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DEVELOPMENT OF PNEUMATIC BRAKE SYSTEM OF MERCEDES 2624 GUN TOWER COMPATIBLE WITH ALL ARTILLERY GUNS

COLLEGE OF
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PROJECT REPORT

DEVELOPMENT OF PNEUMATIC BRAKE SYSTEM OF MERCEDES 2624 GUN TOWER COMPATIBLE WITH ALL ARTILLERY GUNS

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ABSTRACT

The Mercedes-Benz 2624 trucks are known as heavy-duty vehicles primarily employed for long-distance transportation purposes. However, a limitation lies in the braking system of traditional Mercedes-Benz 2624 trucks, which is equipped with two couplings. Conversely, the modern Mercedes-Benz 2028 trucks are designed to be compatible with more range of artillery guns. Rather than disposing of the older trucks, an alternative solution presents itself in the form of modifying their braking systems to meet modern requirements. The fundamental braking system of both the Mercedes-Benz 2624 and 2028 trucks shares similarities. However, specific modifications are necessary to make sure the Mercedes-Benz 2624 trucks achieve universal compatibility. By implementing these alterations, the Mercedes-Benz 2624 trucks can transition from a two-coupling system to three-coupling system. Implementing the necessary modification, the braking systems of both the Mercedes-Benz 2624 and 2028 trucks become indistinguishable, thus rendering them fully compatible with all types of artillery guns. Consequently, modified braking system not only optimizes the efficiency and effectiveness of the older trucks but also maximizes their utility in modern artillery operations. By repurposing the Mercedes-Benz 2624 trucks through braking system modifications, the Pakistan Military can benefit from improved versatility and flexibility in their artillery gun transportation capabilities.

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Chapter 1 – INTRODUCTION

A specialized vehicle known as a "gun towing vehicle" is purpose-built to transport and relocate artillery weapons. These vehicles are built to handle the weight and size of artillery pieces while providing the important power and functionality for towing operations. Gun towing vehicles are available in various shapes and sizes, tailored to meet the specific requirements of military applications. They range from smaller and lighter vehicles suitable for Howitzers or field guns, to larger and heavier trucks capable of towing cannons, artillery guns, or self-propelled anti-aircraft systems. One such truck is the Mercedes Benz 2624, which belongs to the NG (New Generation) series of heavy-duty commercial vehicles produced by the renowned German company. The NG series, manufactured from the late 1970s to the early 1990s, is highly regarded for its durable design, reliability, and versatility across several industries. The Mercedes Benz 2624, specifically configured with a 6x4 arrangement and three axles, directs power to the rear two axles. The model designation "2624" signifies specific truck specifications. Although the Mercedes Benz 2624 trucks have effectively served the purpose of towing older artillery guns, the emergence of modern artillery technology worldwide necessitates modifications to make them compatible with towing contemporary artillery guns. These necessary adaptations are crucial to ensure optimal performance, safe towing operations, and compliance with the unique demands of modern artillery weapons. Through the implementation of these modifications, the Mercedes Benz 2624 trucks can be effectively updated to meet the requirements of towing modern artillery guns. These adjustments will improve the trucks' performance, ensuring secure and reliable transportation of artillery weapons while aligning with the specific needs of the modern era. Such modifications are essential for maintaining compatibility and maximizing the efficiency of gun towing operations in the face of advancing artillery technology.

Recent improvements in the field of gun towing operations have prompted the adoption of a number of ground-braking systems around the globe. Different trucks companies have launched their modern trucks such as Actros, STEYR, Mercedes Benz 2028 and MAN which stand out among these because they have undergone considerable improvements to their pneumatic braking system to improve their ability to carry the modern artillery guns. These vehicles feature

enhanced pneumatic braking systems to suit the rigors of heavy-duty hauling. These enhancements are meant to provide the best possible control, safety, and braking during operations. To improve stability and lower wheel lock-up, upgrades could include the incorporation of cutting-edge brake control systems such as the electronic stability control (ESC) and antilock braking systems (ABS). Moreover, the inclusion of upgraded brake components, such as larger brake discs and better brake pads, has significantly bolstered the braking power of the Actros, Mercedes Benz 2028, MAN, and STEYR trucks, enabling them to effectively handle the augmented weight associated with towing artillery guns. As a result, these trucks have transformed into dependable and competent resources for contemporary gun towing operations, facilitating the better transportation of artillery equipment while upholding uncompromising standards of safety and functionality.

The main goal of this project is to modify the pneumatic braking system of the Mercedes Benz 2624-gun towing vehicle. This modification aims to enhance the efficiency of the gun towing operation while also providing cost savings by eliminating the need to purchase new trucks specifically designed for modern artillery guns. By implementing these modifications, the 2624 truck will be able to safely tow artillery guns. The focus of the modification is to make sure the safe and effective towing of artillery guns using the Mercedes Benz 2624 truck. This will involve significant improvements and refinements to the pneumatic braking system. Upgrades such as larger brake discs and improved brake pads will provide increased braking power and responsiveness, which is important while dealing with the additional weight and demands of towing artillery guns. By improving the braking system, the 2624 truck will exhibit better control and stability during the towing process, ensuring enhanced safety for both the operator and the surrounding environment. The reliable braking functionality will enable precise maneuvering and smooth deceleration, allowing for efficient and accurate towing operations.

One main advantage of this modification is the cost savings it offers. Instead of purchasing new trucks specifically designed for modern artillery guns, optimizing the existing Mercedes Benz 2624 fleet proves to be a more financially viable option. This approach allows for the allocation of resources to other important areas while maximizing the utilization of the current fleet. The cost-effectiveness of this modification makes it an appealing solution for military organizations

looking to upgrade their gun towing capabilities without incurring excessive expenses. In summary, the planned modification of the pneumatic braking system in the Mercedes Benz 2624-gun towing vehicle is a strategic endeavor aimed at improving gun towing operations. By enhancing the braking system, the 2624 truck will have the necessary capabilities to safely tow modern artillery guns. Additionally, the cost savings associated with this modification present a compelling incentive to pursue this project, offering benefits in both operational efficiency and budget management.

Chapter 2 – BACKGROUND AND LITERATURE REVIEW

This section includes the study and understanding of pneumatic braking system of the gun towing trucks. Although very detailed information of these military gun towing trucks braking systems is not available at internet but after searching a lot, we were able to gather information about basic concept, need and working principle of the braking systems of some of the military trucks.

Due to their beneficial qualities and adaptability for military applications, pneumatic braking systems were used in vehicles that pulled guns. The selection of this system and its initial applications were due to its reliability, power source compatibility, control and adjustability and ease of maintenance. Pneumatic brake system's dependability makes them ideal for the use in military vehicles that must function in various difficult circumstances. The system's dependable functioning is a result of its sturdy construction and the use of compressed air as a power source for the braking system. Gun towing trucks frequently already have air systems in place, such as air brakes, which offer a ready source of compressed air. A pneumatic braking system may be simply included in the overall design of the vehicle which will use the same compressor as a power source. Pneumatic braking systems provide fine control over brakes and have room for adjustments. They are easier to repair, maintain and troubleshoot than hydraulic systems they have fewer intricate mechanical equipment. Although the precise date for the invention of this braking system is unclear but for many years since the middle of 20^{th} century, vehicles that are used to tow artillery guns have had pneumatic braking systems.

2.1. Rail Road Train

George Westinghouse first developed the air brakes for use in railway service. He patented a safer air brake on March 5, 1872.Originally designed and used in railroad train systems, airbrakes or pneumatic brakes using the compressor as a power source remain the exclusive systems in widespread use.

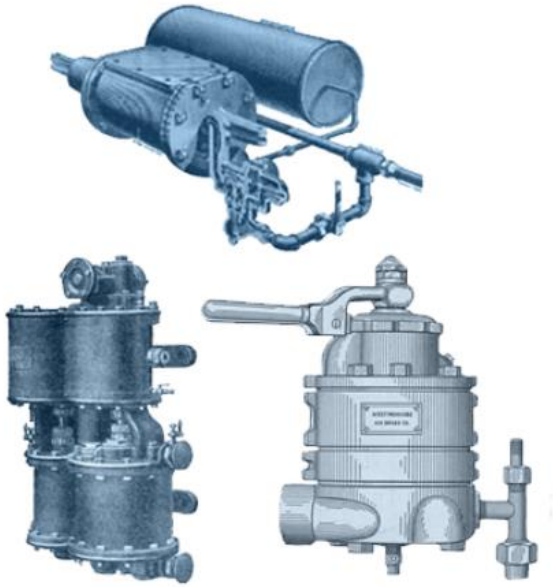


Fig 1: Pneumatic brake components of railroad rains

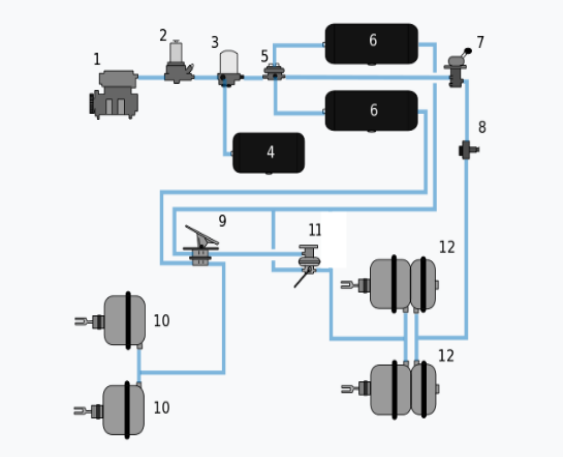
2.2. Pneumatic Brake system on road trucks

Westinghouse improved his air-pressurized brake idea through multiple changes, which gave rise to different iterations of the automated brake. After its benefits in railway use were established in the early 20th century, producers of trucks and heavy equipment embraced it. The use of air brakes on all large trucks, tractor-trailers, buses, fire trucks, and off-road vehicles in 1949 was pushed by World War II. Air dryers, twin brake valves, automated slack adjusters, and the first generation of antilock braking systems were all under development by 1960.

Buses and large lorries are frequently equipped with air brakes. Typical operating pressure is between 100 and 120 psi or 6.9 to 8.3 bars or 690 to 830 kPa. The supply system and the control system make up a compressed air brake system.

The supply system compresses, stores, and delivers high-pressure air to the truck's control system and other air-operated auxiliary systems (such as the clutch pedal air aid servo and gearbox shift control). Filtered air is drawn from the atmosphere by the air compressor, which compresses it, and stores the compressed air in high-pressure reservoirs. The majority of large

vehicles feature a gauge in the driver's line of sight that shows whether there is enough air pressure for the vehicle to operate safely, frequently with warning tones or lights.



