Note on Chuck Aulgur Anti-Skid System for the Rear Bogie

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The GMC Bogie

To understand the need for an improved brake system for the OEM bogie it is essential to review how the existing bogie behaves when braking. The bogie has two wheels in tandem. Each wheel is mounted on a spindle attached at one end of a supporting arm. The other end of this arm is articulated on the coach frame by a pivot. The front wheel is in front of its pivot (the front pin) and the back wheel is behind of its pivot (the back pin). In addition the two arms are connected together by an inflated **single air bag** which provides a spring supporting the rear weight of the coach. Finally a very significant feature at the crux of the matter is that the brake shoes for each wheel are installed on a back plate bolted directly on each supporting arm behind the spindle. There is a bogie on each side of the coach.

To facilitate the understanding of the following presentation it is reminded that the braking force generated by a rolling tire is proportional to the weight carried by the tire. The more weight carried means the more braking force.

A dominant feature of this bogie is that the two wheels **are not independent,** the load on one wheel is reacting on the other wheel through the inflated air bag. The two wheels are equally loaded only when the vehicle is at rest or moving at a constant speed on a level and even pavement (Fig.1). This equally loaded wheels condition is no longer true when the **vehicle is in motion and the brake is applied** to stop the vehicle. The load on the back wheel is shifted to the front wheel of the bogie for 3 reasons:

1. The front wheel is loaded by a horizontal force (the braking force) originated by the reaction of the pavement on the tire pulling the coach backward i.e. creating a breaking action on the coach. Since the front wheel is in front of the pivot point, this horizontal force on the tire, through the drum, the shoes, and the back plate applies a pitch torque on the pivoting arm at the spindle end making the arm rotate "downwards" in the direction of the coach motion (pitch) (Fig.2). This pitching of the pivoting arm is reacted by the frame at the front pin on one end of the arm and the tire to the ground on the other end. The net reaction effect is a combination of a squashing (flattening) of the tire and a lifting of the coach at the pivot point. How much is the coach lifted and how much is the tire squashed is an open question. In any event the vertical load on the wheel is increased.
2. The back wheel is also loaded by a horizontal force on the tire creating braking and also applying a torque on its own pivoting arm. However since the back wheel is behind the arm pivot point, the situation is reverse from to that of the front wheel; the back wheel tends to be lifted from the ground. The tire is unloaded (instead of being more loaded) and the other end of the arm applies a vertical down force on the coach at the rear pin instead of lifting. This unloading of the back wheel shifts a portion the rear vehicle weight to the front wheel of the bogie to maintain the proper equilibrium adding to the load already generated in item 1.
3. In addition there is an added effect because the two wheels are not independent. The pitching of the arm of the front wheel unloads the air bag having the net result of unloading the back wheel even further than item 2 above. The back wheel now carries a lesser load of the coach weight creating less braking force on its tire. In other words most of the weight and the braking force are now carried by the front wheel of the bogie, the back wheel being gradually ineffective to carry the weight and the braking until it finally skids producing negligible braking action and damaging the skidding tires (flat spots) (Fig.3). At that point the braking of the coach is done by only 4 wheels (2 front wheels of the bogie and 2 wheels of the front of the coach. Furthermore the front wheels of the two bogies are overloaded, practically carrying all the rear weight of the coach. This is not a desirable situation for a fully effective and safe braking.

Chuck Aulgur Anti Skid System

The description above shows that when the brake is applied, the resulting rotation of the two supporting arms is the cause of reduced braking.

The pioneering insight of Chuck Aulgur has been to recognize that the key to a successful re-design of the bogie for improved braking, was to eliminate the rotations of these supporting arms. This is accomplished by removing the non-moving braking hardware from the supporting arm and installing this hardware on a separate box which can react the braking force directly on the frame using a reaction bar connecting the box to the frame. By necessity the box is connected to the (OEM) supporting arm by a bearing in order **to induce no torque on both supporting arms (front and back)**, thus preventing their rotation when the brake is applied. This absence of arm rotation eliminates all the load shifting shown in items 1,2,3 above. With the Chuck Aulgur anti-skid system the bogie will behave like Fig. 1 to which braking forces will be added to each wheel with no arm rotation (see Fig. 4). Consequently all the four wheels of the two bogies remain (nearly) equally loaded and the coach is most efficiently braking on six wheels.

For reasons of simplicity and cost the drum/shoe type of brake had to be replaced by a modern disk/caliper brake system. In that respect the disk brake universally used today in the Industry has been proven better than the old drum/shoe brake type. Upgrading from drum to disk by itself is already going in the direction of better braking and easier maintenance.

