The Ackermann Principle of Steering

And How It Relates to the Model T Ford

By Ted Aschman

Ackermann is not a misspelling of this writer s name but refers to Rudolph Ackermann, who advanced a method of vehicular steering that made possible the high speed automobiles of today. He was born in Stolberg in Saxony, in 1764. At n early age he began his apprenticeship in coach building and design at his father s shop. After becoming a journeyman he left and traveled to other German towns, Paris, and finally to London where for ten years he was engaged as a designer for many of the principal coach builders in that area. He died in 1834, long before the earliest automobiles, crude as they were, appeared. He spent most of his later years in the publishing business.

Perhaps, at this point, it might be proper to enter into the principle of steering. In the old horse and buggy days, pulling on one of the reins would swing the horse to that side. The shaft or pole attached to the horse is also attached to the front axle, which is pivoted on a king pin.

Going straight ahead, the front and rear wheels of any vehicle move in a straight line. In making a turn to one side or the other, the front wheels are turned so that they are at an angle to the the rear wheels. In a horse-drawn vehicle, the wheels are square with the axle as the wheels and axle swing or turn together, In an automobile, the front axle does not swing; instead, each wheel pivots at the end of the axle. It would not be practical to steer an automobile like a horse drawn vehicle as the axle would have to be quite heavy to support the weight, making it quite hard to turn. Also, the height of the automobile would be excessive to allow for wheel clearance when making a short turn,

On the fixed front axle of the Model T and other early cars, the pivot on which the front wheels swing is as close to the hubs as possible so to make the steering as easy as possible, among other reasons.

Referring to Figure 1, it will be noted that since the front axle swings on a kingpin, it always points to the center of a circle, and both wheels are perpendicular to the same radius of the circle. In an automobile this is not true. Referring to Figure 2, each wheel is turned at a different angle and at a different radius to the center of the circle due to the two steering arms not being parallel. Now, once again referring to the illustrations, it is easy to note that when making a left turn, the right front wheel covers a greater distance than the left, and when turning right it is the opposite. Note, too, that when making a turn the inside wheel makes a sharper (or shorter) turn, to allow for the shorter distance it travels. If the spindle arms are parallel to one another, they would turn at the same angle and there would be considerable scuffing on one (maybe both) of the tires. To provide for the different turning angle of each front wheel, the steering arms are bent inward if the connecting (tie) rod is behind the axle. (In some of the other old cars, the connecting rod was in front of the axle and the steering arms on these hat an outward bend.) If the steering arms were parallel each wheel would be parallel with the other no matter which direction the wheels were turned.

Forgetting Ackermann and his principle for the time being, the reason for this treatise should be made known. While on the Model T Rally is Australia this past fall, a trio of "bushmen, who many avoided because of their appearance, invited this writer to take a look at their TT. They were a bit puzzled over the fact that for a number of years they had been experiencing difficult steering and a lot of front tire scuffing, even though the camber, caster, and toe-in were set according to factory specifications.

Not knowing exactly how to cure this problem, the smallest of the three (and perhaps the wittiest) resorted to some "gum tree engineering (the Australian equivalent of the American "shade tree variety). By their own admission, they didn t quite know what to do, so they made a trip to the local trade school and borrowed every text they could locate dealing with the automotive front end alignment and steering. (That is where they learned of Ackermann.) In one of the books were several diagrams, portraying the Ackermann Principle, and two or three pages of descriptive narrative. Applying this new-found knowledge to their TT, it didn t take them long to figure out that something was amiss.

