Automotive Styling Features

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First Edition, 2012

ISBN 978-81-323-3026-4

Published by:
Research World
4735/22 Prakashdeep Bldg,
Ansari Road, Darya Ganj,
Delhi - 110002
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Alloy Wheel and Hubcap

Alloy wheel

Alloy wheel on a passenger car

Alloy wheels (also known as **rims**) are automobile (car, motorcycle and truck) wheels which are made from an alloy of aluminium or magnesium (or sometimes a mixture of both). They are typically lighter for the same strength and provide better heat conduction and improved cosmetic appearance.

Characteristics

Alcoa's heavy-duty alloy wheel, for buses and trucks.

Lighter wheels can improve handling by reducing unsprung mass, allowing suspension to follow the terrain more closely and thus improve grip, however not all alloy wheels are lighter than their steel equivalents. Reduction in overall vehicle mass can also help to reduce fuel consumption.

Better heat conduction can help dissipate heat from the brakes, which improves braking performance in more demanding driving conditions and reduces the chance of brake failure due to overheating.

An aluminium alloy wheel

Alloy wheels are also purchased for cosmetic purposes although the alloys used are not corrosion-resistant. Alloys allow the use of attractive bare-metal finishes, but these require to be sealed with paint or wheel covers. Even if so protected the wheels in use will eventually start to corrode after 3 to 5 years but refurbishment is now widely available at a cost. The manufacturing processes also allow intricate, bold designs. In contrast, steel wheels are usually pressed from sheet metal, and then welded together (often leaving unsightly bumps) and must be painted to avoid corrosion and/or hidden with wheel covers / hub caps.

Alloy wheels are prone to galvanic corrosion if appropriate preventive measures are not taken, which can in turn cause the tires to leak air. Also, alloy wheels are more difficult to repair than steel wheels when bent, but their higher price usually makes repairs cheaper than replacement.

Chrysler alloy wheel

Alloy wheels are more expensive to produce than standard steel wheels, and thus are often not included as standard equipment, instead being marketed as optional add-ons or as part of a more expensive trim package. However, alloy wheels have become considerably more common since 2000, now being offered on economy and subcompact cars, compared to a decade earlier where alloy wheels were often not factory options on inexpensive vehicles. Alloy wheels have long been included as standard equipment on higher-priced luxury or sports cars, with larger-sized or "exclusive" alloy wheels being options. The high cost of alloy wheels makes them attractive to thieves; to counter this, automakers and dealers often use locking wheel nuts which require a special key to remove.

Most alloy wheels are manufactured using casting, but some are forged. Forged wheels are usually lighter, stronger, but much more expensive than cast wheels.

Aftermarket wheels

A sizeable selection of alloy wheels are available to automobile owners who want lighter, more visually appealing, rarer, and/or larger wheels on their cars. Many people may think that large wheels automatically result in increased performance, handling and suspension, yet Car and Driver performed a test of different sized wheels from 15" to 19" all outfitted

with the same make and model of tires and showed that both 0-60 times and fuel economy were reduced with larger wheels. They also noted that ride comfort and noise were negatively affected by the larger wheels. The larger aftermarket wheels and the corresponding tires have considerably higher cost and weight, for little benefit in return. The aura of larger wheels apparently is that they seem to signify luxury, sportiness, or wealth. These wheels have become a part of pop culture (as with "dubs").

Aftermarket brands

The many aftermarket wheel brands include Advanti Racing Wheels, Autec Alloy Wheels, Borbet Alloy Wheels, Ronal Alloy Wheels, PDW Wheels, TSW Alloy Wheels, MAK Wheels, BMF Wheels, Eurotech Wheels, Zforce, Akuza, Incubus, Viscera, Cattivo, Ballistic, Menzari, Devino, Eta Beta Wheels, Antera, Marchesini, Sparco, Speedline, TeamDynamics, NAD Wheels, R2 Wheels, Lowenhart, Rial, Orobica Line, M.B Italia, Kormetal, Toora, G.M.P Italia, Vellano, MOZ, Watanabe, SSR Wheels, Wolfhart, Wolfrace, Panther Wheel, American Racing Wheels, UsaRim, Motegi Racing Performance Wheels, Weld Racing, BBS Wheels, CMS, 5Zigen, Volk Racing, Konig Wheels and Rimstock. Most aftermarket wheels are cast, while only a few above are forged, such as Vellano, and Weld. Many companies have been formed over the years (some recently) due to the increasing demand from street racing enthusiasts and the rising demand for larger diameter wheels. MHT wheel markets a brand under the name DUB that offers a Spinner wheel, the center of the wheel continues spinning after the vehicle comes to a stop, and the Floater, the center of the wheel stays stationary during movement giving the look that the vehicle isn't moving.

Cast aftermarket wheels have also been oversaturated due to the vast influx of inexpensive chrome wheels from China. India, through Synergies Castings Ltd. and other companies, of late have also emerged as a major supplier of alloy/chrome wheels. They manufacture products to global scale due to primarily cheap but highly skilled and qualified labour.

American Racing, which owns Motegi Racing and Weld Racing among other brands such as TIS, TIS Modular, is the oldest aftermarket wheel company dating back to 1956. The oldest British company is Wolfrace who was the first company to offer a polished alloy wheel in Europe and to achieve TUV approval. Wolfrace also provided the wheels for thrust SSC and the UK's land speed record bid. A recent trend in the industry includes joint venture partnerships being formed between offshore manufacturers and local importers/distributors such as PDW Wheels which started in Australia in 2006, amongst a few others. Most wheel brands are ultimately sold through dealers such as RhinoTuning.

Some "aftermarket" are/were also available as Original equipment manufacturer (OEM) fitments, with BBS being a notable original equipment supplier to Volkswagen.

Some manufacturers also share patterns and castings, with an example (motorcycle) being the licencing of Marchesini 5-spoke design to Brembo, for the production of alloy (non-magnesium) wheels for Ducati road bikes.

Magnesium alloy wheels

Magnesium alloy wheel on a Porsche Carrera GT

Magnesium alloy wheels, or "mag wheels", are sometimes used on racing cars, in place of heavier steel or aluminium wheels, for better performance. The wheels are produced by one-step hot forging from a magnesium alloy known as ZK60, AZ31 or AZ91 (MA14 in Russia). Cast magnesium disks are used in motorcycle wheels.

The mass of a typical magnesium automotive wheel is about 5–9 kg (depending on size).

Magnesium wheels are flammable and have been banned in some forms of motorsport in the UK following fires which are very difficult to extinguish. Mag wheels have been known to catch fire in competition use after a punctured tire has allowed prolonged scraping of the wheel on the road surface. Some variants of magnesium alloy wheels may have low corrosion resistance.

They have the disadvantages of being expensive and not practical for most road vehicles. Aluminium wheels are often mistakenly called "mag wheels".

Hubcap

A threaded brass hubcap on a cartwheel with artillery style hub.

AMC Marlin Full wire wheel cover with spinner ornament.

The hubcap of a Mitsubishi Lancer, covering a steel wheel, bears the Mitsubishi logo.

A **hubcap**, **wheel cover** or **wheel trim** is a decorative disk on an automobile wheel that covers at least a central portion of the wheel. Cars with stamped steel wheels often use a full wheel cover that conceals the entire wheel. Cars with alloy wheels or styled steel wheels generally use smaller hubcaps, sometimes called center caps. Alternatively, **wheel cover** refers to an accessory covering an external rear-mounted spare tire (also known as a spare tire cover) found on some off-road or survival-type vehicles.

History

The first hubcaps were more commonly known as dust or grease caps. These caps threaded onto the center hub on the wood, steel, or wire wheel. These were made from the beginning to 1932. Pre-1915 were all mostly made of brass that was nickel plated. The 1920s were all mostly aluminum. Grease caps off of the wire wheel brands such as Houk, Hayes, Frayer, Dayton, Buffalo, House, Phelps, Pasco, Rudge Whitworth, Budd, and Stewart are some of the hardest to find. When a customer went to buy the wire wheels, the make of the vehicle would be stamped in the center. In the 1927 to 1928 time, the first snap-on center caps were being made on the wire wheels. After 1932, most every car had a snap-on style center cap on the middle of their wire, steel or wood wheels. Wire wheel center caps in the 30s had a spring-loaded retention clip system that has been used on many hubcaps and center caps on every style of car and truck to present day. Steel

wheels in the 30s had retention clips mounted to the wheel that snapped into a lip in the back of the cap. Wood wheels were a special option. The caps on these had a large chrome base that mushroomed up to another smaller chrome base that would have the emblem on the face. The "stem" up to the second base was usually painted black to make it look as if the top base was floating. These caps were usually made of brass, steel, or aluminum. In 1935 the first full wheel covers were being produced to fit over the entire wheel except for a small bit of the outer lip. Cord and Hudson were the makers. Cord made a plain chrome wheel cover that had a smooth top and holes in the side. The Hudson wheel cover was flat with a lip half way to the middle and the center would say "Hudson", "Hudson Eight", or "Terraplane". This configuration differs from the "knock-off" spinners found on some racing cars and cars equipped with true wire wheels. While the knock-off spinner resembles an early hubcap, its threads also retain the wheel itself, in lieu of lug nuts.

When pressed steel wheels became common by the 1940s, these were often painted the same color as the car body. Hubcaps expanded in size to cover the lug nuts that were used to mount these steel wheels. These hubcaps were typically made from chrome-plated or stainless steel. The next development was, as an option on more expensive cars, a chrome-plated trim ring that clipped onto the outer rim of the wheel, in addition to the center hubcap. Finally came the full wheel cover, which of course covered the entire wheel.

By this time, specialty wheels of magnesium or aluminum alloy had come onto the market, and wheel covers were a cheap means of imitating the styling of those. Plastic wheel covers (known in the UK as wheel trims) appeared in the 1970s and became mainstream in the 1980s. Plastic has largely replaced steel as the primary material for manufacturing hubcaps and trims, and where steel wheels are still used, the wheels are now generally painted black so the wheel is less visible through cutouts in the wheel trim. On modern automobiles, full-wheel hubcaps are most commonly seen on budget models and base trim levels, while upscale and performance-oriented models use alloy wheels. Modern aluminum alloy wheels generally use small removable center caps, similar in size to the earliest hubcaps.

Characteristics and design

Often a hubcap will bear the trademark or symbol of the maker of the automobile or the maker of the hubcap. Early hubcaps were often chrome plated, and many had decorative, non-functional spokes. Hubcaps were immortalized in the Art Deco styling of the spire of the Chrysler Building in midtown Manhattan.

Part of the lore of hubcaps is that on bad roads they have a tendency of falling off due to hitting a bump. Center caps, however, fall off less frequently than older full wheel covers, which were often quite heavy. In the southwest of the U.S., and in Mexico, there were lots of automotive garages whose walls were decorated with all sorts of hubcaps that had fallen off in the vicinity; they were often for sale. This problem persists today in spite of the many different retention systems that have been engineered. Hubcaps generally use

either clip-on retention, where some type of spring steel clip (or plastic clip in the case of plastic hubcaps) engages a groove in the wheel; or bolt-on retention, where a threaded fastener retains the hubcap, or a plastic washer attached to the lugnut itself holds the hubcap on. Honda and, to a lesser degree, Hyundai tend to use the latter system. Clip-on hubcaps tend to pop off suddenly when the wheel impacts a pothole or curbstone, while bolt-on hubcaps are more likely to vibrate loose over time, and tend to rattle and squeak. To prevent loss, many owners attach plastic wheel trims to the wheel itself using an electrical zip tie, which are sold in a silver colour for this very purpose. Enterprising manufacturers also sell a small kit consisting of spare zip ties, a pair of cutting pliers and latex gloves to allow a trim thus secured to be removed easily in the event of a puncture.

In the U.S., during the age of custom cars (1950s–early 1960s), decorating one car with the wheel covers from another was common. Two very desirable wheel covers were those of the 1950 Cadillac (called the "Sombrero") and that of the 1953 to 1955 Oldsmobile, which resembled a huge, three-tined spinner. Aftermarket suppliers included the "Mooneyes" brand (named after the firm's founder Dean Moon) hubcaps and wheel covers that were some of the first independently offered for hot rods and custom cars.

Another variant of the wheel cover is that commonly manufactured by the German wheelmaking brand BBS. These are attached on to the wheel first, then bolted on as if the driver/mechanic is bolting the wheel to his car in the manner of changing their wheel. Commonly made from aluminium, they are designed to distribute airflow, therefore generating downforce depending on the shape. Thus, these wheel covers are functional rather than merely decorative. Although they have been used since the 1970s, a carbon fiber variant has found its way into Formula One when it was used by Scuderia Ferrari whom BBS supply its wheels to.

Non-rotating hubcap

A non-rotating hubcap retains the same orientation even when a vehicle is in motion. This allows for messages or advertising to be placed on the hubcap and be read even while a car is moving. Non-rotating hubcaps with advertisements may be found on race cars, taxis, commercial vehicles, industrial machinery, buses, and golf carts.

Chapter 2

Chrome Plating

Decorative chrome plating on a motorcycle

Chrome plating, often referred to simply as **chrome**, is a technique of electroplating a thin layer of chromium onto a metal object. The chromed layer can be decorative, provide corrosion resistance, ease cleaning procedures, or increase surface hardness.

Process

A component to be chrome plated will generally go through these different stages:

- degreasing to remove heavy soiling;
- manual cleaning to remove all residual traces of dirt and surface impurities;
- various pretreatments depending on the substrate;
- placement into the chrome plating vat, where it is allowed to warm to solution temperature; and
- application of plating current, under which the component is left for the required time to attain thickness.

There are many variations to this process depending on the type of substrate being plated upon. Different etching solutions are used for different substrates. Hydrochloric, hydrofluoric, and sulfuric acids can be used. Ferric chloride is also popular for the etching of Nimonic alloys. Sometimes the component will enter the chrome plating vat electrically live. Sometimes the component will have a conforming anode either made from lead/tin or platinized titanium. A typical hard chrome vat will plate at about 25 micrometres (0.00098 in) per hour.

Various Linishing and Buffing processes are used in preparing components for decorative chrome plating. The overall appearance of decorative chrome plating is only as good as the preparation of the component.

The chrome plating chemicals are very toxic. Disposal of chemicals is regulated in most countries.

Hexavalent chromium

Hexavalent chromium plating, also known as *hex-chrome*, Cr^{+6}, and *chrome (VI)* plating, uses chromic anhydride, also known as chromium trioxide, as the main ingredient. Hexavalent chromium plating solution is used for decorative and hard plating, along with bright dipping of copper alloys, chromic acid anodizing, and chromate conversion coating.

A typical hexavalent chromium plating process is: (1) activation bath, (2) chromium bath, (3) rinse, and (4) rinse. The activation bath is typically a tank of chromic acid with a reverse current run through it; this etches the workpiece surface and removes any scale. In some cases the activation step is done in the chromium bath. The chromium bath is a mixture of chromic acid (CrO_3) and sulfate (SO_4); the ratio of which varies greatly between 75:1 to 250:1 by weight. This results in an extremely acidic bath (pH 0). The temperature and current density in the bath affect the brightness and final coverage. For decorative coating the temperature ranges from 95 to 115 °F (35 to 46 °C), but for hard coating it ranges from 120 to 150 °F (49 to 66 °C). Temperature is also dependent on the current density, because a higher current density requires a higher temperature. Finally, the whole bath is agitated to keep temperature steady and increase a uniform deposition.

Disadvantages

One functional disadvantage of hexavalent chromium plating is low cathode efficiency, which results in bad throwing power. This means it leaves a non-uniform coating, with more on edges and less in inside corners and holes. To overcome this problem the part may be over-plated and ground to size, or auxiliary anodes are used around the hard-to-plate areas.

From a health standpoint, hexavalent chromium is the most toxic form of chromium. In the U.S. it is heavily regulated by the Environmental Protection Agency (EPA); the EPA lists it as a hazardous air pollutant because it is a human carcinogen, a "priority pollutant" under the Clean Water Act, and a "hazardous constituent" under the Resource Conservation and Recovery Act. Due to the low cathodic efficiency and high solution viscosity a mist of water and hexavalent chromium is released from the bath, which is toxic. To control these emissions wet scrubbers are used. The discharge from the wet scrubbers is then treated to precipitate the chromium from the solution, because it cannot be discarded in the waste water.

Maintaining a bath surface tension less than 35 dynes/cm requires frequent cycle of treating the bath by a wetting agent and confirming the effect on surface tension. Traditionally surface tension is measured by a stalagmometer. This method is, however, tedious and suffers from inaccuracy (errors up 22 dynes/cm has been reported), and is dependent on user's experience and capabilities.

Additional toxic waste that is created from hexavalent chromium baths include lead chromates which form in the bath because lead anodes are used. Barium is also used to control the sulfate concentration, which leads to the formation of barium sulfate, a hazardous waste.

