Tire Manufacturing

A tire is generally accepted as the single most complicated item there is to produce. And yet most of us take this process for granted, staking the safety of ourselves, family members and grandchildren on four rubber footprints, each the size of less than a square foot. We make these tire selections routinely and yet this is our passion.

John Kelsey of the Kelsey Tire Company concludes public speeches with those comments, and as sports car enthusiasts, we understand perfectly. His message is simple: When we make decisions about tire purchase, are we compromising tire safety and the lives of those close to us by those decisions?

We drive America's high-performance sports car because we know we have instant speed in the event conditions call for execution of that. We've also learned that tires are speed-rated to match a vehicle's engineering performance envelope such as the Z-rated tires on C5s and C6s. The C6 ZR1, for example, will be equipped with tires rated for speeds in excess of 186 mph.

Consider the 2009 620 hp LS9 ZR1, capable of speeds in excess of 200 mph. It sports P285/30ZR19s in the front and P335/25ZR20s in the rear, and both carry a speed rating of (Y) or tested for speeds in excess of 186 mph. The results would be catastrophic if tires failed at those speeds for not only occupants but tire and automobile manufacturers as well.

"Where the Rubber Meets the Road," published in the Winter 2008 edition of *The Corvette Restorer*, established a base for understanding the 1978-82 Corvette production tire. That article differentiated the Goodyear P series PRODUCTION tire from the SERVICE replacement. It concluded with the message that classic Corvette owners must be cautious when taking new old tires on the road, and crucial to tire safety is the ability of knowing how to interpret tire date codes. The Bridgestone/Firestone recalls of this century demonstrated that tires sitting in perches for long periods (six years), become liabilities to vehicle safety when mounted and driven.

Today's tire manufacturing is complex and high-tech in contrast to methods used in the 1970s, but the process still must follow several basic steps. The intent here is to offer an overview so that the reader will understand how sidewall engraving nomenclature and date codes are applied along the way and how this helps the restorer/judge recognize the variations in date codes and safety labels in order to understand production changes. *See related story "Treadwear vs Tire Age," page 22.*

Manufacturing

High-performance sports cars are engineered to sustain high speeds and their companion **ultra high-performance** tires are constructed with expensive materials to sustain those high speeds and accompanying high temperatures. (One example is the halogenated inner liner that delivers the strength to sidewalls to minimize sidewall/tread separation characteristic of the Bridgestone/Firestone recalls of 2001.)

Making a tire is not unlike baking a loaf of bread. We have the gathering of ingredients depending on the type loaf we desire. A white loaf has basic ingredients, while whole-wheat raisin is heavy-duty and requires not only whole-wheat flour and raisins, but also much more gluten (flour protein) to provide the same level of elasticity to get the same size loaf of bread. Ingredients are mixed; then the loaf is permitted to rise; and finally it is baked. It's the baking that transforms all those ingredients into an edible and usable product.

Tire manufacturing follows a similar path with the selection and mix of ingredients, sub-assemblies, tire assembly and finally vulcanization (or curing) of the finished product. It's the mixing of ingredients that determines the type of tire (steel cord versus fabric or multi-ply versus belted), rating of the tire, and whether it is for truck, passenger or high-speed use for America's sports car, the Corvette.

Rubber Compound Mixing

The first step is the mixing of numerous compounds and preparing them for producing the material for tire sub-assemblies. Rubber is the main ingredient, along with fillers, but the mix varies depending on the purpose that the tire will serve. In addition to natural rub ber, synthetics are used for the sub-assemblies of tread and sidewalls, and these include styrene-butadiene rubber (SBR) and polybutadiene rubber (BR). Other rubbers, such as butyl rubber and halogenated butyl rubber, are used for the innerliner or that part of the tire that holds the air and makes it tubeless. Fillers include such ingredients as carbon black, silica, anti-oxidants, anti-aging agents, activators and a package of accelerators and curators.

The selection of ingredients depends on the requirements set by automobile manufacturers and follows those federal safety guidelines described above. Lighter-load bearing vehicles and low-performance vehicles do not have the same requirement as high-load bearing vehicles or those rated for high speed. And as you might expect, compound ingredients vary in cost, and thus the cost of a tire varies. Doubt it? Check what a set of run-flat Extend Mobility Tires (EMT) service replacements will cost for a C5 or C6. For the weight savings of having no spare and no jack, there is a price for a tire that can run fifty miles with a sidewall that remains erect. EMTs are tires on Viagra. High-performance, high-speed tires, such as those used on Corvette, call for these higher standards because of speed and performance ratings.