1	Air compressor	7	Park brake hand control valve
2	Pressure regulator	8	Park brake safety release valve
3	Air dryer	9	Brake foot valve
4	Regeneration reservoir	10	Front air-brake chambers
5	Four-way protection valve	11	Brake-relay valve and load-sensing valve
6	Compressed-air reservoirs	12	Rear-spring brake chambers

Fig 2: Highly simplified Air brake system of a truck

2.3. Pneumatic air braking system in HMVs (Historical Military Vehicles)

Most of the HMVs have four type of air systems

- Air over Hydraulic (Used mostly in M series deuces)
- Early straight air (mostly used with mechanical parking)
- Later straight air (used on some modern M series deuces)
- CTIS (Central Tire inflation system)

2.3.1. Air over Hydraulic System

Compressed air is used in air-over-hydraulic systems to increase the braking power of traditional hydraulic brakes using a component frequently referred to as an "air pack." This device is comparable to the power braking systems seen on many cars and light- to medium-

duty trucks, with the exception that it operates under air pressure rather than vacuum. The brake pedal of the car activates a conventional hydraulic master cylinder in the majority of these systems, which in turn activates the air pack, which in turn activates a different hydraulic master cylinder, which in turn activates the car's hydraulic wheel cylinders, applying the brake shoes to the brake drums.

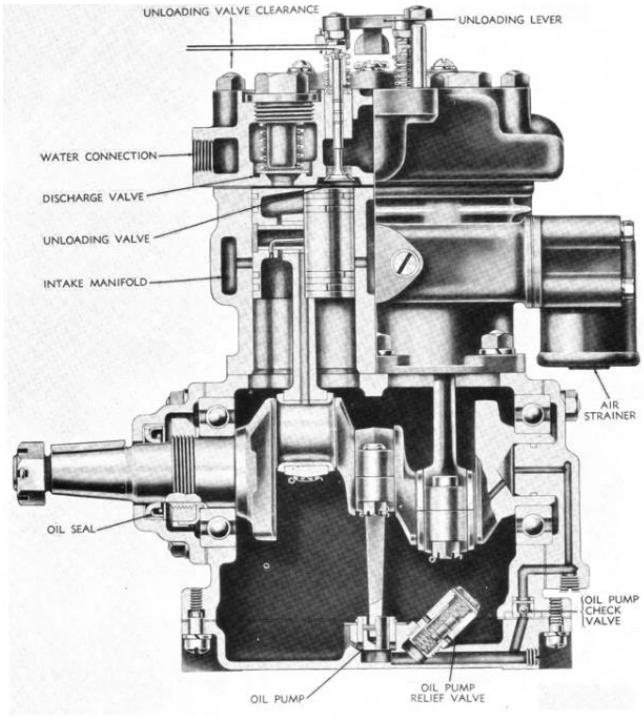


Fig 3: Rare picture of and air compressor driven by the engine.

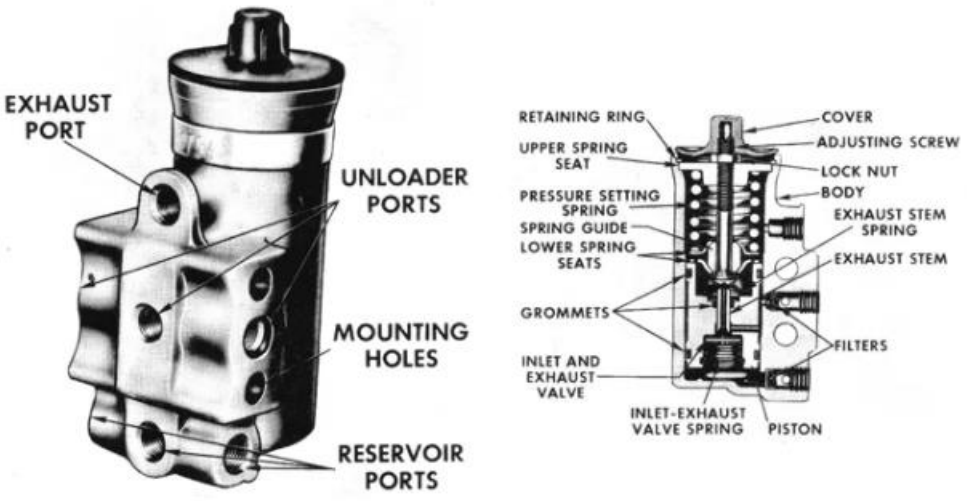


Fig 4: Internal schematic of an air governor

2.3.2. Straight Air Systems (early and Late)

Early and later straight air systems use the brake foot pedal to control a valve that sends compressed air, often through a relay valve, to air chambers (also known as "brake pots") at the wheels of the vehicle. These air chambers apply the brake shoes to the brake drums. The brakes will stop working if air pressure is depleted.

The parking brake is mechanical and separate from the service brake system in the majority of early-style systems, like my Autocar, and it may be used to slow down or stop the car sometimes. The main benefit is a significantly higher braking force than straight hydraulic brakes or power-assisted hydraulic brakes, as well as a significantly higher resistance of the wheel systems to heat. Another benefit is the general simplicity. Thus, only the air system needs maintenance. As was already said, the main drawback is that if air pressure is lost, you can only hope that the parking brake will cause the car to slow down or stop.

The latter variety Similar to the early model, the Straight Air System functions much the same. The key distinction is the presence of strong springs inside the wheel air chambers, which are typically only found on the rear axle or axles. The spring retains the brake shoes against the braking drum when there is no air pressure in the chamber. This mostly serves as a parking brake feature.

Prior to releasing the spring brakes, air pressure must reach a certain level during vehicle startup, often over 60 psi. The system then starts working.

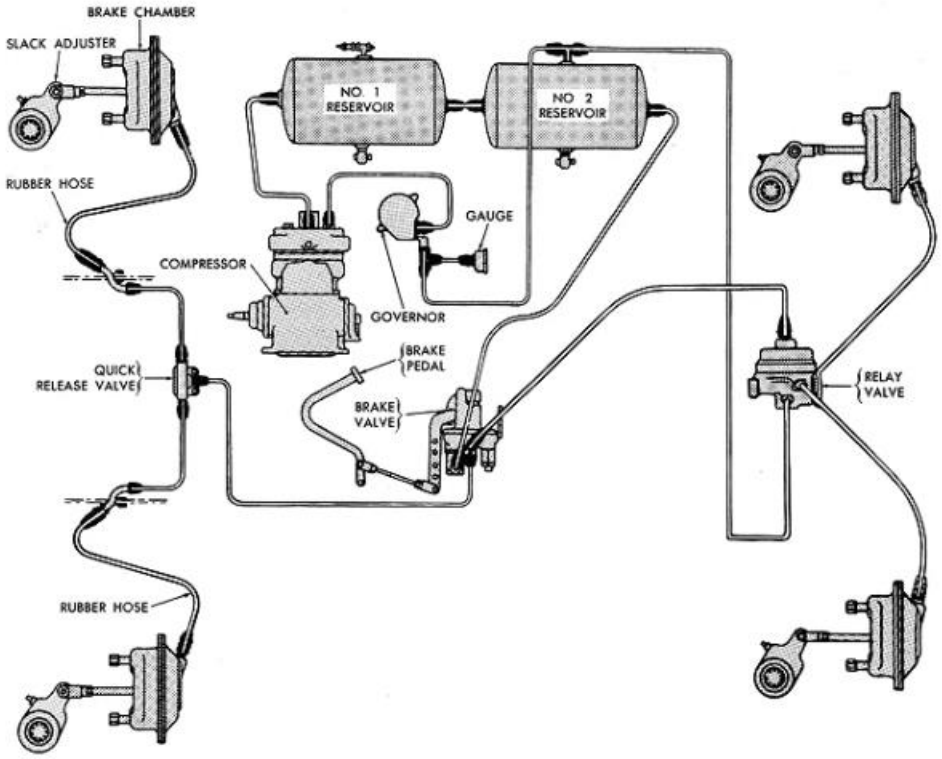


Fig 5: pneumatic Braking system of a Truck

2.3.3. CTSI

The CTIS system, which DUKW owners are likely familiar with, has many of the same parts as the other three, with the exception that the air is used to inflate the car's tires. As is the case with the majority of CCKWs and other WWII deuces, the service braking system of a DUKW is hydraulic with a vacuum booster. However, some more recent and present-day automobiles also support hydraulic brakes using the CTIS air system. On the other hand, certain cars also perform CTIS using their air brake system. However, most HMV hobbyists own relatively simple versions of the four types mentioned above. As a result, we'll now go into some basic descriptions of their various components and how to troubleshoot and maintain them. While air brake systems have advanced greatly in the decades since I guided runaway trucks down

mountains.

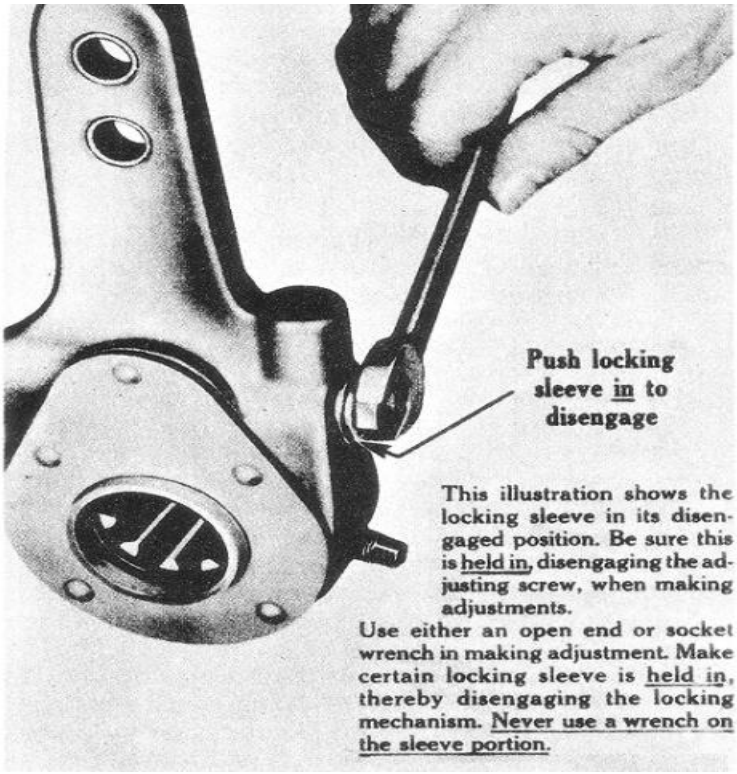


Fig 6: Adjustment of a typical slack-adjuster

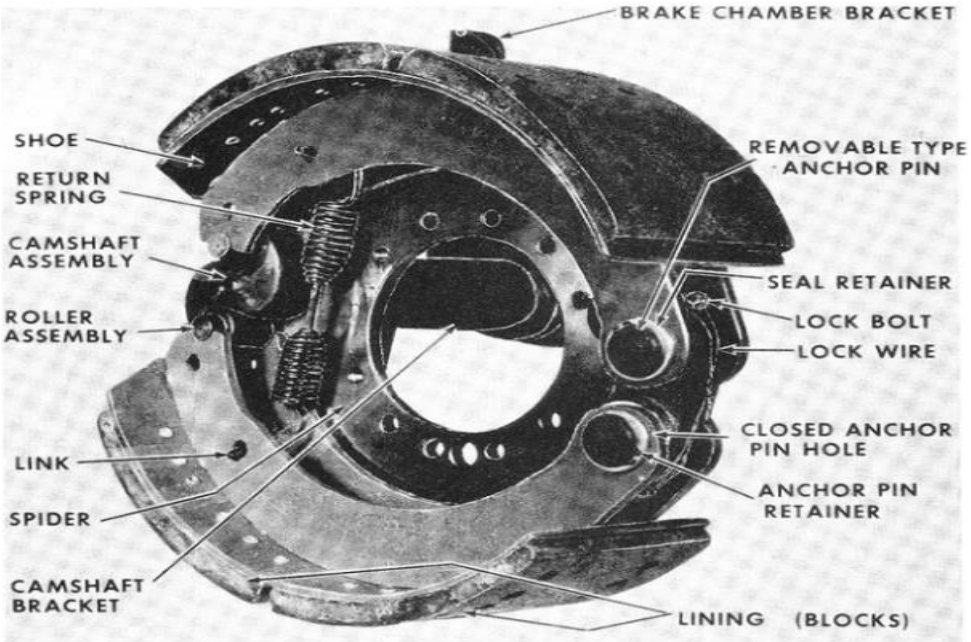


Fig 7: Basic Air brake wheel shoe assembly

2.4. Electro Pneumatic Braking System

The electro-Pneumatic braking system uses laws of pneumatics to apply brakes. They will automatically apply brakes upon sensing any hurdle in the path using the help of sensors thus reducing the ratio of accidents caused by the unawareness of human beings. The brake will be applied when the vehicle will cross the distance being set with the help of sensors.