Trivalent chromium

Trivalent chromium plating, also known as *tri-chrome*, Cr^{+3}, and *chrome (III)* plating, uses chromium sulfate or chromium chloride as the main ingredient. Trivalent chromium plating is an alternative to hexavalent chromium in certain applications and thicknesses (e.g. decorative plating).

A trivalent chromium plating process is similar to the hexavalent chromium plating process except for the bath chemistry and anode composition. There are three main types of trivalent chromium bath configurations:

- A chloride- or sulfate-based electrolyte bath using graphite or composite anodes, plus additives to prevent the oxidation of trivalent chromium to the anodes.
- A sulfate-based bath that uses lead anodes that are surrounded by boxes filled with sulfuric acid (known as shielded anodes), which keeps the trivalent chromium from oxidizing at the anodes.

- A sulfate-based bath that uses insoluble catalytic anodes, which maintains an electrode potential that prevents oxidation.

The trivalent chromium plating process plates workpieces at a similar temperature, rate and hardness, as compared to hexavalent chromium. Plating thickness range from 0.005 to 0.050 mil (0.00013 to 0.0013 mm).

Advantages and disadvantages

The functional advantages of trivalent chromium are higher cathode efficiency and better throwing power. The better throwing power means production rates are greater. Less energy is required because of the lower current densities required. The process is more robust than hexavalent chromium because it can withstand current interruptions.

From a health standpoint trivalent chromium is intrinsically less toxic than hexavalent chromium. Because of the lower toxicity it is not regulated as toughly, which reduces overhead costs. There are other secondary health advantages:

- Higher cathode efficiencies lead to less chromium emitted into the air
- Lower concentration levels result in less chromium waste
- The anodes do not discompose

One of the disadvantages when the process was first introduced was that decorative customers disapproved of the color differences, however additives are now used to adjust the color. In hard coating applications, the corrosion resistance of thicker coatings is not quite as good as hexavalent chromium. The cost of the chemicals is greater, however this is usually offset by greater production rates and lower overhead costs. In general, the process must be controlled more closely than in hexavalent chromium plating, especially with respect to metallic impurities. This means processes that are hard to control, such as barrel plating, are much more difficult using a trivalent chromium bath.

Types

Decorative

Decorative chrome is designed to be aesthetically pleasing and durable. Thicknesses range from 0.002 to 0.020 mil (0.00005–0.0005 mm), however they are usually between 0.005 and 0.010 mil (0.00013 and 0.00025 mm). The chromium plating is usually applied over bright nickel plating. Typical base materials include steel, aluminum, plastic, copper alloys, and zinc alloys.

Hard

Hard chrome plating

Hard chrome, also known as *industrial chrome* or *engineered chrome*, is used to reduce friction, add wear resistance, or increase corrosion resistance. It is very hard, measuring between 66 to 70 HRC. Hard chrome tends to be thicker than the decorative treatment, typically ranging from 0.075 to 0.25 millimetre (0.0030 to 0.0098 in), but can range from 0.005 to 0.01 mil (0.00013 to 0.00025 mm). Surface defects and roughness are amplified, because hard chrome does not have a leveling effect. Hard chromium plating is subject to different types of quality requirements depending on the application, for instance, the plating on hydraulic piston rods are tested for corrosion resistance with a salt spray test.

Automotive use

Formerly most decorative items affixed to cars were referred to as "chrome", by which phrase was actually meant steel that had undergone several plating processes to endure the temperature changes and weather that a car was subject to outdoors. The most expensive and durable process involved plating the steel first with copper, and then nickel, before the chromium plating was applied.

Prior to the application of chrome in the 1920s, nickel electroplating was used. In the US for the short production run prior to the entry into the Second World War, plating was banned to save chromium and the decorative pieces were painted in a complementary color. In the last years of the Korean War, the banning of chrome was contemplated and several cheaper processes (such as plating with zinc and then coating with shiny plastic) were considered.

In 2007, a Restriction of Hazardous Substances Directive (RoHS) was issued banning several toxic substances for use in the automotive industry in Europe, including hexavalent chromium, which is used in chrome plating.

Chapter 3

Convertible

Jaguar XK c. 2008, with heatable glass rear window and fully automatic cloth top with integral top-concealing rigid tonneau

A **convertible** is a type of automobile in which the roof can retract and fold away, converting it from an enclosed to an open-air vehicle. Many different automobile body styles are manufactured and marketed in convertible form.

Roof designs vary widely, but a few characteristics are common to all convertibles. Roofs are affixed to the body of the vehicle and are usually not detachable. Instead the roof is hinged and folds away, either into a recess behind the rear seats or into the boot or trunk of the vehicle. The roof may operate either manually or automatically via hydraulic or electrical actuators; the roof itself may be constructed of soft or rigid material. Soft-tops

are made of vinyl, canvas or other textile material; hard-top convertibles have roofs made from steel, aluminum, carbon fiber or plastic materials.

Contemporary convertibles are known and marketed under several different terms due to the convergence of body styles over the years. A soft-top convertible may also be referred to as a **cabriolet** or **cabrio** or **spyder**, although two-seater soft tops often retain the name roadster, referring to their body style. Hard-tops are marketed under the terms **coupé cabriolet**, **coupé convertible** or simply **retractable hardtop**, while two-seaters more commonly use **coupé roadster**/**roadster coupé**.

Folding textile roof

The collapsible textile roof section (of cloth or vinyl) over an articulated folding frame may include linings such as a sound-deadening layer or interior cosmetic headliner (to hide the frame) — or both — and may have electrical or electro-hydraulic mechanisms for raising the roof. The erected top secures to the windshield frame header with manual latches, semi-manual latches, or fully automatic latches. The folded convertible top is called the **stack**.

Cons

Convertibles offer the flexibility of an open top in trade for:

- potentially reduced safety
- poor break-in protection
- deterioration and shrinkage of the sun-exposed textile fabric over time
- diminished rear visibility, from a large roof structure, small rear window, or obstructed rear window — or all of these: e.g., Mini convertible.
- generally poor structural rigidity. Contemporary engineering goes to great length to counteract the effects of removal of a car's roof. For example, a 2007 article in the *New York Times*, referring to the Volkswagen Eos, reported:

> *“To neutralize the loss of torsional rigidity inherent in any convertible, VW engineers cleverly took the basket-handle roll bar of the VW Cabrio, inverted it and placed it under the rear seat pedestal. A beefed-up windshield frame of hot-stamped ultra-high-strength steel is connected directly to the floorpan’s reinforced frame rails. Steel tubing provides more stiffness behind the doors for an extra layer of safety. Partly as a consequence, rear seat passengers have about 10 inches less shoulder room than in the smaller Rabbit"”*

- specifically poor structural rigidity, such as pronounced scuttle shake, a characteristic whereby the structural design of the bulkhead between engine and passenger compartment of a convertible suffers sufficiently poor rigidity to

negatively impact ride or handling — or allow noticeable vibration, shudder or chassis-flexing into the passenger compartment.
- lesser handling qualities in sports models due to lower torsional stiffness - and therefore requiring harder suspensions to achieve the equivalent roadholding, but at the expense of worse ride quality.
- higher curb weight due to mass of the automatic raising mechanism, as well as the extra structural reinforcement to compensate for lesser rigidity. This invariably means weaker performance than an equivalent coupe.
- In most cases, less cargo space, with some models the "trunk space is ridiculously skimpy" or almost none such as in the Volvo C70 when the hard roof is stowed.

Tonneau covers

Folding textile convertible tops often do not hide completely the mechanism of the folded top or can expose the vulnerable underside of the folded top to sun exposure and fading — in which case tonneau covers of various designs snap or secure into place to protect the folded roof and hide the mechanicals. Detachable foldable, rigid or semi-rigid covers require space-consuming storage inside the vehicle — and sometimes complicated installation from outside the stationary vehicle. Foldable vinyl and cloth covers can be prone to shrinkage, further complicating installation.

Evolution of the tonneau cover

- The MKI (first generation) MGB (1963) roadster featured a manually-assembled convertible frame which required the driver to install the separate vinyl or cloth convertible top — from outside the car. Likewise, a similar detachable frame installed to support a foldable vinyl tonneau cover with a series of twenty press fit snaps.

- Convertibles such as the Chrysler LeBaron (c. 1988) used sleeve and groove systems to anchor foldable vinyl tonneau cover, again installed manually from outside the car. Later textile convertibles used semi-rigid plastic tonneau covers, e.g., the first generation Audi TT and Cadillac Allanté.

- Convertibles such as the fifth generation of the Cadillac Eldorado featured a detachable two-part, fully rigid, manually installed tonneau sufficiently strong to support a seated person — also known as a *parade boot*.

- Convertibles such as the second generation Mercedes SL popularized the integral manually operated self-storing rigid tonneau cover—in its case accompanied by a separate removable hardtop. In either case, the design required manual operation from outside the stationary vehicle.

- Convertibles such as first Porsche Boxster, Toyota MR2 and third generation Mazda MX5 (NC) featured **Z-fold** (aka zig-zag fold) tops, whereby the exterior of

the neatly retracted fabric roof also protected the remaining roof from sun exposure — eliminating the aesthetic or protective need for a tonneau cover.

- Convertibles such as the second generation Ford Thunderbird (1958) convertible and the fourth generation Mercedes SL popularized the complex electro-hydraulic roof mechanism that automatically secured the folded top under a rigid tonneau — button activated by a seated driver — and later more routinely available on convertibles such as the Volvo C70, Chrysler Sebring and Mitsubishi Eclipse Spyder.

- The contemporary retractable hardtop convertible such as the Chevrolet SSR include tonneau covers that "self-store" the roof assembly.

Detachable hardtops

Convertibles such as both the first and eleventh generation of the Ford Thunderbird and the second and third generations of the Mercedes SL featured as standard or optional equipment fully rigid, manually installable hardtops — later examples including heatable rear windows. These hardtops provided acoustic insulation but also required space-consuming off-season storage — and a cumbersome two-person installation. The optional aluminum (i.e., lightweight) detachable hardtop for a Porsche Boxster weighed 51 lb (23 kg). Two current-day examples of vehicles with a detachable hardtop available are the Jeep Wrangler, and the Mazda MX-5.

Convertible windows

Convertible side windows have evolved from non-existent in the earliest models, to detachable side screens and manually or power operated glass side windows. Rear-windows have evolved similarly, with plastic rear-windows appearing as late as the first generation Porsche Boxster. Contemporary convertibles and retractable hardtops feature heatable glass rear windows to maximize visibility — though rear windows often can compromise visibility by their size, as with the case of the very small rear window and restricted visibility of the Mitsubishi Eclipse Spider. Plastic windows can degrade, fade, yellow and crack over time, diminishing visibility.

Windblockers

Windblockers, also known as wind screens, wind deflectors, or wind shields, minimize noise and rushing air from reaching the occupants — specifically cold air (and the noise that comes with it) rushing from behind the passengers having been forced over the windshield then returning to the natural lower-pressure zone where the passengers sit.

Mazda pioneered the windblocker with its Mazda RX7 convertible featuring an integral rigid opaque panel that folded up from behind the two seats. Current convertibles feature windblockers of various designs including detachable fold-up designs (e.g.,Toyota

Solara), vertically retractable glass (e.g.,Audi TT), carefully designed minimal flaps (e.g.,Mazda Miata) — or other integrated wind controlling systems.

Mercedes and Audi currently offer a feature that routes a heating duct to the neck area of the seat on SLK, SL and A5/S5 models, marketed as the "Air Scarf".

According to the chief engineer for the 2008 Chrysler Sebring, Jim Issner, the windblocker for the Sebring reduces "wind noise by approximately 11 to 12 decibels".

Safety

Contemporary convertible design may include such features as electrically-heated glass rear window (for improved visibility), seat belt pre-tensioners, boron steel reinforced A-pillars, front and side airbags, safety cage construction — a horseshoe like structure around the passenger compartment — and roll over protection structures or (ROPS) with pyrotechnically charged roll hoops hidden behind the rear seats that deploy under roll-over conditions whether the roof is retracted or not.

Notably, the Volvo C70 retractable hardtop includes a door-mounted side impact protection inflatable curtain which inflates *upward* from the interior belt-line — vs. downward like the typical curtain airbag. The curtain has an extra stiff construction with double rows of slats that are slightly offset from each other. This allows them to remain upright and offer effective head protection even an open window. The curtain also deflates slowly to provide protection should the car roll over.

Variations

Convertibles have offered numerous iterations that fall between the first mechanically-simple but attention-demanding fabric tops to highly complex modern retractable hardtops:

Roadster: Originally the term roadster suggested a minimal convertible, possibly with a frame that required actual assembly (i.e., not retracting) and separately installable soft "window" panels — offering little protection from inclement weather and requiring a time-consuming, complicated installation. Examples would be the vintage Porsche Speedster introduced in 1955, and the classic Jaguar XK120 Roadster unveiled in 1948. A contemporary roadster is a two-seater convertible, like the Audi TT, the modern classic BMW Z8, and Pontiac Solstice.

Landau & Rigid Door: Citroën's early Citroën 2CV featured a roof that rolled back on itself leaving rigidly framed side doors in place — followed in concept by such cars as the 1950 Nash Rambler Convertible Coupe.

Citroën currently markets the C3 Pluriel (Pluriel is a cognate with the English *plural*), which can be configured into five iterations, hence the name:

- a hatchback with a multi-layer insulated top.
- a full-length "landau" sedan, operable partially or to the back window or any stage in between, with a buffet-minimizing wind deflector over the windshield.
- a semi-convertible, with the roof open to the back window, the roof assembly folds into a well in the trunk floor.
- a full convertible, whereby roof side rails are unlatched and removed.
- a roadster pick-up, where the back seats fold to a pickup-like bed with a drop-down tailgate.

View: Citroën C3 Pluriel diagram

The Four Door: A four door convertible is referred to as a phaeton, while a two-door is referred to as a cabriolet. Modern 4-door models, e.g., the Lincoln Continental, c.1960. A current example of a 4-door convertible is the Jeep Wrangler Unlimited.

Peugeot presented the a concept four-door retractable hardtop convertible, the Peugeot 407 Macarena in 2006. Produced by French coachbuilding specialist Heuliez, the Macarena's top can be folded in 60 seconds, with a steel reinforcing beam behind the front seats incorporating LCD screens for the rear passengers into the crossmember.

View: Peugeot 407 Macarena, in action.

Drophead Coupe, Cabriolet or Cabrio: A type of convertible with only two doors, and thereby recalling the cabriolet carriage. With its Mazda RX7 convertible, Mazda introduced a two-seater convertible with a removable rigid section over the passengers, removable independently of power operated textile section behind with heatable glass rear window. During the 1980s, Jaguar produced an XJ-SC with two removable panels over the front seats and a partial fold-down convertible section in the back. It retained the rear side windows of the coupe and had fixed cant rails above these and the door glass. This allowed an almost full convertible with roll-over safety. Going back in Jaguar history, during the 1950s the XK 120 Drophead Coupe (DHC) and later variants, provided open-air motoring with quite civilized fully-lined insulated tops with the weather-protection of the hardtop models.

History in the United States

Until the 1910 introduction by Cadillac of the first closed-body car, the convertible was the primary body style. US automakers manufactured a broad range of models during the 1950s and 1960s — from economical compact-sized models such as the Rambler American and the Studebaker Lark to the more expensive models such as the Packard Caribbean, Oldsmobile 98, and Imperial by Chrysler.

Threatened rollover safety regulations in the mid-1970s led to diminished popularity by the 1970s. In 1976 Cadillac marketed the Eldorado as "The last convertible in America". During this period of very low convertible production, T-tops became a popular alternative.

Elsewhere globally, convertible production continued throughout this era with models such as the Mercedes SL, the VW Beetle Cabriolet, the VW Golf Cabriolet, and the Jaguar E-type.

In the 1980s convertibles such as the Chrysler LeBaron and Saab 900 revived the body style in the United States — followed by models such as the Mazda Miata, Porsche Boxster, Audi TT and later retractable hardtop models.

Retractable hardtop roof

A Volvo C70 with retractable hardtop

Rear view of Ferrari California, a hard top convertible.

A **retractable hardtop**, also known as **coupé convertible** or **coupé cabriolet**, is a type of convertible that forgoes a folding textile roof in favor of an automatically operated, multi-part, self-storing hardtop where the rigid roof sections are opaque, translucent or independently operable.

The retractable hardtop solves some issues with the convertible, but has its own compromises, namely mechanical complexity, expense and more often than not, reduced luggage capacity. A 2006 *New York Times* article suggested the retractable hardtop may herald the demise of the textile-roofed convertible, and a 2007 *Wall Street Journal* article suggested "more and more convertibles are eschewing soft cloth tops in favor of sophisticated folding metal roofs, making them practical in all climates, year-round."

Construction

Retractable hardtops can vary in material (steel, plastic or aluminum), can vary from two to five in the number of rigid sections and often rely on complex dual-hinged trunk (*British: boot*) lids that enable the trunk lid to both receive the retracting top from the front and also receive parcels or luggage from the rear — along with complex trunk divider mechanisms to prevent loading of luggage that would conflict with the operation of the hardtop.

