THE ELMER A. SPERRY AWARD FOR 1977

...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 1977

to

Clifford L. Eastburg

Harley J. Urbach

with Citation to

The Railroad Engineering Department
of The Timken Company

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 Honors Assembly of the ASME

Wednesday, November 30, 1977 □ Hyatt Regency Atlanta □ Atlanta, Georgia

Founding of the Award

Elmer Ambrose Sperry 1860-1930

☐ 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 transportation. 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.

The 1977 Elmer A. Sperry Board of Award

FRANK G. FISHER — TERRENCE SECORD
The American Society of Mechanical Engineers

WILLIAM C. HITTINGER — RICHARD D. THORNTON
Institute of Electric and Electronics Engineers

L.V. HONSINGER, *Vice Chairman* — ROBERT P. GIBLON
The Society of Naval Architects and Marine Engineers

JOHN D. CAPLAN — JAMES E. FINK
Society of Automotive Engineers

WELKO GASICH, *Chairman* — ROBERT W. RUMMEL
American Institute of Aeronautics and Astronautics

Honorary Members

PRESTON R. BASSETT
GEORGE W. BAUGHMAN
NORMAN E. CARLSON
C. STARK DRAPER
LUDWIG C. HOFFMAN
GEORGE J. HUEBNER, JR.
WILLIAM JACOBSEN
SPERRY LEA
ROBERT B. ORMSBY
THOMAS O. PAINE
HARRY W. PIERCE
LEONARD RAYMOND
GLENN B. WARREN
WILLIAM N. ZIPPLER

Clifford L. Eastburg

Harley J. Urbach

Award Citations

☐To Clifford L. Eastburg and Harley J. Urbach for their leadership in the original development, subsequent improvement, manufacture, and application of tapered roller bearings for railroad and industrial uses.

Certificate of Citation

☐To the Railroad Engineering Department of the Timken Company for their contributions to the development, improvement, manufacture and application of tapered roller bearings to railroad and industrial uses.

☐ The economic and industrial growth of America in many ways parallels the growth and development of the railroad. In the 1800's our capacity for westward expansion was determined by the availability and accessibility of rail transportation.

As our industrial station and economic capabilities expanded, our technological sophistication evolved to meet the challenges of a burgeoning economy. The role that the railroad industry played in contributing to that economic development makes our current history reflective of our past.

Clifford L. Eastburg and Harley J. Urbach, have been instrumental in the development, improvement, manufacture, and application of tapered roller bearings to railroad and industrial uses; technological advances which represent significant events in the evolution of the railroad industry in America.

The Timken "AP" Bearing

Figure 1. The First Timken Roller Bearing Equipped Box Car Placed in Service in 1923.

☐ The Timken "AP" (All-Purpose) bearing was first placed in service on American railroads in August of 1954. For 23 years it has provided the railroad industry a means of reducing train delays and derailments by reducing hot boxes. Roller bearings have been used on railroad equipment for over 50 years. Shown in Figure 1 is a box car that was placed in service in 1923. Although the state of the art was continually advanced from that early start, the introduction of the "AP" bearing was the real turning point for the adoption of roller bearings for freight cars.

First costs of acquisition, handling, and installation of the roller bearing made it difficult to justify its use in place of friction journal bearings when building new or rebuilding freight cars, particularly those used in railroad interchange service.

Although difficult to justify the cost of roller bearings for freight cars, adoption of them on passenger cars was more easily accepted because the owner benefited directly.

Railroad Development

☐ Clifford L. Eastburg was hired by The Timken Company in September, 1927 because of his experience in the railroad car building industry where he had worked for the Bettendorf Corporation. He was first employed as an Industrial Engineer in the Railroad Division.

Eastburg's work consisted of the design and application of roller bearings to freight cars, steam locomotives, and passenger cars. Most of his time in the early days was spent on steam locomotive applications which, like passenger cars, needed the reliability of roller bearings. Their cost would provide a good return on investment to the owner.

As might be expected, roller bearings for locomotives were not immediately accepted without question. They had to be proven. This led the company to purchase from American Locomotive Works, the first steam locomotive fully equipped, on all axles, with roller bearings. Eastburg designed the bearing applications that were used on this locomotive. This locomotive, shown in Figure 2, was loaned to many railroads for demonstrations. It successfully convinced railroad administrations of the advantages of roller bearings. Later, in 1934, roller bearings were applied to crosshead and all crank pins of a steam locomotive.

Eastburg was involved in most of these steam locomotive designs and developments. Concurrently, freight car application of roller bearings was also the subject of intense study.