The proposed methodology of this system is shown in the block diagram below which shows the components of the Pneumatic braking system. IR Transmitter and IR Receiver, Solenoid valve, Flow control valve, Compressor, Pneumatic Cylinder, and mechanical brake. When the vehicle gets too close, the sensor transmits the signal which is received by the receiver, and then air starts to flow from the compressor, and the brake is applied mechanically by a Pneumatic cylinder.

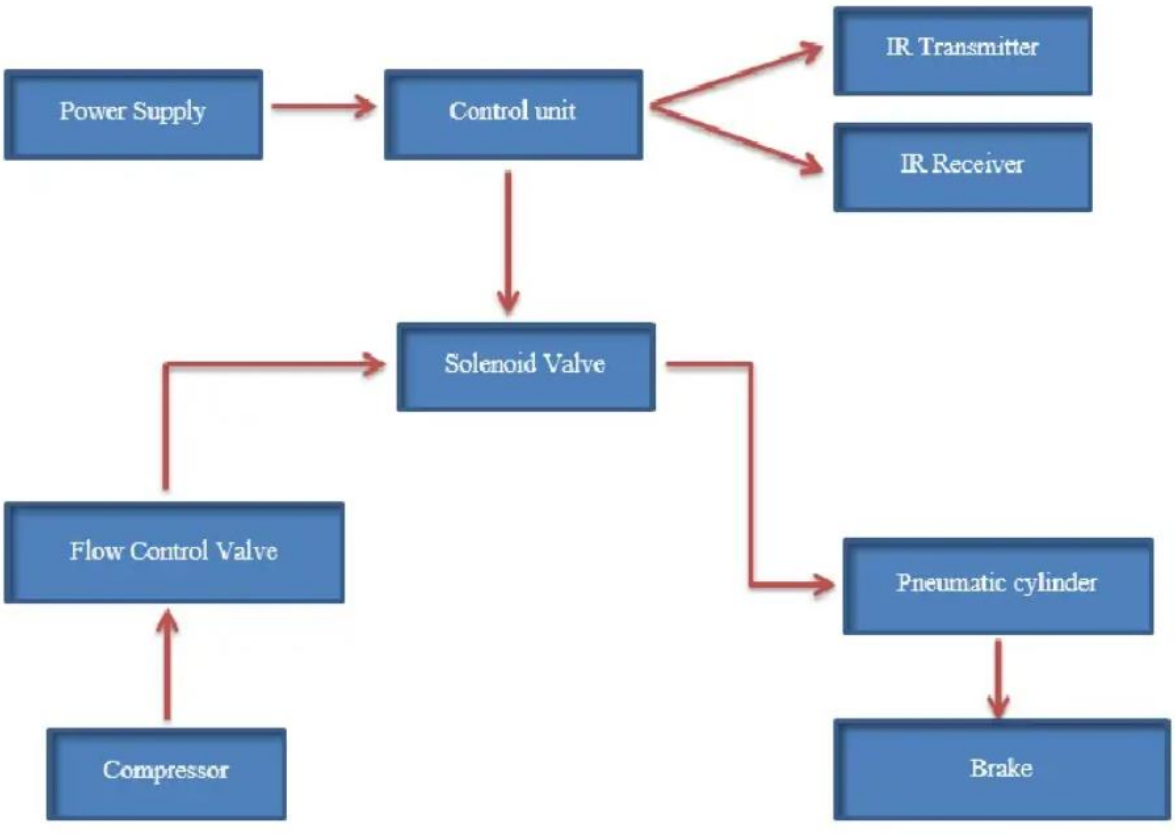


Fig 8: Electro Pneumatic Braking System.

A figure below shows the working of a pneumatic solenoid which controls the pneumatic airflow when an electric signal is provided to the solenoid.

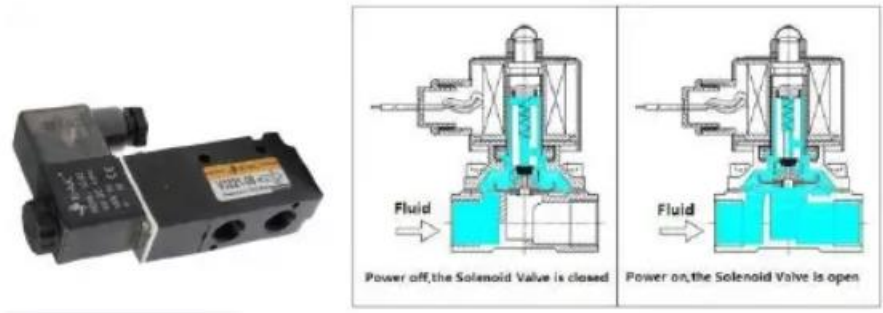


Fig 9: Working of a pneumatic solenoid.

2.5. Development of Automatic braking system

The increase in population is causing an increase in the demand of the vehicles. The increase in the number of accidents in recent years are ubiquitous. The increase in number of accidents means the threat to life and property has also been increased.

2.5.1. Objective

The main goal of this project is to design and put into practice a sophisticated autonomous braking system that successfully reduces accident risk and improves all-around vehicle safety. The main objective is to create an advanced security car braking system that uses cutting-edge ultrasonic sensors to considerably lessen the need for human attention when driving. This initiative must be integrated into every car as a vital safety measure, and it must be done immediately. The technology is particularly intended for use when there is little light, such as when driving at night. Due to driver weariness brought on by lengthy commutes, accidents are shown to happen more frequently during these times. Drivers may thus unintentionally crash with the car in front of them or with trees along the roadside. But now that this technology has been put into action, the car is outfitted with an autonomous braking system that successfully stops it, successfully averting accidents. We can significantly reduce the likelihood of accidents and encourage safer driving experiences for all road users by using this cutting-edge technology.

2.5.2. Scope

The scope of this project is to stop the vehicle automatically when the ultrasonic sensor will detect an obstacle. The ultrasonic sensor will drive a servo motor which will act as an actuator.

2.5.3. Methodology

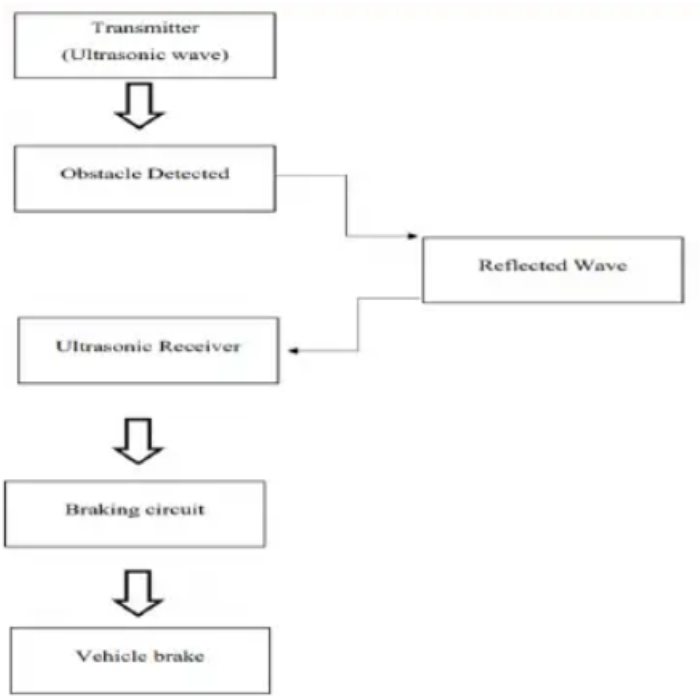


Fig :10 Methodology

2.5.4. Working Principle and Designing

A pipeline transports the compressed gas from the compressor, which runs at a pressure range of 5 to 7 bar, to a solenoid valve with a single input. This solenoid valve has one input and two outputs and is controlled by a control timing unit. The air entering the system flows through the input and is then released through the two outputs when the timing control unit is activated. The connecting rod is propelled upward by this mechanism, which takes advantage of the difference in air pressure below and above the piston. The difficulty area, which is swivel-jointed to the control unit, is raised as the connecting rod rises. The punch or rivet then receives this force. There is a crucial component in the circuit for transferring ultrasonic waves. The ultrasonic waves bounce off any obstructions in their route. These reflected ultrasonic waves are picked up by a receiver circuit known as the "ultrasonic receiver." The negative feedback circuit

receives and decodes the reflected ultrasonic waves in the ultrasonic receiver circuit, which then produces a control signal. The acting pneumatic cylinder receives all of the pressurized gas when the solenoid valve is opened. The pneumatic cylinder is turned on by the compressed gas, which starts the connecting rod moving. The braking mechanism is started if the piston advances.

The braking system's function is to either quickly or gradually stop the wheel from rotating in reaction to the piston's movement. A valve known as the "Flow Control Valve" is used to alter the braking speed. The goal of our research is to use this braking system as a model for a single wheel. The needed compressed gas is obtained from the compressor in order to do this. The solenoid valve and flow control valve, which are connected in the circuit diagram, are reached after the compressed gas has been directed via a polyurethane tube Valve" is used to alter the braking speed. The goal of our research is to use this braking system as a model for a single wheel. The needed compressed gas is obtained from the compressor in order to do this. The solenoid valve and flow control valve, which are connected in the circuit diagram, are reached after the compressed gas has been directed via a polyurethane tube. Expanding on these ideas and applying them to our project will allow us to create a dependable and efficient braking system that will increase safety and control for wheel-based applications.