Construction variations

- The Volkswagen Eos features a five-segment retractable roof where one section is itself an independently sliding transparent sunroof.
- The Cadillac XLR features a retractable aluminum hardtop requiring 6'-10½" of vertical clearance during retraction, and manufactured by a supplier joint venture between Mercedes-Benz and Porsche.
- The Mercedes SL hardtop features a glass section that rotates during retraction to provide a more compact "stack."
- The Mazda MX-5 retractable hardtop is manufactured by the German firm Webasto and is marketed alongside a largely identical folding-textile convertible, with an increase of 77 lb (35 kg) and no reduction in cargo capacity — the hardtop is constructed of polycarbonate.

- Daihatsu marketed the Copen in the ultra-compact Japanese Kei class.
- The Chrysler Sebring's retractable hardtop is marketed also alongside a softtop. According to development engineer Dave Lauzun, during construction, the Karmann-made tops are dropped into a body that is largely identical: both softtop and retractable feature the same automatic tonneau cover, luggage divider and luggage space. The retractable does feature an underbody cross-brace not included in the softtop.
- The Volvo C70, its retractable hardtop manufactured by Webasto includes a *global window switch* that allows simultaneous raising or lowering of all windows, and a button to power-activate the raising of the folded top stack within the trunk to access cargo below.
- The Vauxhaul/Opel Astra TwinTop, its three-piece retractable hardtop manufactured by Webasto includes a *global window switch* that allows simultaneous raising or lowering of all windows, an easy load where you raise boot lid vertically by 10 cm to allow an easy access to the boot while roof is down, and a button to power-activate the raising of the folded top stack within the trunk to access cargo below.

Pros and cons

The retractable hardtop convertible trades higher initial cost, mechanical complexity and, with rare exception, diminished trunk space — for increased acoustic insulation, durability and break-in protection similar to that of a fixed roof coupe.

Pro: The retractable hardtop eliminates:

- the need for a storage-consuming, manually-from-outside-the-vehicle-installable, separate or integral, rigid or foldable, tonneau cover to conceal the mechanicals of a folded textile top.
- the need to protect the vulnerable underside of a folded textile top from UV fading.

- the need for a separate rigid hardtop requiring space-consuming off-season storage and a cumbersome twice-yearly, two-person manual installation and removal — a system popularized, for example, by the Mercedes-Benz SL-Class of 1963 to 1988.

Con: In addition to higher initial cost, diminished trunk space, and increased mechanical complexity — and thereby potentially higher repair cost:

- The retractable hardtop may lift the articulating sections of the roof during retraction, requiring increased vertical clearance. For example, the Volvo C70 requires 6.5 feet (2.0 m) of clearance during operation. The Cadillac XLR requires 6'-10½" of vertical clearance.
- The retractable hardtop may, such as in the case of the Mercedes SLK, require additional rear clearance behind the car during operation of the top, the trunklid extending rearward while retracting or raising the top.

- The retractable hardtop relies on battery power, and in the event of battery failure, can leave a retracted roof vulnerable to a downpour. Volvo includes an emergency roof cover with each Volvo C70. The Cadillac XLR owners manual contains seven pages of detailed instructions on how to manually raise the top. This problem is not unique to retractable hardtops since some softtops rely on battery power as well.

- With numerous articulated sections, each joint or seal is an opportunity for water leakage.

- Failure of hydraulics or electrical systems may result in substantial repair bills.

History

1922 Ben P. Ellerbeck conceived the first practical retractable hardtop system in 1922 — a manually operated system on a Hudson coupe that allowed unimpeded use of the rumble seat even with the top down. — but never saw production.

1935 Peugeot introduced the first production, power-operated retractable hardtop in 1935, the 402 Éclipse Décapotable, designed and patented by Georges Paulin. The French coachbuilder, Marcel Pourtout, custom-built other examples of Paulins designs on a larger Peugeot chassis as well. The first Eclipse 402s offered a power-retractable top, but in 1936 was replaced by a manually operated version on a stretched chassis, built in limited numbers until World War II.

1941 Chrysler presents the retractable hardtop concept car, the Chrysler Thunderbolt.

1953 Ford Motor Company spent an estimated US$2 million (US$16,424,469 in 2011 dollars) to engineer a Continental Mark II with a servo-operated retractable roof. The

project was headed by Ben Smith, a 30-year-old draftsman. The concept was rejected for cost and marketing reasons.

1955 Brothers Ed and Jim Gaylord showed their first prototype at the 1955 Paris motor show, but the car failed to reach production.

1957 Ford introduced the Skyliner in the United States. A total of 48,394 were built from 1957 to 1959. The retractable top was noted for its complexity and intermittent reliability in the pre-transistor era. Its mechanism contained 10 power relays, 10 limit switches, four lock motors, three drive motors, eight circuit breakers, as well as 610 feet (190 m) of electrical wire, and could raise the or lower the top in about 40 seconds. The Skyliner was a halo car with little luggage space (i.e., practicality), and cost twice that of a baseline Ford sedan.

1989 Toyota introduced a modern retractable hardtop, the MZ20 Soarer Aerocabin. The car featured an electric folding hardtop and was a marketed as a 2-seater with a cargo area behind the front seats. Production was 500 units.

1995 The Mitsubishi 3000GT Spyder convertible by ASC was marketed in the U.S. The design was further popularized by such cars as the 1996 Mercedes-Benz SLK. and 2001 Peugeot 206 CC.

2006 Peugeot presented the a concept four-door retractable hardtop convertible, the Peugeot 407 Macarena. Produced by French coachbuilding specialist Heuliez, the Macarena's top can be folded in about 30 seconds. It has a reinforcing beam behind the front seats which incorporates LCD screens into the crossmember for the rear passengers.

View: 1957 TV ad for the Ford Skyliner featuring Lucille Ball and Desi Arnaz.
View: Peugeot 407 Macarena, with top retracting.
View: Photographs of a 1938 Peugeot 402 Éclipse Décapotable
View: time lapse photograph of Mercedes SLK, with top retracting
View: Sales brochure of the 1995 Mitsubishi Spyder

List of retractable hardtop models

Early models

- Hudson 1922
- Peugeot 402 Éclipse Décapotable (1935)
- Chrysler Thunderbolt concept car 1941
- Continental Mark II concept car c.1953
- Ford Skyliner (1957–1959)
- Gaylord (1956)

Later models

- Toyota Soarer Aerocabin(1989)
- Mitsubishi 3000GT Spyder Mk.2 (1995–

- BMW Z4 (2010)
- BMW M3 (2008)
- BMW 328i/335i Cabrio (2007)
- Cadillac XLR (2004)
- Chevrolet SSR (2003)
- Chrysler Sebring (2008)
- Chrysler 200 (2011)
- Daihatsu Copen (2002)
- Ferrari California (2009)
- Ford Focus CC (2007)
- Infiniti G Convertible (2009)
- Lexus SC 430 / Toyota Soarer (2001)
- Lexus IS 250/350 C (2009)
- Mazda MX-5 (2007–present)
- Mercedes-Benz SLK-Class (1996)
- Mercedes-Benz SL-Class (2003–2009)
- Mitsubishi Colt CZC (2006)
- Nissan Micra C+C (2005)
- Nissan Silvia Varietta (2000)
- Opel Astra TwinTop / Vauxhall Astra TwinTop (2006)
- Opel Tigra TwinTop / Vauxhall Tigra TwinTop (2005)
- Peugeot 206 CC (2001)
- Peugeot 307 CC (2003)
- Peugeot 207 CC (2007)
- Peugeot 308 CC (2008)
- Pontiac G6 (2006)
- Renault Mégane CC Mk.2 (2003)
- Renault Mégane CC Mk.3 (2010)
- Toyota MR-S (2000–2007)
- Volvo C70 Mk.2 (2006)
- Volkswagen Eos (2006)

Convertible gallery

Ford Model T c. 1925, with minimal weather protection

Jaguar XK120 Roadster c.1950, with a very light weight canvas top and removable side curtains screwed to the doors — with no external door handles (shown: top stored)

Nash Rambler Convertible "Landau" Coupe c. 1950, with retracting roof and rigid doors, featured car of Lois Lane of 1950s television series *Adventures of Superman*

Austin A40 Sports, c.1951, a four passenger, aluminum bodied convertible designed by Eric Neal and manufactured by Austin of England in conjunction with Jensen Motors

MG TD c.1953, with manual soft top and manually detachable **sidescreens** with clear plastic windows and Perspex rear window

Cadillac Eldorado c.1959, with zipper operable clear plastic rear window

Jaguar E-type c. 1970, with vinyl foldable tonneau installed and snap-secured

Cadillac Eldorado 1972, with detachable, two-part, fully rigid "parade boot" tonneau cover

Citroen 2CV c. 1975, with roll-back roof and rigid doors

Rolls Royce Corniche c. 1986, a high-end prestige marque with a **manually** installed tonneau cover

Chrysler LeBaron c. 1989, with manually installed "metallic" vinyl tonneau cover, color-matching to the car body, secured with a 'sleeve and groove' system

Cadillac Allanté c. 1993, with detachable, rigid plastic tonneau cover. Built in Italy by Pininfarina, completed bodies were flown to the U.S. 56 at a time in specially equipped Boeing 747 with final assembly at Hamtramck, Michigan.

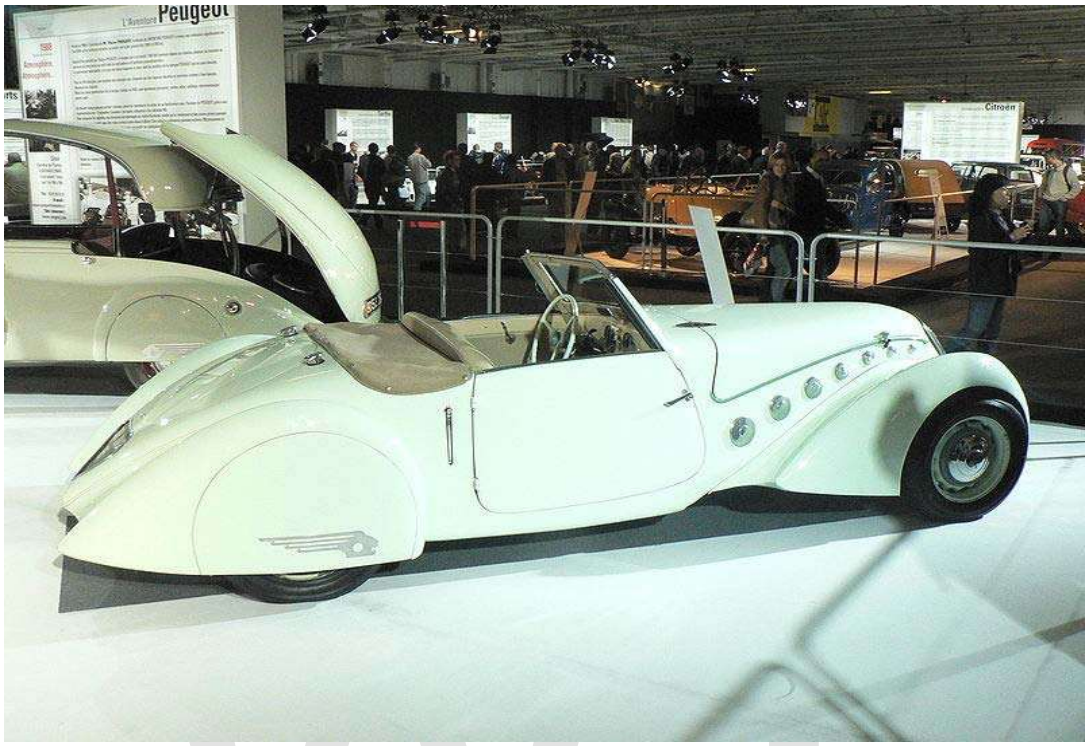
Porsche Boxster c. 2004, with detachable clear plastic windblocker and a **Z-fold** top, automatically raisable in 12 seconds and optional 51 lb (23 kg) detachable aluminum hardtop

MINI Cooper, c. 2006, with large blindspots from the top itself, small rear window, and interior rear roll hoops severely obscuring the driver's rear view

Citroën C3 Pluriel c. 2007, a multi-configurable convertible with roll-back textile roof and removable rigid sidebars

Volkswagen New Beetle c. 2008, with raised textile (cloth) convertible top featuring interior headliner, an acoustic insulation layer, and heatable glass rear window

Retractable hardtop gallery



Background: the Georges Paulin patented automatic folding roof in action.

Cadillac XLR c. 2007, with fully retracted aluminum (i.e., lightweight) hardtop concealed by self-storing tonneau cover, the hardtop manufactured by a supplier joint venture of Mercedes-Benz and Porsche.

Daihatsu c. 2001 with retracted hardtop, qualifying for the ultra-compact Japanese Kei class.

Ford Skyliner c. 1958 retracting its roof

Ford Focus CC c. 2006 with its roof retracted, its final assembly performed by Pininfarina

Volkswagen Eos c. 2007, the five-segment top features an independently sliding sunroof, the roof designed and built by OASys, a subsidiary of Webasto Germany.

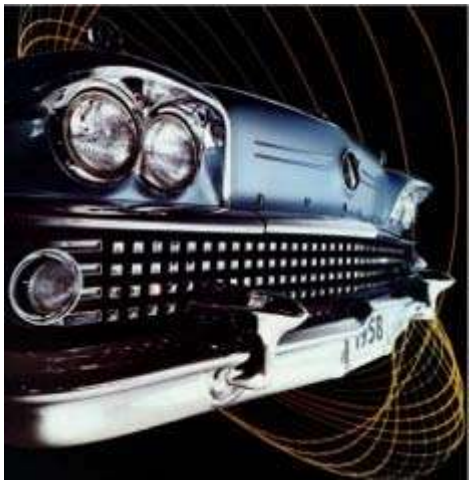
Volvo C70 c. 2007, retractable hardtop in action, the first production 3-segment retractable,

Chapter 4

Dagmar Bumpers and Fastback

Dagmar bumpers

1953 Mercury Convertible with Dagmars



Buick advertising image of the *Fashion-Aire Dynastar* grille work with reflective squares and Dagmars featured on 1958 Buicks

Lincoln B with Dagmar bumpers

1957 Chevrolet Bel-Air with rubber-tipped Dagmars

Dagmar bumpers, also known simply as **Dagmars** (*dag*-mar), is a slang term for the artillery shell shaped styling elements found on the front bumper/grille assemblies on several makes of cars produced in the 1950s, an era recognized for its flamboyant designs and prominent use of chrome details.

The term was coined by customizers in direct reference to Dagmar, an early 1950s television personality well known for her pronounced cleavage on *Broadway Open House*. Dagmar's physical attributes were further enhanced by low-cut gowns and the shape of her bra cups, which were somewhat conical. She was amused by the tribute.

Evolution

As originally conceived by Harley Earl, GM Vice President of Design, the bumper guard elements would mimick exaggerated artillery shells and were placed at either end of the front bumpers of Cadillacs. Their presence was both as a styling element indicating speed (as in the speeding bullet or projectile) and as bumper guards.

However as the 1950s wore on, the element on the Cadillac grew more pronounced, and in 1957 the Cadillac Eldorado Brougham gained black rubber tips, which were referred to in slang terms as "pasties".

As the 1959 model year designs approached, American car designs were beginning to shed both their rear fins and the missile shaped grille elements. In 1960 the era of the Dagmar bumper ended when Lincoln dropped the element from its 1961 Lincoln Continental.

Dagmars as a massive grille or bumper decoration competed against not only "spinners," as on the 1949 Ford and 1950 Studebaker, but also against a similar decorative element, which had a concave tip. Buick had these in a circular form both before and after the firm's stint with dagmars. Oldsmobile had these in an oval form and never used dagmars.

Vehicles sporting Dagmar bumpers

Postwar Cadillacs began sporting missile pointed bumper elements with their 1946 models. Beginning with the 1951 models, stylists began lifting these bumper guards up into the grille work, however by 1953 their shape and detail began to take on a bullet motif with the tips of the element being scored in the manner in which a bullet casing is shaped. In 1957 black rubber tips were placed on the element which was now placed at the top of the grille, approximately ten inches above the lower bumper. The element continued to become more pronounced in size through 1958, but were eliminated in the 1959 Cadillac redesign.

Mercury sprouted prominent Dagmars in 1953 and continued the look through the 1956 model year. Lincoln added Dagmars to its 1960 Lincoln and Continentals. The design took a different approach than GM, with the use of a black rubber ring separating the body of the element from the chrome tip.

Buick sported Dagmars on its 1954 and 1955 models. In 1954 the element was part of the bumper assembly; in 1955 the element moved up into the grille area.

Fastback

A **fastback** is a car body style whose roofline slopes continuously down at the back. The word can also designate the car itself. The style is seen on two-door coupés as well as four-door sedans.

