of the manufacturer. Essentially this is a stiffer arrangement with less wash than the wet alternative. They don't appear to have been offered by Plus Parts (formerly Special Tuning) for road use. However you could probably argue the point to your local transport authority if you choose to convert. Presuming that you can prove who made the original part and that yours are the same. NONE of the aftermarket versions I have encountered make any direct reference to legal road use.*

Similarly, the steel coil alternative has been available to Minis for over a decade. From what I gather, all such kits are targeted at Minis that already have dry suspension. They are not intended as a wet to dry (steel) conversion. Once more I haven't seen any brand that makes all the necessary declarations for legal road use, anywhere in the world. I haven't tried any of these in order to make a ride comparison.

Mini also has the rubber option but to perform this conversion properly is rather involved. Both sub-frames are structurally different. A wet front can be modified but the rear would require a dry donor unit for (welded) structural changes. Most conversions tend to be more than a little half hearted. The legal and safety aspect is a current day concern. Unless done to the letter, any wet to dry conversion can be considered unsafe and illegal. Conversion shortcomings basically come down to work ethic issues. In Australia, owners still fantasise that they will be able to find a perfectly serviceable, used dry car for parts. This is thirty years after local Mini production ceased.

The potential is there for the owner/repairer to convert to dry with all new parts (including sub-frames). This would create a fix and forget situation. Something that can never be achieved with wet. In the late 1970s rubber springs were redesigned for increased comfort. These remain as the only genuine MG Rover spring available today. Moulton did design and release his own revised version of rubber spring. However I haven't read any notable long term reports on their use. Moulton, in his later book Bristol to Bradford-on-Avon (2009), avoids age issues with wet and dry and doesn't mention the revised rubber spring.

With the exception of certain competition use or sustained towing, dry has no benefit over wet. Hydrolastic Minis can have a wash affect under brakes or acceleration. Competition parts are available to control this without any notable loss of ride comfort. Minimetro can have a high speed issue with corrugations; the car can try and skip sideways. Speed reduction is the quick and probably smart fix. Otherwise the system can be modified to run the rear displacers independently.

If the car of the future doesn't float on fluid then it definitely rides on rubber.

*Steel coil alternative for F only, in Australia only.

- I certify vehicle modifications in Queensland, Australia. While looking for unrelated information in the Transport Bulletins that the State government doesn't disseminate very well, I found one only F reference. This stated that one only brand of steel coil conversion was legal for F only, in Australia only.
- I haven't physically encountered the product to pass any judgement. However the way the bulletin reads, without exaggeration; the local travelling medicine man sold the government a wonder cure for an illness that didn't exist. The medicine man was granted a warrant as a result.
- The bulletin's wording may well represent the simplest way to get approval but it just doesn't read well to anyone that knows anything about Hydrolastic or Hydragas.
- Providing that you intend to use this one only approved brand, in Australia only, you can prove that the parts are this brand, fitted correctly, with no other problems with the vehicle, then the modification should be approved.

Competition parts:

Various genuine parts were available to change the characteristics of wet suspension. Over the years the names have changed; Special Tuning, ST, Plus Parts... However many of the items are still available as reproductions or N.O.S.

BMC and its heirs were unusual as a car manufacturer, in entering so many of their products in motorsport. Therefore competition parts exist for most wet suspension vehicles. A general purpose smart choice is to replace your standard bump stops with Aeon units. Though notably larger, the Aeon item is hollow and assists in reducing roll and wash, with nominal degradation of ride comfort. At the other extreme, many parts were never intended for road use. Similarly many never went into production and were virtual one-offs, such as vehicle mounted pumps; 18G685 for Mini and 18G703 for Maxi.

Schrader valves:

One of the oldest pieces of automotive technology. For the purpose of service or repair these can be considered no different to the ones on your road wheels, save for their rigid metal stem.

Although rare, valve cores have been known to fail once disturbed. Having a couple of spares and a fitting tool on hand is worthwhile. Both being available from your local automotive store for a nominal sum.

Genuine Schrader valve caps have at least two distinct designs within our scope of production. Both are similar, non ferrous and notably larger and egg shaped compared to the typical tyre valve cap. After Hydragas had progressed to fixed, non removable outer stems, caps appear to change to that of generic, stainless tyre valve caps with a knurled out finish. Regardless of style, the caps have a purpose and should always be replaced after removal. As with tyres, expect to encounter many missing caps, therefore have spares to hand.

