The Elmer A. Sperry Award for 1978

. . . for Advancing the Art of Transportation

The Elmer A. Sperry Medal

Purpose of the Award

The Elmer A. Sperry Award shall be given in recognition of a distinguished engineering contribution which, through application, proved in actual service, has advanced the art of transportation whether by land, sea or air.

In the words of Edmondo Quattrocchi, the Sculptor of the Elmer A. Sperry Medal:

"This Sperry medal symbolizes the struggle of man's mind against the forces of nature. The horse represents the primitive state of uncontrolled power. This, as suggested by the clouds and celestial fragments, is essentially the same in all the elements. The Gyroscope, superimposed on these, represents the bringing of this power under control of man's purposes."

Presentation of

The Elmer A. Sperry Award for 1978

To Robert Puiseux

with Citation to

The Employees of the Manufacture Francaise des Pneumatiques Michelin

By

The Board of Award under the sponsorship of

The American Society of Mechanical Engineers
Institute of Electrical and Electronics Engineers
Society of Automotive Engineers
The Society of Naval Architects and Marine Engineers
American Institute of Aeronautics and Astronautics

At the Passenger Car Meeting of the Society of Automotive Engineers
Wednesday, June 13, 1979 Hyatt Regency, Dearborn, Michigan


Elmer Ambrose Sperry 1860-1930

Founding of the Award

The Elmer A. Sperry Award commemorates the life and achievements of Dr. Elmer A. Sperry (1860-1930) by seeking to encourage progress in the engineering of transportation. Much of the great scope of the inventiveness of Dr. Sperry contributed either directly or indirectly to advancement of the art of transportaton. His contributions have been factors of improvement of movement of men and goods by land, sea and air.

The award was established in 1955 by Dr. Sperry's daughter, Mrs. Robert Brooke Lea, and his son, Elmer A. Sperry, Jr.

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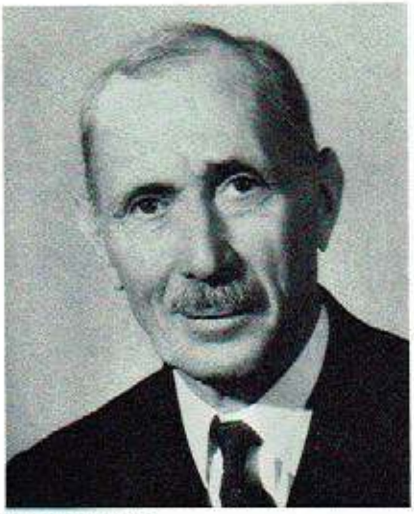


Robert Puiseux

Award Citation

To Robert Puiseux for his leadership in the development of the radial tire.

Certificate of Citation

To the employees of the Manufacture Francais des Pneumatiques Michelin for their contributions to the design, development and application of the radial tire.

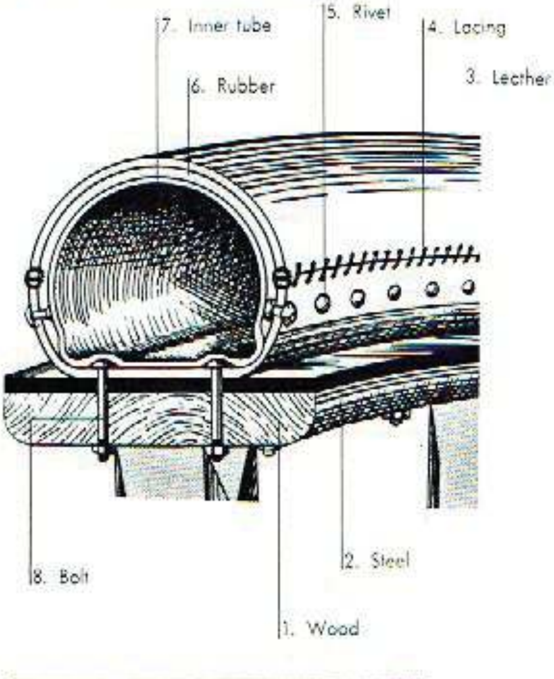
Introduction

The general principle of construction, to which the name of "aerial wheel" was given, was discovered in 1845 by R.W. THOMSON, an English engineer. He reached his goal only five years after GOODYEAR developed the process of vulcanization of rubber in 1840.