Art Deco fastback: 1935 Stout Scarab

Finned fastback: 1936–1950 Tatra T87

Low-drag fastback: 1949 Saab 92

History

Automobile designs that were ahead of their time when exhibited during the early 1930s included "teardrop streamlining at the rear, similar to what would become known as 'fastback' 25 years later." 'Fastback' was first recognized as a definition by Merriam-Webster in 1954, many years before the term 'hatchback' was popularized and entered the dictionary in 1970. Opinions vary as to whether the terms are mutually exclusive.

A contributor to an automotive-interest website singles out the unusual Stout Scarab from the early 1930s as "[p]ossibly the epitome of the early fastback definition". The Packard 1106 Twelve Aero Sport Coupe, introduced in 1933, is cited elsewhere as a fastback that foreshadowed trends which continued into the 1940s.

Early European fastback automobiles include: Bugatti Type 57 Atlantic, Porsche 356, Saab 92/96, Standard Vanguard, GAZ-M20 Pobeda, and Bentley Continental R-Type.

Numerous fastbacks were also made in America, where the style was previously called "torpedo back". They included Cadillac's Series 61 and 62 Club Coupes as well as various models from General Motors, Ford, and Chrysler.

At a 2007 U.S. car show, entries from the mid-1930s to the mid-1950s in a class called "Fabulous Fastbacks" included Nash Ambassador, Buick Roadmaster and Hudson Commodore models.

At a 2007 *concours d'élégance* in England, a similarly-named class for 1950s cars attracted examples from Maserati, Lancia, Fiat and Ferrari.

Aerodynamic advantages

Rear-engined fastback: Porsche 356

Fastbacks provide an advantage in developing aerodynamic vehicles with a low drag coefficient. The Kamm tail is a related concept. The trend towards a more steeply raked

rear window on traditional three-box sedans blurs the distinction between fastback and notchback designs. The current Lexus LS460 exemplifies the trend. However, the roof of a true fastback design slopes down continuously to the rear, most often to the base of the trunk at the rear bumper. There is no distinct change of angle to a rear deck, whereas most four-door cars with steeply raked rear windows have less angled trunk lids; also high tails to maximize cargo space. In 2008, the fastback design appeared on a concept car that almost defies categorization, the Chrysler ecoVoyager, that "Jack Telnack, former design chief for the Ford Motor Company, declared, 'It's a fastback van.'" New types of crossover vehicles and different body proportions made possible by technological advances and new powerplants, are changing the shape of automobiles. Traditional nomenclature describing distinct vehicle bodies, such as the three-box sedan (engine compartment, passenger cabin and trunk) will vanish.

Fastback types

Fastback but also a hatchback/liftback: late-model Toyota Celica

Hatchbacks and liftbacks

When the rear window of a car with a fastback profile is integral to a lid or 'fifth door' (i.e. a hatch) giving access to the trunk area, the car may also fit the classification of hatchback or liftback. The late-model Toyota Celica and the Chevrolet Vega are examples.

Road & Track's definition of a fastback addresses this distinction: "A closed body style, usually a coupe but sometimes a sedan, with a roof sloped gradually in an unbroken line from the windshield to the rear edge of the car. A fastback naturally lends itself to a hatchback configuration and many have it, but not all hatchbacks are fastbacks and vice

versa." Some small family cars have evolved over time from fastbacks into liftbacks without altering their profile, e.g. Fiat 127, Volkswagen Passat, and Citroën GS.

Two-door fastbacks

1950 Chevrolet Fleetline, one of several American fastbacks

GT fastback: race-prepared 1966 Toyota 2000GT

Pony car fastback: 1968 Ford Mustang

Small fastback: Fiat 127 first series

Four door fastback: Citroën CX

Modern fastback: Mercedes-Benz CLS-Class

- 1931-1936 Stout Scarab
- 1934-1937 Pierce-Arrow
- 1936-1937 Bugatti Type 57SC Atlantic
- 1938-2003 Volkswagen Type 1 (Beetle)
- 1947-1966 Volvo PV
- 1948-1965 Porsche 356
- 1948-1949 Cadillac Series 61 and Series 62 Club Coupe Sedanet(te)
- 1948-1952 Hudson Commodore
- 1948-1955 Bristol 401, 402 and 403
- 1949 Tatra T601 Monte Carlo (Finned Fastback)
- 1949-1951 Nash Ambassador Airflyte
- 1949-1979 Saab 92/96
- 1950-1950 Martin Stationette
- 1953-1955 Bentley Continental R-Type
- 1961-1975 Jaguar E-type
- 1963-present Porsche 911
- 1964-1969 Plymouth Barracuda
- 1965-1967 AMC Marlin
- 1965-1973 Ford Mustang GT (several generations)
- 1966-1970 Oldsmobile Toronado
- 1966-1967 Dodge Charger
- 1966-1973 Volkswagen Type 3 Fastback (dates are from U.S. lineup)
- 1966-1976 Jensen Interceptor

- 1967-1973 Maserati Ghibli
- 1968-1973 Ferrari Daytona
- 1968-1973 Ford Fairlane Torino/Torino SportsRoof
- 1968-1978 Lamborghini Espada
- 1968-1969 Mercury Cyclone
- 1968-1972 Oldsmobile 442 and Cutlass
- 1968-1974 Volkswagen Type 4
- 1969-1974 Ford Capri
- 1969-1976 Audi 100 Coupé S
- 1969-1978 Nissan S30
- 1970-1981 Chevrolet Camaro
- 1970-1977 Ford Maverick and Mercury Comet
- 1970-1975 Mitsubishi Galant GTO
- 1970-1981 Pontiac Firebird
- 1971-1977 Chevrolet Vega
- 1971-1980 Ford Pinto
- 1972-1987 Alfa Romeo Alfetta GTV-6
- 1975-1980 Buick Skyhawk
- 1975-1980 Chevrolet Monza 2+2 and Monza Spyder
- 1975-1988 Nissan Silvia
- 1975-1980 Oldsmobile Starfire
- 1975-1977 Pontiac Astre
- 1976-1977 Mercury Capri II
- 1976-1980 Pontiac Sunbird
- 1978-1979 Buick Century
- 1978-1979 Oldsmobile Cutlass Salon
- 1979-1987 Mercury Capri
- 1980-1991 Audi Quattro
- 1981-1987 Audi Coupé GT
- 1986-1988 Pontiac Fiero GT
- 1992-2003 Ferrari 456
- 1979-2002 Toyota Supra
- 2003-2005 Smart (automobile) Roadster Coupe
- 2004-Present BMW 645Ci
- 2004-Present Ferrari 612 Scaglietti
- 2004-Present Bentley Continental GT
- 2006-2009 Pontiac Solstice Coupe
- 2006-Present Ferrari 599 GTB Fiorano
- 2008-Present Altima Coupe

Four-door fastbacks

- 1933-1935 Pierce-Arrow Silver Arrow
- 1933-1936 Riley Nine (Kestrel)
- 1934-1938 Tatra T77/T77A (Finned Fastback)
- 1936-1939 Tatra T97 (Finned Fastback)

- 1937-1950 Tatra T87 (Finned Fastback)
- 1946-1952 Tatra T600 Tatraplan (Finned Fastback)
- 1946-1958 GAZ-M20 Pobeda
- 1947-1953 Jowett Javelin
- 1948 Tucker
- 1948-1952 Hudson Commodore
- 1948-1954 Hudson Hornet
- 1949-1951 Nash Ambassador Airflyte
- 1950-1953 Tatra T87-603
- 1955-1958 GAZ-M72 (M20 4x4 conversion)
- 1951-1957 FSO Warszawa (Polish M20 clone)
- 1968-1974 Volkswagen Type 4
- 1969-1978 Citroën Ami 8
- 1970-1979 Citroën GS
- 1972-1982 Lancia Beta Berlina
- 1973-1981 Volkswagen Passat
- 1974-1990 Citroën CX
- 1975-1984 Lancia Gamma Berlina
- 1976-1986 Rover SD1
- 1978-1980 Buick Century
- 1978-1980 Oldsmobile Cutlass Salon Brougham
- 1990-1998 Mazda 323F
- 2005-Present Mercedes-Benz CLS-Class
- 2006-Present Citroën C6
- 2009- Porsche Panamera
- 2009- Aston Martin Rapide
- 2009- Audi A5 Sportback
- 2009- Volkswagen Passat CC
- 2010- Honda Crosstour/Accord Crosstour

Chapter 5

Grille

A **grille** or **grill** (French word from Latin *craticula*, small grill) is an opening of several slits side by side in a wall or metal sheet or other barrier, usually to let air or water enter and/or leave but keep larger objects including people and animals in or out.

Spelling

In the United States, "grille" is used to differentiate the automotive part from the cooking device, called a "grill".

In powered vehicles

BMW's distinctive kidney-shaped grille on an E34 M5.

Audi's "single frame" grille, here on a second generation TT.

Crown Victoria Police Interceptor black honeycomb grille.

In automotive engineering, a **grille** covers an opening in the body of a vehicle to allow air to enter. Most vehicles feature a grille at the front of the vehicle to protect the radiator and engine. Other common grille locations include below the front bumper, in front of the wheels (to cool the brakes), in the cowl for cabin ventilation, or on the rear deck lid (in rear engine vehicles).

The grille is often a distinctive styling element, and many marques use it as their primary brand identifier. For example, Jeep has trademarked its seven-bar grille style.

Rolls-Royce is famous for arranging its grille bars by hand to ensure that they appear perfectly vertical. Other makers known for their grille styling include Bugatti's horse-collar, BMW's split kidney, Rover's chrome "teeth", Mitsubishi's forward swept, fighter aircraft-style grilles for their cars 2008 Lancer and Lancer Evo X, Dodge's cross bar, Alfa Romeo's six-bar shield, Volvo's slash bar, Audi's relatively new, so-called *single-frame* grille, and an egg-crate grille on late-generation Plymouths. The unusual 1971 Plymouth Barracuda grille is known as a *cheesegrater*. Ford's three-bar grille, introduced on the 2006 Fusion, has become distinctive as well.

The contrary styling pattern also occurs. Starting from the late 1930s, Cadillac would alternate its pattern from horizontal bars to various patterns of crosshatching as a simple way of making the car look new from year to year, for this make did not have a standard grille form. Sometimes there is a sort of fashion trend in grille bars. For example, in the early years after World War II, many American car makers generally switched to fewer and thicker grille bars.

A billet grille is an aftermarket part that is used to enhance the style or function of the original OEM grille. They are generally made from billet, solid bar stock aircraft-grade aluminum, although some are CNC machined from one solid sheet of aluminum.

Customizers would alter the grille as a matter of course in personalizing their car, taking the grille bar from another make, for example. Even sheet metal with patterned holes for ventilation grating sold to homeowners for repair has been found filling the grille opening of custom cars.

Grille types

Per mounting location on the car body:

- Radiator grille
- Bumper skirts grilles (front and rear);
- Fender grills (brakes ventilation duct covers);
- Hood scoop grill (allow intercooler air flow)
- Roof grilles or trunk grills (rear engine vehicles);

Per style

The American aftermarket restyling industry defines two major grille styles:

- OEM factory-style grilles – Such grilles have no difference with those manufactured by the automobile producers;
- Custom style – produced in small quantities and have an assortment of materials.

Per fastening method

- Bolt over style

In this installation method, the billet grille simply bolts over the existing OEM plastic grille. This method does not require drilling or cutting of the OEM grille shell. Hidden bolts, brackets and clamps are used for this simple installation. The downside is it may not look as clean as the replacement style, because you can still see the OEM grille underneath. Bolt overs should take no more than 30 minutes to install.

- Replacement style

The OEM grille must first be removed and then the replacement billet grille must be mounted in place of the OEM grille. Drilling and sometimes cutting is required for this method. Installation instructions are always provided by the grille manufacturer, but unless you are a handyman you will need to take this job to a professional garage.

Material types

Chevrolet Vega plastic "egg-crate" grill

- ABS plastic grilles – The major part of the OEM Grilles is produced by casting ABS plastic with various admixtures, which bring in plasticity to this less expensive and often fragile material.
- Billet grilles - are made from Aluminum. Billet grilles have a high-luster polished or chromed front face with a black baked on powder coating finish back ground.
- Mesh grilles - This grille type usually used in fast cars, made of stainless steel woven mesh, Electro polished to a high-luster finish or zinc plated, then finished with baked on powder coating. For steel to be considered stainless, it needs to have at least a 10.5% chromium content. There are two types of steel used in mesh grilles, 409 series and 304 series stainless steel. The 304 series has a higher chromium content and is more durable and more resistant to corrosion.

History

Grilles on automobiles have taken on different designs through the years. This feature first appeared on automobiles in 1903. Several years later, the arch-shaped design became common and became the standard design on automobile grilles for many years. The "split" grille design first appeared in 1923 on the Alfa Romeo sports car.

In the 1930s and 1940s, automobile manufacturers became creative with their grille designs. Some of these designs were bell-shaped (Buick, Chevrolet, and Pontiac), split and slightly folded (Silver Arrow, Mercury, 1946 Oldsmobile), cross-shaped (pre-war Studebaker Champion models, 1941 Cadillac, 1942 Ford), while some including Packard, Rolls-Royce, and MG-TC models still followed the older arch-shaped design.

Grilles took on a new look after World War II. Following the introduction of the 1947 Buick, Studebaker, and Kaiser, grilles became shorter and wider to accommodate for the change in design.

In heating and ventilating and air conditioning

In heating and ventilating and air conditioning for room air distribution, a *grille*, specifically spelled with the ending *e*, is a class of air terminals. Most HVAC grilles are used as return or exhaust air inlets to ducts, but some are used as supply air outlets. Diffusers and nozzles, are, for example, used as supply air outlets too. *Registers* are a type of HVAC grille that also incorporates an air damper.

Chapter 6

Hood Scoop and Econobox

Hood scoop

Functional hood scoop on a Subaru Impreza WRX

A **bonnet/hood scoop** is an upraised component on the hood of an automobile that either allows a flow of air to directly enter the engine compartment, or appears to do so. It has only one opening and is closed on all other sides. Its main function is to allow a direct flow of air to the engine, hence the need for it to be upraised so as to effectively channel air to the engine compartment. It may be closed, and thus purely decorative, or serve to enhance performance in several possible ways.

Hood scoop functions

Cool air

One possible use of a hood manifold. In most modern automobiles, internal combustion engines "breathe" under-hood air or air ducted from under the front bumper through plastic and rubber tubing. The high operating temperatures in the engine compartment result in intake air that is 28°C (50°F) or more warmer than the ambient temperature, and consequently less dense. A hood scoop can provide the engine with cooler, denser outside air, increasing power.

Ram air

At higher road speeds, a properly designed hood scoop can increase the speed and pressure with which air enters the engine's intake, creating a resonance supercharging effect. Such effects are typically only felt at very high speeds, making ram air primarily useful for racing, not street performance.

Pontiac used the trade name **Ram Air** to describe its engines equipped with functional scoops. Despite the name, most of these systems only provided cool air, with little or no supercharging effect.

Intercooler scoops

Some engines with turbochargers or superchargers are also equipped with top mounted intercoolers to reduce the temperature and increase the density of the high-pressure air produced by the compressor. Channeling outside air to the intercooler (which is a heat exchanger similar to a radiator) increases its effectiveness, providing a slight improvement in power.

Scoop design

To be effective, a functional scoop must be located at a high-pressure area on the hood. For that reason, some functional scoops are located at the rear of the hood, near the vehicle's cowl, where the curvature of the windshield creates such a high-pressure zone, and may be placed so that their opening faces the windshield (a **reversed scoop**).

The scoop will be most effective if it is either mounted high enough to clear the boundary layer (the slow-moving air that clings to the surface of a moving object) or if it is a "**NACA duct**," mounted below the surface and designed to draw the faster moving air outside of the boundary layer into the duct. A shallow scoop that is *not* a NACA duct may not admit a useful amount of air even if it is open.

Under the hood, an effective scoop must funnel air into the engine's intake in as short and direct a path as possible, preferably through a tub or channel that is insulated against underhood heat.

A scoop may be part of the hood, or may be part of the engine's air cleaner assembly, protruding through a hole cut into the bonnet. Such a scoop is called a shaker hood, because the scoop vibrates noticeably when the engine is running, especially under power.

Hood scoops and off-road racing

A hood scoop/top mounted intercooler can be beneficial, especially during an off-road rally race. Rocks and debris can be kicked up by a car in front, and those objects can damage a front mounted intercooler. However, rock guards can be installed to prevent this problem.

Econobox

1985 Austin Rover Mini

An **econobox** is a US slang term for any of a series of small, boxy, fuel-efficient car with few luxuries and a low sticker price.

Description

The typical econobox is a subcompact car, usually with a three-door hatchback format with transverse engine mounting and front-wheel drive, to maximize interior space despite overall small dimensions. They are usually outfitted with vinyl bucket seats, basic AM radio, a rudimentary heater, foam-cushioned plastic trim, two-speed wipers and painted steel rims with a chromed wheel nut cap.