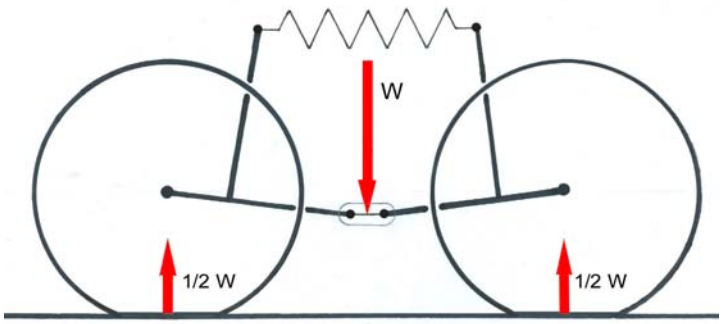


Fig 1.
System at rest or moving at a constant speed on level ground. Both wheels are equally loaded.

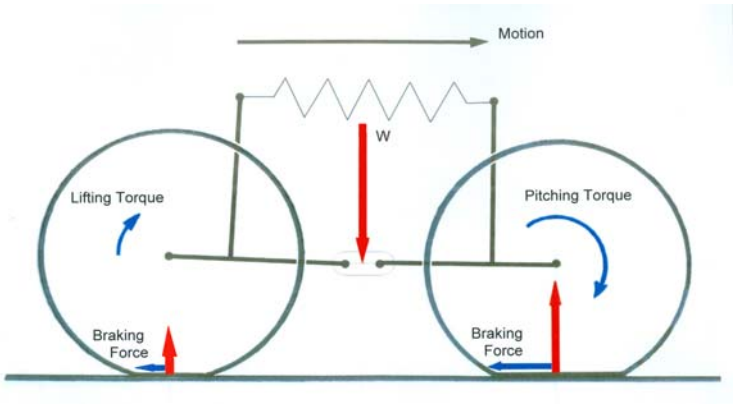


Fig. 2
Intermediate case when the front wheel carries more load than the back wheel and produces more breaking

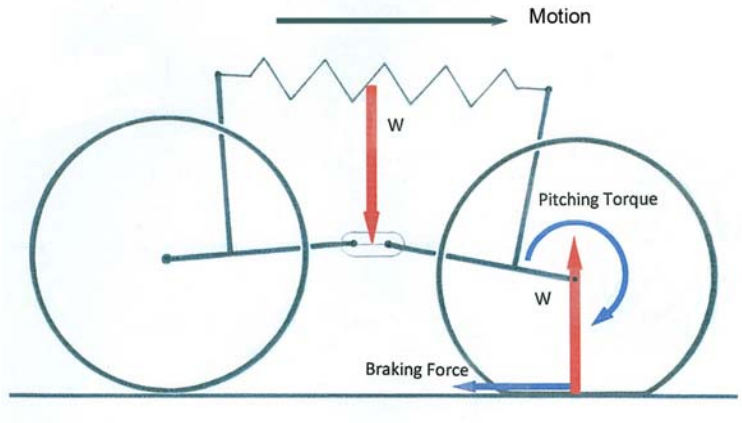
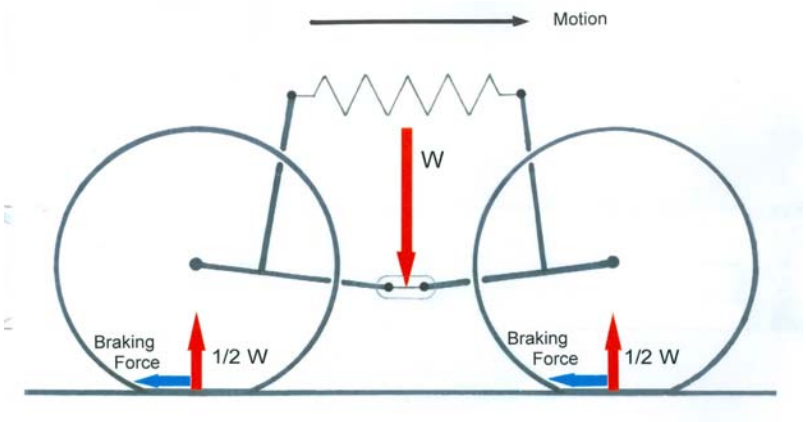


Fig. 3
Extreme case when the back wheel just leaves the ground.
All the rear load of the coach is supported by the front wheel of the bogie.
The rear wheel carries no load and produces no braking.



Fig, 4
Braking with Chuck Aulgur Anti-Skid system.
No torque applied on the supporting arms and no lifting of the rear of the coach