His patent, filed in England in 1845, in France in 1846, and in the U.S. in 1847, covers the essential features of the pneumatic tire as it is known today (Figure 1).

An ancestor of the pneumatic tire, the "aerial wheel" was not immediately adopted for equipping the vehicles of that era. Admittedly, as applied by Thomson to automobiles without any springs, its introduction was a failure, in spite of the existence of high quality vulcanized rubber. And it was with solid tires that the first automobiles, trucks and buses were equipped.

Figure 1: Thomson's Pneumatic Tire



The Beginnings of the Pneumatic Tire

During the last quarter of the 19th century, the development of the safety bicycle, driven by a chain, drew the attention of numerous inventors. The pneumatic tire permitted this form of locomotion to develop at an overwhelming pace.

The first pneumatic tire for cycles was manufactured in 1888 by John B. DUNLOP. Although the principle utilized was comparable to that of THOMSON, it was nonetheless original because of the use of crossed strips of fabric in its construction. This tire was composed of a tube covered with rubberized fabric, glued to the rim, in such manner that each flat tire took on overtones of a catastrophe.

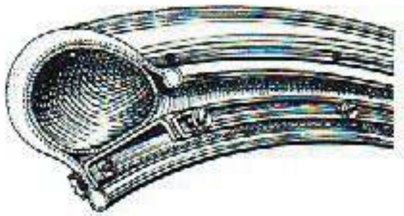
The demounting, repair, resewing and remounting of this assembly of gum and glued fabric were delicate and laborious operations requiring much time and skill. And the repaired tire had to be allowed long hours of drying time.

In spite of real advantages, the key to the development of the tire was the possibility of repairing and changing it rapidly in case of necessity. This is what the MICHELIN brothers recognized and were able to realize by filing a series of patents which ended in 1891 with the creation of the first demountable tire (Figure 2). The air chamber was independent of the casing, which, itself was not permanently fixed but held on the rim by bolts.

The Evolution of the Tire

In 1895, the MICHELIN brothers equipped, for the first time, an automobile with pneumatic tires. The tire was no longer bolted to the rim. The beads were inserted in hook-shaped rim flanges which matched the hook-shape of the beads, thus utilizing a system discovered and patented in 1892 by a German law student (Figure 3).

Figure 2: The demountable MICHELIN tire



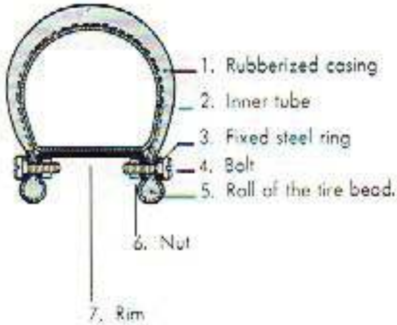
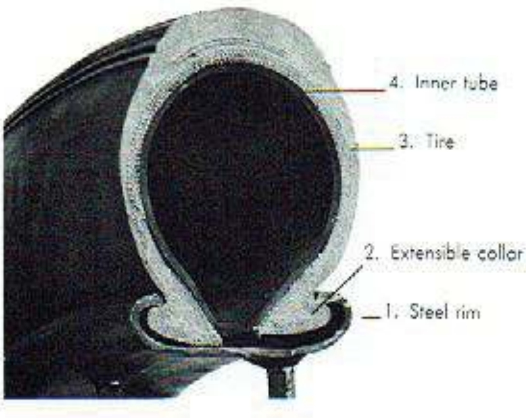


Figure 3: "Clincher" tire for automobile



In 1905, perfecting a system that had been in use for two years, Edouard and André MICHELIN created a tire protected by a rivetted leather belt. This was the famous "MICHELIN SOLE". Originally intending to combat skidding (the tires of the era had no tread design and the roads were often muddy before the general use of asphalt surfacing), it considerably prolonged the life of the tire and protected it against flats. One proof of its quality was given when it was used on an 8-cylinder, 12-liter DARRACQ automobile at a speed of 105 mph.

With the appearance of trucks and buses, which were heavily loaded, MICHELIN introduced the "dual" tire in 1908. In 1914, the demountable steel wheel was introduced, a concept still used today. The hub remains an integral part of the axle on the automobile and the mounted tire and wheel assembly is placed on it and attached to it with nuts.