Other relevant papers by this author (suggested reading):

- BMC Australia Cooper S, suspension, steering and brakes, 1999.
- BMC Australia Cooper S Mk. 2, suspension, steering and brakes, 2001.
- Death through Dehydration, 2010.
- Hydragas for Dummies, 2010.
- Another 1800 Metro miles, 2011.
- Queensland Transport Vehicle Modification Approval Scheme, 2010.
    - Now replaced by NCOP and QCOP

Recommended reading:

- The owner's handbook/passport to service for your vehicle.
- Crossroads Alice, journeys with gelignite jack. Evan Green 1965 (out of print).
- How to Modify your Mini. David Vizard (HP Books or Haynes).
- BMC Australia, Service Bulletin ST32 (16/04/1964), leg reinforcement.
- BMC Australia, Service Bulletin ST41 (29/06/1964), fluid circuit repair.
- Hydragas Register website.

If you have an original Dalek I strongly suggest you obtain a copy of Service Bulletin ST41 (or equivalent). This contains some very useful information and schematics. There is one typo however. Each service unit contains three 3/16" stainless steel balls (one above and one below the pressure pump plus one below the bleed screw for the pressure line). The service bulletin incorrectly states these as being an impossibly small 3/64".

Of the pumps I've had apart, I am yet to find one that has both pressure pump valves present. This hasn't appeared to impede operation. What I did eventually realise is that both banjo fittings are machined to accommodate the brass ferule that accompanies the stainless ball. Other detail points not covered include thread forms. Pressure seal retaining plates are secured by three, 2BA round head, slot screws. Not 10-32 as a Fitter once insisted, despite me identifying that these bind after two turns.

Part numbers:

- 18G685 Portable service unit
- 18G703 Service unit V.L. Churchill
- 18G 703 Service unit Healing Industries (Austaloy)
- 18G703A Major repair kit for pumps
- 18G703B Minor repair kit for connectors
- 18G703C Conversion kit for wheels and handle, probably Australia only
- 18G703C Pressure connector (Rover/Churchill publications)
- 18G703F Vacuum connector (Rover/Churchill publications)
- 18G703X Service unit with trolley wheels,
    - probably by Healing Industries/Geo. H. Sample & Sons (Austaloy)
- 18G703V Service unit V.L. Churchill (Rover/Churchill publications)
- 18G703Q Service unit Liquid Levers, pressure and vacuum
- Service unit Liquid levers, pressure only

Also listed:

- 18G682A Major repair kit for pumps and connectors
- 18G682B Minor repair kit for connectors only

There are some part number discrepancies depending on the reference material you are using, (VLC, BL, AR, Service bulletin…) and the publication date. I suspect the two above are a VLC typo. The workshop manual for MG-F illustrates an 18G703V but titles it as an 18G703Q. Which is correct or whether VLC made suffix Q as well, I haven't been able to establish.

Genuine replacement parts were available such as the flexible hoses. However the part numbers are unknown. Essentially it was a case of make it the problem of your tool supplier.

Other repair tools:

What I keep in a little bag alongside the pump unit and have on-hand for any fluid side activity:

- Schrader valve tool,
  - cores sometimes leak
- valve caps – any type,
  - either missing to begin with or I manage to lose them during the repair
- valve cores,
- pliers,
  - valve caps don't always like coming off by hand
- 6" shifter,
  - MGF trim panel
  - the modern fluid connector needs to be tightened on to the stem
- small/fine slot screwdriver,
  - MGF trim panel
  - F owners tend to be too cheap to want to pay for replacement of the often missing trim fasteners, so I don't carry any
- tape measure (dual reading), and
- carry bag,
  - such as a pencil case for all of the above.

Clean white cotton sheets, disposable latex gloves and head torch are stored somewhere else but something I now reach for automatically.

Time, motion, money, reality:

Another area in which opinion is rampant. Almost always with no facts or thought in support.

I allow one hour for a trim adjustment of any wet vehicle. Therefore one hour of my time, plus materials used (fluid, disposable PPE) and cost of owning and maintaining the equipment. As this is only a trim height adjustment the vehicle is just sitting low, has no other apparent faults, is holding pressure and fluid input will be nominal (circa one pint).

