HOW to BLEED BRAKES, BUILD a VACUUM or PRESSURE BRAKE BLEEDER & SELECT THE BEST BRAKE FLUID FOR YOUR APPLICATION

By: John GIBBINS [artificer on G503] Friday 13th March 2015

INTRODUCTION:

I decided to do this write-up because of folk continually talking of 'pedal pump bleeding' needing 2 people. As soon as I hear 'pedal pump bleeding' I think the same thing & that is 'are these people going to create themselves an expensive major repair job' because of following this old time book or TM method where pumping may be suggested'.

It is important to understand that TM's were written in/& for a time when these vehicles were relatively new, plus US Army Mechanics rarely repaired things, just replaced parts.

ANY vintage vehicle with hydraulic brakes with DOT brake fluid [with perhaps the exception of DOT 5] will most likely have water & rust inside the brake system components. These DOT fluids are HYGROSCOPIC. They all attract & absorb water from the atmosphere. DOT 5 is not hygroscopic & is the exception. Read more in Fig. 39' on brake fluids @ the end of this tutorial.

Think how far the master cylinder piston travels in the bore of a normal, properly adjusted & free from air, brake system? Would 3 or 4 mm or 0.25" be about right? What does this convert to @ the brake pedal?

Now imagine the master cylinder piston moving 50mm or 2" or more from one end of travel to the other & over portions of the master cylinder bore that contains accumulated rubbish, rust & pitting. The master cylinder seals rely on a perfect conical sealing knife edge. Get the drift?

This extended travel can & does cause damage to the master cylinder primary & secondary seals & can contribute to both internal & external fluid leaks. I don't care how many times folk say they have been lucky, eventually they will pay the price [maybe the ultimate one] & there is absolutely no reason to do so.

When a brake system has been fitted with all new parts including the master cylinder or all the parts especially the master cylinder have been properly refurbished/overhauled & new fluid [I would be using DOT 5 on any such system, especially one infrequently used] is in the system, then pump bleeding is fine.

If one insists on doing this 'pedal pump bleeding' then I would recommend that something, like a block of wood, is put in place to stop the brake pedal going right to the floor boards & the master cylinder piston bottoming out, as this can cause primary seal damage in the master cylinder.

BUT in this write up I am offering simple methods to make & use a better mousetrap.

There are 4 common ways to bleed brakes....

1. *GRAVITY* [master cylinder piston DOESN'T move inside the master cylinder bore]

   Gravity bleeding is accomplished very easily when the master cylinder is firewall mounted [or above all the wheel cylinders] but doesn't achieve the desired outcome with chassis mounted master cylinders unless one uses some creative thinking regarding feeding the sealed master cylinder reservoir from a height. It can be done.

2. *VACUUM* [master cylinder piston DOESN'T move inside the master cylinder bore]

   Vacuum bleeding is using a vacuum source @ individual bleeder screw/s so that atmospheric pressure on top of the master cylinder reservoir forces brake fluid through to that lower pressure vacuum. Any air leak between the master cylinder & vacuum will negate the effectiveness of this system. Typically an atmospheric leak will be around the bleeder screw being serviced, if not sealed [see later suggestion].

3. *PRESSURE* [master cylinder piston DOESN'T move inside the master cylinder bore]

   Pressure bleeding is when a pressure higher than atmospheric is applied to the fluid in the master cylinder reservoir & bleeder screws are in turn opened & closed until all air has been removed or:

   REVERSE PRESSURE [master cylinder piston DOESN'T move inside the master cylinder bore]

   Is where one applies pressure to the bleed screw/s rather than the master cylinder & is rarely used.

   HIGH pressures are not really necessary in either method & if using other than DOT 5 spray or excess brake fluid WILL REMOVE PAINT.

4. *PUMPING* [master cylinder piston DOES MOVE full stroke inside the bore]

   One person pumps the brake pedal & another person releases & re-tightens the appropriate bleed screw until each line & wheel cylinder is free of air. There are special bleed screws with an internal spring loaded ball that one can purchase to alleviate the need for 2 participants.
   No matter what method is employed the bleed screw needs to be @ the highest point of where air can be trapped. Some early model hydraulic braked vehicles missed this point & one had to be inventive to work out how to remove air from the brake system....Land Rover was one of them.