In a few years, the requirements for rapid demounting and replacement helped design a product very similar to the modern tire. The tubular tire gave way everywhere, except for bicycles and some trucks, to a system of a tube contained within a removable tire.

As for the tires themselves, the innumerable types tried led quickly to the clincher type and to the steel bead wire type originated in the U.S.A., mounted on a flat rim, that became the predominant style shortly after 1920.

During World War I and the following years, the circumstances of the time and the tastes of the user, in conjunction with the development of automobile transportation, brought considerable improvement in tire design. Progress was made in comfort and traction, parallel with the upgrading of the road system.

MICHELIN'S answer to the recent change was the introduction in 1923 of the "CONFORT BIBENDUM" assembly, very much like the modern bias tire (Figure 4).

Figure 4: The "Confort Bibendum"

1. Flat rim opposite the valve
2. Valve nut
3. Hard rubber insert filling the well of the rim in order to avoid separation of the tire from the rim during use.
4. Grooved rim, valve side, in order to permit the mounting of the envelope.
5. Non-expandable bead wire

The Birth of the Radial

It was at this time that the in-depth study of the functioning problems of tires intensified and the resulting experience made way for the radial tire concept. Researchers were concerned with the dynamic instability of vehicles in motion, so they started to experimentally establish a theory of "road-holding". According to the theory:

"A vehicle is stable in its path if the resistance of the rear tires to the lateral thrust is greater than that of its front tires. It is unstable in the reverse case."

For more than ten years, the reinforcement layers of the tire casing had consisted of cotton strands placed side-by-side. Several layers crossed over one another, from one bead wire to the other, according to a technique still in use and known as "bias construction".

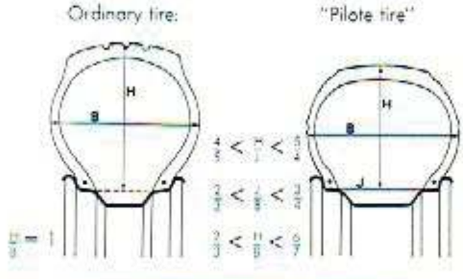
Among the parameters which influence road-holding, it was observed that the angle at which the different layers crossed one another was of considerable importance. Simply stated, it can be said that the best road-handling results are obtained from a small bias angle but at the price of great difficulty in production, due to the increased length of the strands. Furthermore, there were other limitations like the lack of comfort and the availability of adequate reinforcing materials.

However, if one does not succeed in obtaining in this manner the ideal in road-holding, one could go to the other extreme, and it was thus, as an experiment, that the first radial tires were constructed. They were composed of cables placed perpendicular to the bead wire. This eliminated the stabilization feature which a peripheral belt could have provided. This design was totally devoid of road-holding characteristics, and remained a "school exercise", without practical development.

In the meantime, MICHELIN went ahead in the production of bias tires introducing in 1937 the "PILOTE" tire. Mounted on a wide rim, this tire for the first time had a height-to-width ratio (aspect ratio) of less than 1 (Figure 5). The PILOTE incorporated the new "Zig-Zag" tread design with anti-skid sipes – which although subsequently improved – are still in use today. For its time, the PILOTE had a remarkably high level of road-holding ability.

Similar efforts were being made almost everywhere in the world to combine better comfort, road-holding ability, traction and endurance, and at the same time to increase wear and road hazard resistance.

Figure 5: The "Pilote"



The appearance of new materials, such as synthetic rubbers, carbon black and synthetic textiles, contributed greatly to the growing expertise acquired by tire manufacturers.

At Michelin, the search for higher-performance materials was oriented toward a particularly original route: the use of steel cords. In 1937, the "Metalic", a steel reinforced tire came out. It was capable of bearing very heavy loads, and it had excellent heat-resistance qualities due to the low number of plies in its carcass (2 or 4) permitting dramatic reduction in the number of blow-outs then so frequent on long trips. But above all, the combination of rubber and steel, created after a dozen years of research, as well as high-precision manufacturing technology attained at this time, made a considerable contribution to the development of the radial tire.

World War II disrupted or stopped many activities in the company, but the research activity continued. Seeking to reduce internal friction that causes energy losses and destructive heat build-up, and to improve road-handling, a series of experimental tires was constructed. One of them, under its tread, featured a belt composed of several steel cord plies, crossing at a slight angle. Such a design gave to the crown a high level of rigidity.