- Preliminaries; grabbing the box (milk crate in my case) of tricks, checking that it's all there and enough fluid is on hand. Adding two clean sheets from the pile and PPE (rubber gloves).

- Dealing with the vehicle involves many of the steps covered in this paper. Connecting to the vehicle, bleeding the line, pressurize, measure, repeat for the other side, disconnect, test drive, check for leaks, repeat any or all of these steps for final settings, test drive and measure again.
- You can save quite a few minutes if you have the original QD line fittings in serviceable condition.

- Clean up the vehicle, which will at least include a few paw prints and hand back to the owner.

- Reconcile; clean up the mess, sheets in the wash, restock on fluid and gloves and pack everything else away for the next time.

Extras:

- A proper inspection of the vehicle's suspension and associated components prior to commencing work. Jack, wheel chocks, PPE, written report… The critical point often being what is the actual cause of low ride height. Easily thirty minutes.
- Evacuate means you have to suck down and hold a void for several minutes. Another ten minutes plus added to the job.
- Flush means inflate and deflate repeatedly. I guarantee you will be sick of this after thirty minutes. Unless it's an MGF, the clear meths you are pumping in will still be coming out brown. Plus the additional time and cost of clear spirits and emptying and cleaning the pump beforehand. Then you're back to the point where you can evacuate and pressurise.

Some readers might want to pause and think about what they're actually getting for the bargain basement price on offer from certain providers. Or before professing what prices are too dear. How much value do you place on your time?

Footnote on tool manufacturers:

Churchill (V.L. Churchill, VLC et al) exists until the late '80s or early '90s, when they are replaced by CARTOOL. I'm not aware of CARTOOL manufacturing either direct equivalent or their own interpretation of Hydrolastic tools, save for general Mini suspension items etc. CARTOOL is in turn superseded in the 21st century but again with no apparent supply of Hydrolastic specific tooling.

In Australia Churchill was distributed through Healing Industries, manufacturers of Austaloy tools. Local content substitution as described in the main text ensues. Tools are initially supplied from a central office but then through state outlets. By 1970 Healing has changed to Geo H. Sample & Son Pty. Ltd. as both Churchill Suppliers and Austaloy manufacturers. This is alluded to but not confirmed by bulletin ST 4/68. Tools still being available through state offices. Though more correctly these are authorised outlets and not company offices. I am unclear what was involved with this change. By 1973/74 Austaloy is replaced entirely by Litchfield Tools. I haven't found any evidence of Litchfield making or selling any Hydrolastic equipment. By this stage of course wet suspension had been dropped from local production. I haven't been able to establish whether other countries such as South Africa were organising similar local tool production.

In the main text I have referred to 18GA703. This was used purely to differentiate units and make readers think, it is otherwise incorrect. As the Australian made part was a direct replacement for a UK tool (with no improvements), it would have been listed under the normal UK part number as per many other Austaloy products. When reading BMC-A service/technical bulletins it is unclear as to which manufacturer they are referring. Save for the introduction of 18G703 which is a Churchill tool, covered in bulletin ST 30.

The introduction of 18G703X with its standard wheels and trolley handle is covered in ST 9/65. This unit should be Australian produced, along with the conversion kit for earlier models 18G 703C. There is a previous bulletin (ST 32), which refers to reinforcing the removable legs of the Churchill unit. As yet I haven't encountered any Austaloy pumps that do not have fixed legs. There is however BMC-A induced confusion from lack of detail in what information they did make available.

By 1970 a repair service eventually became available in Australia. Units could be returned to Geo. H. Sample & Sons Pty. Ltd. (ST 2/70). As yet no information has come to light as to what was involved;

- level of repair,
- final finish,
- modifications, changes,
- identifying marks...