1. GRAVITY BLEEDING:

A basic rule of physics is that fluid will find its own level. The master cylinder reservoir always has to be acted on by air pressure @ 1 atm or 101.3 kPa [14.7lb/in^2].
Pressure differential is how ALL brakes work!
So if one hooks up a tight fitting long tube to a bleed screw then raises plus secures this tube's open end above the master cylinder height, opens the bleed screw & comes back in about ½ an hour all the air will be out of that line & the fluid in the tube will be level with the master cylinder. It's that easy, but takes a while to get around the whole job.

2. VACUUM PUMP BLEEDING:

Remember what we said about air pressure in Gravity bleeding....well add a vacuum or low pressure source to the bleeder screw & we can get the job done much more quickly.
This is my preferred method of bleeding brakes on most vehicles.
I made this tool out of a discarded Jeep fuel pump Fig. 1 You can also use any lever operated old fuel or vacuum pump [doesn't need a glass bowl or any bowl @ all, plus a fully sealed fuel pump like Mopar's had will work.
Fill the master cylinder reservoir then, in turn, fit a tube to each bleeder, loosen the bleeder [you may need a bead of wet thick paint around the exposed bleeder screw thread near the wheel cylinder body] then pump the extended lever until the brake fluid runs clear & free of air bubbles. Lock the bleeder then go on to the next bleeder & longest line.
Continually re-fill the master cylinder reservoir & don't let it run dry otherwise you can start all over again or go to jail.

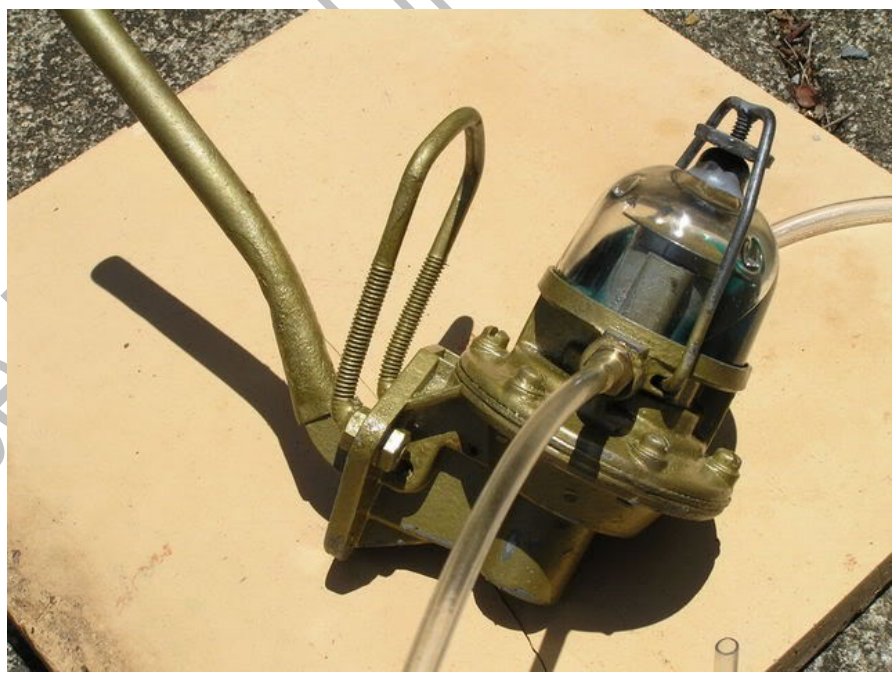

Fig. 1

3. PRESSURE BLEEDING:

Again we are using basic principles of pressure differentials to get the job done efficiently & quickly. We multiply the atmospheric pressure by applying pressure above atmospheric to the fluid in the master cylinder reservoir. The top of the master cylinder is closed so the new pressure is contained. Then if we open a bleed screw this pressure forces air out & this air is replaced by brake fluid. Just do each item in the correct sequence BUT ensure to replenish the reservoir fluid regularly.

Look @ some homemade professional style tool/s....1 litre for smaller vehicles & less waste or 2/4 litre for larger vehicles, with instruction on how to make them.

SAFETY:

It is up to you to establish whether the containers you buy will take pressure but I'd say the ones I got will handle 30 to 40 lb/in^2 easily & that is considerably higher than generally needed.
The pressure unit's thread & lid are the limiting factors.
I take absolutely no responsibility for what you might do, so you are on your own.

Fig. 2 & Fig. 3

Fig.2 is a job was made up quickly using a herbicide pump container. Just pulled the innards out of the sprayer nozzle section, sorted a flex line on an old master cylinder cap & used the units hand pump to raise the pressure on the brake fluid in the container. Worked fine but I do not like the idea of aerating any brake fluid [especially DOT 5 as it takes a long time for the air to settle out, but it does]. So the next version came along.