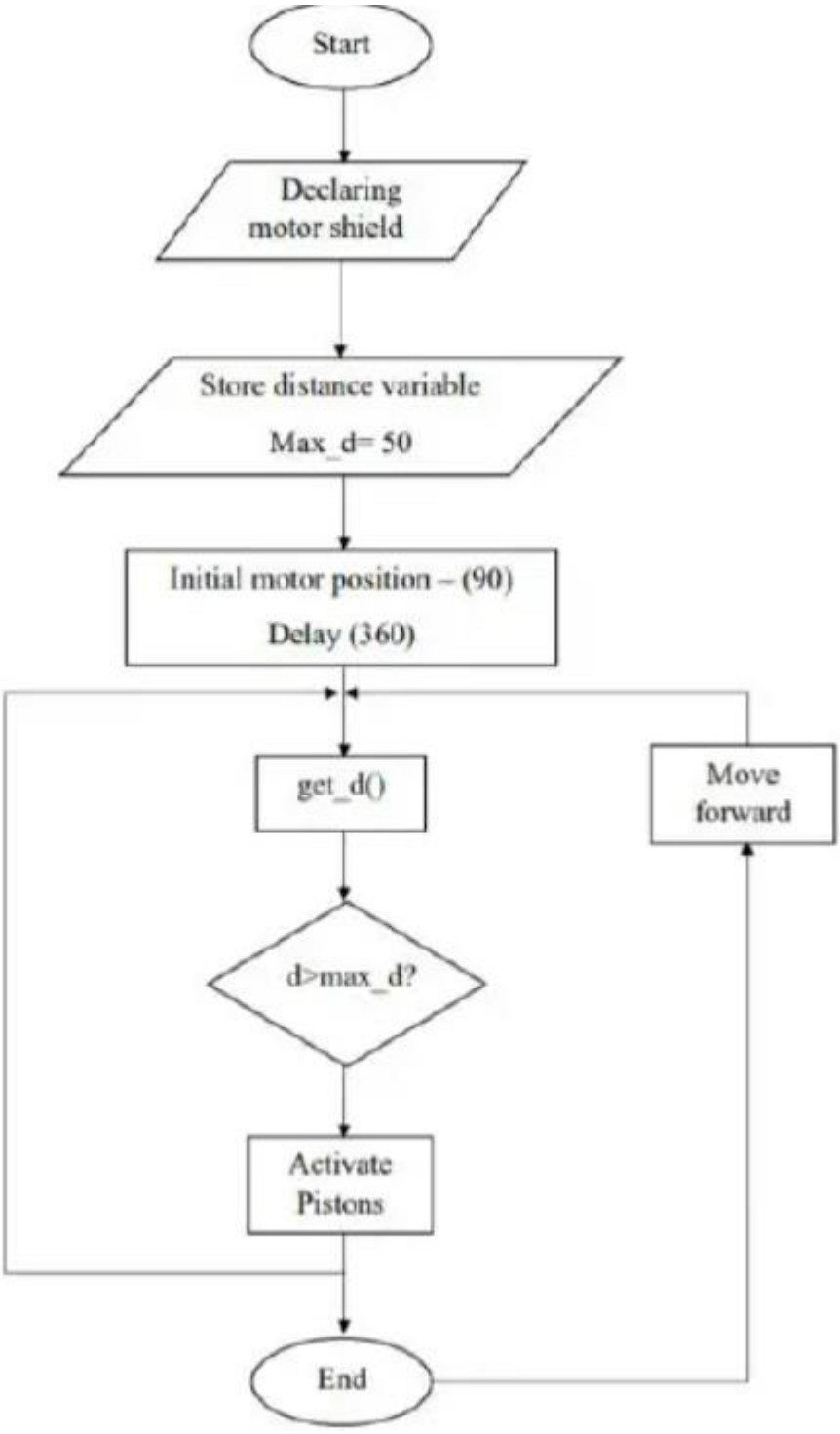


Fig 11: Flowchart of Advance Pneumatic braking system

Chapter 3 – METHADOLOGY

3.1. MERCEDES-BENZ 2028

The pneumatic braking system is an essential component of commercial vehicles, particularly trucks, as it plays a vital role in ensuring their safety and efficiency on the road. The 2028 Mercedes pickup features a pneumatic braking system that is not only advanced but also incorporates modern technologies and methodologies.

Understanding the principles of operation, components and advancements of this pneumatic braking system is essential to better understand the sophisticated and up to level braking mechanisms used in modern commercial vehicles.

Military trucks including the 2028 Mercedes Truck, rely on pneumatic braking systems due to their reliability, durability, and effective control over the braking mechanism. Unlike hydraulic brake systems, which use hydraulic fluid, pneumatic brake systems use compressed air to operate various components and facilitate precise and perfect control of braking forces. Harnessing the power of compressed air, the 2028 Mercedes Truck's pneumatic braking system ensures efficient and reliable braking performance, even under demanding driving conditions.

This methodology aims to provide a comprehensive understanding of the pneumatic braking system on the 2028 Mercedes truck. It delves into the operating principles, components and advances of this system, highlighting the intricate mechanisms that allow the truck to stop safely and be controlled. By exploring key components such as the air compressor, reservoirs, brake chambers, valves, sensors, and the role they play in the overall functionality of the system, we gain insight into the intricate workings of this advanced pneumatic braking system.

In addition, this methodology emphasizes the advances and innovations implemented in the air braking system of the 2028 Mercedes Pickup. These advances include improved response times, improved braking forces, reduced energy consumption, and the integration of advance technologies, such as advanced actuators and control algorithms. By incorporating these innovations, the pneumatic braking system of the Mercedes Truck 2028 achieves exceptional braking performance, guaranteeing

maximum safety and efficiency during braking maneuvers.

Understanding the pneumatic braking system on the 2028 Mercedes truck provides valuable knowledge not only for truck manufacturers and engineers, but also for drivers, technicians, and anyone interested in the intricate workings of modern Military vehicles. By learning about the components, principles of operation, and advancements of this system, Forces can appreciate the engineering excellence behind the safe and reliable braking mechanisms used in trucks.

The 2028 Mercedes pickup air brake system is a complex and sophisticated system that provides efficient and reliable braking performance. The system consists of several key components, including the air compressor, reservoirs, brake chambers, valves, sensors, and brake control module. These components work together to ensure that the brakes are applied and released in a safe and efficient manner, providing a safer and more reliable braking solution for commercial trucks.

3.1.1. Key Components:

The 2028 Mercedes pickup air brake system is a complex and sophisticated system that uses compressed air to provide efficient and reliable braking performance. The system consists of several key components, including:

3.1.1.1. Air compressor: The air compressor is the heart of the pneumatic braking system. It is responsible for generating and maintaining a sufficient supply of compressed air throughout the system. The air compressor draws in ambient air and compresses it to a higher pressure before sending it to the reservoirs, then come the air dryer filter it is supposed to pass a pressure of 8 bar only not less not more; if for instance air pressure is low then 8 bar then pressure brake with not operate properly and not more then 11bar but air dryer tries to keep it under 8 bar for as long as possible.

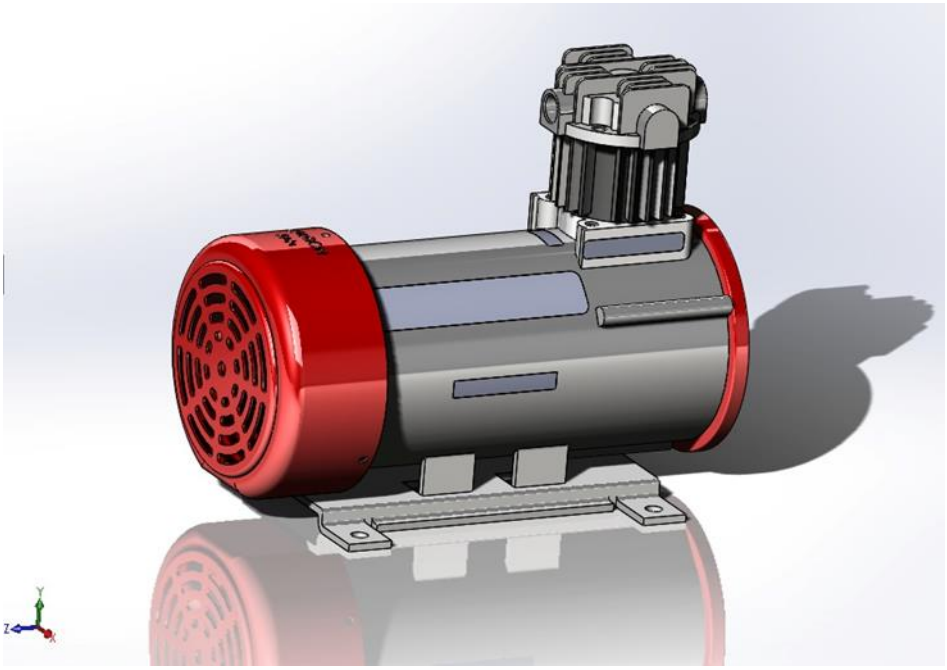


Fig 12: Compressor

3.1.1.2. Reservoirs: The compressed air generated by the air compressor is stored in strategically located reservoirs inside the truck. These reservoirs act as storage tanks, these are four air tanks one is left for extra air mostly people use it for excess air or if they get their tire flat, and all these tanks contain 8 bar pressure stored in them ensuring that an adequate supply of compressed air is available for immediate use when the brakes are applied. The reservoirs maintain the air pressure necessary for the efficient operation of the brake system, providing quick and responsive braking performance.

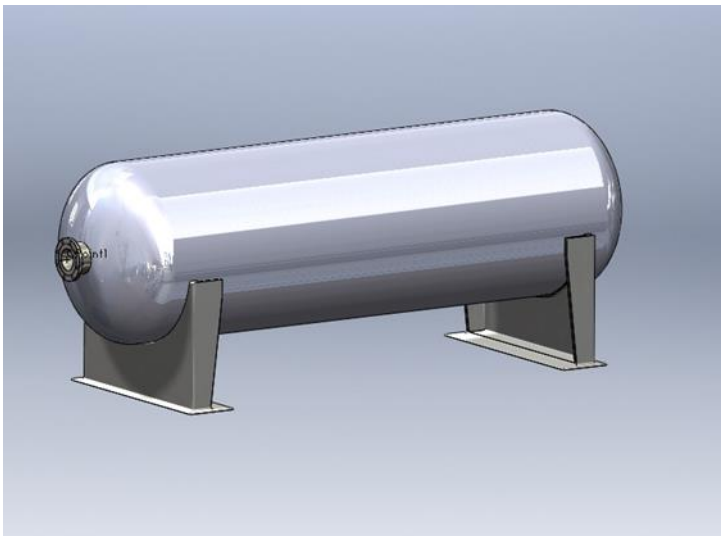


Fig 13: Reservoir

3.1.1.3. Brake chambers: Brake chambers play a crucial role in converting the energy from the compressed air into mechanical force to actuate the truck's brakes. These chambers are located near each wheel and contain a diaphragm or piston they are also called boosters a mechanism that converts air pressure into a buoyant force. When compressed air is released into the brake chambers, it forces the diaphragm or piston to extend, pressing against the brake shoes or pads, thus activating the brakes and generating the friction necessary to slow or stop the vehicle.