18G703 tabulated data and repair/overhaul information:

Common

- Vacuum valve
  - Saunders diaphragm type, ¼”
    - cast aluminium body, BSP female threads
    - replaceable diaphragm
    - drive pin securing rotating, cast aluminium handle
      - There appears to be an evolution in handle retention. Either a parallel sided roll pin or tapered solid pin. Making handle, pin and shaft items all specific.
    - mounting screws, 2 of 2BA x 5/8 round head, slot, zinc plated, attaches and seals directly against left hand side panel
      - Some replacement valves are equipped with Cheese Head screws.
    - operating handle is painted yellow
    - Later replacement valve assemblies can be found with black plastic handles and Cheese head screws. Fittings are similar to but not 2BA as with the originals.
- Vacuum pump
  - machined brass body and end caps
  - blued steel connecting rod with brass piston and single Hallite seal; 1-1/2 x ¼ 14411
    - either BSF full nut, or
    - special brass half nut securing piston to shaft
      - There is evolution in the pump’s piston and seal. Early units have a thicker seal and appropriate piston.
      - This eventually changes to the 14411 seal. Piston, connecting rod and nut change at the same time.
  - 2 of ¼ UNF x ½ set screw, zinc plated
  - 2 of translucent Alkathene (plastic) washers
    - 43mm OD (1-45/64”)
    - 30.5mm ID (1-13/64”)
    - 1.5mm thick (1/16”)
- Pressure valve
  - Braemar - S.T.G. PTY LTD cast brass body tap
    - Braemar still exist. In industry terms, this is a Braemar, bronze, flow control valve. ¼ BSP female at both ends.
  - 1 of 2BA brass nut securing cast aluminium, black, rotating handle with disc placard identifying open/close direction
- Pressure pump
  - machined brass body
  - single stainless steel piston

- single Hallite seal and plastic spacer/spreader mounted in body
  - replacement seals come as a kit or set (17352)
    - Spreader (base), end and a series of interlocking seals which are fitted as required to arrive at the correct thickness. This won't match the original thickness and will require the pump's brass cap to be machined.
- 3 of 2BA x ½, round head, slot, zinc plated
- 4 of ¼ UNF x ½, set screw, zinc plated

- Inline valves
  - 1 of free floating, pentagonal valve, vacuum pump inlet, Paxoline type material
  - 1 of free floating, pentagonal valve, vacuum pump outlet, Paxoline type material
  - 1 of 3/16 stainless steel ball, free floating, with short brass restrictor at pressure pump inlet
    - banjo bolt is machined to accept the restrictor
  - 1 of 3/16 stainless steel ball, free floating, with longer brass restrictor at pressure pump outlet
    - outlet fitting is machined to accept the restrictor
      - the double ended brass fitting is the same as the one connected to the Saunders valve
    - it is a little unclear whether a ball is actually fitted here, though its presence doesn't appear to negatively effect operation
  - All internal line valves are free floating accompanied by a flow restrictor. There are no springs to apply constant tension or maintain positive sealing. In case of the vacuum pump, the restrictor is incorporated into the pump's base and outlet fitting.
  - 1 of 3/16 stainless steel seating ball, with 'T' handle screw on quick disconnect pressure fitting
    - This seems more of a replaceable seat arrangement for a bleed screw, than a valve

- Reservoir
  - Integral, circa five litre/ one gallon capacity
  - top fill
  - level check through viewing aperture in rear panel
  - loose fit in cradle
  - vented lid
  - 2 punched holes fitted with:
    - brass fittings for hose attachment, 3/8 BSP external, ¼ BSP internal
    - 2 brass 3/8 BSP thin nuts
    - 4 of translucent Alkathene (plastic) washers
      - 32mm OD (1-17/64")
      - 16.6mm ID (21/32")
      - 1.5mm thick (1/16")