This rigid crown design was first tested on a bias casing, the only one at that time available. The result was not encouraging, the new tire being definitely too stiff. So it was decided to try a radial casing, resuming the experimentation of the radial concept studied earlier. The test soon revealed that this combination allowed the crown and the casing to work quasi-independently, givng the tire road-handling abilities far greater than previously achieved. In addition, the crown stabilized by the belt reduced tread squirm and dramatically improved tire resistance to wear.

This new assembly was original enough to look like a bird cage, the radial plies representing the bars and the crown the roof. But the bars were so close to each other that the researchers called it a fly cage or, in French, a "cage à mouche" abbreviated: CAM (Figure 6).

The patent for the radial tire was filed in France on June 4, 1946, but there was still much to do. A decision was made to concentrate all of the efforts on development and manufacture of the materials necessary for production. This was a management decision and a tribute must be paid to those involved, primarily Robert PUISEUX.

Such a radical change, of course, demanded a firm commitment to face the new requirements:

- to reach an unknown degree of production precision to make tires without lateral pull and consequently develop, economically, a new level of systematic quality assurance.
- to initiate a new sales policy to check the market resistance to such a long-life tire; to advocate the mounting of the same type of tires on one axle, and preferably on one vehicle; to market a more expensive product with outstanding handling performance thus creating a new standard and a new class of tires.
- to show to the car manufacturers, at first reserved but generally enthusiastic after a few tests, the benefit of the change and gain their acceptance.

Figure 6: The CAM tire

In early 1948, only a few sets of tires were available and in June 1948, real sales began. The new tire was called "X".

Complete tire lines had to be developed for passenger cars, light and heavy trucks, and earthmoving machines, in the midst of a rapidly expanding motor industry and changing as well as growing conditions of use. Around the world, every tire manufacturer, faced with approximately the same alternatives, reacted according to their traditions, their market and their means.

While MICHELIN, followed by some, mainly used steel as the reinforcement material, they also developed different fabrics, such as rayon, for use in passenger car and agriculture tires.

Recent evolution of high-module fibers, such as glass and aramids, have introduced since then new possibilities for deversification and progress.

The Radial Technique

The classic tire, which is also called diagonal, conventional, or bias, is composed of an assembly of textile layers, superimposed at a given angle. The number of plies, and therefore the thickness of the carcass, increases with the load to be borne (Figure 7).

Figure 7: Bias Tire

While in motion, this construction is the source of internal friction generating a high degree of heat which is damaging to the integrity and the fatigue life of the tire and also increases the rate of fuel consumption.

The sidewalls of such a tire cannot flex freely under the load. The result is imperfect tread contact with the ground and a squirm in the contact area leading to rapid and irregular wear as the most noticeable consequence.

The progress achieved these last few years has permitted notable improvements: stronger fabrics permitting the reduction of the number of plies, and synthetic rubbers strengthening the resistance to various adverse conditions. But if the conventional construction still gives good results in certain very particular applications, in a general sense it has been surpassed and made obsolete in most current applications.

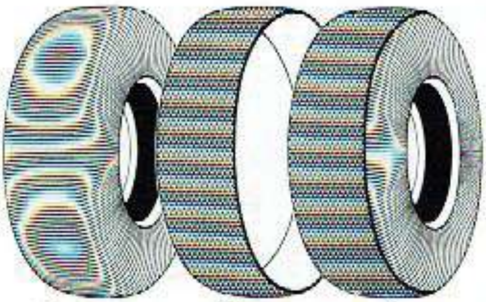
In the radial tire (Figure 8), the cords

Figure 8: MICHELIN X Tire

of the casing run archwise radially from bead to bead. These cords may consist of textiles, natural or synthetic fibers, or steel. In most cases, only one casing ply is necessary. Usually one finds in passenger car tires one (or two) plies, generally rayon but possibly nylon or polyester; in truck tires and up to the largest of the earthmoving tires, one finds only a single ply of steel cord. These cords flex under the load and cushion the irregularities of the terrain. The casing is belted by several plies of cords placed at different angles, which reinforce and stabilize the tread.