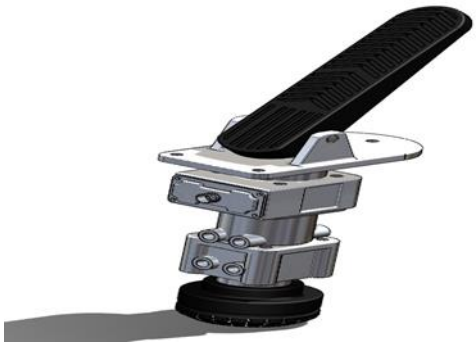


Fig 14: Brake Chamber

3.1.1.4. Valves: Valves serve as control mechanisms within the pneumatic braking system, regulating the flow of compressed air and directing it to the

appropriate components. These valves include relay valves, quick release valves (Gun control valve), check valves, and others. Relay valves control the application and release of the brakes, ensuring smooth and gradual braking. Quick release valves speed the release of air pressure from the brake chambers, allowing for faster disengagement of the brakes. Check valves prevent backflow of air, maintaining system integrity and pressure. These valves work in synchronization to precisely control brake application and release, contributing to overall system efficiency and safety, these valves are used to drag highly equip Artillery guns and trailers also known as Gun towers.

Fig 15: Trailer Valve

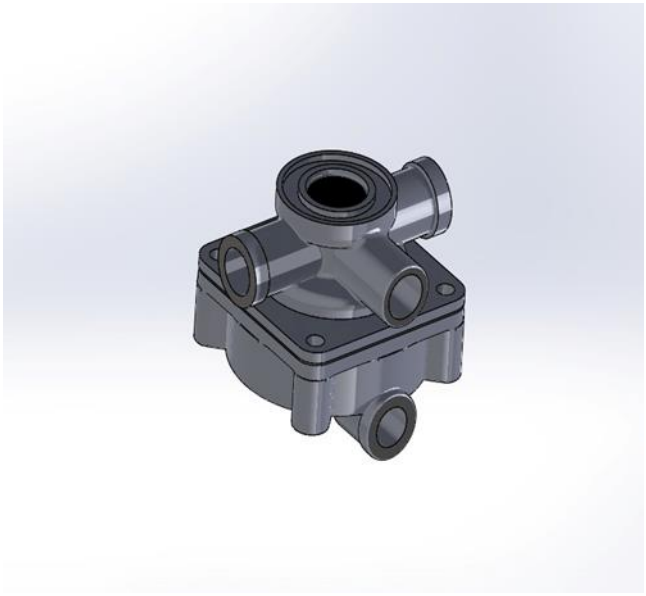


Fig 16: Relay Valve

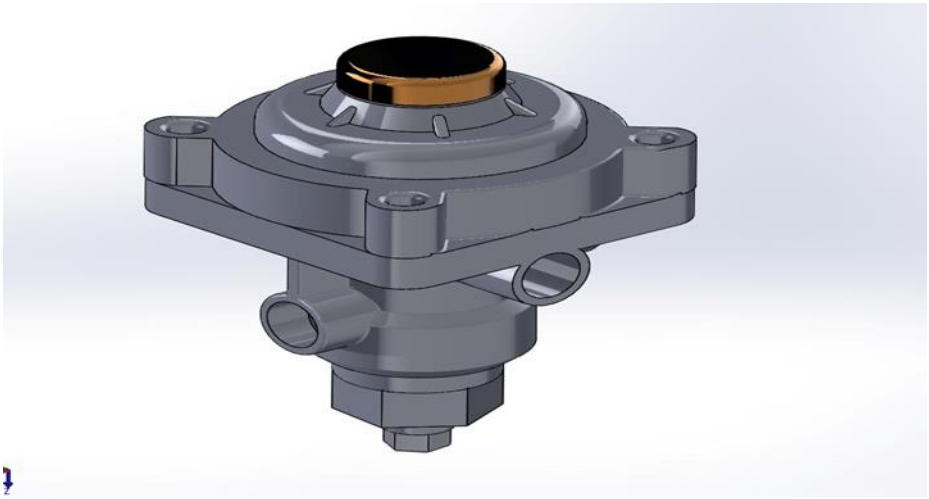


Fig 17: Gun Tower Valve

3.1.1.5. Sensors: The sensors embedded in the pneumatic braking system play a crucial role in the control and feedback of various parameters. These sensors detect important factors such as wheel speed, braking force, air pressure, and system integrity. By continuously monitoring these parameters, the sensors allow the system to optimize braking performance and respond effectively to changing road conditions or emergency situations. The information provided

by the sensors is transmitted to the vehicle's central control unit, which can then make adjustments in real time to ensure optimum braking efficiency and safety.

3.1.2. Advantages over traditional Hydraulic Braking System

The 2028 Mercedes pickup air brake system offers several advantages over traditional hydraulic brake systems, including:

- **Greater efficiency:** The use of compressed air reduces the amount of energy required to operate the brake system.
- **Improved reliability**: The air brake system is less susceptible to leaks and other problems than hydraulic brake systems.
- **Greater durability:** The air brake system is designed to withstand the harsh conditions of commercial truck operation.

As a result of these advantages, the 2028 Mercedes pickup air brake system provides a safer, more efficient, and more reliable braking solution for commercial trucks

3.1.3. Additional Details

Here are some additional details about the key components of the 2028 Mercedes pickup air brake system:

3.1.3.1. Air compressor:

The air compressor is typically driven by the engine, although some systems may use an electric motor. The air compressor draws in ambient air and compresses it to a high pressure, typically between 90 and 120 psi. The compressed air is then stored in reservoirs.

3.1.3.2. Reservoirs:

The reservoirs store the compressed air, providing a constant supply that is available to the brake system when it is needed. The reservoirs are typically made of steel or aluminum and are designed to withstand the high pressures involved in air brake systems.

3.1.3.3. Brake chambers:

The brake chambers convert the compressed air into mechanical force, which actuates the truck's brakes. Brake chambers are typically made of steel or aluminum and are located near each wheel. When compressed air is released into the brake chamber, it causes a diaphragm or piston to move, which actuates the brakes.

3.1.3.4. Valves:

Valves control the flow of compressed air to the brake chambers, ensuring that the brakes are applied and released in a controlled manner. There are two main types of valves used in air brake systems: relay valves and check valves. Relay valves control the application of the brakes, while check valves prevent backflow of air from the brake chambers.

3.1.3.5. Sensors:

Sensors monitor various parameters, such as wheel speed, brake force, and air pressure, and provide feedback to the brake control module. The brake control module uses this feedback to ensure that the brakes are applied and released in a safe and efficient manner.

3.1.3.6. Brake control module:

The brake control module is the brain of the system. It receives input from the sensors and uses advanced control algorithms to ensure that the brakes are applied and released in a safe and efficient manner. The brake control module is typically located in a centralized position within the vehicle, allowing efficient communication with the various components of the brake system.

3.1.4. Anti-Lock Braking System (ABS)

The Anti-Lock Braking System (ABS) in the 2028 Mercedes Pickup is a sophisticated safety feature that uses wheel speed sensors, a Hydraulic Control Unit (HCU), and advanced control algorithms to prevent wheel lockup and maintain optimum braking performance.

When the ABS control algorithm detects that a wheel is about to lock up, it

releases brake pressure to that wheel. This allows the wheel to continue rotating, which prevents skidding and maintains traction. The ABS system then quickly applies brake pressure to the wheel again, which helps to slow the vehicle down. The ABS system can modulate brake pressure and release it quickly, when necessary, which ensures maximum traction, stability, and control during emergency braking situations. ABS provides significant benefits in terms of safety, braking performance, and tire life, making it a valuable resource in improving the overall driving experience and vehicle safety.

3.1.4.1. Sensors used in ABS

The ABS system in the 2028 Mercedes pickup relies on several sensors to ensure effective operation and maintain optimal braking performance:

3.1.4.1.1. Wheel Speed Sensors:

These sensors measure the speed of each wheel, allowing the ABS control algorithm to detect possible wheel lockup.

3.1.4.1.2. Brake Pressure Sensors:

These sensors measure the pressure in the brake lines and provide information to the ABS control algorithm for precise distribution of brake pressure to each wheel.

3.1.4.1.3. Air Pressure Sensors:

These sensors measure the pressure in the air tanks, allowing the ABS control algorithm to verify proper inflation of the tanks.

3.1.4.1.4. Temperature Sensors:

These sensors monitor the temperature of the brake pads and rotors, which helps the ABS control algorithm to identify if the brakes are overheating.

These sensors work together to provide the ABS control algorithm with crucial data, preventing wheel lockup and maintaining optimal braking performance.

3.1.4.2 Benefits of ABS

Here are some of the benefits of ABS:

- Improved braking safety: ABS can help to prevent accidents by preventing wheel lockup and maintaining steering control.
- Optimized braking performance: ABS can help to shorten stopping distances and improve overall vehicle control during emergency braking maneuvers.
- Reduced tire wear: ABS can help to reduce tire wear by minimizing skidding and excessive heat buildup in the braking system.

If you are considering buying a new truck, I highly recommend that you look for one that is equipped with ABS. It is a valuable safety feature that can help to prevent accidents and improve your overall driving experience.

3.1.5. Additional Sensors

In addition, the 2028 Mercedes pickup incorporates additional sensors to monitor the air brake system:

3.1.5.1 Valve Position Sensors:

These sensors track the position of the valves within the brake system, ensuring their precise opening and closing for proper brake functionality.

3.1.5.2 Wiring Integrity Sensors:

These sensors monitor the integrity of the brake system wiring, identifying any potential issues that could lead to brake failure.

3.1.5.3 Power Supply Sensors:

These sensors monitor the power supply to the brake system and alert the ABS control algorithm of any power related issues that could compromise braking performance.

These sensors work together to provide essential information to the ABS control algorithm, ensuring the safety and reliability of the air brake system.

3.2. MERCEDES-BENZ 2624

3.2.1. Key Components:

The pneumatic braking system in a Mercedes-Benz 2624 truck, similar to other commercial vehicles, typically includes the following components:

3.2.1.1. Air Compressor:

The function is to compresses the atmospheric air and then supplies high pressurized air to the pneumatic.

3.2.1.2. Air Reservoirs:

They are used to store air which are four tanks and are used when the brakes are applied in the pneumatic system.

3.2.1.3. Brake Pedal:

The driver is the operator of the pedals whether he applies foot brake or hand brake.

3.2.1.4. Brake Valves:

It controls the flow of compressed air to different parts of the pneumatic system. They include:

3.2.1.4.1. Foot Brake Valve:

It is mounted at the feet of the driver from where the driver controls the braking of the whole truck, it regulates the air pressure applied to the wheel brakes.