- Fluid joints
    - 14 of 1/4 BSP, self centring Dowty washers
        - 3 at reservoir inlet
        - 2 at reservoir outlet
        - 3 at vacuum pump
        - 4 at pressure pump
        - 2 at vacuum valve
            - the 2 washers at the Saunders valve, may be fibre or Dowty
- Fluid lines
    - high pressure, translucent plastic tubing, 3/16 ID, 5/16 OD (NOT metric)
        - vacuum line to vehicle, circa 2 metres
        - vacuum line to gauge
        - pressure line to vehicle, circa 2 metres
        - pressure line to gauge
    - both lines stowed on two hooks at the rear of the unit
    - low pressure, clear plastic tubing, ¼ ID (OD varies), secured with either 'O' (crimped-on) clips or swaged connections
- Filter
    - 1 of gauze strainer micro-filter, soldered into banjo bolt at reservoir outlet
- Lubrication
    - vacuum pump
        - SAE10 mineral oil
    - pressure pump
        - Hydrolastic fluid
    - initial assembly of both pumps
        - Molybdenum disulphide grease
- Schrader valve connectors
    - pressure
        - twin claw, external latching, with outer sliding lock-ring
        - central, screw in, valve core depressor
        - female ¼ BSP hose fitting is to the side of the connector
        - an inline bleed screw with loose 3/16 ball seat, screws into the side of the connector, this is a separate fitting complete with 3/16 barb for the plastic tube
        - brass storage bung, on chain around plastic tubing
        - black plastic identification sleeve loose on line
    - vacuum
        - RENRUT Universal Connector
            - by W. M. Turner (KISMET) Ltd. Sheffield
        - rotating outer attachment ring
            - this compresses the sealing section to the Schrader valve instead of actually screwing on
        - flip lever valve core depressor
        - supply hose fitting on side of connector

        - brass storage bung on chain
        - yellow plastic identification sleeve loose on line

    - present day fitting
        - if supplied in a SCHRADER box, then the fitting alone is under the Schrader part number 2755
            - Schrader 2755 High pressure inflating connector
            - Note that there is no mention of ‘low loss’
            - You will still need to obtain additional fittings to adapt to your existing lines

VL Churchill

- Panelling and frame
  - black, grain finish Marviplate over zinc-seal/zinc-alum steel sheet
  - panels attached with 6g x ¼ self tapping screws
  - stowage hooks for pressure lines attached by pop rivets (two each)
  - all steel frame with detachable hollow tube legs, satin black paint over raw steel
- Carry handles
  - front and rear attached by 2 pop rivets each
- Instruction placard (plastic)
  - 4 of pop rivets
- Removable legs
  - 4 of 2Ba x hex head, set screws, zinc plated
  - 4 of 2BA nuts, zinc plated
  - 4 of spring washers, zinc plated
- Feet
  - 4 of 3/4" diameter, black rubber stops
- Pivot points
  - headless clevis pins
  - 'E' clips
- Gauges
  - black or white faced VENTURE gauges
    - Black faced (early)
    - White faced for remainder of production
  - pressure gauges 0 > 400psi dual scale
    - I have seen pictures of white faced gauges with a 600psi scale but haven't been able to examine them or locate any data
    - Needle rotates clockwise
    - some gauges are equipped with an inline brass fitting containing stainless steel ball and spring valve
      - probably to control gauge reading in relation to pumping action
  - vacuum gauge 0 > 30" HG scale
    - Dual reading
      - inches of mercury/millimetres of mercury, or
      - negative inches of mercury/bar
    - Needle rotates anticlockwise

AUSTALOY

- Panelling and frame
  - hammer finish blue paint direct over bare sheet steel
  - front and rear panels may have provision for carry handles (three 1/8 punched holes per handle)
  - top panel in two pieces, gauge facia and reservoir cover
    - a third (tin ring) filler panel may be present if the model has a steel reservoir
  - stowage hooks for pressure lines spot welded to rear panel
  - panels attached with Pozi-drive, mushroom head, self boring thread screws, zinc plated (close to 4BA)
  - all steel frame with solid, fixed legs, gloss black paint over raw steel
    - frame construction is notably simpler than VLC unit, relying more on generic steel extrusions, cut and welded together
    - there are some minor differences in frame construction depending on precisely when it was made, particularly in the area of reservoir carrier
- Trolley handle screws
  - 4 of 8g x ½ Pan head, slot, zinc plated, self tapping screws
- Instruction placard (aluminium)
  - 4 of 4g x ¼ pan head, slot, zinc plated, self tapping screws
- Operating levers x 2 (silver cadmium plated)
  - knob end 3/8
  - pump end ½
  - with respective, screwed on, colour coded, round knobs
- Feet
  - 4 of ½" diameter, with black rubber stops
    - rear two feet may be missing if trolley conversion fitted
  - stirrup between front legs, which may prevent feet from touching ground
- Pivot points
  - headless clevis pins
  - spilt pins
- Gauges AUSTALOY branded by FLOYD
  - chrome bezels are either round or flatten out towards their extremity
    - mounting is either by two studs and bracket, or
    - incorporated with the fluid coupling
    - internal chrome finisher rings tend to corrode and deposit debris inside the gauge
    - vacuum tends to have red script which fades
  - pressure gauges 0 > 600psi scale (early)
  - pressure gauges 0 > 500psi scale (late), stepped thread with an auxiliary (inline) brass fitting containing stainless steel ball and spring valve
    - probably to control gauge reading in relation to pumping action
  - vacuum gauge 0 > 30" HG scale