Tire Sub-Assembly

Once compounds are prepared, sub-assembly begins with the production of belts, bead assembly, tread and sidewall extrusion. Belt manufacturing goes through a process called calendering. This is a process in which body plies and steel belting material are prepared for coating with rubber before moving on to be sized for the respective tire being constructed. The innerliner also goes through this process.

The bead assembly is the unit that mounts the tire to the wheel; the sidewall extrusion incorporates white walls and white letters, while the tread is the portion of the tire that hits the road. The primary component in the bead assembly is the wire loop, but there is also a rubber wedge filler and other ingredients, all of which ensure that when mounted, the tire will remain secured or locked onto the wheel. These components are assembled on a special machine and once again bonded together as a sub-assembly.

Both the tread and sidewall go through an extrusion process, one of the most important operations, where rubber is forced through a machine that will shape and form it for final assembly. Heat and pressure are used once again as the rubber is molded into the shape of a tire. To make the tread, three different extruders are used: one for each different part of the tread–base, side and that portion with which we are familiar, the tread that hits the road. The mix of rubbers varies, as does the amount of heat and pressure used to extrude each tread component before assembly.

In contrast to tread, a sidewall may have three and perhaps four extruders. This can be a bit more complicated than tread extrusion, especially when requirements call for the fourth extruder to make white lines or raised white letters, so familiar to 1978-82 Corvettes.

Carcass Assembly

A number of sub-assemblies have been produced and are ready for assembly into what will become the tire carcass. This process is highly automated using robotics to merge the bead, calendered plies, innerliner, tread and sidewall.

Assembly is a two-stage process beginning with wrapping a couple layers of body ply around the innerliner. The bead assembly is positioned on the body-ply assembly. The sidewalls are positioned and the sub-assembly is ready for the next stage. The second stage begins with this carcass as the belts, nylon cap, and tread is added.

Vulcanization

We still don't have a tire as we know it, just a carcass with no tread. It's vulcanization that will cure and give it the shape of a tire. This process is where tread patterns, tire safety and consumer messages are molded and the tire identification information (TIN) gets pressed into the tire's inboard side. A large press that has a top and bottom mold is used and is not unlike a waffle iron.

A tire plant will have numerous production lines with each one having perhaps as many as sixteen presses. Once the carcass is in the mold, it is closed, baked and curing begins. This is subjected to high-temperature, high-pressure and a chemical transformation as it begins to take the shape of what we consumers see. It's at this point that the tire receives the Department of Transportation (DOT) marking and TIN, identifying the plant, production line, mold and date which helps with recalls.

A final point on how regulatory changes get incorporated into a tire mold: Regulations include a date when all tires must show a particular message or change, but tire manufacturers do not stop production lines to change all molds at one time. Rather, as a mold breaks, the new template is applied to the new mold. Thus, molds go into producing a tire that meets the current DOT requirements over time. At the same time, tires are still being produced under expiring regulations. Both tires will have the same date code, but one will include the new safety message while the other will be produced without it. Production will go on for months before all molds are updated with the new DOT requirements. So, with observation, we learn that changes were incorporated over a range of months and can easily approximate a year, which is what we see with the DOT safety message.

Inspection

Of course there must be inspection of the finished product. Tires are subject to both visual and x-ray analysis to determine if flaws are inherent in the finished product naked to the human eye. It's also during this finishing process that excess rubber material is trimmed from the tire and from the sidewall revealing whitewalls or white lettering.

Tire production is not a simple process and can be quite costly. Consumers want the safest product they can buy even if it costs a bit more. Our lives, our families' lives, and our expensive sports cars depend on the less than one square foot that meets the road.

The author thanks NCRS member Bill Blackmon for the inspiration to write this article and assistance with insights into tire manufacturing. Thanks also go to John Kelsey of the Kelsey Tire Company.

Tom Russo
NCRS# 22903
hunt4cleanair@earthlink.net

NCRS Road Tour Chairman, Bill Sangrey, has his car decaled up ready to lead the road tour to the National Convention in St. Charles.

"GM next" is the GM 100th anniversary logo. GM is proud of its history but is looking forward to the next 100 years. General Motors has approved and encouraged NCRS use of "GM next" on the 2008 road tour.