First I looked for a screw on cap with the correct thread ....the black one [an irrigation cap] initially had issues with sealing properly & my not having or being able to make a suitable good gasket.
This was solved later on the 2 litre model; see Figs.31, 34 & 36.
I also used the original caps & modified them to suit both units.
How I did this will be in the following with pictures:

2 litre Fig. 4 $9.99 sprayer, 2 schrader valves $4.99 & a cheap pool type pressure gauge $19.99.
1 litre Fig. 5 $4.99 sprayer, 2 schrader valves $4.99 & a cheap pool type pressure gauge $19.99.
I had to get a few extra bits so as to use the original caps but I am happy with the overall design/s

Fig. 4 & Fig. 5

Following are the bits needed for the 1 litre job:

1 off 1 litre garden sprayer using original cap Fig. 5
1 off 2mmx50mmx12mm [2"x0.5"] washer Fig. 5
1 off 2mmx32mmx12mm [1.5"x0.5"] washer Fig. 5
2 off schrader valves [holes drilled 11.05mm] plus 1 more valve if you intend to use in a drilled old master cylinder cap Fig. 4 & 5
1 off pressure gauge good for about 400kpa [60lb/in^2] Fig. 6
1 off original cap seal Fig.6
1 BSP nut to fit the thread on the gauge [may be NTP in USA] Fig. 7
1 drill multi [as in picture below] Fig. 7
1 schrader valve tool Fig. 7
1 silicone RTV sealant & Boston gas thread sealer Fig. 7

Fig. 6 & Fig. 7

Fig. 8 & Fig. 9

Remove all the innards of the pressure sprayer cap. Fig. 8 & 9.

With a good solid Stanley type knife or hacksaw cut across on an angle like shown in Fig. 10 on both sides of the handle being careful not to slip & damage your hand. Then drill a hole @ the end of this angle Fig. 11 so as to just intersect with the angle cut but not go below the flat surface of where you 50mm [2"] washer will eventually sit & be sealed.

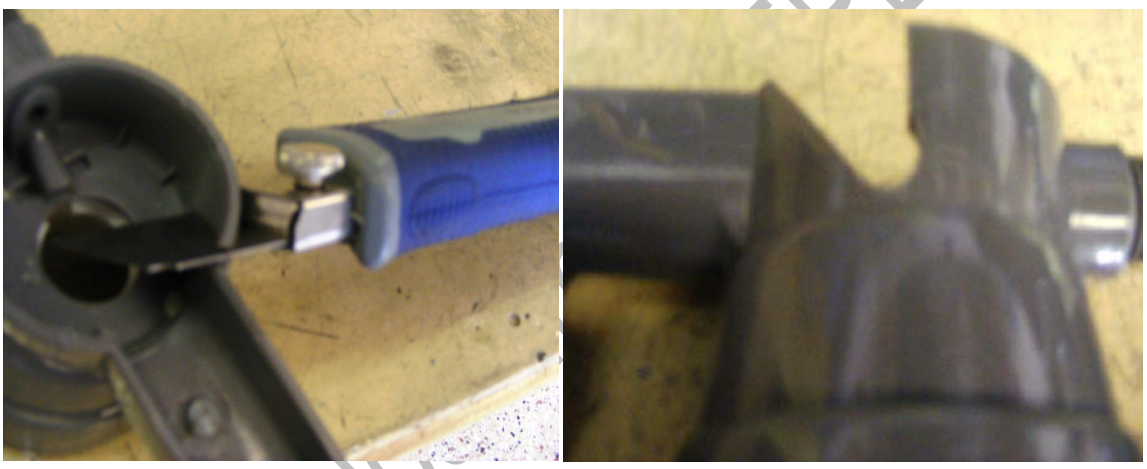

Fig. 10 & Fig. 11

Now get out the angle grinder or hacksaw Fig.12 & remove cap portion that will not be needed. Fig. 13 Also drill out the small hole into the thread section that goes thru the sealing washer. Fig.13.
The cap's top & underside need to be flat as that is where the 32mm [1.5"] washers need to sit flat & seal.

Fig. 12 & Fig. 13

Slightly relieve the 12mm [0.5"] diameter in the 50mm [2'] washer so that the gauge can sit right on board but not loose Fig. 14. Then apply plenty of RTV or sealant adhesive to the flat cap area that has been cleaned of all protrusions or gusset material that would stop that large washer being pulled flat & sealing Fig. 15.