- Options
    - trolley conversion kit
    - how the trolley conversion kits are fitted, varies dramatically
- There is no clear data available as to when the first or last AUSTALOY 18G703 units were produced or how many were made. However evolution is present. Though nothing that would affect operation.
    - The possibility arises of a steel reservoir on some units with a clear fluid level window. Although the locally made top panel continues to be pressed with the large hole for the plastic reservoir's neck. What few apparently original tin tanks have been located, are accompanied by an additional filler (neck) panel to reduce this hole size. This sub panel is secured by two screws. Most top panels are known to Not have these two holes. Hence enforcing the plastic tank prevalence. Although delicate, plastic is the more preferable storage medium.
        - Tin tanks have four components:
            - main body panel, wrapped and soldered with one overlapping joint
            - top panel, inward folded lip, soldered as a butt joint
                - plain steel tube neck, splayed base
            - bottom panel, inward folded lip, soldered as a butt joint,
                - sheet steel appears to be zinc-seal or zinc-alum (protective coating)
                - brass fittings are installed before the top panel and the final assembly is externally painted in black
        - Fluid windows appear to be of far better design and construction than the reservoirs to which they are attached. Therefore probably a generic shelf item from an unknown supplier at the time.
            - inner captive nut panel, spot welded in place
            - cork gasket
            - plastic window
            - outer retainer
            - countersunk Pozi-drive screws with fibre washers
- I have also encountered a small brass (tubular), inline restrictor. I suspect this was intended as an alternative to one of the floating disc valves.

Common faults (including units that otherwise look complete and operational)

- General
  - reservoirs heavily discoloured, stained, perished, split and or cracked
  - screw or drill holes in reservoir
  - fluid contamination
  - sediment build-up in reservoir
  - filter blocked or missing
  - fluid level window stained beyond use
  - reservoir cap split or missing
  - surface rust to panels and frame
  - oversized replacement panel screws
  - missing or damaged legs
  - removable legs corroded in place
  - rubber stoppers on end of legs missing
  - instruction placard obliterated or missing
  - all clear low pressure fluid lines heavily stained, shortened, stiff or brittle
- Pressure
  - gauge damaged or replaced with substitute
  - removable lever seized into main (rocking) lever
  - black knob broken or missing
  - all clevis pins worn
  - clevis pin holes in rocker arm flogged
  - clevis pin holes in both link rods flogged
  - one or more of three spacers for links rods missing
  - minor leak from main pressure seal
  - screw heads corroded and burred
  - main pressure (plastic) tube no longer translucent
  - quick disconnect fitting incomplete, damaged or missing, along with part of the plastic tube
  - one or more stainless balls and or brass ferrules missing
- Vacuum
  - gauge damaged, missing or replaced with substitute
  - vacuum side not working
  - removable operating lever seized into main lever
  - yellow knob broken or missing
  - piston end of steel connecting rod and BSF nut severely corroded
  - connecting rod seized into square steel end cap
  - main seal perished or stuck to cylinder wall
  - all clevis pins worn
  - vacuum valve screw heads, corroded and burred
  - main pressure (plastic) tube, no longer translucent
  - quick disconnect fitting incomplete, damage or missing along with part of the plastic tube

