Tow Brake Design

We tow a 2000 Jeep Wrangler a lot of the places we go to enjoy the opportunity to explore the area were in without having to move or camp. Most states require that towed equipment (whether trailers or vehicles) have an independent system of braking that can both provide a share of the braking in motion and to stop the Jeep should it 'break away' from the truck.

Most trailers come equipped with electric trailer brakes that are managed by a brake controller in the prime mover. Towed vehicles, however, are not set up to brake remotely. More intricate equipment is needed. Using this equipment typically requires significant modification to the tow or significant effort to install and remove the equipment before driving the tow. ALL of these systems are very expensive.

I wanted a system that was not overly involved to convert from towing to driving and thought that using the on-board air systems of both vehicles would be the 'best use' of my assets. The basis of the system is to use air pressure and a pneumatic cylinder under the driver seat to depress the brake pedal. Braking is activated by the truck's brake light signal. There are a number of issues to resolve in order to make this system safe and effective. In no particular order, below are the issues and their method of mitigation;

- ISSUE: Because the Jeep's engine is not running, the vacuum assistance of the power brakes is not available. The braking force of the tow brake system needs to provide a lot more force than a normal human leg. MITIGATION: Compressed air at 120PSI can apply any amount of force necessary but 120psi can easily drop to 90 with repetitive application. If I assume that I use a force of up to 50 pounds in normal, assisted braking, I want to be able to deliver up to 3 times that with an air cylinder. This means I need a cylinder with 150lbs/90psi = 1.67SqIn area, (>1.46" diameter).
- ISSUE: Braking force must be adjustable from the drivers position so differing driving conditions can be accommodated. MITIGATION: An air pressure regulator within reach of the driver will allow reduction of the tank pressure to braking pressure over the entire pressure range available.
- ISSUE: Understanding the status of the braking system. Since available air pressure is a fundamental problem with air brake systems, a pressure gauge showing both the compressor tank pressure and regulated braking pressure, within sight of the driver, is necessary. MITIGATION: Pressure gauges showing values of both are to be located in the console.
- ISSUE: Brake application cannot be sudden. Since the brake light is the signal and is either 'on' or 'off', there is no possibility to sense gradual application of the truck brake. Application of the tow brake should be gradual over a short time, reaching a fixed level of maximum braking (set by the regulator). The gradual application needs to be adjustable but can be fixed once established. MITIGATION: Use of a needle valve style 'flow control' is an industry common device for regulating response timing. One can be placed at the outlet of the pressure regulator

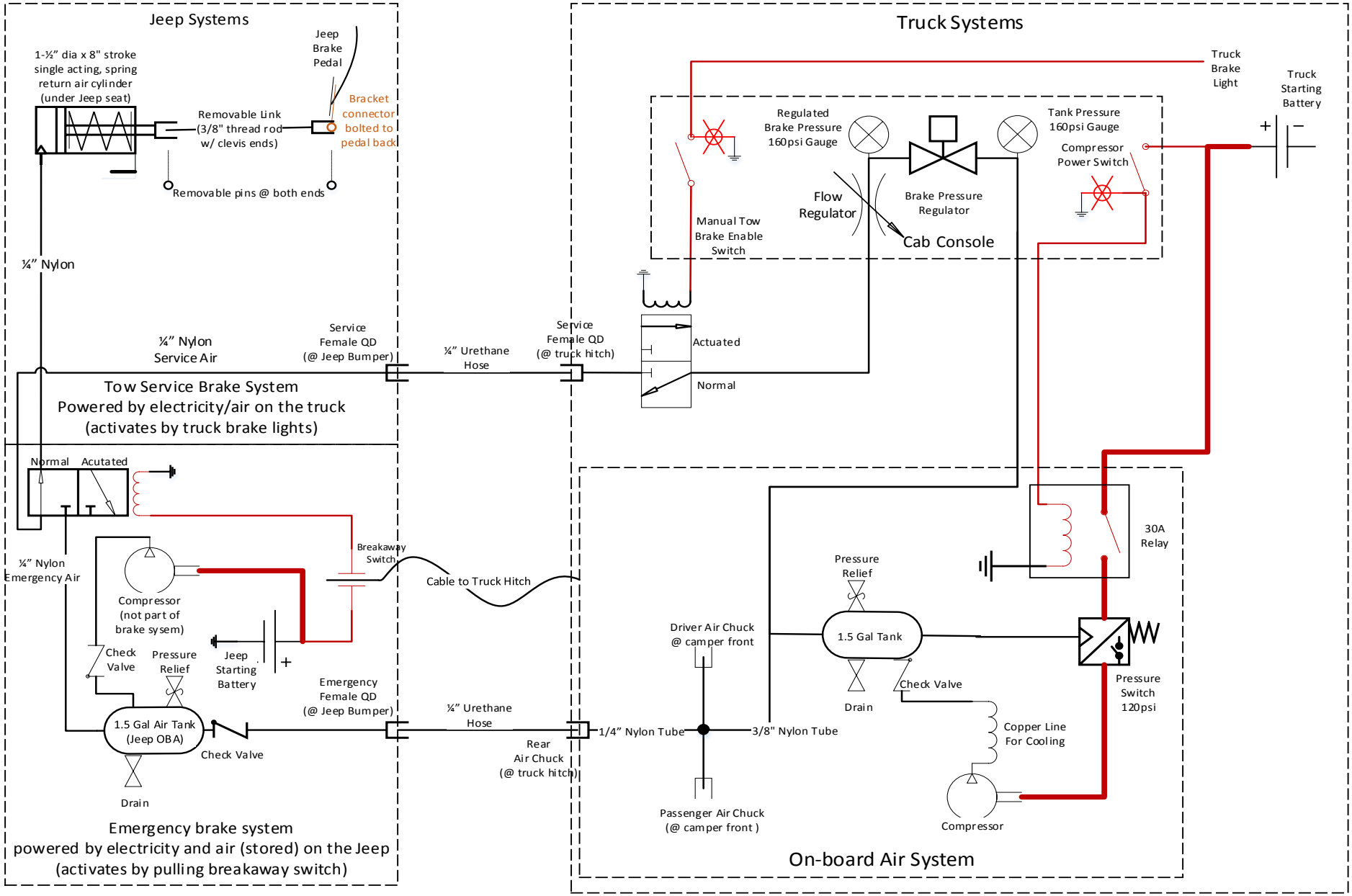
that can be within reach of the driver but also contains a lock nut to prevent adjustment creep once the optimal setting is obtained.