One reference stated that the Ackermann Principle was simply "the front wheels must turn in such a manner that they always have a constant relationship to the rear wheels; sort of an engineering cop-out that didn t give the uninitiated much to work with. The principle, as inferred by these drawings, more adequately illustrated, that an imaginary straight line drawn from the center of the kingpin (spindle bolt) through the center of the spindle arm connecting rod bolt, should (must) pass through the exact center of the rear axle. With the aid of a chalk string, the tests run by the three indicated that these imaginary lines centered about

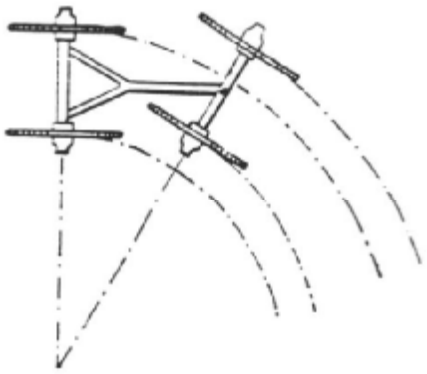


Fig. 1. Showing how a front axle of a horse-drawn vehicle gives the direction the vehicle runs.

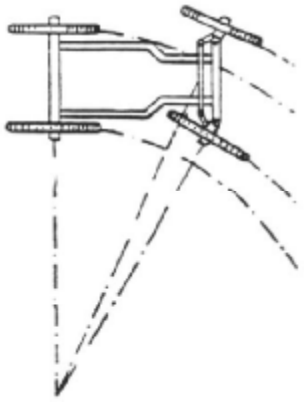
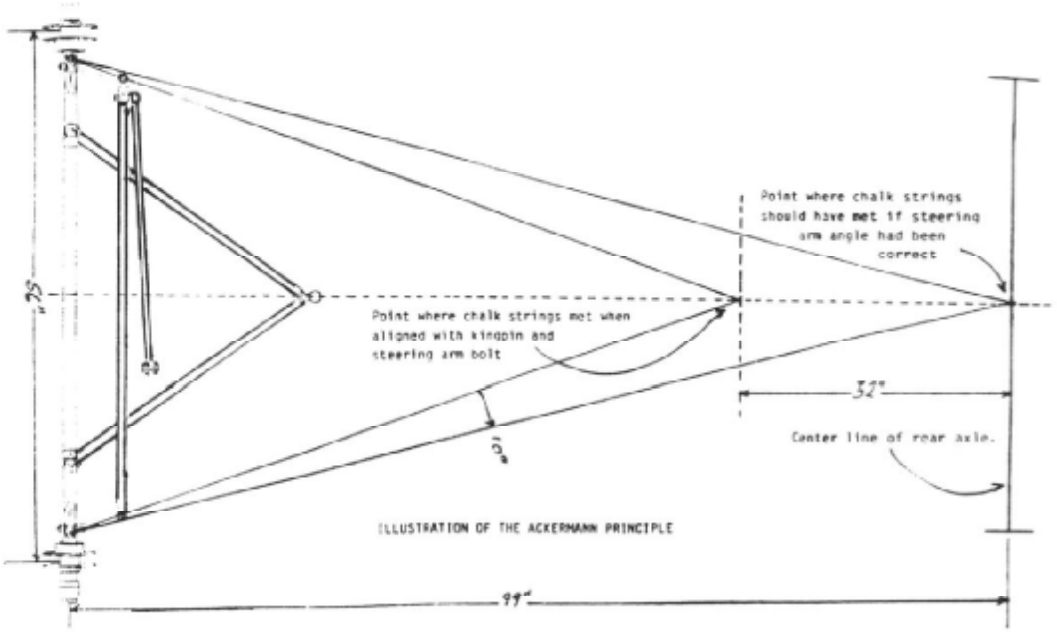


Fig. 2. Showing how the front wheels of an automobile give the direction the car runs.



twenty-two inches ahead of the rear axle. To get it all into the proper perspective, they had to bend each spindle arm outward about five-eights inch *(this must be done cold as heating them removes the effect of "heat treatment on which much of their strength depends.)* This gave birth to another problem which is not unusual with a Model T - you cure one thing and get set upon by another.

This alteration made it necessary to lengthen the connecting (tie) rod about an inch and a half. From then on, the truck handled well. Turns were made with an ease previously unknown (even with just one hand) and there was no tire scuffing (feathering of the tread).