Notes

- Materials
    - Do Not make replacement reservoirs from steel!
    - Do not buy replacement fluid fittings that are steel!
        - moisture and chemical enriched fluid promotes rust, you will one day find that the sediment layer is the only thing sealing the unit
        - Galvabond and zinc plated components react and corrode when constantly wet, hence banjo fittings can block while the unit is sitting
        - there is a reason why most fluid components are brass and plastic from new
        - if in desperate need, utilise a 3 or 4 litre plastic milk bottle as a temporary reservoir, just keep it away from sunlight
            - For a longer term solution (having one pump that was in pieces for ever and a day) I went to the local hardware store. PVC plumbing conduit and fittings can provide three small reservoirs to sit inside the cradle and within the panel work. Bottoms are bonded on. Tops remain a push fit for cleaning at any future point, plus access to the banjo captive nuts. The plastic (especially where end caps overlap the tube) are thick enough to drill and tap. Popular NPT brass fittings, clear tube and clamps can be used to link all three reservoirs. A plastic (male/male) threaded adaptor provides a neck for the cap. The new plastic end plug (now painted red or blue) creates the external finishing item.
            - Not a brilliant system but functional, serviceable and suitable to be left till something better turns up.
    - Australian steel tank reservoirs don't sit in their carrier very well. If overhauling your unit, you might want to relive the vertical part of the frame alongside the window frame.

- Refitting STC brass tap to top of pressure pump.
    - This can require fittings to be virtually over-tightened in order to maintain sealing whilst acquiring correct alignment. I have some success with using aluminium sealing washers to fill the gap.

- Valves
    - There are four types of valve found within the unit. Two are true valves in that they have a formal open and closed position. The others are listed as valves but are probably closer to flow restrictors.
        - Formal valves:
            - Main pressure valve, which can be compared to a domestic brass tap.
            - Saunders diaphragm valve for the vacuum circuit.

        - Flow restrictors:
            - The free-floating pentagonal washer at the vacuum pump's inlet can almost block the colander inlet within the pump's base or the banjo bolt's opening depending on piston stroke direction.
            - The free-floating pentagonal washer at the vacuum pump's outlet can press against the serrated face of the outlet's hose fitting or the pump's opening, depending on piston stroke direction.
            - The free-floating 3/16 ball at the pressure pump's inlet, either sinks to the bottom of the banjo bolt or can press against the serrated face of the inline brass restrictor.
            - The free-floating 3/16 ball at the pressure pump's outlet may seal the pump's chamber when the main valve is open. Gravity plus line pressure from the vehicle forces the ball into the outlet port. As soon as line pressure drops or the piston is moved on a compression stroke, the ball is moved of it's seat and into the serrated face of the inline brass restrictor.
    - Plus the inline valve that may be found on some pressure gauges. The body is brass and both ball and spring are stainless steel. The body does have flutes at the ball seat. Though it appears as a one-way valve, it has a slow return function.
        - Pressure valve. Trouble finding 3/16 Stainless steel balls? I certainly did for several years;
            - search e-bay for BSA Bantam steering head bearings
        - several aftermarket suppliers sell these in stainless, you'll have to buy a set but it's better than a box of 1000
    - Although I haven't encountered enough survivors to prove the point, the brass restrictor at the inlet to the pressure pump appears to be shorter than the one at the outlet.
    - Internal line valves are free floating accompanied by a flow restrictor. There are no springs to apply constant tension or maintain positive sealing.

- Plastic lines
    - Replacement high-pressure lines need to be exact Imperial sizes. Not a near-enough metric 'equivalent'. Otherwise expect to replace all the olives at the same time.
        - Most replacement plastic hose these days will bare the relevant safety standards to which it conforms.
        - Nylon tube, 5/16 OD, 3/16 ID, translucent/natural, not black and definitely NOT the near enough metric sizes of 8mm/5mm that some suppliers may try and fob you off with.
        - Olives are tapered one end and stepped the other with an internal

taper to slightly less than 5/16.
        - Pressure and vacuum lines are about 2m long and you need about another metre for all the internal lines.
    - Having fun assembling your fittings into the high-pressure flexible plastic lines?
        - With a little trial and error I found that my pipe-flaring tool works quite well. A little experimentation, a lot of silicon spray and the 5/16 jaws allowed me to press some of the fittings in place.
        - Mercedes Benz manufacture a hand tool for this task. Much of their truck fleet is riddled with plastic tube of varying diameters and pressure ratings. Benz sell what can be best described as a pair of Vice Grips with set jaws, for three or four common sizes of plastic line. Clamp the line in place, lube up and whack the fitting in place with a hammer. It is a three handed affair but it works.
        - A flaring tool can be used in a similar way to the Mercedes tool; holding the plastic line while a well lubricated fitting in be driven into place.
        - Warning.
            - The two main flexible lines have to be assembled AFTER they have passed through the Unit's back panel. The panel holes aren't large enough to let the nuts through.