3.2.1.4.2. Relay Valve:

It is attached with every wheel with the boosters attached to I, When the brakes are applied the piston, moves and holds the tire so it stops

3.2.1.4.3. Spring Brake Valve:

Activates the parking brake when the system pressure drops below a certain threshold.

3.2.1.5. Brake Chambers:

It is used for the conversion of air pressure into force that engages that brake

shoes. They include:

3.2.1.5.1. Spring Brake Chambers:

It is Used for parking brakes (foot braking mechanism) and emergency brakes (hand braking mechanism).

3.2.1.5.2. Service Brake Chambers:

It is engaged when the foot brake is applied.

3.2.1.6. Brake Lines and Hoses:

These are the pipes which connect different parts of the system and distributing the air to the certain parts of the system.

3.2.1.7. Brake Drums or Discs:

The components which cause the friction to reduce the speed on the brake pads.

3.2.1.8. Anti-lock Braking System (ABS):

Many modern trucks are equipped with ABS, which includes additional components such as wheel speed sensors, ABS modulator valves, and an electronic control unit (ECU). ABS helps prevent wheel lock-up during braking, improving control and stability.

3.2.2. Explanation:

The detailed explanation of components of Mercedes-Benz 2624 is given below:

3.2.2.1. Air Compressor:

The air compressor in pneumatic braking system is important component responsible for sucking and supplying compressed air to the reservoirs of the system. The system working and mechanism is shown following:

3.2.2.1.1. Function:

The main function of the air compressor is to suck the air from the atmosphere, then compress the atmospheric air and deliver it to the various components of the whole braking pneumatic system, including the foot brake valve, hand brake valve, relay valve, air reservoirs, and

other devices that rely on compressed air.

3.2.2.1.2. Operation:

The compressor is within the engines and the engine drives the compressor through gear mechanism. The engines rotate the co pressor crank shaft which drives the cylinders within the compressor.

The reciprocating motion of the pistons in the cylinders create a vacuum during the downward stroke of the engine which in turns creates the vacuum and the atmospheric air is drawn through the inlet valve of the engine. The atmospheric air is compressed and distributed to the four cylinders in the system during the upward stroke.

3.2.2.1.3. Features:

- Cylinder and Piston Assembly: There are a number of cylinders with a piston attached to it. The number of cylinders can vary based on the compressor design and the truck's requirements.
- Intake Valve: It opens during the downward stroke known as intake stroke which creates vacuum and draws the atmospheric air into the cylinder. It closes during the compression stroke.
- Discharge Valve: The valve opens when the compression stroke is in process which enables the compressed air to exit the cylinder and to the pathways which leads to the reservoirs. It closes during the intake stroke to prevent air from escaping back into the cylinder.
- Lubrication Systems: Proper lubrication is required to the compressor so there is no friction or wear and tear in the parts where the air is supplied. It may be equipped with an oil supply and oil filter to provide lubrication to the moving parts.
- Cooling System: The compressor heats up the system when the air is compressed so a cooling mechanism is required for example air vents and air coolers.

- Pressure Regulator: A pressure regulator is built in the air compressor which helps to maintain the desired air pressure by controlling the compressor's operation or by adjusting the airflow to the air reservoirs.
- Pressure relief valves: release the exceeded pressure if it increases from a certain limit. This is advantageous as it will not destroy the pipes or the braking system.

3.2.2.2. Air Reservoirs/Cylinders:

The air reservoirs are used to store the drawn air which are known as air tanks or air storage tanks. These are the main part of a truck's pneumatic braking system. The functions of the reservoirs of the system are as following:

3.2.2.2.1. Air Storage:

The air is continuously being drawn into the cylinder from the compressor into the tanks. These tanks serve as the temporary storage for the compressed air and is utilized whenever the brakes are applied.

3.2.2.2.2. Pressure Stabilization:

The stability of the pressure is very important and it should remain consistent for the desired output. The minimum pressure required to run the truck is 8 bar. The air dryer filter releases the extra air from the system and the pressure relief valve maintains the pressure.

3.2.2.2.3. Emergency Energy Source:

This is the emergency tank which is filled with the compressor and is utilized when the other tanks are not working or failure is occurring by using those supplies.

3.2.2.2.4. Brake Application:

When the brakes are applied the reservoirs release the air to the foot or hand brake valve which in turn operates the relay valves and the touring valves. The relay valves and the touring valves engage the

boosters of the truck tires and the load attached to it which engages the piston of the cylinder.

3.2.2.2.5. Pneumatic Accessories:

The air is not only supplied to the braking system it can be utilized anywhere, such as air-powered suspension systems, air-operated doors or ramps, and pneumatic control systems for transmission or differential locks.

It's important to note that the number, size, and configuration of air reservoirs can vary depending on the truck model, manufacturer, and system requirements. The specific location of the air reservoirs can also differ, but they are typically mounted in accessible areas of the truck chassis, such as underneath the cabin or along the frame rails.

For precise information about the air reservoirs in a particular Mercedes-Benz truck model, it is advisable to refer to the vehicle's user manual or consult a certified Mercedes-Benz dealer or service center.

3.2.2.3. Foot Brake Valve:

The mechanism of the pneumatic system in the foot brake valve involves the control and regulation of compressed air flow to activate the brakes. While the specific mechanism can vary between different foot brake valve designs, here is a general overview of the pneumatic operation:

3.2.2.3.1. Air Inlet:

The foot brake valve receives compressed air from the air reservoirs or air supply system. The air inlet is typically connected to the main air supply line.

3.2.2.3.2. Release Position:

In the released position, the valve is designed to block or minimize the flow of compressed air. This position allows the brakes to remain

disengaged and the truck to coast or roll freely.

3.2.2.3.3. Brake Application:

When the driver presses the brake pedal, the foot brake valve is actuated. This actuation allows the valve to shift to the brake application position. As a result, the air passage within the valve opens up, enabling the compressed air to flow through the valve.

3.2.2.3.4. Compressed Air Supply:

In the brake application position, the foot brake valve allows the compressed air from the air reservoirs to flow through the valve. The air is then directed towards the brake chambers or other braking components, such as wheel cylinders or calipers.

3.2.2.3.5. Brake Chamber Activation:

The supplied compressed air reaches the brake chambers, where it exerts pressure on the pistons within the chambers. This pressure causes the brake pads or shoes to engage with the brake rotors or drums, generating the friction needed to slow down or stop the truck.

3.2.2.3.6. Brake Release:

When the driver releases the brake pedal, the foot brake valve returns to the release position. In this position, the valve blocks the flow of compressed air to the brake chambers, allowing the brakes to release and the truck to resume its movement.

3.2.2.4. Hand Brake Valve:

The hand brake valve, also known as the parking brake valve or hand control valve, is another component in the pneumatic braking system of a truck. It is typically located within reach of the driver's hand and is used to activate the parking brakes separately from the foot-operated brakes. Here's an overview of the mechanism of the hand brake valve:

3.2.2.4.1. Parking Brake Activation:

The hand brake valve is designed to activate the parking brakes. When the driver operates the hand brake valve, it controls the flow of compressed air to engage the parking brakes.

3.2.2.4.2. Control Handle or Lever:

The hand brake valve features a control handle or lever that the driver operates to engage or disengage the parking brakes. The handle is often spring-loaded and has different positions, typically labeled or marked for ease of use.

3.2.2.4.3. Compressed Air Flow Control:

When the control handle or lever is pulled or engaged, it opens the air passage within the hand brake valve. This allows compressed air from the air reservoirs to flow through the valve and reach the parking brake chambers or actuators.

3.2.2.4.4. Parking Brake Engagement:

As the compressed air reaches the parking brake chambers or actuators, it applies pressure to activate the parking brakes. This pressure causes the brake pads or shoes to engage with the brake drums or rotors, preventing the truck from moving.

3.2.2.4.5. Parking Brake Release:

When the driver releases the control handle or lever of the hand brake valve, the air passage within the valve closes, cutting off the supply of compressed air to the parking brake chambers. This action releases the pressure on the brake pads or shoes, disengaging the parking brakes and allowing the truck to move freely.

3.2.2.5. Relay Valve (For Hand & Foot Brake)

The relay valve is a crucial component in the pneumatic braking system of a truck. It is responsible for controlling and distributing compressed air to

activate the brakes on multiple axles simultaneously. Here's an explanation of the mechanism of the relay valve:

3.2.2.5.1. Air Supply Inlet:

The relay valve receives compressed air from the main air supply line or the foot brake valve. The air supply inlet is connected to the main air source, typically the air reservoirs.

3.2.2.5.2. Control Port:

The relay valve has a control port that receives the signal or input from the foot brake valve or the driver's braking action. This control port determines when the relay valve should allow or block the flow of compressed air to the brake chambers.

3.2.2.5.3. Primary and Secondary Air Ports:

The relay valve has primary and secondary air ports that connect to the brake chambers on different axles. The primary airport supplies compressed air to the brake chambers on the front axle or the primary axle, while the secondary airport delivers air to the brake chambers on the rear axles or the secondary axles.

3.2.2.5.4. Diaphragm and Piston:

Inside the relay valve, there is a diaphragm or piston mechanism that moves in response to the control signal from the control port. The movement of the diaphragm or piston controls the distribution of compressed air to the brake chambers.

3.2.2.5.5. Control Signal Activation:

When the driver applies the brakes by pressing the foot brake valve, the control port of the relay valve receives a signal. This signal initiates the movement of the diaphragm or piston within the relay valve.

3.2.2.5.6. Air Distribution:

As the diaphragm or piston moves, it opens the air passages within the relay valve. Compressed air flows through the primary airport,

supplying the necessary air pressure to the brake chambers on the primary axle. Simultaneously, the relay valve redirects and proportionally distributes compressed air through the secondary air ports to the brake chambers on the secondary axles.

3.2.2.5.7. Brake Activation:

The compressed air reaching the brake chambers applies pressure to the pistons or diaphragms in the chambers. This pressure converts the pneumatic force into mechanical force, causing the brake shoes or pads to engage with the brake drums or rotors, thereby activating the brakes on all axles simultaneously.

3.2.2.6. Relation of Relay Valves & Boosters

In a pneumatic braking system, the relay valve is connected to the brake boosters to assist in amplifying the force applied by the driver on the brake pedal. The relay valve helps in transmitting the compressed air to the brake boosters, which then further amplify the force to activate the brakes. Here's how the relay valves are connected to the boosters:

3.2.2.6.1. Compressed Air Supply:

The relay valve receives compressed air from the main air supply line or the foot brake valve. The compressed air is typically stored in the air reservoirs.

3.2.2.6.2. Relay Valve Ports:

The relay valve has multiple ports, including the primary airport and secondary air ports. These ports are connected to the brake chambers on the various axles of the truck.

3.2.2.6.3. Brake Boosters:

The brake boosters are vacuum or pneumatic devices that assist in amplifying the force applied by the driver on the brake pedal. The boosters are typically connected to the master cylinder and the brake pedal linkage.

3.2.2.6.4. Vacuum or Pneumatic Connection:

The relay valve is connected to the brake boosters through vacuum or pneumatic lines. These lines allow the flow of compressed air from the relay valve to the boosters.