Another dimension that enters into the proper spindle arm adjustment is the wheel base of a Model T. While most of us think of it as being 100 inches, factory data tells us that it is ninety-nine inches (the truck is 123 inches). Surprised? So was this writer when he learned this some years back. From experience, very few T s observed had a ninety-nine inch wheelbase. Most of the early T s checked came up short by up to three-quarters inch, while the later ones measured in excess of ninety-nine inches, and in one example, 100.75 inches. It is the consensus this situation could be caused by whether the front radius rod was fastened to the top of the axle or to the bottom; i.e., an early or late Model T. With the radius rod fastened to the top of the axle, there is a tendency, after years of chuck holes and bumps, for the front axle to be rotated, effectively shortening the wheelbase. In the later Model T s, with the wishbone fastened to the bottom of the axle, there is a tendency for the front axle to be rotated in the opposite direction, substantially lengthening the wheelbase.

The big one of the three (and he was BIG) asked if Ford ever made different spindle arms - one type for the passenger cars and another for the trucks. Parts books show Ford made a straight armed spindle that was used on both sides of the early (until 1919) T s, and from then until the end of production, Ford employed an arm that was bent vertically to clear the wishbone when it was moved to the bottom side of the axle. This change required the use of two arms; one for each side. Whether or not one was made especially for the TT s could not be resolved at that time.

These boys were concerned why Ford didn t make the arms correct in the first place. A good query, but at this point it is a rather moot question. It is possible the reasoning behind this was Ford wanting to keep parts and the resultant confusion to a minimum. Maybe, as the TT traveled at a relatively slow speed, altering the steering arms to fit the truck, with its longer wheelbase, was considered to be hardly worth the trouble.

Returning home, five NOS spindle arms from the parts bin were checked and none of them had exactly the same degree of inward bend. Close but not quite the same. All were genuine Ford parts (the *chop marks* indicated that they had been made by different suppliers), so apparently a precise measurement in this area was not considered critical or even necessary. Moving on; the spindle arms on the three T s (a 1912, a 1921, and a 1925) sitting in the barn were also gauged, and they, too, didn t have the same degree of bend.

With winter on its way there was only time to work on one of the T s Since the '25 touring was the handiest, it was chosen. A chalk string was dug out of one of the work bench drawers, and with one end fastened to the bottom of the spindle bolt (it was threaded through the cotter pin hole) and the other end was secured to the center of the differential housing. The ends of neither spindle arm came close to aligning with the string. The right spindle arm was bent outward one-half of an inch, and the left one three-quarters of an inch. The bending was accomplished with a six foot length of pipe, but not before the front wheels were secured by vise-like clamps fashioned from some pieces of two inch angle iron.

As was expected, the connecting rod was too short and had to be lengthened. It was removed from underneath the car and after being secured in a vise, it was cut in two, exactly at the center. Each end was threaded; one with a standard right-hand thread and the other with a left-hand die borrowed from a local machine shop. This same shop made up a sleeve, threaded with matching threads. Each end of this sleeve was split about an inch, and once the alignment was correct, heavy clamps were secured to these split ends. This way, the integrity of the adjustment would be preserved.

It is important, before resorting to this adaptation, to make doubly sure that camber, caster, and toe-in are correct (toe-in, of course, being determined by the adjustment of the modified tie rod).

It now appears that all we T owners are faced with four, not three, important front end adjustments: toe-in, camber, caster, and spindle arm angle - all this, thanks to three inquisitive Australian "swagmen. C est la guere!

One thing for sure, if we were still using the center pin, fifth wheel wagon type of steering in our modern cars, thirty miles per hour would be a perilous experience, so maybe the old Ackermann s Principle has merit. If you doubt this, just watch the gyrations of the last trailer of a triple bottom eighteen wheeler the next time you venture out on the interstate.

Editor s notes:

Ted did not comment in the above article as to whether or not there was an improvement in the steering of his 1925 - so I called him. He said that while it was too cold to really give the car a good