The belt, that has great transversal rigidity and great radial flexibility, is also very resistant to local deformation, permitting the tread to roll like the track of a tank. In relation to the intended application, the construction can vary markedly. In this manner, each part of the radial tire, sidewalls and tread, works independently of each other with a minimum of interference, and fulfills its specific function (Figure 9).

Figure 9.



1. Radial casing with cords running archwise from bead to bead.
2. Belt composed of several plies of steel cords.
3. Assembly of radial casing and belt.

The advantages of the radial technique are considerable. With such a construction, experience has shown that it is possible to:

- dissociate the functions of the sidewalls and the tread;
- do away with friction between plies;
- reduce to a minimum the squirm in the contact patch.

The consequences are no less remarkable:

- increased mileage, at least twice as much as the bias tire;
- improved traction, by structural change and not just tread design change;
- increased straightline stability;
- reduced heat build-up in the tire, therefore longer life for the material and better retreadability;
- decreased fuel consumption since the tire absorbs less energy;
- improved comfort and protection of the vehicle, the casing having greater vertical flexibility.

Over the years, by upgrading the quality of basic materials, by perfecting manufacturing processes, or by refinements in construction and design, MICHELIN has incessantly sought to develop the possibilities of the radial technique and to enlarge the field of its application. The aim was a diversification of the products in order to satisfy all categories of users.

The X tire , for passenger cars, is the oldest of the generation which has undergone spectacular development. The ZX and the XZX followed it. As of 1965 the XAS, with an asymmetrical structure and tread, was offered to demanding users of fast cars. It has been followed by the XVS, the XWX and the XDX.

Radial tires have now been included in international standards, such as ETRTO (European Tyre and Rim Technical Organization) TRA (Tire and Rim Association) and ISO (International Organization for Standards). The U.S. Department of Transportation took the radial tire into consideration in Standards 109 and 110.

The radial has shown advantages which are even more perceptible in the area of equipping trucks and earthmoving machines. The diversity of situations, vehicles, users and assignments has led to different types of tires being created, assuring in all circumstances, a maximum, of profitability and reliability. Without enumerating all of them it appears useful to emphasize the spectacular advantages obtained in rapid long distance transportation, as well as in off-the-road operations on yielding terrain, such as mud and sand.

Subways equipped with tires likewise benefit from the radial technique. It was in Paris in 1951 that the Metro rolled on tires for the first time. These tires were of the bias ply "Metalic" type. But since then, in Montreal, Mexico City, Santiago-de-Chile, Marseilles, Lyons, Tokyo, and of course, Paris, the radial has been introduced, bringing considerable progress in energy saving, endurance, comfort, weight reduction, and economy.

The latest born of the radial car tire family is the TRX. The TRX benefits from the latest advances in radial construction, made possible by the adoption of a rim profile which was specially studied (TR profile). These advances are particularly effective when the new construction is combined with the adoption of a low aspect ratio (on the order of 0.60).

Mounted on these special-profile rims, with a seat diameter increased for an identical exterior tire diameter, it makes available more space to house the braking system.

Manufacture of the Tire (Figure 10)

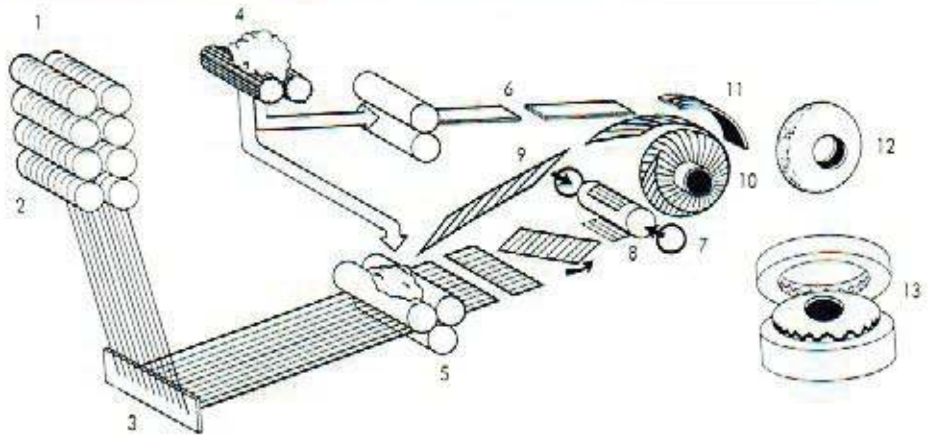


Figure 10.