History

Econoboxes first came to prominence in the United States due to the 1973 oil crisis. Japanese automakers were leaders at producing smaller, fuel-efficient cars, as well as enjoying generally higher reliability and build quality than their US counterparts, so their

offerings such as the Honda Civic generally outperformed their American competitors such as the Chevrolet Vega and Ford Pinto.

Possibly the first econobox was the Austin Mini, first built in England in 1959 (although the Metropolitan was also built in England to be imported by Nash-Hudson, known later as American Motors Corporation [AMC]as early as 1957). The best known American econoboxes were the Chevrolet Chevette and the Dodge Omni/Plymouth Horizon. Japanese econoboxes include the Honda Civic (in particular the first and second generations) and the Datsun B-210. The Fiat 127 and its Yugoslavian counterpart the Yugo are also famous econoboxes.

Other well known economy cars like the Volkswagen Beetle and the Citroën 2CV are sometimes referred to as econoboxes, though they do not have the requisite square shape of a true econobox.

Other cars such as the Chevrolet Sprint, Geo Metro, & Chevrolet Aveo as well as the Ford Festiva and Ford Aspire would be considered econoboxes. Although these cars had American nameplates, they were manufactured in foreign countries. American car manufacturers have typically had a hard time making money off of econoboxes, and they consider them "loss leaders" that only existed to meet CAFE fuel economy standards. So, over the course of time, American car companies shifted from manufacturing econoboxes themselves, and partnered with a foreign manufacturer to build them. A perfect example of this is the American Ford Escort. The Ford Escort replaced the Pinto in 1981, and was manufactured by Ford until 1990. The Escort built from 1991-1996 however was built using a Mazda "B" series. Chevrolet did the same thing using its "GEO" line, to sell cars built by Suzuki and Toyota. Chrysler did as well, using cars built by Mitsubishi.

Today

Many long-running nameplates that have gotten their start as econoboxes have since moved upscale. The Austin Mini and VW Beetle, for instance, have been revived or succeeded by high performance vehicles whose retro exterior pays tribute to the originals, but they are now targeted at performance enthusiasts rather than the masses. Meanwhile, the Toyota Corolla and the Honda Civic, two of the world's best selling vehicles, started as subcompact econoboxes but are now on the high-end of the compact size line.

Automakers created new lines of entry-level economy vehicles, such as the Toyota Yaris, Honda Fit and Nissan Versa, whose base models are no-frills vehicles. However, due to engineering advances, they have now incorporated more safety features while also providing substantial interior volume, despite the exterior dimensions. However, unlike original econoboxes, amenities such as power windows and air conditioning are available as options or on more expensive trims. Usually, the mid-level trims that contain some of these luxuries will be the most common models produced by their factories. The unfortunate drawback to all these added features however is that modern econoboxes do not achieve the same remarkable fuel economy numbers that their counterparts built in the eighties could produce

Chapter 7

Custom Car

'32 3-window with a classic-style flame job and Moon tank, very reminiscent of Chapouris' *California Kid*.

Custom '51 Merc with red "ghost flames" and appletons

"Rat rodded" Deuce coupe with Edelbrock head and chrome carb hats on late-model flatty.

The iconic "T-bucket" custom. Exposed engine is virtually mandatory, as are flat windshield, headers, and open pipes. Soft top (shown) is optional. Also features chrome five-spokes, dropped tube axle, transverse front leaf spring, front disc brakes, open-face aircleaner, Weiand valve covers, and single 4-barrel (probably a QJ).

Front suspension of yellow lowboy Deuce roadster. Note color-matched springs on coilover shocks, tube axle, vented disc brakes.

'41 Willys. Note the non-stock one-piece windshield.

'55-7 Chevy with fuzzy dice

'Big Daddy' Roth 'bloodshot eyeball' shift knob, a 1960s craze.

'28 A roadster with Kelsey-Hayes wire wheels.

A **custom car** is a passenger vehicle that has been modified in either of the following two ways. First, a custom car may be altered to improve its performance, often by altering or replacing the engine and transmission. Second, a custom car may be a personal "styling" statement by the re-styler/re-builder, making the car look "unique" and unlike any car that might have been factory finished. Customs are distinct from hot rods; exactly where the difference lies has been the subject of debate among customizers and rodders for decades.

History

A development of hot rodding, the change in name corresponded to the change in the design of the cars being modified. The first hot rods were pre-World War II cars, with running boards and simple fenders over the wheels. Early model cars (1929 to 1934) were modified by removing the running boards and either removing the fenders entirely or replacing them with very light "cycle fenders". Later models usually had "fender skirts" installed on the rear fenders. Many cars were "hopped up" with engine modifications such as adding additional carburetors, high compression heads and dual exhausts. "Engine swaps" were done, the object of which was to put the most powerful engine in the lightest possible frame and body combination. The suspension was usually altered. Initially this involved lowering the rear end as much as possible with the use of "lowering blocks" on the rear springs. Later cars were given a "rake job" either adding a "dropped" front axle or heating front coil springs to make the front end of the car much lower than the rear. Much later some hot rods and custom cars swapped the old solid rear axle for an independent rear axle, often from Jaguar. Only rarely was the grille of one make of car replaced by another; one exception was the 1937 Buick grille, often used on a Ford. (In the 1950s and 1960s, the grille swap of choice was the 1953 De Soto.) The original hot rods were plainly painted like the Model A Fords from which they had been built up, and only slowly begun to take on colors, and eventually fancy orange-yellow flamed hoods or "candy-like" deep acrylic finishes in the various colors.

With the change in automobile design to encase the wheels in fenders and to extend the hood to the full width of the car, the former practices were no longer possible. In addition, there was tremendous automotive advertising and subsequent public interest in the new models in the 1950s. Hence custom cars came into existence, swapping headlamp rings, grilles, bumpers, chrome side strips, and tail lights, as well as "frenching" and "tunnelling" head- and taillights. The bodies of the cars were changed by cutting through the sheet metal, removing bits to make the car lower, welding it back together, and adding a lot of lead to make the resulting form smooth (hence the term "lead sled"; lead has been replaced by Bondo). By this means, "chopping" made the roof lower; "sectioning" made the body thinner from top to bottom. "Channeling" was cutting notches in the floorpan where the body touches the frame to lower the whole body. Fins were often added from other cars, or made up from sheet steel. In the custom car culture, someone who merely changed the appearance without also substantially improving the performance was looked down upon.

Features

Paint

Paint was an important concern. Once bodywork was done, the cars were painted unusual colors. Transparent but wildly-colored candy-apple paint, applied atop a metallic undercoat, and metalflake paint, with aluminum glitter within candy-apple paint, appeared in the 1960s. These took many coats to produce a brilliant effect — which in hot climates had a tendency to flake off. This process and style of paint job was invented by Joe Bailon, a customizer from Northern California.

Customizers also continued the habit of adding decorative paint after the main coat was finished, of flames extending rearward from the front wheels, scallops, and hand-painted pinstripes of a contrasting color. The base color, most often a single coat, would be expected to be of a simpler paint. **Flame jobs** later spread to the hood, encompassing the entire front end, and have progressed from traditional reds and yellows to blues and greens and body-color "ghost" flames. One particular style of flames, called "crab claw flames", which is still prevalent today, is attributed to Dean Jeffries.

Painting has become such a part of the custom car scene that now in many custom car competitions, awards for custom paint are as highly sought after as awards for the cars themselves.

Engine swaps

Engine swaps have always been commonplace. Once, the flathead, or "flatty", was the preference, supplanted by the early hemi in the 1950s and 1960s. By the 1970s, the small-block Chevy was the most common option, and since the 1980s, the 350 cu in (5.7 l) Chevy has been almost ubiquitous. The flatheads and early hemis have not entirely disappeared, but ready availability, ease of maintenance, and low cost of parts makes the SB Chevy the most frequent engine of choice.

Once customizing post-war cars caught on, some of the practices were extended to pre-war cars, which would have been called fendered rods, with more body work done on them. An alternate rule for disambiguation developed: hot rods had the engine behind the front suspension, while customs had the engine over the front suspension. The clearest example of this is Fords prior to 1949 had Henry Ford's old transverse front suspension, while 1949 models had a more modern suspension with the engine moved forward. However, an American Museum has what could be the first true custom, 1932 Clobes .

With the coming of the muscle car, and further to the high-performance luxury car, customization declined. One place where it persisted was the U.S. Southwest, where lowriders were built similar in concept to the earlier customs, but of post-1950s cars.

As the supply of usable antique steel bodies has dried up, companies such Westcott's, Harwood, Gibbon Fiberglass and Speedway Motors have begun to fabricate new

fiberglass copies, while Classic Manufacturing and Supply, for one example, has been making a variety of new steel bodies since the 1970s. California's "junker" (or "crusher") law, which pays a nominal sum to take "gross polluters" off the road, has been criticized by enthusiasts (and by SEMA) for accelerating this trend.

Starting in the 1950s, it became popular among customizers to display their vehicles at drive-in restaurants. Among the largest and longest lasting was Johnie's Broiler in Downey, California. The practice continues today, especially in Southern California.

Customizers

Examples of notable customizers include George Barris, Bill Cushenberry, the Alexander Brothers, the "legendary" Gil Ayala, Darryl Starbird, Roy Brizio, Troy Trepanier (of Rad Rides by Troy), Boyd Coddington, Harry Westergaard, Dave Stuckey, Dean Jeffries, "Posie", Ron Clark and Bob Kaiser (of Clarkaiser Customs), Joe Bailon (inventor of candy apple paint), Gene Winfield, Joe Wilhelm, "Magoo", Chip Foose, and Pete Chapouris. Others, such as Von Dutch, are best known as custom painters. Several customizers have become famous beyond the automobile community, including Barris, Jeffries, and Coddington, thanks to their proximity to Hollywood; Barris designed TV's Batmobile, while Chapouris built the flamed '34 three-window coupé in the eponymous telefilm "The California Kid". Another Barris creation, *Ala Kart* (a '29 Ford Model A roadster pickup), made numerous appearances in film (usually in the background of diner scenes and such), after taking two AMBR wins in a row.

Awards

The highest award for customizers is the AMBR (America's Most Beautiful Roadster) trophy, presented annually at the Grand National Roadster Show since 1948 (also known within the customizer community as the Oakland Roadster Show until it was moved to Southern California in 2003). This competition has produced famous, and radical, customs.

Another is the Ridler Award, presented at the Detroit Autorama since 1964 in honor of show promoter Don Ridler. With one of the most unusual of car show entry requirements, winners of the prestigious Ridler Award are selected as the most outstanding from among cars being shown for the first time. This prompts builders of many high-end roadsters to first enter the Autorama first and then the Grand National show in order to have the chance to win top honors at both shows. Few cars and owners can claim this achievement.

Notable customs

Some customs gained attention for winning the AMBR trophy, or for their outlandish styling. Notable among these is *Silhouette* and Ed Roth's *Mysterion*. Some of these more unusual projects turned into Hot Wheels cars, among them *The Red Baron*.

Other custom cars became notable for appearances in film (such as *Ala Kart* {1958}, *The California Kid* three-window {1973}, or the yellow deuce from "American Graffiti" {1973}) or television (such as *The Monkeemobile*, the "Munsters" hearse, or, more recently, Boyd's full-custom *Tool Time* '34, or Pete and Jake's '33 three-window, *Eliminator*, built for the ZZ Top video). Specialist vehicles, such as the T/A, KITT, from *Knight Rider*, are not usually considered customs, but movie or TV cars, because they retain a mostly stock exterior.

Still others exemplified a trend. One of these is the '51 Merc built by the Barris brothers for Bob Hirohata in 1953, known forever after as the Hirohata Merc. Even without an appearance in film ("Runnin' Wild"), it is iconic of '50s customs, and of how to do a Merc right. The same year, Neil Emory and Clayton Jensen built *Polynesian* for Jack Stewart, starting with a '50 Olds sedan. *Polynesian* made the cover of *Hot Rod* in August, and saw 54 pages of construction details in *Motor Trend Custom Car Annual* in 1954.

Language

Certain linguistic conventions are followed among rodders and customizers:

- The model year is rarely given in full, except when it might be confused, so a 1934 model is a '34, while a 2005 might be an '05 or not.
    - A '32 is usually a Deuce and most often a roadster, unless coupé is specified, and almost always a Ford.
    - A '55/6/7 is always a Chevy, unless specified.
- A 3- or 5-window is usually a Ford, unless specified.
- A flatty is a flathead V8 (always Ford, unless specified); a late (or late model) flatty is probably a Merc.
- A hemi ("*hem* ee") is always a 426, unless displacement (331, 354, or 392) is specified; a 426 is a hemi, unless Wedge is specified.
- A 392 is a early hemi.
    - A 331 or 354 is known to be an (early) hemi, but rarely referred to as such
- A 270 "Jimmy" was a 270 cubic inch GMC truck engine often used to replace a smaller displacement Chevrolet six cylinder.
- A 392 is an early hemi.
- Units are routinely dropped, unless they are unclear, so a 426 cubic inch (in^3) displacement engine is simply referred to as a 426, a 5 liter (litre) displacement engine is a 5.0 ("five point oh"), and a 600 cubic feet per minute (cfm) carburetor is a 600. Engine displacement can be described in cubic inches or liters (for example, a 5.7 liter engine is also known as a 350 {"three fifty"}); this frequently depends on which units the user is most comfortable or familiar with.

The "cutoff year" as originally promoted by the *National Street Rod Association* (NSRA) is 1949. Many custom car shows will only accept 1948 and earlier models as entries, and many custom car organizations will not admit later model cars or trucks, but this practice is subject to change. The NSRA has announced that starting in 2011 it will switch to a shifting year method where any owner with a car 30 years or older will be allowed

membership. So in 2011 the owner of a 1981 model year vehicle will qualify, then in 2012 the owner of a 1982 model year vehicle will quality, and so on. Additionally, the Goodguys car show organization has moved the year limit for its "rod" shows from 1949 to 1954 in recent years.

Some other common terms:

- 3 deuces — arrangement of three 2-barrel (twin-choke) carburetors; distinct from Six Pak and Pontiac and Olds Tri-Power (also 3x2 arrangements)
- 3-window — 2-door coupé; so named for having rear window and one door window on each side
- 3 on the tree — three-speed manual transmission operated by a steering column mounted shifter.
- 4 on the floor — four-speed manual transmission operated by a floor mounted shifter.
- 5-window — 2-door coupé; so named for having rear window plus one door window and one quarter window on each side
- 97s — Stromberg carburetors
- A-bone — Model A coupé
- Appletons (sometimes Appleton spots) — spotlights, mounted in the cowl, similar to those used by police cars
- Barn fresh — a newly discovered vehicle typically found in storage (i.e. a barn, etc.), either long forgotten or abandoned, that is still in its original condition from when it was first stored
- Blue oval — Ford product (for the Ford badge)
- Blue dots —
    - Pontiac tail lights
    - Any taillight equipped with a blue crystal to give it a "purple-ish" appearance when illuminated.
- Bondo — brand name for a body filler putty, often used as a generic term for any such product
- Bowtie — Chevrolet product (for the Chevy badge)
- Bullnosing — Replacing the hood ornament with a "bullnose" chrome strip or filling the mounting hole with lead.
- Cabriolet (or cabrio) — A vehicle with a removable or retractable cloth top, characterized by integrated side windows.
- Cherry — like new
- Channeled or channeling - lowering a vehicle by cutting out the floor and mounting the body lower on the frame rails.
- Chopped — removing a section, usually of the window posts, to lower the roofline of a vehicle.
- Convertible — cabriolet.
- C.I.D. (sometimes Cubic Inches or Inches) — cubic inches displacement
- Crank — crankshaft
- Dagmars — large front bumper "bullets" (after the actress)
- Decked — trunklid trim removed

- Deuce —
  - '32 Ford Model B (most often a roadster); now commonly on A frame rails
    - rarely, 1932 model of any manufacturer.
  - Chevy II Nova
  - A truck of the 2-ton class
- Duvall windshield — a v-shaped windshield with a center post, as opposed to the typical stock straight-across type.
- Elephant — Chrysler hemi
- Fat-fender — 1934-48 (U.S.) car
- Flatty — flathead engine (usually refers to a Ford; when specified, the Mercury-built model)
- Fordillac ("for di lack") — Ford with transplanted Caddy
- Frenched —
  - Antenna sunken into the body or fender
  - Headlight slightly sunken into fender
  - Tail lights slightly sunken into body or fendr
- Gennie — genuine
- Hairpins — radius rods
- Hiboy (or highboy) — fenderless, but not lowered Distinct from gasser.
- Hopped up - A stock engine modified to increase performance
- Inches — CID
- Indian (also "Tin Indian") — Pontiac (for the grille badge)
- Jimmy (or Jimmy Six) — GMC straight 6
  - Any GMC product
- Lead sled — customized vehicle where lead has been melted and adhered to a metal body to smooth its surface, as filler. (Lead has since been replaced by Bondo.)
- Lakes pipes — straight exhaust pipes that run along the lower edge of a rod, typically near the rocker panels, without mufflers. The name comes from their original use on cars used on dry lakes by land speed racers.
- Loboy (or low boy, lowboy) — fenderless and lowered
- Mag — magnesium wheel, or steel or aluminum copy resembling one such
- Mill — any internal combustion engine on such a vehicle
- Moons (or Moon discs; incorrectly, moon discs) — Plain flat chrome or aluminum hubcaps, originally adopted by land speed racers. Smaller examples are "baby moons". Named for Dean Moon.
- Mouse — small-block Chevy
- Nailhead — Buick V8
- Nerf bars — bumper horns
- N.O.S. — New Old Stock: original-manufactured part, kept in storage at supplier
- Nosed — hood trim removed
- Phantom — body style never built by the original manufacturer (a term also adopted by model kit builders)
- QJ — Quadrajet (Rochester 4-barrel carburetor)
- Q-jet — Quadrajet
- Ragtop — convertible