- ISSUE: The tow brake system cannot apply forces to the Jeep brake pedal that do not occur in normal operation. Specifically the equipment that applies the brakes must completely release all force to the pedal under non-braking conditions. MITIGAITON: The air cylinder must have its own retraction spring to prevent the brake pedal spring from having to return anything other than the pedal to slack condition. If the cylinder were to be a typical double acting type, it would require force from the vehicle brake system spring to return it to initial conditions. There must be NO residual force on the pedal that could cause 'brake dragging'.
- ISSUE: Breakaway braking issues are different than service brake (above) issues. The breakaway system must be able to apply the Jeep brakes using only resources available on the Jeep. By definition, 'break away' infers the brake is applied after the Jeep and truck are separated. When a breakaway occurs, the brakes need to be applied rapidly and permanently. The service brake systems on the truck cannot be used for break-away functions. MITIGATION: A source of stored air and electricity on the Jeep must be able to provide for emergency braking. The Jeep also has an onboard air system (compressor and tank). The tank, if charged from the truck OBA ssytem, can be the source for brake power without operating the Jeep compressor. This brings out several requirements; 1) The air reservoir on the Jeep must be charged by a separate 'emergency air' hose, at constant tank pressure from the truck. 2) If the emergency air hose is severed, the Jeep's tank must not loose pressure (needs a supply side check valve). 3) The Jeep's battery is disconnected during towing to prevent running the battery down but some energy must be available to power the emergency system (breakaway switch and solenoid valve), if and only if it functions.
- ISSUE: The connection of the tow brake system to the Jeep's brake pedal must be completely removed for driving. No part of the tow brake system can be connected in any way that might alter the operation of the Jeep brake. MITIGATION: The actuating cylinder will be mounted completely underneath the driver seat so that in retracted position, no part of it will extend beyond the seat. The mounting lug on the back side of the brake pedal will be small and unable to interfere with either the placing of the foot on the pedal or to limit the pedals range of motion during braking. The connecting link will be completely removed and stored away in a place where it cannot interfere with vehicle operation.
- ISSUE: A means of turning the auxiliary brake system on and off in the truck cab as well as an indicator it is in operations should be provided on the console, witin reach/observation of the driver. MITIGATION: A guarded, illuminated safety switch is located on the center console to turn the system on and off. The switch illumination will light whenever the brake lights are actuated; indicating the tow brake is in operation.
- ISSUE: There should be no interference between service and emergency brake systems. With the service air valve always venting the cylinder, actuation of the emergency valve would result in emergency air being vented out of the service valve rather than actuating the cylinder. MITIGATION: Service air must flow <u>through</u> the emergency valve. 1) When the emergency system is de-energized (normal operation), service air will flow in both direction through the

emergency valve (vent and service ports), as the valve is not blocking either port. 2) When the emergency valve is actuated, the path to the service valve is closed and ONLY the emergency air is sent to the cylinder. 3) Once the emergency system is energized, it remains on until 'breakaway switch' is reconnected or battery power is exhausted. Either will de-energize the emergency valve. If there is a need to rapidly remove the emergency brake activation, the cylinder hose cab be disconnected or cut, draining the emergency air system.

- ISSUE: Emergency brake air supply. Because the Jeep's engine is not operating, all brake air is coming from the truck. Because the source of emergency brake air must be in the Jeep, there must be a way to move tank pressure air from the truck to the Jeep that will not result in the Jeep air tank being depressurized if/when a break-away occurs. MITIGATION. A separate air supply line runs from the rear truck OBA connector to a front OBA connector on the Jeep. Adding a check valve on the supply line permits the truck system to pressurize the Jeep system but prevents Jeep the air tank from losing pressure if destructively disconnected.

Maximus' Tow Brake and On-board Air Systems



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