Fig. 14 & Fig. 15

Use sealant on the area shown under the 50mm [2"] washer then fit the gauge & washer to the prepared cap Fig. 16.


Fig. 16 & Fig. 17

Notice that the smaller 32mm [1.5"] washer has been slightly relieved so the gauge can go easily through & assemble all the parts [the gauge & washers] with sealant. The excess will be squashed out to be cleaned off Fig. 18 thru Fig. 22.


Fig.18 & Fig. 19

Now fit the correct nut @ the bottom of the gauge & tighten

ALWAYS USE AN OPEN ENDED WRENCH ON THE GAUGE SQUARE TO STOP THE GAUGE TURNING.

DO NOT HOLD THE GAUGE BODY/FACE TO ACHIEVE THIS!

Fig. 20, Fig. 21 & Fig. 22

Carefully relieve the sealing gasket fit to the cap without becoming distorted or stressed in any way Fig. 23. & allow everything to set up overnight Fig. 24.

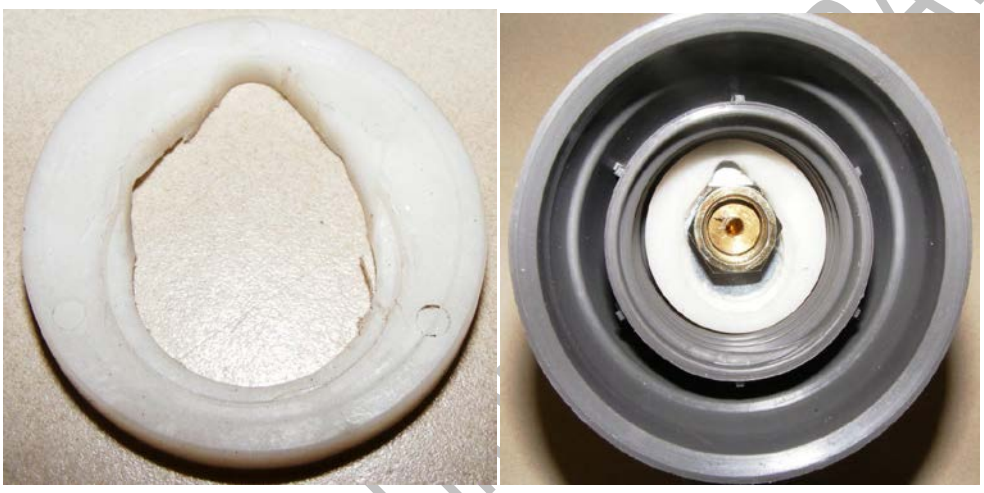

Fig. 23 & Fig. 24

Now drill your container/s with the correct drill to suit the schrader valves. Fig. 25.
My multi drill was just right on the last land 11.05mm Fig. 26.
Make sure to drill one hole close to the bottom as this will mean minimal brake fluid wastage.
Clean any waste, sharp edges etc. from around the drilled holes & make sure there is no drill swarf [rubbish] inside your container.

Figure 25 & Figure 26

Drop one schrader valve in the container, it takes a little juggling to get the schrader valve where you want, but moving the container around will allow you to get hold of & pull lightly through the correct size hole Fig 27, then connect your valve tool & pull the valve right home. Fig. 28.
Remove the valve core from the valve housing on the bottom valve [as in the picture]. Fig. 29.



Fig. 27, Fig. 28 & Fig. 29

Next day screw the plastic schrader dust cap tightly on the bottom valve, hook up & test you have no air leaks & the job is finished.

The small 1 litre unit shown below, as well as the 2 litre held 40 lb/in^2 for 24 hours [still has pressure 3 weeks later]. Fig. 30.

Fig. 30

2 , 4 litre or larger style.

1 off 2 or 4 litre garden sprayer
1 off cap to suit the sprayer bottle thread
2 off 2mmx32mmx12mm [1.5”x0.5”] washer [centre must be relieved slightly so gauge thread goes through without interference]
2 off schrader valves [holes drilled 11.05mm] plus 1 more valve if you intend to use in a drilled old master cylinder cap
1 off pressure gauge good for about 400kpa [60lb/in^2]
1 off ‘O’ ring seal
1 BSP lock nut to fit the thread on the gauge may be NTP in USA
1 drill multi [as in picture below]
1 schrader valve tool
1 silicone RTV sealant & Boston gas thread sealer

Fig. 31, Fig. 32 & Fig. 33

Black plastic & 38mm rubber sink plug Fig. 31 cap centre popped Fig. 32, drill to tapping size for ¼ BSP [11.05mm as for schrader valves will do for plastic when using an intermediate tap]. Then fit gauge Fig.33.