- Rat — Chevy 454 cu in (7,440 cc) engine
- Repop — reproduction (not NOS)
- Resto — restoration, or restored
- Rockcrusher — Muncie M22 4-speed transmission
- Rake job - Car with suspension modified to lower the front end
- Rocket — Oldsmobile, in particular their early V8s
- SB — small-block (Chevy)
- Sectioning — The practice of removing an entire section of the body (front to back or top to bottom).
- Shoebox — '49-'54 Ford (for the slab-sided apppearance)
- Skirts - Covers installed on the openings on rear fenders
- Slantback — sedan with forward-angled but straight rear window and sheetmetal. Distinct from straightback.
- Sombreros — '47-'51 Cadillac hubcaps
- Souped (souped up) — hopped up, performance improved (more common in '40s and '50s)
- Steelies — stock steel rims
- Stock — original equipment
- Stone stock — all-original (usually referring to a project's starting condition)
- Stovebolt — Chevy straight 6
- Straightback — sedan with vertical rear window and sheetmetal. (Known as squareback in the VW community.)
- Street rod - A modified car licensed for use on streets and highways.
- Studillac ("stewed i lack") — Studebaker with transplanted Caddy
- Suicided — changed from front- to rear-hinged ("suicide door")
- Suicide front end — a front axle configuration where it is mounted forward of the front cross member or the end of the frame rails.
- Tin Indian — Pontiac (for the grille badge)
- Toploader — Ford 4-speed manual transmission
- Track T — Model T roadster built in the style of a dirt track race car
- Tuck-and-roll — upholstery technique creating a "pleated" look
- Tunneled — deeply sunken into fender
- V-butted (or vee-butted) — with windshield center post deleted, original panes meeting in the middle (distinct from fitting a one-piece windshield), or to make such a change ("the windshield was vee-butted", "he vee-butted the windshield")
- Vicky — Victoria body style
- Wide whites — wide-stripe whitewall tires, typical of the '50s, as opposed to modern ones
- Woody — Typically a station wagon manufactured by most of the major manufacturers where much of the body behind the firewall was replaced with wood construction.
- Zoomie pipes (or zoomies) — short exhaust pipes with no mufflers, used for racing, or just for show (not street legal)

Some terms have an additional, different meaning among hot rodders than among customizers: NOS, for instance, is a reference to nitrous oxide, rather than new old stock.

Another classic flame job.

'53-6 F100 with long-fork flame job, an idea dating to around 1978.

Fork flame job, a style introduced after 1975, on a '53-6 Ford F100

Ghost flames, a contemprary concept

The Brighton Kid? (A '40 Prefect.)

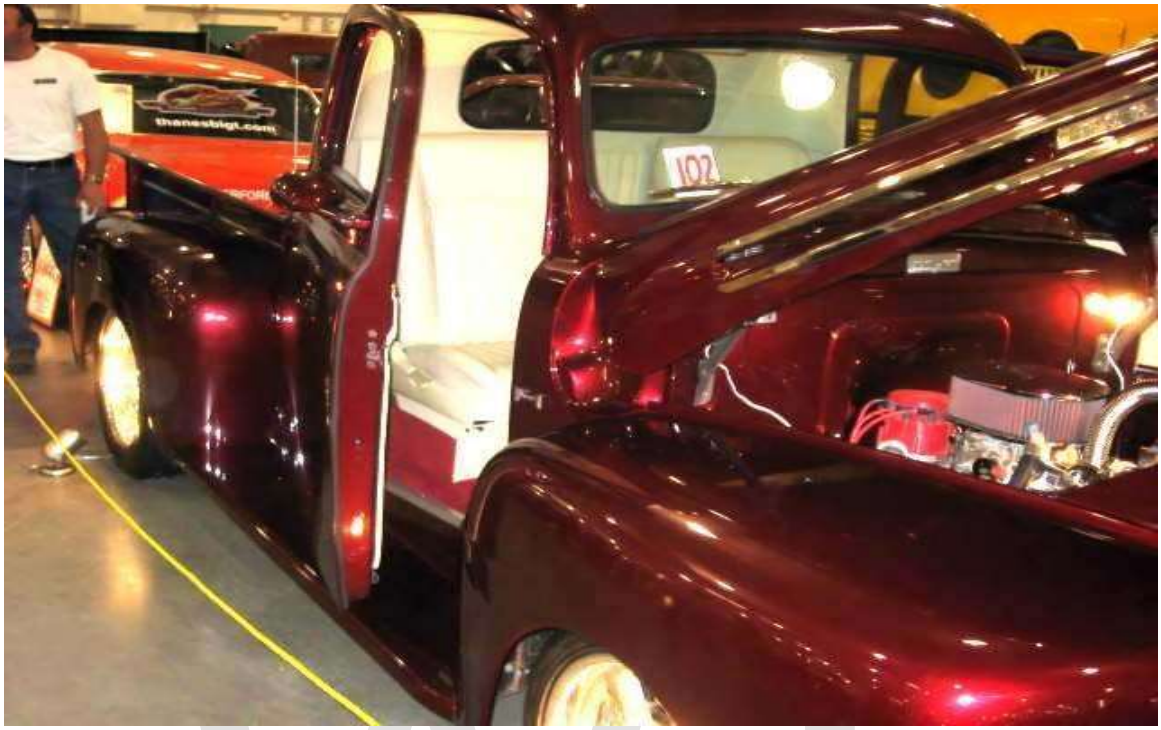
Moon tank mount, common on '50s customs

Unusual custom front turnsignals

'38 Chevy 5-window with custom tilt nose and side graphic

Deuce with chrome dropped tube axle and shocks. Note Model A chassis (extended frame horns), disc brakes, zoomie pipes.

'31 A roadster with '32 grille shell (a common change), 3 deuces, zoomie pipes, drilled I-beam, custom windshield, custom drum brakes with finned rear covers, & custom radius rods.

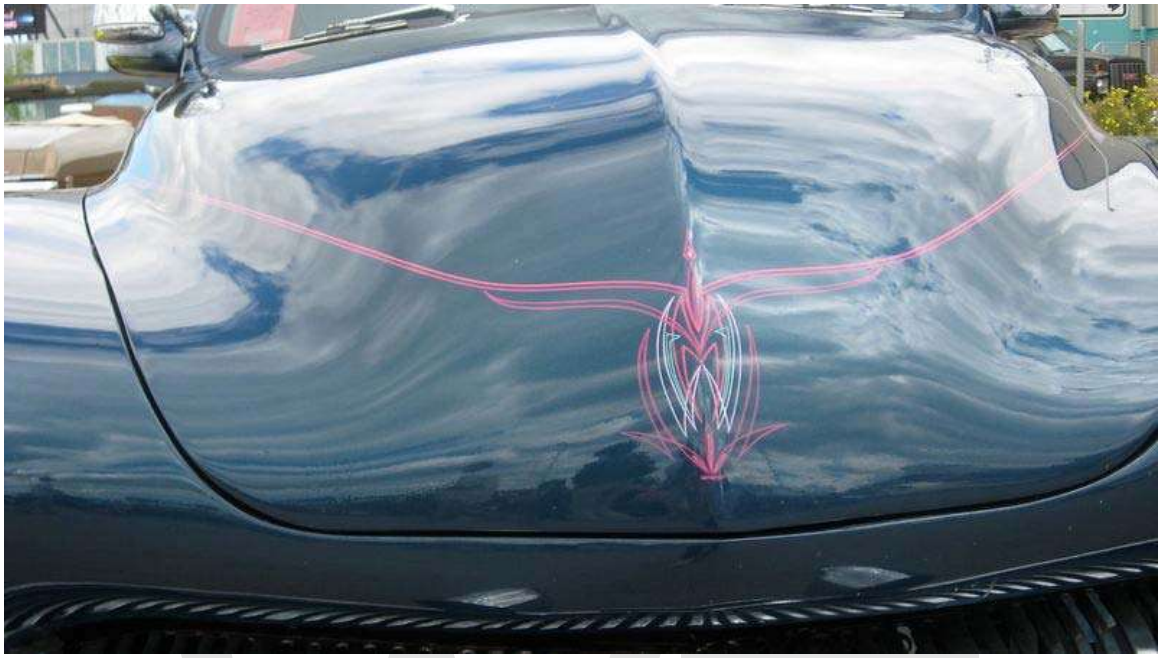


'49 Ford pickup with custom paint and suicided door

'40 Chev custom with painted grille, small front turnsignals, custom door mirror, and frenched radio aerial. Note non-stock one-piece windshield.

'49 Merc with metalflake paint job, custom tube grille, Carson top and tunneled headlights. Retains stock hood and trim spears.

Custom Merc with pinstriping, skirts, '81 Lincoln taillights, and Appletons



Custom Merc with sophisticated hood pinstriping

Modern interpretation of the '34 3-window: deeply chopped, monochrome, spoke rims

'32 Bantam roadster with *faux* mags (not gennie Halibrands), colormatched plugwires and distributor cap, disk brakes, hairpins, headers and sidemount pipes, chrome valve covers, and mirror firewall. Also has custom interior.

Stretched Model T

'47 Fargo pickup with custom third door

'62 Chevy II wagon, custom paint

'56 Ford pickup with Appleton spots

Chrome aircleaner, custom-milled with flames

'56 Crown Vic taillight with '59 Cad spike

Oval LED taillight

Custom oval LED front turnsignal

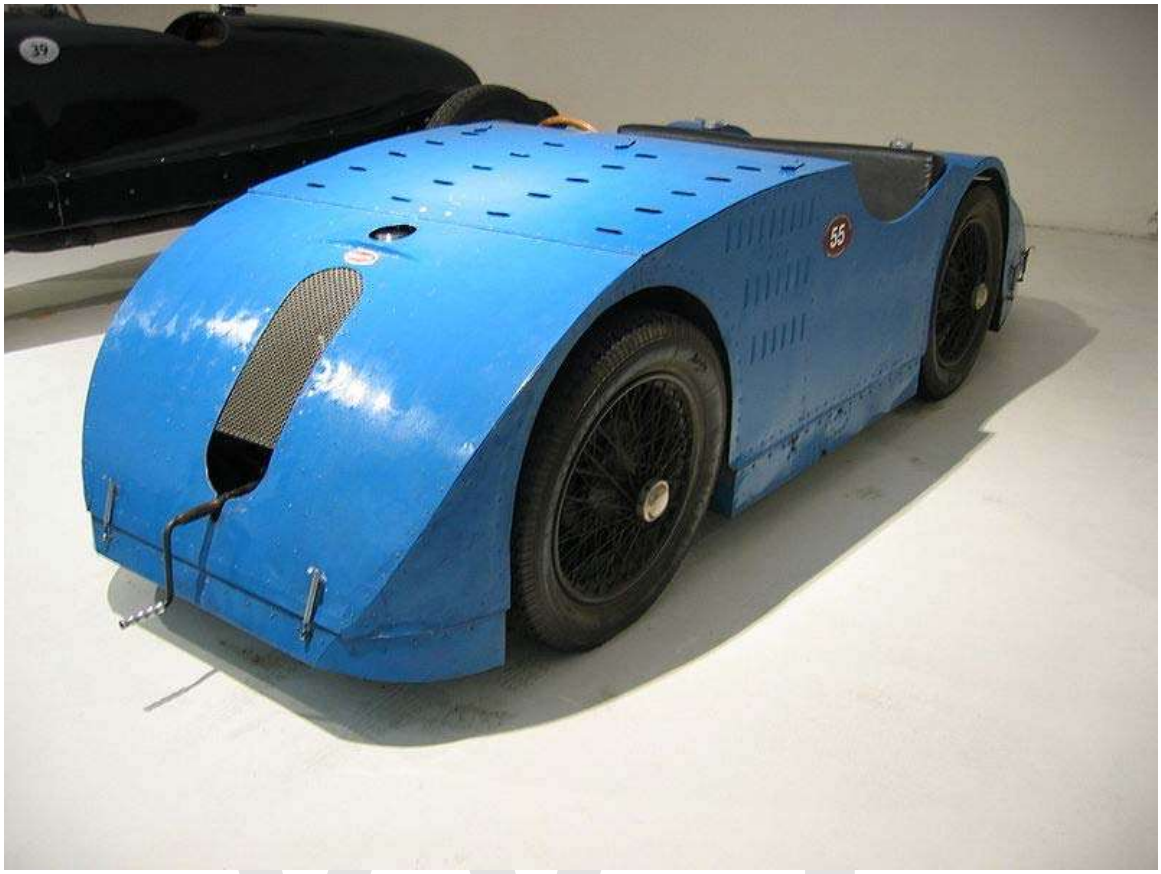
Three deuces with louvered chrome hats

'74 Ford Taunus 2000 GXL that has been chopped, shaved, louvered on the rear quarter panels, and fitted with an all steel body kit

Chapter 8

Ponton (Automobile)

1959 Renault Frégate, a typical postwar design with **ponton styling.**



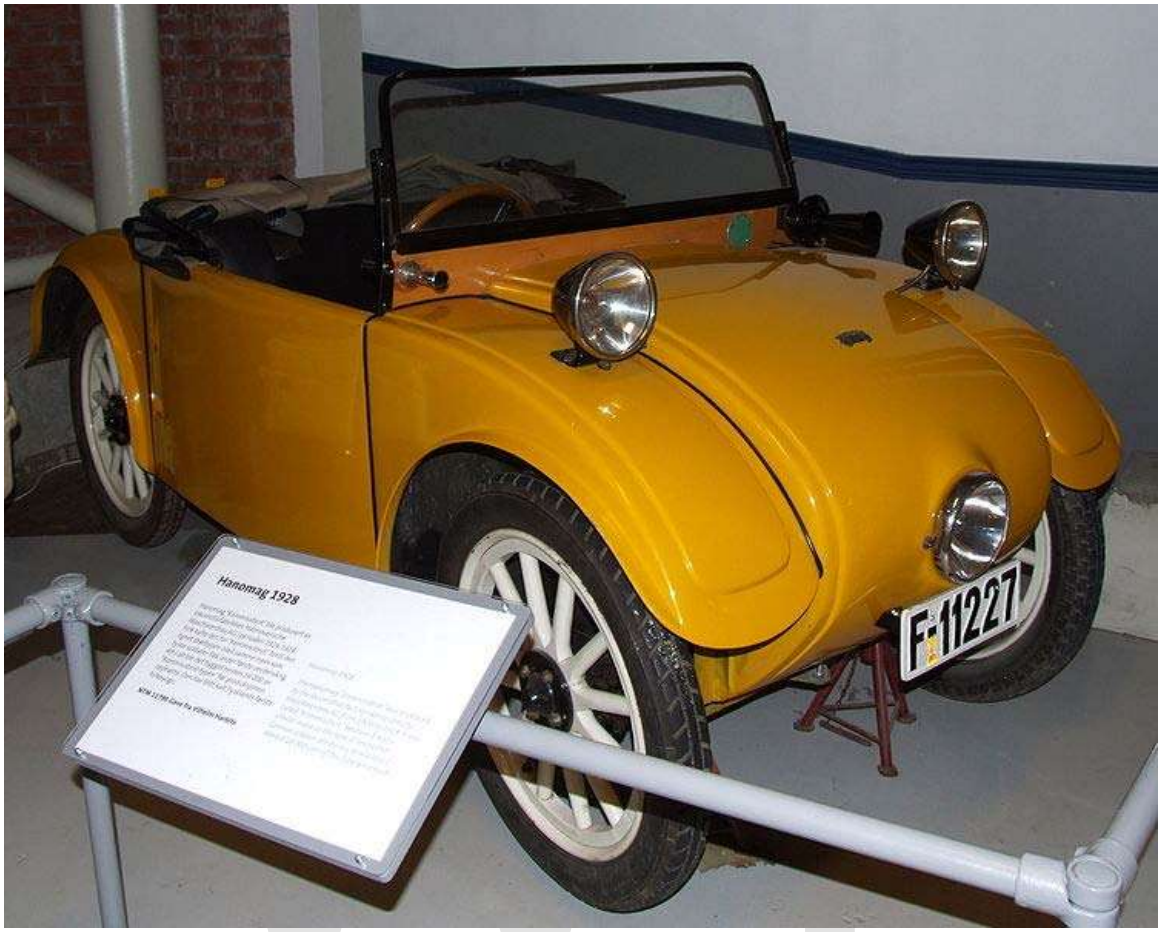
1923 Bugatti Typ 32 'Tank'

Ponton or Pontoon styling refers to a 1930s-1960s design genre — ultimately the precursor of modern automotive styling. The trend emerged as distinct running boards and fully articulated fenders became less common and bodywork began to enclose the full width and uninterrupted length of a car. The trend was also called *envelope styling*.