An experimental application of roller bearings was made in 1930 to 100 70-Ton hopper cars which were tested on the Pennsylvania Railroad, including complete dynamometer tests. The experimental roller bearing trucks were completely designed, developed, and supplied by The Timken Company. These were the first tests ever made on a complete freight train equipped with roller bearings. The results clearly demonstrated the advantages of roller bearings for freight cars.

The adoption of roller bearings for freight cars in North America faced the difficult obstacle of interchange service. In North America there were many privately owned railroads operating under the standards of the Association of American Railroads (AAR). These railroads freely exchange or interchange freight cars from one line to another. Roller bearings represented a high initial cost compared with friction bearings. With the interchange of cars from one railroad to another, the owning railroad would not realize the full benefit (lower operating and maintenance costs) of such an investment. Also, the early housing type roller bearing applications required separate spare axle assemblies for each different type of truck side frame, thus complicating maintenance.

The first applications of roller bearings were made to freight cars which did not leave the owner's line. This way the owner was able to realize the full return on investment.

Because of their success, roller bearings became standard equipment on passenger cars as well as diesel and electric road locomotives, which eventually replaced the steam locomotive. Also, approximately 10,000 car sets of housing type roller bearings were applied to freight cars into the 1950's.

While the obstacle of justifying cost of roller bearings on freight cars remained; the poor performance of the friction bearings continued to be responsible for large expenses from hot boxes which may lead to derailments and excessive maintenance.

It was against this background of unacceptance of roller bearings for freight cars that Clifford Eastburg was working to develop an acceptance breakthrough. He was now Assistant Chief Engineer—

Figure 2. The Four Aces was the first steam locomotive equipped with roller bearings on all axles. It was built by American Locomotive Works in 1930 and loaned to various railroads prior to being sold to Northern Pacific in 1933.

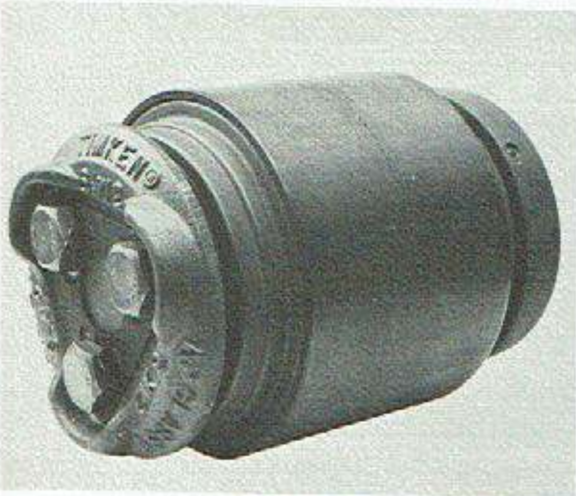


Figure 3. The present-day form of the "AP" bearing which is similar to the original design placed in service in 1954.

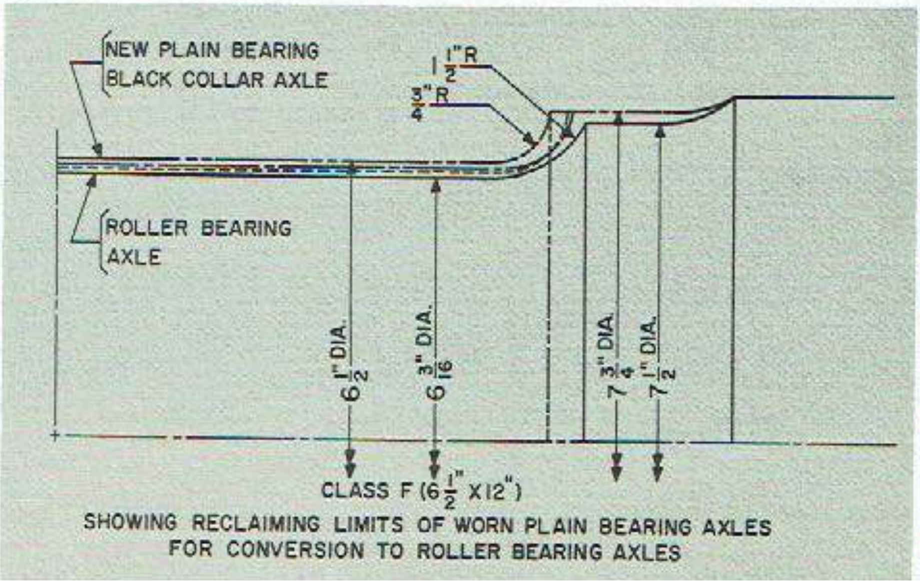
Figure 5. This shows the design of the integral box used with friction bearings and how it can be modified to apply the "AP" bearing so it is not necessary to replace side frames under existing cars. →