3.2.2.6.5. Air Pressure Amplification:

When the driver applies pressure to the brake pedal, the foot brake valve actuates the relay valve, allowing compressed air to flow through the primary and secondary ports. This compressed air reaches the brake boosters through the vacuum or pneumatic lines.

3.2.2.6.6. Force Amplification:

The compressed air supplied to the brake boosters helps in amplifying the force applied by the driver. The boosters utilize the compressed air to multiply the force, allowing for increased braking power.

3.2.2.6.7. Brake Activation:

The amplified force from the brake boosters is then transmitted to the master cylinder. The master cylinder converts the force into hydraulic pressure, which is used to engage the brake calipers or wheel cylinders, ultimately applying the brakes and slowing down or stopping the vehicle.

The connection between the relay valves and the brake boosters is crucial in ensuring efficient and effective braking performance. The relay valve provides the necessary compressed air to the boosters, which then assist in amplifying the force and providing adequate braking force to the wheels. The specific configuration and design of the connection can vary between different truck models and manufacturers. For precise information, it is recommended to refer to the vehicle's user manual or consult a certified dealer or service center for the specific truck, such as a Mercedes-Benz model.

3.2.2.7. Spring Brake Chambers

Spring Brake chambers are an essential component of the braking system in

commercial vehicles, including trucks and trailers. They are designed to provide a reliable parking or emergency braking function. The mechanism of spring break chambers involves the following steps:

3.2.2.7.1. Construction:

A spring brake chamber consists of a housing that encloses a diaphragm, a push rod, a piston, a return spring, and a set of brake shoes or pads. The chamber is divided into two sections: the service chamber and the spring chamber.

3.2.2.7.2. Air Supply and Release:

The service chamber of the spring break chamber is connected to the compressed air supply from the pneumatic system. When air pressure is applied to the service chamber, it forces the diaphragm and push rod assembly to move outward, compressing the return spring.

3.2.2.7.3. Brake Activation:

As the diaphragm and push rod assembly move outward, the push rod transmits the force to the piston, which in turn applies pressure to the brake shoes or pads. This causes the brake shoes or pads to engage with the brake drums or rotors, activating the brakes.

3.2.2.7.4. Spring Brake Function:

The spring chamber of the spring brake chamber is equipped with a powerful return spring. This spring is initially compressed when the brakes are released. In case of an air loss or system failure, the compressed spring in the spring chamber becomes the source of braking force.

3.2.2.7.5. Emergency Brake Application:

If there is an air loss or system failure, the loss of pressure in the service chamber allows the powerful return spring in the spring chamber to expand. This expansion of the spring pushes the diaphragm

and push rod assembly back into the chamber, applying force to the piston and engaging the brakes.

3.2.2.7.6. Parking Brake Function:

Spring brake chambers are commonly used as parking brakes. When the parking brake control is activated, the air pressure in the service chamber is released, allowing the powerful return spring in the spring chamber to expand and engage the brakes. This keeps the vehicle stationary when parked.

3.2.2.7.7. Brake Release:

To release the brakes, air pressure is restored to the service chamber, overcoming the force of the return spring. The diaphragm and push rod assembly move outward, retracting the piston and disengaging the brake shoes or pads from the brake drums or rotors.

The mechanism of spring brake chambers ensures that there is a fail-safe parking and emergency braking function in the event of an air loss or system failure. It provides an additional layer of safety and helps prevent unintended vehicle movement. Proper maintenance and inspection of spring brake chambers are essential to ensure their reliable operation.

3.2.2.8. Emergency Brake Chamber

The emergency brake chamber, also known as the emergency brake actuator or emergency brake booster, is a component in the pneumatic braking system that provides additional braking force for emergency situations. Its mechanism involves the following steps:

3.2.2.8.1. Construction:

An emergency brake chamber consists of a housing that encloses a diaphragm, a push rod, a piston, a return spring, and a set of brake shoes or pads. The chamber is divided into two sections: the service chamber and the emergency chamber.

3.2.2.8.2. Normal Braking Operation:

During normal braking, compressed air from the pneumatic system is supplied to the service chamber of the emergency brake chamber. This air pressure acts on the diaphragm, pushing it and the push rod assembly outward.

3.2.2.8.3. Emergency Braking Activation:

In an emergency braking situation, such as sudden deceleration or loss of control, the driver can activate the emergency brake system by pulling a lever or pressing an emergency brake button. This action releases the air pressure from the service chamber and simultaneously supplies compressed air to the emergency chamber.

3.2.2.8.4. Air Pressure Transfer:

When the air pressure is supplied to the emergency chamber, it acts on the diaphragm, pushing it and the push rod assembly further outward. This results in increased force being transmitted to the piston.

3.2.2.8.5. Brake Activation:

As the push rod assembly moves outward, it applies force to the piston, which in turn applies pressure to the brake shoes or pads. The brake shoes or pads engage with the brake drums or rotors, generating significant braking force to quickly slow down or stop the vehicle in an emergency situation.

3.2.2.8.6. Brake Release:

After the emergency braking event, the driver releases the emergency brake lever or button, cutting off the air supply to the emergency chamber. This allows the air pressure in the emergency chamber to be released, and the return spring brings the diaphragm and push rod assembly back to their initial positions, disengaging the brakes.

The mechanism of the emergency brake chamber provides an additional braking force in emergency situations, helping the driver to quickly and

forcefully apply the brakes when needed. It serves as a crucial safety feature in the event of an unexpected hazard or loss of control. Proper maintenance and inspection of the emergency brake chamber are important to ensure its reliable operation when required.

3.2.2.9. Trailer Control Valve

The trailer control valve, also known as the trailer supply valve or trailer relay valve, is an important component in the pneumatic braking system of a truck with a trailer. It is responsible for controlling and regulating the supply of compressed air to the trailer's braking system. The mechanism of the trailer control valve involves the following steps:

3.2.2.9.1. Air Supply Inlet:

The trailer control valve receives compressed air from the main air supply line of the truck's pneumatic system. This air supply is typically provided by the truck's air reservoirs or air compressor.

3.2.2.9.2. Trailer Connection:

The trailer control valve is connected to the trailer's braking system through appropriate air lines or connections. This connection allows the compressed air to be transmitted from the truck to the trailer.

3.2.2.9.3. Control Port:

The trailer control valve has a control port that receives signals or inputs from the truck's braking system, typically from the foot brake valve or other control devices.

3.2.2.9.4. Trailer Brake Activation:

When the driver applies the brakes in the truck by pressing the foot brake valve, a signal is sent to the control port of the trailer control valve. This signal initiates the braking process in both the truck and the trailer.

3.2.2.9.5. Compressed Air Distribution:

Upon receiving the control signal, the trailer control valve opens its air passages and allows the flow of compressed air to the trailer's braking system. The valve proportionally distributes the compressed air to the trailer's brake chambers or actuators.

3.2.2.9.6. Brake Activation in the Trailer:

The distributed compressed air reaches the brake chambers or actuators in the trailer. The air pressure in the chambers actuates the pistons, causing the brake shoes or pads to engage with the trailer's brake drums or rotors. This results in the activation of the brakes in the trailer, aiding in slowing down or stopping the trailer.

3.2.2.9.7. Brake Release:

When the driver releases the foot brake pedal, the signal to the trailer control valve is ceased. As a result, the valve closes its air passages, cutting off the supply of compressed air to the trailer's braking system. This action releases the pressure in the trailer's brake chambers, disengaging the brakes and allowing the trailer to roll freely.

3.2.2.10. Two Couplers attached to the Truck

The two couplers attached after the trailer control valve in a pneumatic braking system are commonly referred to as the supply coupler and control coupler. They play a crucial role in the distribution of compressed air to the trailer's braking system. Here's an explanation of their mechanism and function:

3.2.2.10.1. Supply Coupler

The supply coupler is responsible for supplying compressed air from the truck's pneumatic system to the trailer's braking system. Its mechanism involves the following steps:

- **Connection:** The supply coupler is physically connected to the trailer control valve through an airline. This connection allows

the flow of compressed air from the control valve to the supply coupler.

- **Air Passage:** Inside the supply coupler, there is a built-in air passage or channel. This passage allows the compressed air to flow from the control valve to the supply coupler.
- **Compressed Air Distribution:** As the compressed air reaches the supply coupler, it is distributed to various components of the trailer's braking system. This includes the trailer's brake chambers, actuators, and other braking mechanisms.
- **Brake Activation:** The distributed compressed air applies pressure to the brake chambers or actuators in the trailer, causing the brake shoes or pads to engage with the brake drums or rotors. This results in the activation of the trailer's brakes, aiding in slowing down or stopping the trailer.

3.2.2.10.2. Control Coupler:

The control coupler is responsible for transmitting the control signals from the truck's pneumatic system to the trailer's braking system. Its mechanism involves the following steps:

- **Connection:** The control coupler is physically connected to the trailer control valve through an airline. This connection allows the transmission of control signals from the control valve to the control coupler.
- **Control Signal Transmission:** Inside the control coupler, there are electrical or pneumatic connections that enable the transmission of control signals. These signals include commands for brake application, release, and other braking functions.
- **Control Signal Distribution:** As the control signals reach the control coupler, they are distributed to the corresponding

components in the trailer's braking system. This includes the trailer's brake chambers, actuators, and other control devices.

- **Brake Control:** The distributed control signals actuate the brake chambers or actuators in the trailer, controlling the engagement and disengagement of the brakes as per the driver's commands. This allows for precise control over the trailer's braking operation.

The supply coupler and control coupler work together to ensure that the necessary compressed air and control signals are transmitted from the truck to the trailer's braking system. They play a vital role in synchronizing the braking actions between the truck and the trailer, allowing for safe and effective braking performance during towing operations.

Chapter 4 – Results & Conclusion

The addition of a gun tower valve after the trailer has expanded the towing ability of the 2624 gun towing vehicle, providing three couplings for efficient gun towing. This modification ensures compatibility with modern artillery guns and offers better functionality. The addition of a third coupling specifically caters to generating higher pressure, effectively facilitating the towing of artillery guns. By incorporating this feature, the 2624 truck has significantly improved its capacity to transport heavy weaponry. The integration of the gun tower valve and the three couplings empowers the truck to meet the rigorous demands of modern artillery guns, emphasizing mobility and firepower. This upgrade guarantees seamless coordination between the truck and the towed artillery gun. Consequently, the Mercedes Benz 2624 truck, with its increased towing capabilities, presents an optimal solution for military forces requiring efficient transportation and operation of advanced artillery systems.