The term, which is now largely archaic, especially describes the markedly bulbous, slab-sided configuration of postwar European cars, including those of Mercedes-Benz, Opel, Auto Union, DKW, Borgward, Lancia, Fiat, Rover, Renault and Volvo — as well as similar designs from North America.

The term derives from the French and German word **Ponton**, meaning *pontoon*. The Langenscheidt German-English dictionary defines *Pontonkarrosserie* as "all-enveloping bodywork, straight-through side styling, slab-sided styling.

Origin of the trend



1928 The Hanomag 2/10 PS, it "dispensed with running boards and integrated the fenders in the body to save on weight."

The term ponton styling may have derived from the wartime practice in Germany of adding full-length tread armor along each side of a tank, attached primarily on the top edge — which resembled pontoons. As this roughly coincided with automobile styling trend where bodywork, especially running boards and fenders, became less articulated — with cars carrying integrated front fenders and full-width, full-length bodywork — the design took on the "pontoon" or "ponton" descriptor.

One of the first known cars with a ponton body is the Bugatti type 32 "Tank" which participated in the 1923 French Grand Prix at Tours.

In 1924, Fidelis Böhler designed one of the first production cars with a ponton body, the Hanomag 2/10. The car's body resembled a loaf of bread earning it the sobriquet of "Kommissbrot" - a coarse whole grain bread as issued by the army. The economical car was produced from 1924 to 1928. Böhler built the core body around two side-by-side passenger seats. He dispensed with running boards and integrated the fenders in the body to save on weight. The cheap car became a best seller in Germany.

In 1935, Vittorio Jano, working with the brothers Gino and Oscar Jankovitz, created a one-off mid-engine prototype on a Alfa Romeo 6C 2300 chassis, which Jano had shipped to Fiume, Croatia in 1934. The brothers Jankovitz had been close friends with leading Hungarian aerodynamicist Paul Jaray, and the prototype, called the Alfa Romeo Aerodinamica Spider, featured ponton styling — an especially early and clear example of the bulbous, uninterrupted forms that would come to characterize the genre.

See: 1935 Alfa Romeo Aerodinamica Spider, front three quarter view.
See: 1935 Alfa Romeo Aerodinamica Spider, profile view.

In 1937, Pinin Farina designed a flowing ponton-style body for the Lancia Aprilia *berlinetta aerodynamica* coupé, and also the open body on the 1940 Lancia Aprilia Cabriolet.

1936 BMW 328 Mille Miglia

1946 Pinin Farina's Cisitalia 202

The 1946 Cisitalia 202 coupé, which Farina designed from sketches by Cisitalia's Giovanni Savonuzzi, was the car that "transformed postwar automobile design" according to New York's Museum of Modern Art (MoMA). MoMA acquired an example for its permanent collection in 1951, noting that the car's "hood, body, fenders, and headlights are integral to the continuously flowing surface, rather than added on. Before the Cisitalia, the prevailing approach followed by automobile designers when defining a volume and shaping the shell of an automobile was to treat each part of the body as a separate, distinct element." Also introduced in 1947, the Alfa Romeo 6C 2500 was another ponton-style Farina design which, together with those by Touring and others on the same chassis, has also been credited with setting the trend for post-war automotive design.

Rounded, flowing forms, with unbroken horizontal lines between the fenders— the style had identified as "the so-called Ponton Side Design" became "the new fashion in Europe", offered by Alfa-Romeo, Fiat, Rover and other companies.

An inspiration to American and Japanese manufacturers as well as to Europeans, Farina's "ponton line" would be copied round the world. One of the first American cars to adopt it was the 1947 Studebaker Champion, designed by Virgil Exner and Roy Cole but sometimes erroneously attributed to Raymond Loewy. Another, the Howard "Dutch"

Darrin-designed 1947-1950 Kaiser-Frazer, was said to have been the inspiration for the 1949 Borgward Hansa 1500, Germany's first sedan in the ponton style.

In the Soviet Union the GAZ-M20 Pobeda came into production in 1946, about 1 month after the first 1946 Kaiser rolled off the production line, and in Britain the Standard Vanguard went on sale the following year.

Ford and General Motors followed the trend with their own designs in 1949.

Examples of "ponton" in automotive contexts

1954 Mercedes-Benz 180, nicknamed the "Ponton"

The term is now commonly used in reference to Mercedes-Benz models from 1953-1962. For example a book about the marque refers to "the Ponton", the "Ponton saloon", "Ponton 220", "Ponton 220S and SE coupes and cabriolets", and "the Ponton models".

A General Motors document refers to the 1953 Olympia Rekord as "the first Opel with a full-width, or ponton, body shell".

In a reference work on alternative-energy vehicles, electrical-engineering academics used the term as a generic for saloon cars with three-box design ; also a 2007 German work on

car design and technology mentions a "Rover-Ponton" (ponton-style Rover); and a French book on art and design also used the term in an automotive context in 1996.

Given that the Volkswagen Beetle carried articulated running boards and fenders its entire life, the subsequent Volkswagen Type 3 became known for its ponton styling; in Holland the Volkswagen Type 3 (1961–1974) 2-door notchback sedan from the fastback and wagon versions was called the 'Ponton."

The 1948-1950 Packard had a "'Ponton'-style side section with the fenders running through from front to back", according to a blogger who also describes the 1951 Packard Patrician as "one of the first cars that featured the new Ponton-style *(sic)* with integrated front-fenders *(sic)* at the same level with the hood and a curved onepiece-windscreen *(sic)*."

Farina-designed 1947 Alfa Romeo 6C 2300 SC

1950-1958 Lancia Aurelia B20

1950 Ford (USA) Club Coupe

1950 Studebaker Champion

1951 Standard Vanguard

1961-1974 Volkswagen Type 3, sometimes called "ponton" in Holland

1956-1970 Volvo Amazon

Chapter 9

Quarter Glass and Opera Window

Quarter glass

Non-retractable quarter "vent" window in the front door

Stationary quarter glass in the rear door

Two non-movable quarter windows, one as part of door and a second mounted in the C-pillar

Interior view of a venting quarter glass in the rear of a minivan between the C and D-pillars

Quarter glass (or **quarter lite** (NB American English spelling)) on automobiles and closed carriages may be a side window in the front door or located on each side of the car just forward of the rear window of the vehicle. Only some cars have them. In some cases the fixed quarter glass may set in the corner or "C-pillar" of the vehicle. Quarter glass is also sometimes called a **valence window**.

This window may be set on hinges and is then also known as a **vent window**. Most often found on older vehicles on the front door, it is a small roughly triangular shaped glass in front of and separate from the main window that rolls down. It has hinges and a latch, thus it can be opened for additional ventilation. Most vehicles since the 1960s have removed this feature for cleaner styling, known as "ventless" windows. Some vehicles also have glass that rolls down like a regular window or have hinged opening vent quarter windows for rear seat passengers. This may be a side window between the B-pillar and the C-pillar, and in the case of minivans between the C and D-pillars (examples include the Chrysler Town and Country).

They can also be non-movable and mounted in the door itself because that section of the rear side glass would not be able to slide down because of the cut out in the rear doors to

clear the rear wheel housings. The fixed portion of the glass is separated from the main window that rolls down by a slim opaque vertical bar.

A quarter glass can be found set in the body or A-pillar ahead of the front door opening (examples include the Chevrolet Lumina APV and eighth generation Honda Civic 4-door sedan).

In some automobiles the fixed quarter glass may set in the corner or "C-pillar" of the vehicle. There are also designs that incorporate two quarter windows one that is part of the door and the second mounted in the roof pillar. This arrangement may help to increase driver visibility. In this case, the quarter glass in the C-pillar would not be called an "opera window."

Opera window

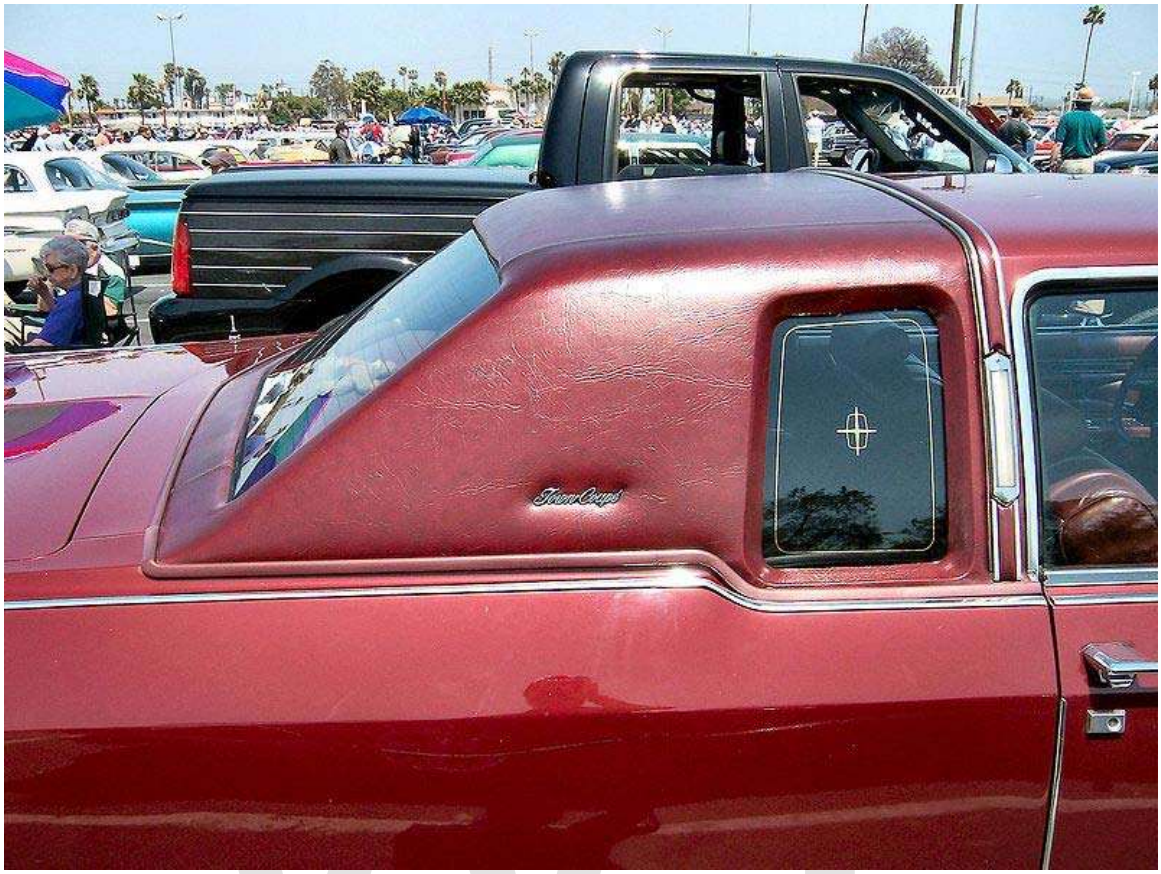
Opera window and padded Landau roof on a AMC Matador Barcelona coupe

Opera Windows are small porthole sized side windows in the C-pillar of some cars. Typically offered in unison with a vinyl roof, they were a very common design feature of American automobiles during the 1970s. The design was new at the time, "... and would prove to be very popular, indicated by its imitation by almost every domestic

manufacturer. The opera window was a fixed rear side window surrounded by a vinyl roof." Automotive designers hoped that incorporating opera windows in their cars would serve as a marketing tool by helping to evoke in consumers' minds the elegance and romance of a night at the opera.

History

Triple opera window on 1973 Dodge Charger SE coupe



Lincoln Continental Town Coupé - **"Landau"** vinyl

This design element was used during the classical era of automobile styling. For example, "...the Elcar in 1924 was good looking...and even a fabric top in the style of a brougham with oval opera windows framed by landau bars.... Opera windows saw their demise in the 1930s. Perhaps the most notable return was the "porthole" in the 1956-57 Ford Thunderbird. It was provided as an option to improve rear-quarter visibility with the removable hardtop in place... Opera windows were once again reintroduced on the 1972 Lincoln Continental Mark IV as an optional luxury feature, but it was almost universally ordered.

During the 1970s they became a very common design element. "...The hottest thing going was the "porthole" window in the rear side pillar - called "opera windows" that came in during the horse and buggy [era]... Most often, they were applied on two-door hardtop or coupé models and in all types of vehicles, from economy compacts to luxury brands. They also "were recognition elements" in the specialty, personal-sized car market. Practically all cars in the personal luxury market offered these windows as part of their seemingly vintage-oriented styling.

The windows were intended to offset the significant blind spots created by the very wide C-pillars that were characteristic of American cars produced at this time. Even narrow opera windows helped rear visibility. In an age of decreasing dimensions and

increasingly common use of non-opening rear side windows on 2-door models, the small opera windows helped rear passengers to be somewhat less claustrophobic.

These windows were usually non-functional; however, in the case of the AMC Matador coupe NASCAR racers, the small windows that came with the Barcelona II trim package actually helped to clean up the aerodynamics when such windows were open to the wind under racing conditions.

In some cars, an additional feature was the so-called **opera light** that was mounted on the outside of the B-pillar or C-pillar and lit up when the exterior lights were turned on.

Opera windows had fallen into disuse by the mid-1980s, as changing automotive styles moved away from the upright notchback. Smaller, more aerodynamic cars made opera windows appear gaudy or out of place. Contemporary examples of opera windows are sometimes found on modified or customized automobiles.

Cars with opera windows

This is a partial list of models that had opera windows as standard or optional feature:

- AMC Concord (1978-1982 Coupe, 1980-1983 4-door sedan)
- AMC Matador (1976-78 Coupe)
- Cadillac (Coupe DeVille after 1973; 1971-78 Eldorado)
- Chevrolet Monte Carlo (1973–1980)
- Chrysler Cordoba
- Chrysler TC by Maserati (1989–1991)
- Dodge Charger (B-body) (1973–1977)
- Dodge Magnum (1978–1979)
- Dodge Mirada (1980–1983)
- Ford Elite
- Ford Granada (coupe)
- Ford Mustang II Ghia
- Ford Thunderbird
- Lincoln Continental
- Lincoln Mark series
- Mazda RX-5 (1975- 1980)
- Mercury Cougar
- Oldsmobile Toronado (1974-78)
- Daihatsu Mira (1980–1985)
- Ford Torino (1974-1976)

Chapter 10

Spinner (Wheel) and Racing Stripe

Spinner

Spinner

A **spinner** is a type of hubcap that spins independently inside of a wheel itself when the vehicle is in motion, and continues to spin once the vehicle has come to a stop. Being an

attachment to the car's wheel, spinners operate by using one or more roller bearings to isolate the spinner from the wheel, allowing it to turn while the wheel is at rest. The spinner's own momentum helps it overcome what little friction is transmitted through the bearing. When the car is in motion, the small amount of friction transmitted through the bearing sets the spinner in motion. Spinners were popular within the hip-hop community of the United States and are gradually fading out of vogue in popular culture.

Invention

In October 1992, a United States wheel spinner patent was filed by American inventor James (J.D.) Gragg from Tulsa, Oklahoma, who conceived and invented the original free-spinning spinner in the late 1980s. The American Tru Spinners Wheel Enhancer spinner patent (United States Patent #5,290,094) was issued on March 1, 1994, making it the first free-spinning wheel spinner patent of its kind with foreign patents to follow, Patent(#187,015) issued in October 1997. Gragg has over 80 inventions and has built many versions of spinning wheels including one that spun for over 18 minutes and Triple-Spinner with 27 different spinning mode capabilities. Many imitation versions were made and sold. In 2003, Davin Wheels was issued a U.S. patent #6,554,370 for a non-adaptable spinning wheel only version called the continuous motion wheel.

Introduction to market

American Tru Spinners originally introduced its patented free-spinning wheel spinner in 1994 back when Tru-Spinners were only on an exclusive selected group of "Custom and Concept Cars", this is when Tru-Spinners were first viewed by the public and others saw the concept and then proceeded to pirate the technology. Tru-Spinners is known to be the leader in the field of the "Spinning Wheel Technology" with documented spin tests that stayed in motion for over 18 minutes and also has versions with multiple-spinners that have 27 different spinning mode capabilities. The Tru-Spinner was so popular worldwide that the illegal pirating was on a massive scale and considered to be the largest case of patent infringement in legal history. Over one-million U.S. Patents later, Davin Wheels introduced a non-adaptable wheel only version at the Los Angeles Auto Show. When Davin Wheels was unable to obtain a booth at the Auto Show, they were invited to join another vendor at the show, NBA star Latrell Sprewell's Sprewell Racing. Coincidentally, Sprewell is a Milwaukee native. For this reason, spinners are sometimes also called "Sprewells", although Sprewell has stated that he was not the inventor of Sprewells.