ALWAYS USE AN OPEN ENDED WRENCH ON THE GAUGE SQUARE TO STOP THE GAUGE TURNING & DO NOT HOLD THE GAUGE BODY/FACE

Fig. 34, Fig. 35 & Fig. 36

Using an old 13/16 socket & good hammer over an steel plate, remove the centre from the rubber sink plug Fig. 34 then apply sealant to the inside of the black plastic cap Fig. 35 Next tighten the locknut to the gauge thread & push the rubber sink plug right home. Fig. 36.

Remove ALL excess sealant then screw cap on canister & leave overnight. Fig. 37.

Fig. 37

Now what do we use for the line between the unit/s & the master cylinder?
A plastic line, dip ends in boiling water & attach over the schrader valve thread. That method is permanent & shouldn't leak under pressure. If worried one can fit a hose clamp.
For the top of the master cylinder... find an old cap & one can do exactly the same with a schrader valve there as well....there are other simple ways but that is up to your imagination. Fig. 38.

Fig. 38

3. PUMP BRAKE PEDAL BLEEDING:

Everything about this method is in the introduction.
This system will work in most applications BUT there are inherent negatives that are not present in the other 3 methods suggested, so this bleeding method is not recommended unless on a new/rebuilt system, then with limitations.

BRAKE FLUIDS

THIS IS NOT MINE!

This was saved nearly a year ago, because I thought it was appropriate & concise information. I did not think it would be used like this, so unfortunately I am unable to nominate the source & would willing do so if possible.

How Often Do You Want To Change Your Glycol Based Brake Fluid?

It is apparent that the drop in boiling point of DOT 3 brake fluid over time due to water contamination means you must consider changing the fluid every 12 months, regardless of how much you drive. If you live in a dry, arid climate, you can extend that somewhat. Conversely, if you live where it is wet and humid, the 12 month interval might be too long. If you use a DOT 4 fluid, be aware that it actually absorbs water faster than DOT 3 fluids, but the reduction in boiling point is less. With DOT 4, consider changing the fluid every 18 to 24 months. DOT 5.1, consider changing the fluid every 5 years.

Are Silicone Fluids Better?

Compared to glycol fluids, silicone has some distinct advantages. They are very stable over wide temperature ranges, and they resist physical and chemical change under severe heat, cold, sheer, oxidation, and other operational conditions that will break down other fluids. They are inert, non-corrosive, non-toxic, and have low volatility. They will not affect paint work. Silicone fluids also have “the lowest viscosity change with temperature of almost any hydraulic fluid.”

Are Silicone Fluids Better For Water Absorption?

Unlike glycol based fluids, silicone fluids are not hygroscopic. Silicone brake fluid will absorb a tiny amount of moisture (on the order of 280 parts per million, or .0028%) and then absorb no more. If we have a brake system with a total volume of 900mls the maximum amount of water absorbed will amount to 0.0252mls. Because water will not mix with silicone fluid, any water that gets into the system will tend to pool in the lowest parts of the system. This resistance to water absorption is a critical difference that makes silicone fluids attractive for cars that are driven seasonally, which makes the longer term issues of corrosion more important that they are with a daily driver.

What About Silicone Fluids Boiling Point?

Silicone fluids have very high dry boiling points – generally around 280°C / 536°F.

Will Silicone Fluids Damage Your Paint?

Unlike glycol fluids, silicone fluids do not damage paint. This is of particular importance for show-cars where a spill or leak of glycol fluid can have seriously damaging results. A newly rebuilt and scrupulously clean brake system filled with silicone fluid should outlast a system filled with glycol fluid by several times.

Silicone fluids have what appears to be an obvious advantage over glycol based fluids. Given all the trouble caused by water contamination of glycol based brake fluid, silicone fluid has some appeal.

Will Silicone Fluids Feel Spongy?

Because of the dissolved air, silicone fluids are up to three times more compressible than glycol based fluids,. This can contribute to a slightly spongy feeling brake pedal, particularly near the higher end of their temperature range but well below the dry boiling point.

Fig.39

ADDED: My Jeep & others I have heard of are not affected in any way by the last statement about spongy feeling.
The fluid being un-necessarily aerated before or adding to the system or by PUMP BLEEDING will contribute to a spongy condition. After a few days this aeration will clear itself & the system ready for a final bleed.

GOOD SAFE BRAKING GUYS

JG & JR