- Dowty washer sealing
    - With regards to 1/4 BSP fittings, the shaft you are trying to seal is 1/2" diameter. As per the original item, the synthetic rubber centre of the Dowty washer is a firm fit against the shaft it is endeavouring to seal. There will be no side play whatsoever. If there is then you've been sold the wrong washer.

- Mechanical joints
    - Clevis pins need to be shimmed to prevent sideways movement in levers. Otherwise fit bolts (not set screws) and Nyloc nuts.
    - All pivot points should be a neat push-fit, no slop or elongated holes.
    - Plaster all joints with grease or anti-seize during assembly.
        - Correct sized clevis pins are hard to find. Even when shimmed correctly they do not adequately control side movement. VLC or AUSTALOY provide no shims. As a result I frequently fit overly long bolts (not set screws) that have been shortened. Their unthreaded section now bears the load. A Nyloc nut reduces free movement to a minimum while still allowing linkages to pivot. The less rock (free movement) the better control you have over the unit and future wear is reduced.
            - Trim surplus thread from any new bolts as required.

- Regular lubrication of the service unit's joints doesn't appear in any service information. Lubrication is needed and the lack of, in part accounts for the general poor state of most pumps. A few drops of clean oil on obvious joints before use, isn't going to hurt.
- The vacuum pump has to be able to rock (pivot) in its mountings, circa 10 degrees. As such the retaining (pivot) screws need to be retained with Loctite or similar thread adhesive.
    - Certainly in the case of AUSTALOY units, the mounting brackets are notably wider than the pump's base. I usually shim this area to limit potential free movement.
    - Again for AUSTALOY, the outer set-screw for the vacuum pump can be difficult to install. Assuming that you are fitting one long enough to allow for the gap mentioned and full seating into the pump's base. It may be necessary to relieve part of the outer frame for present and future ease of access.

- Vacuum pump
    - Though fiddly to repair, the pump is very similar in construction and operation to that of a brass Yabby pump. The major difference being a closed base, with valve on the inlet and outlet ports.

- Fluid connectors
    - On or about the time 18G703-V was introduced, the Schrader couplings are changed. Rover Group tool lists identify vacuum and pressure hose end couplings as separate components. In either case Schrader valve dimensions remain unchanged.
    - This introduces the 'No-Loss' aircraft type connector for the pressure side (18G703-C). A generic industrial component, which is widely available today. These can usually be found by searching under; aircraft grade Schrader valve fittings. These are Not a quick disconnect (QD) design as with the earlier Churchill arrangement. Instead, the fitting now screws on to the fine Schrader thread, which can prove difficult in many vehicle installations.
    - In an unnumbered, undated bulletin, VLC explain replacing the copper, sealing washer (having no part number), which is visible inside the main opening of such new couplings. They further explain an additional main servicing kit for repair of the entire coupling (18G703-E).
    - If you are fitting one of these connectors as a replacement for an original, you will need to buy or make an adaptor between ¼ BSP and 1/8 NPT.
    - Of note is that there are still two different fittings depending on the task (pressure or vacuum). Though you can manage with the one design.
    - The new vacuum fitting (18G703-F).

Sundry

It isn't clear what was contained in the 18G703A Major service kit. I haven't encountered one or any true information on them. So far it would seem:

- Vacuum side
    - 2 plastic washers
    - 2 fibre valves
    - 5 Dowty washers
    - 1 pump seal
- Pressure side
    - 1 pump seal

Regretfully, I haven't been able to locate a virgin 18G703 of any brand or period for dissection. Nor found anyone else's comprehensive work on the subject or manufacturer's publication. There may well be minor points that are missing from the above data.

18G685 Hand pump:

- Having trouble finding replacement fibre washers to seal the steel tube reservoir to the brass pump head? I certainly did, until I remembered having used them before.
    - Visit your nearest Laycock-DeNormanville repairer or parts outlet. The only model overdrive with an accumulator uses the correct sized fibre washer to seal the larger brass access bung.

WEAR PPE!

It wasn't until the mid 1990s that Rover Group started printing PPE warnings in workshop manuals. Just because your 1963 publication doesn't mention safety, doesn't mean that you shouldn't be safe or anyone around you!