The Rolls-Royce Phantom has anti-spinners — the "RR" logo in the center of the hub is mounted on a spinner with an offset weight designed to ensure that the logo is always the right way up when the car is parked. The hubometers used on large trucks and buses operate basically by this same principle.

Historical

1967 AMC wheel cover with spinner

The term *spinner hubcaps* has been in use since the 1950s, but describes a different item from those used today.

These classic spinner caps feature a rigidly mounted propeller-like center element, usually with two or three projecting "blades", intended to simulate the knock-off hubs that were used on vintage racing vehicles and classic sports cars.

These spinner hubcaps were most often an optional appearance upgrade to the standard equipment hubcaps or full wheel covers that attached to stamped steel wheels.

These hubcaps were the inspiration for a Detroit-area R&B/soul group, The Domingoes, to rename themselves The Spinners in the late 1950s. A second-tier Motown act in the 1960s, the Spinners would go on, in the early 1970s, to score a string of hits in the Philly soul style.

Racing stripe

Cunningham C-4R — a later example of the first race car brand to use the ***Cunningham racing stripes***, which were initially, but briefly called the linesides of the car, also became a popular decoration for "sporty" production vehicles.

The original **racing stripes** were stripes applied to the Cunningham team of racing cars to identify them in the field during races. Another purpose is to make it easier for a driver to align a spun out car with the circuit.

Cunningham racing stripes

The first **racing stripes** were applied to high-performance prototype automobiles built as racecars by Briggs Cunningham and placed into competition as his motorsport team, beginning in 1951. Cunningham racecars usually carried two parallel blue stripes running from front to rear in the center of the white body so that spectators could identify the team's automobiles readily during races. The stripes often were called "Le Mans stripes" because of the repeated efforts of Cunningham to win the 24 Hours of Le Mans in France, where the French had a great affection for him. His tradition was soon adopted by other racing teams in many venues. Thereafter, the use of racing stripes soon became common in the 1960s and early 70s for both race and road cars.

Many automobile manufacturers soon decided that imitation of the Cunningham tradition could be profitable, and some "sportier" models of a manufacturer's range often featured stripes out of the factory (hence the derisive use of the term, *go-faster*). The Cunningham tradition was followed by Carroll Shelby on his Cobra and some prototypes built as "Shelby" that sometimes were driven on the street in New Jersey.

Saab 96 in the classic blue on white colours and format used by Cunningham.

The imitative trend continues—although striping has tended to become more subtle. In North America, owners of performance sport compact cars use a narrower version of the classic striping, similar to that of the Renault Clio Gordini.

Recently the striping was used on the Dodge Viper by Carroll Shelby, starting a revival in Europe, so they are sometimes referred to as *Viper Stripes*.

Purists call them Cunningham racing stripes, although the more generic *American racing stripes* also is used in Europe, because Cunningham epitomized the American motor-sportsman and racing car constructor. For three decades, Briggs Cunningham and his team were well known and extremely popular among spectators and racing professionals at European racing events.

Tradition established

The Cunningham tradition was quickly adopted on other racing cars of the 1950s and 1960s, which also began to have *racing stripes* applied to their paintwork. It had the effect of giving the cars a distinctive appearance on the track and made them easier to identify for spectators and commentators.

In some cases, the stripes were applied asymmetrically and were used to identify on which side of the race car the driver was situated. Applying similar stripes to street cars is thought to give them the appearance of these racing cars, and by association, that the cars themselves had been modified for extra speed, whether or not they really had been. It can be seen as a mild form of car customization.

At times the tradition fades and is revived again.

Go-faster stripes

The humorous term *go-faster stripes,* was used in the *Daily Mirror* comic strip, *The Perishers*, on the premise that go-faster stripes are popular with boy racers. A running gag in the strip had one character selling his slow-witted friend a series of home-made buggies with "go-faster stripes" as a feature.

A typical form of the 'classic' *go-faster stripes* is a pair of parallel stripes in a contrasting color to the main bodywork which is fixed to the hood, roof, and trunk in a continuous run (with breaks for the windscreen and rear window). Other arrangements such as side stripes and stripes which form a loop across the hood, or trunk, and along the sides are seen frequently. The racing car appearance is continued by the application in some cases of competition number panels on the doors, hood, etc.

Chapter 11

Suicide Door

Delahaye Type 135.

A **suicide door** is a car door hinged on the trailing edge, the edge closer to the rear of the vehicle. Such doors are rarely used on vehicles in modern times because of their disadvantages.

Although the term is often used in the custom car trade., it is avoided by major automobile manufacturers, in favour of terms such as "coach doors" (Rolls-Royce), "FlexDoors" (Opel Meriva) "freestyle doors" (Mazda), "rear access doors" (Saturn Ion), and "rear-hinged doors".

Origins of the name

Mazda RX-8 uses clamshell door design to avoid suicide door safety problems.

The origin of the term is unknown. The name reflects the increased danger of the door falling open if it becomes unlatched while the car is moving. The problem arises while driving at high speed: if the door opens even a little, it will catch the fast-moving air like a sail and open, potentially being damaged from the force of the air.

On a conventional car, if the door becomes unlatched, the fast moving air around the car, which is going rearward relative to the car, will outweigh the pressure difference with the interior even when the windows are closed and the venting at the front is open, and hold the door closed. With suicide doors, this pressure difference holds the door open. This danger is compounded if the occupant is not wearing his or her seatbelt. This problem is greatly increased when driving around a bend. Lateral G-force combined with the low-pressure air moving around the car will fling open an unlatched door, and the occupant could be thrown out if not wearing a seatbelt. In reality, this is very unlikely to happen because the locks and latches for suicide doors are built to withstand greater forces than most locks and latches.

Most modern cars with rear suicide doors have front doors which overlap the rear doors so the latter cannot open unless the front door is open, commonly called "clamshell doors". Examples include the Mazda RX-8 sports coupé and the Honda Element. Another safety device is a lock that prevents the rear doors being opened unless the vehicle is stationary, such as used in the Rolls-Royce Phantom and in London cabs. By using this electronic safety, the doors can be opened independently.

Some believe that the name stems from the fact that if, in an emergency, the user exits the vehicle while it is moving forward, the door will hit them upon exit. Others assume the name stems from a weakness inherent to body design. In a heavy, rear-end collision, the lead vehicle has a tendency to fold up (accordion) at its weakest point. This weakest point is assumed to be at the leading edges of suicide doors, just in front of occupants, instead of behind them with conventional doors. This assumption is based on the small amount of structure required to latch, but not needed to support the hinges and weight of the doors.

Still others contend the name originated in the 30s when many depression-era gangsters sometimes used cars with front opening doors that offered little protection in gun battles compared the shielding offered by conventional doors.

History

Fiat 600 Multipla was an example of a car using a combination of suicide and conventional doors

Suicide doors were not uncommon on cars manufactured in the first half of the 20th century. They were especially popular in the gangster era of the 1930s – supposedly because "It's a lot easier to shove somebody out with the wind holding the door open", as Dave Brownell, the former editor of *Hemmings Motor News* stated.

Post-World War II examples are almost universally the rear doors of four-door cars. The most well-known use of suicide doors on post-World War II automobiles was the Lincoln Continental sedan from 1961 through 1969, and on the unique Lincoln Continental four-door convertible from 1961 through 1967 (the last four-door convertible built in the United States prior to the introduction of the 4-door Jeep Wrangler in 2007.) Many people are familiar with a modified version of the 1961 Lincoln model 74A convertible, known as SS-100-X, in that it was the vehicle in which President Kennedy was riding when he was assassinated. Another example of this vehicle can frequently be seen in episodes of the TV show *Green Acres*, as one was owned by the main character, Oliver Douglas. Since the four-door Lincoln convertible did not have a center "B" pillar, the rear door glass was designed to electrically retract a few inches when the rear doors were opened in order for the weather-stripping to clear the front door glass. This meant that if the battery was dead, the only way out of the back seat was to crawl over the front seat.

However in 1956 the Italian automaker Fiat introduced the mini MPV Fiat 600 Multipla and later in 1963 the Spanish automaker SEAT launched the city car SEAT 800, which were both models four-door cars featuring front only suicide doors and rear doors with a conventional opening. This combination of both conventional (rear) and suicide (front) doors simply meant that all four doors were attached to the B-pillars of the car.

Modern use

A Lincoln concept car reusing classic "suicide door" styling first seen in 1961. Note total lack of B-pillar.

For a time, the last true, independently opening suicide doors on a mass produced car were fitted on the Ford Thunderbird four-door sedan from 1967 through 1971. The 1971 model was the last American production automobile to feature rear suicide doors, because after this time, safety concerns prevented their use. More recently, rear suicide doors that cannot be opened until the regular front doors are opened have been appearing on a number of vehicles, including extended cab pickup trucks, the 2nd generation Saturn SC, the Saturn Ion QuadCoupe, the Honda Element, the Toyota FJ Cruiser, and the Mazda RX-8. In 2003, true independent suicide doors reappeared, this time on the new Rolls-Royce Phantom. The Spyker D12 officially presented in 2006 also has suicide doors. The Rolls-Royce Phantom Drophead Coupe four-seat convertible, based on the 100EX show car also has suicide front doors.

Rear passenger suicide doors had been a constant feature of Hackney carriages, otherwise known as Black (London) Cabs. However, with the replacement of the Austin FX4 by the new TX models, suicide doors were replaced with standard hinged doors.

Suicide doors are used on the Carbon Motors Corporation E7 concept car, a purpose built police vehicle and features rear suicide doors to help officers get handcuffed individuals in and out of the back seat.

Advantages

- Rear-hinged doors make entering and exiting the vehicle much easier. The occupant can enter in a natural way, walking forward toward the vehicle and turning to sit, and then can exit by stepping forward out of the vehicle.
- Rear-hinged back doors (in combination with front-hinged front doors) make exiting easier for the driver, who can then reach the handle of the back door to open it for the passenger. Austin FX4 taxi drivers were able to reach the rear door handle through the driver's window without getting out of the vehicle.

Disadvantages

- Conventionally hinged doors in front and suicide doors in the back make it difficult for passengers to exit from the front and rear seats simultaneously due to the limited space between the front edge of the rear door and the rear edge of the front door.
- If the user exits the vehicle while it is moving forward, the door will hit him or her upon exit.
- Although a latch or lock usually ensures the door remains securely closed, human error can prevail. *Consumer Reports* reported in 1969 that the door on a Subaru 360 they were testing opened into the wind while driving with the door partially latched.

Models

Lloyd LT 600 van with a front suicide door.

Examples of models with suicide doors include those from Austin (Princess Limousine, FX4), Citroën (2CV, Traction Avant), Fiat (500, 600, 1100), Ford (F-150 SuperCab, Thunderbird), Lincoln (Continental, Cosmopolitan, Saab (92, 93, 95), and Saturn (SC1, SC2, Ion).

Chapter 12

Sunroof

A sliding glass moonroof on an Acura Integra

An automotive **sunroof** is a fixed or operable (venting or sliding) opening in an automobile roof which allows light and/or fresh air to enter the passenger compartment.

Sunroofs may be manually operated or motor driven, and are available in many shapes, sizes and styles.

Sunroofs, by historical definition are opaque and slide open to allow sunshine and fresh air into the passenger compartment. Today, most factory sliding sunroof options feature a glass panel and are sometimes marketed as **moonroofs,** a term introduced in 1973 by John Atkinson, a marketing manager at Ford for the Lincoln Continental Mark IV. For the first year, Ford sent out its Mark IVs to American Sunroof Company for offline installation.

Variations of both the sunroof and moonroof have become the norm in both factory installed and aftermarket offerings, creating a wide range of features and choices.

Sunroof systems may be manual or electric, while most moonroof systems are electric/electronic. Manual sunroofs may be lever actuated, as in venting type pop-ups, manual lever or crank operated for sliding systems. Electric roof systems are usually cable driven by a motor and feature some form of sliding opening. Most moonroof systems today are electric and have either a combination pop-up/inbuilt or a pop-up/spoiler configuration.

Roof systems may be original equipment, factory installed options (provided by the car company), or installed aftermarket by a roof installation professional for the car dealer or retail customer. Once the vehicle leaves the assembly line, the factory option can no longer be integrated into the roof, making aftermarket the only option.

Sunroof Types

Roof systems are available in many shapes, sizes and styles, and are known by many names. The generally accepted sunroof/moonroof industry terms are as follows:

- ***Pop-up*** sunroofs are simply a manually-operated tilting panel. These panels are usually removable, and like T-roofs, must be stored when removed. The tilting action provides a vent in the roof, or a full opening when the panel is removed. Pop-ups can be installed in most vehicles, and are relatively inexpensive. Familiar examples include metal panels in Porsche 944, early Mazda RX-7 and many glass panel factory and aftermarket installations.

- ***Spoiler*** sunroofs (*tilt-&-slide*s) combine the features of a pop-up with those of a sliding roof system. They tilt to vent and slide open above the roof, requiring little headroom or roof length. Spoilers typically do not provide as large an opening as other roof systems, but offer the convenience of a self-storing panel. Most spoiler roofs are electric, with optional features like integrated sun shades and express open/close. Spoilers are ideal for short-roof vehicles where other types of sliders can't be installed. Familiar examples include Honda CRX, Saturn SC and Mazda RX-8.

- ***Inbuilt*** sunroof systems have a panel which slides between the metal roof and interior headliner, requiring some loss of headroom but providing a full opening in the roof. All inbuilts slide inside the roof, while some also include a rear venting feature, and/or express open/close functions. Inbuilts don't fit every vehicle, as the panel must slide and store completely within the vehicle roof. Historically, inbuilts were a metal sunroof panel painted to match the vehicle roof, but now most are glass-panel systems with sliding sunshades (typically referred to as moonroofs).

- ***Folding*** sunroofs (often called rag-tops or cabrio coach) are a European tradition. They offer the convenience of a sunroof, with an opening more like a convertible. The panel is made of fabric (often vinyl), which folds back as it slides open. After a long absence in European and North American Markets, folding sunroofs have experienced a resurgence with several new factory-installed options. Aftermarket versions were once only manual, but now are also available in powered versions. Familiar examples include the original VW Beetle, Renault Twingo and Jeep Liberty.

- ***Top-mount*** sliding sunroofs (rail mount topslider) have been a popular factory option in Europe for many years. A large glass panel slides open in tracks on top of the roof, with no loss of headroom. Most feature an integral wind deflector to eliminate wind noise. Examples include Donmar's original Skyroof topslider (aftermarket system), the London Taxi and Renault 5 cars.

- ***Panoramic roof systems*** are a new type of large or multi-panel moonroof which offer openings above both the front and rear seats and may be operable or fixed glass panels. Large operable openings are often accomplished with top-slider (tracks in the top of the roof) or spoiler type mechanisms. Familiar examples include the Acura ZDX, Lexus ES, BMW Mini, Scion tC, Pontiac G6, Ford Flex, and Cadillac SRX.

- ***Removable roof panels*** (T-tops or targa roofs) open a vehicle roof to the side windows, providing a wider opening than other roof systems. T-roofs have two removable panels and leave a T-shaped structural brace in the roof center. Targa roofs include only one (opaque or transparent) panel and leave no cross brace. Aftermarket kits are no longer made, but several companies sell replacement and remanufactured panels, parts and accessories. Familiar examples include Pontiac Firebird, Chevrolet Corvette and Porsche 914.

Aftermarket Pop-up (Sunmate Pop-Up)

Aftermarket Spoiler (Skyroof LSS Spoiler)

Folding Sunroof in a VW Beetle

Inbuilt (Moonroof) in Chevy Blazer

Aftermarket Top-mount slider (Skyroof II Topslider)

Panoramic roof in a BMW Mini

T-Tops in Pontiac TransAm

The panoramic roof of a Pontiac G6

- ***Electric vs. Electronic*** Motorized power roof systems may be operated by a simple push-and-hold switch, or may include an electronic control module (ECM) to provide single-touch express opening, express closing and/or auto-closing on ignition off.

- ***Solar sunroof*** Solar sunroofs actually are made of glass, which unlike the proper moonroof terminology standards have an inlaid photovoltaic solar insert, or solar panel, making the glass totally opaque (thus allowing the proper term 'sunroof'). While they operate identically to conventional factory-fitted glass moonroofs (tilting and retracting), the solar panel provides electricity to power the interior ventilation fans, for cooling the car interior on hot days when the car is standing outside in the sunlight. These are available as a factory option on the 2010 Prius, recent Audi cars, Renault Zoé, and also were available on some versions of the Mazda Millennia.