1. Steel or textile cords
2. Cord spools
3. The cords are gathered into plies
4. Rubber, carbon black, chemicals
5. Calendering: coating the parallel cords with rubber
6. Cutting
7. Beads
8. The plies form a sleeve, built on an expandable cylinder
9. Steel belt plies
10. The sleeve is expanded to a toroidal casing
11. The casing is covered with rubber parts and tread
12. Raw tire
13. Cured tire

Market Penetration of the Tire ("Radialization")

Western Europe – U.S.A. (Figure 11)
Beginning in France, the radial technique has spread rapidly in Europe and it is becoming widespread throughout the entire world today. By 1975, the radail tire was equipping 86% of passenger cars, 71% of light trucks and 79% of heavy trucks in Western Europe and almost 100% of all autos and trucks in France.

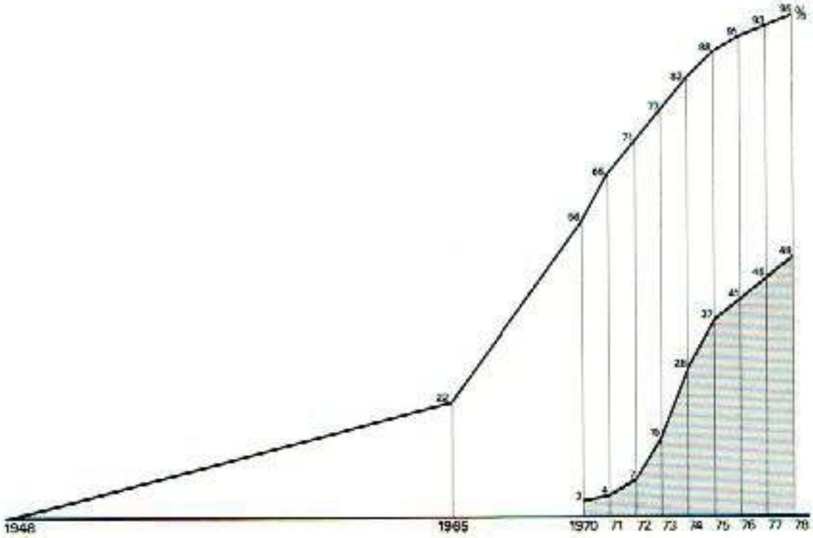
In the United States the radialization of the auto market was insignificant in the early 70's. Today, however, the rate of radialization has just passed 40 percent in the replacement market and exceeds 70% in the original equipment market. Parallel evolution is seen in the truck tire market, slowed only by the huge investments required for the manufacturing of radial tires. Bias tires are keeping several solid positions, particularly when it comes to the equipment of specific types of machines.

MICHELIN, the pioneer in radials, is still first in worldwide production of radial tires with more than 75 million units made in 1977.
All tire manufacturers are now producing radial tires. Some of them have attempted new approaches by using belt materials other than steel, rayon or glass, for example.

The general spread of this advanced-technology tire permits the realization of precious economies of materials, as well as the reduction of fuel consumption in automotive vehicles. In return, it requires more sophisticated and expensive tooling, more precise methods and more rigorous quality control at all stages of production.

Through it, the tire has become the most characteristic example of a mass-consumption article produced through refined techniques.

Figure 11: Radialization of passenger cars



Robert Puiseux

Robert Puiseux was born on March 1, 1892 in Paris, France. He attended school at the Lycee, St. Louis, majoring in mathematics. His education was interrupted by World War I in which he served as a lieutenant and artillery observer. In 1919, he joined Michelin and initially his responsibilities included quality control, research, and testing. He assumed greater responsibilities until in 1938 he was elected to the position of co-gerant serving in that capacity until 1950, at which time he assumed the position of gerant, holding that office until his retirement in 1959.

For several years during this period he also served as Chairman Societe des Automobiles Citroen. Since his retirement he has continued to serve Michelin as a Member of the Conseil de Surveillance of the Campagnie General des Establissements Michelin.

Previous Elmer A. Sperry Awards

1955 to *William Francis Gibbs* and his Associates for development of the S.S. United States.