CAD model of the modified assembly:

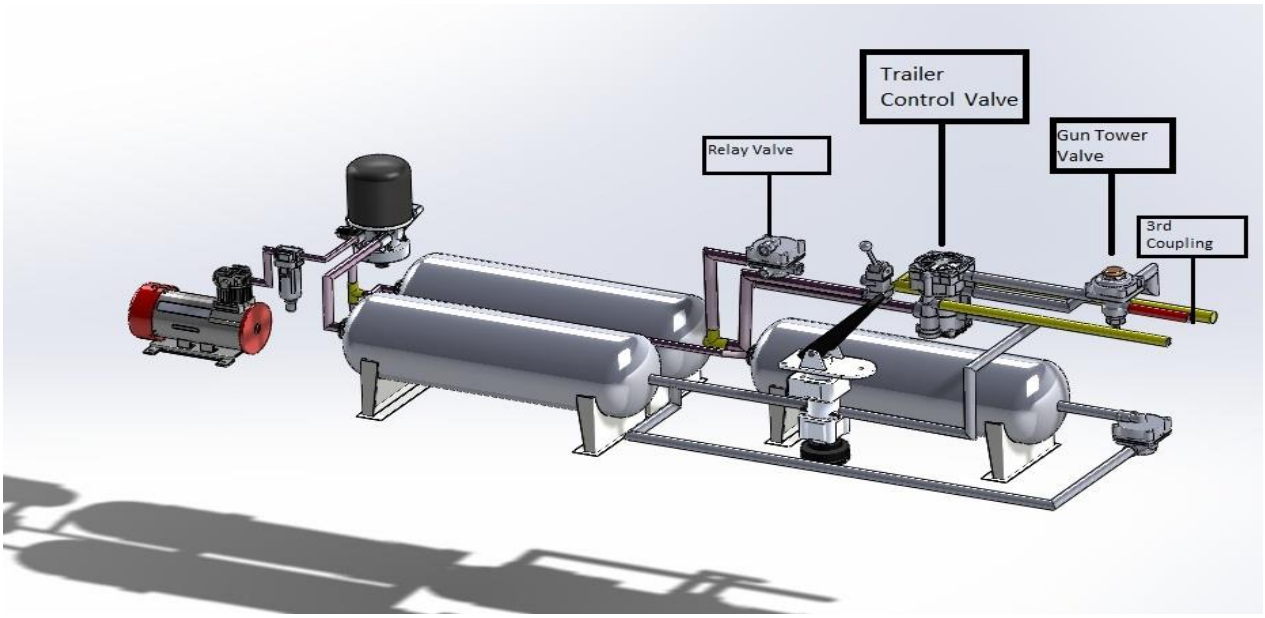


Fig 18: Complete Assembly

Ansys Analysis

An Ansys CFD analysis was done on air splitters, pipes, and Gun tower valve, with an inlet velocity of 0.3 m/s and a mesh size of 0.03 mm. The obtained figures provide proof that both the pipes, valves and splitters are able of supporting high air pressures. Moreover, the analysis confirms the ability of the Gun tower valve to withstand and regulate these elevated pressures effectively. These results underscore the strength and dependability of the analyzed components in managing the flow of high-pressure air.

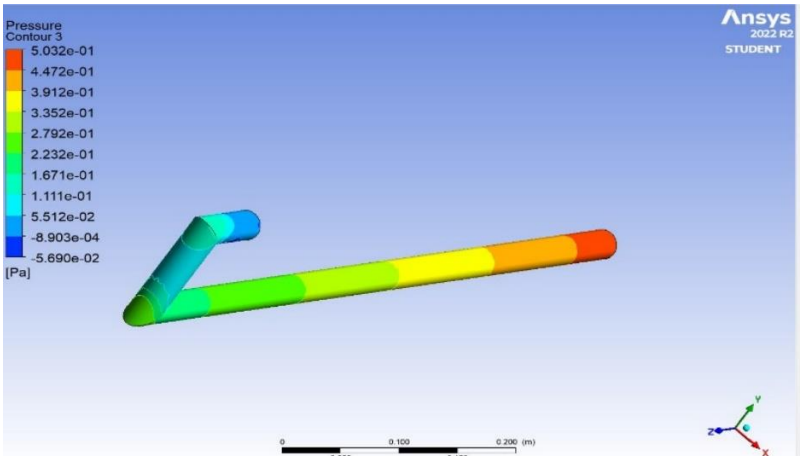


Fig 19: CFD of splitter attached Trailer control valve

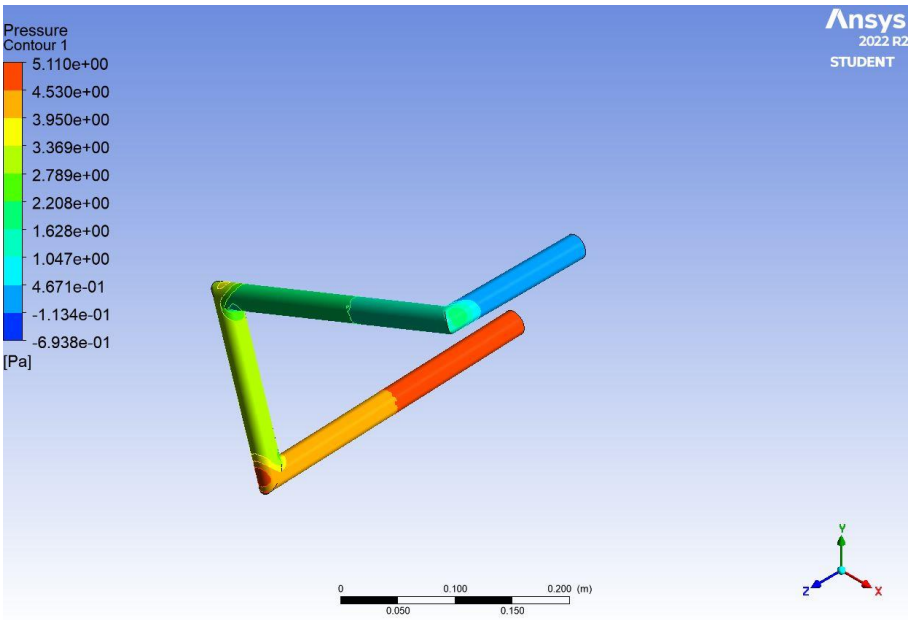


Fig 20: CFD of Gun Tower valve steel pipe

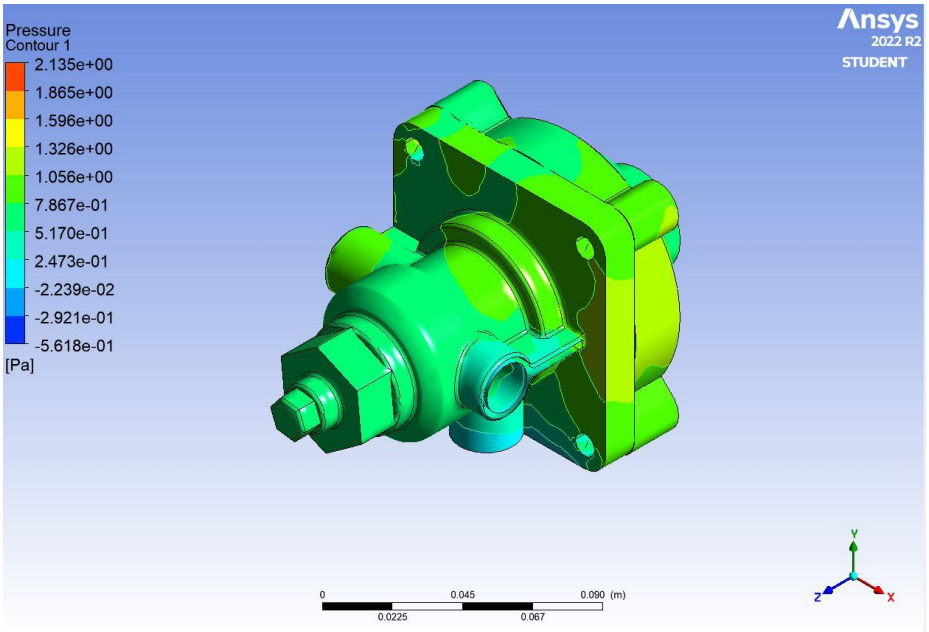


Fig 21: CFD of Gun tower Valve

Hardware Model:

The images provided show the finalized mechanical model of the modified pneumatic braking system for the gun towing vehicle 2624. These visual representations show the completed design, highlighting arrangement and configuration of the structural components. The model demonstrates the successful integration of the pneumatic braking system into the vehicle, resulting in enhanced braking performance and increased operational safety

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Fig 22: Complete Hardware

Chapter 5 –Conclusion & Future work

5.1 Conclusion

The conversion of the 2624 truck from a two-coupling system to a three-coupling system is an important development that greatly enhances the safety and gun towing capabilities of the gun towing vehicle. The project's primary objective is to improve the truck's functionality by enabling it to connect with modern artillery guns that only require a single coupling, such as the 130 mm Gun M46, 130 mm Gun M59, and 122 mm HOW 1953-54.

By incorporating an additional coupling, the truck becomes more versatile and adaptable to different types of artillery systems. Previously, the truck was restricted to towing artillery guns that utilized a two coupling system. However, with this modification, it is now capable of securely and effectively transporting modern guns that using only one coupling. This expanded compatibility significantly broadens the range of artillery equipment options for military operations, providing greater flexibility in selecting the most suitable tools for specific missions.

Enhancing safety is a crucial aspect of this modification. The inclusion of a three coupling system improves the truck's stability and towing capacity. This ensures that the gun towing vehicle can handle the weight and forces exerted by the artillery gun during transportation, reducing the risk of accidents or damage to both the truck and the gun. The additional coupling creates an extra point of attachment, distributing the load more evenly and alleviating strain on any single connection point. As a result, the modified 2624 can confidently navigate various terrains and maneuver through challenging conditions, maintaining a high level of safety throughout the transportation process.

Furthermore, this modification offers operational benefits. Ability to tow modern artillery guns with one coupling allows for faster and more efficient deployment. With fewer couplings to connect and disconnect, the process of attaching and detaching the gun becomes simpler and less time-consuming. This significantly improves the readiness and responsiveness of

military units, enabling them to quickly reposition and adapt to changing situations on the battlefield.

In conclusion, the conversion of the 2624 truck to a three-coupling system shows a commendable project that greatly enhances both the safety and gun towing capabilities of the gun towing vehicle. By accommodating modern artillery guns with a single coupling, the truck becomes more versatile, efficient, and adaptable to a variety of military operations. This upgrade is a valuable contribution to artillery transportation, ensuring the effective deployment of weapons while prioritizing the safety of personnel and equipment.

5.2 Future Work

In the coming years, there will be advancements in pneumatic braking systems that will surely enhance the safety and reliability of gun towers. These advancements will focus on developing more efficient braking systems to improve control and responsiveness during transportation. The modern pneumatic braking systems will incorporate advanced technologies and innovative designs to increase braking performance and decrease stopping distances. By enhancing the braking capabilities, these systems will contribute to the overall safety of gun towers by minimizing the risk of accidents and ensuring the reliability of the braking mechanism. Users will have increased confidence in the ability of the braking system to safely control and stop the gun tower when necessary. Ultimately, the introduction of more efficient pneumatic braking systems will drive continuous improvement and progress in gun tower technology.

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Vendors' Contact

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