1956 to *Donald W. Douglas* and his Associates for the DC series of air transport planes.

1957 to *Harold L. Hamilton, Richard M. Dilworth* and *Eugene W. Kettering* and Citation to their Associates for the diesel-electric locomotive.

1958 to *Ferdinand Porsche* (in memoriam) and *Heinz Nordhoff* and Citation to their Associates for development of the Volkswagon automobile.

1959 to *Sir Geoffrey De Havilland, Major Frank B. Halford* (in memoriam) and *Charles C. Walker* and Citation to their Associates for the first jet-powered aircraft and engines.

1960 to *Frederick Darcy Braddon* and Citation to the Engineering Department of the Marine Division, *Sperry Gyroscope Company*, for the three-axis gyro-scopic navigational reference.

1961 to *Robert Gilmore Letourneau* and Citation to the Research and Development Division, *Firestone Tire and Rubber Company*, for high speed, large capacity, earth moving equipment and giant size tires.

1962 to *Lloyd J. Hibbard* for application of the ingitron rectifier to railroad motive power.

1963 to *Earl A. Thompson* and Citation to his Associates for design and development of the first notably successful automobile transmission.

1964 to *Igor Sikorsky* and *Michael E. Gluhareff* and Citation to the Engineering Department of the Sikorsky Aircraft Division, *United Aircraft Corporation*, for the invention and development of the high-lift helicopter leading to the Skycrane.

1965 to *Maynard L. Pennell, Richard L. Rouzie, John E. Steiner, William H. Cook* and *Richard L. Loesch, Jr.* and Citation to the Commercial Airplane Division, *The Boeing Company*, for the concept, design, development, production and practical application of the family of jet transports exemplified by the 707, 720, and 727.

1966 to *Hideo Shima, Matsutaro Fujii* and *Shigenari Oishi* and Citation to the *Japanese National Railways* for the design, development and construction of the New Tokaido Line with its many important advances in railroad transportation.

1967 to *Edward R. Dye* (in memoriam), *Hugh DeHaven* and *Robert A. Wolf* and Citation to the research engineers of *Cornell Aeronautical Laboratory* and the staff of the Crash Injury Research projects of the *Cornell University Medical College*.

1968 to *Christopher S. Cockerell* and *Richard Stanton-Jones* and Citation to the men and women of the *British Hovercraft Corporation* for the design, construction and application of a family of commerically useful Hovercraft.

1969 to *Douglas C. MacMillian, M. Neilsen* and *Edward L. Teale, Jr.* and Citations to Wilbert C. Gumprich and the organizations of *George G. Sharp, Inc., Babcock and Wilcox Company*, and the *New York Shipbuilding Corporation*, for the design and construction of the N.S. Savannah, the first nuclear ship with reactor, to be operated for commericial purposes.

1970 to *Charles Stark Draper* and Citations to the personnel of the *MIT Instrumentation Laboratories*: Delco Electronics Division, *General Motors Corporation*, and Aero Products Division, *Litton Systems*, for the successful application of inertial guidance systems to commercial air navigation.

1971 to *Sedgwick N. Wight* (in memoriam), and *George W. Baughman* and Citations to William D. Hailes, Lloyd V. Lewis, Clarence S. Snavely, Herbert A. Wallace, and the employees of *General Railway Signal Company*, and the Signal & Communications Division, *Westinghouse Air Brake Company*, for development of Centralized Traffic Control on railways.

1972 to *Leonard S. Hobbs* and *Perry W. Pratt* and the dedicated engineers of the Pratt & Whitney Aircraft Division of *United Aircraft Corporation* for the design and development of the JT-3 turbo jet engine.

1975 to *Jerome L. Goldman*, *Frank A. Nemec* and *James J. Henry* and Citations to the naval architects and marine engineers of *Friede and Goldman, Inc.*, and *Alfred W. Schwendtner* for revolutionizing marine cargo transport through the design and development of barge carrying general cargo vessels.

1977 to *Clifford L. Eastburg* and *Harley J. Urbach* and Citations to the Railroad Engineering Department of *The Timken Company* for the development, subsequent improvement, manufacture and application of tapered roller bearings for railroad and industrial uses.


FOR ADVANCING THE ART OF TRANSPORTATION
LEONARD S. HOBBS
1972