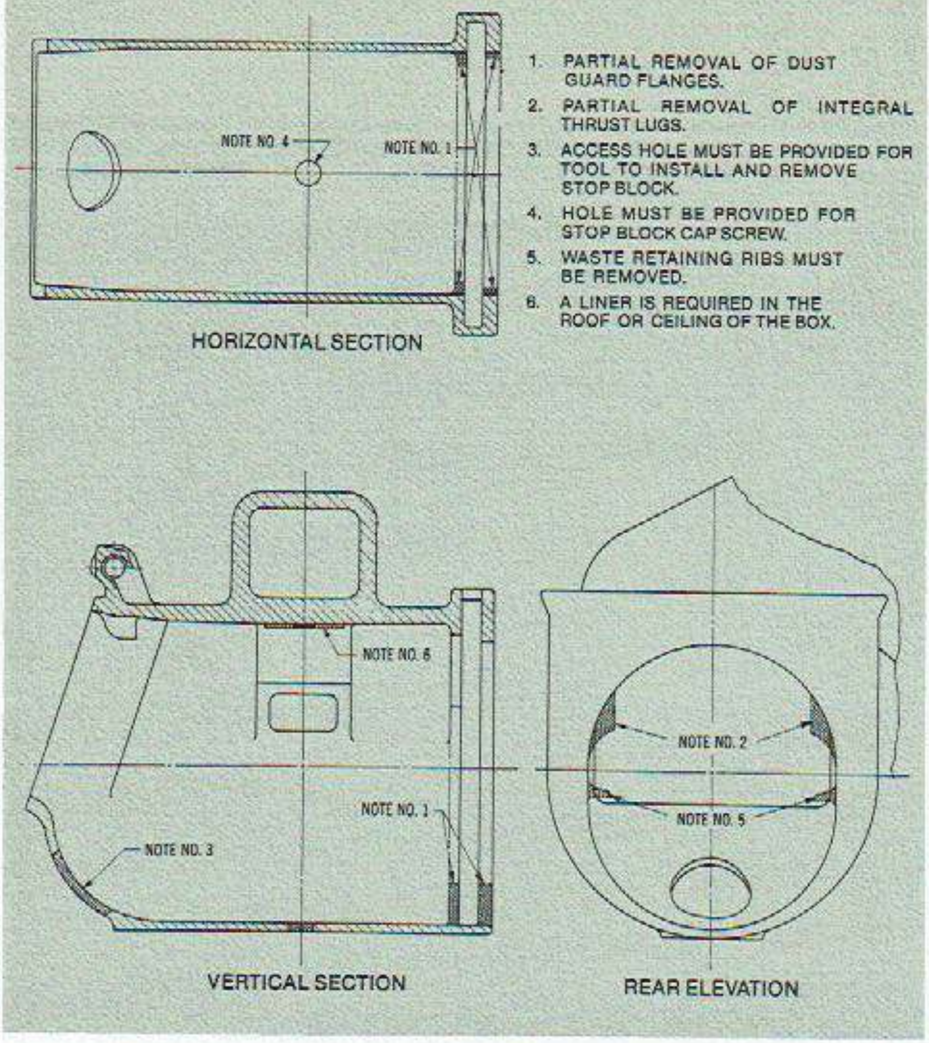
Railroad Division, having received that promotion in May, 1945, the position he held until his retirement May 1, 1962.

In 1954, Eastburg proposed a new freight car roller bearing design incorporating the idea of producing a double cup, self-sealed bearing with seals pressed into both ends of the double cup. This idea evolved into the "AP" (All-Purpose) design, a present-day form of which is shown in Figure 3. The idea was developed by the Company's Railroad Division working with engineering and the production departments. A double cup of such a design had not been produced by any company up to the time of this development. So that the bearing could be assembled as a complete package, it was necessary to develop the design of the seal as well as a method of locking the seal in the counterbore of the double cup. Due to previous problems of housing-type bearing assemblies not being properly assembled and lubricated, the preassembled, prelubricated bearing was developed so it could be shipped to customers and applied to the axles with no further assembly work.

The simplicity and versatility of this new design preassembled, prelubricated, cated, completely self-contained bearing was what was needed to justify adoption for freight cars. It was adaptable to high production, which made it economical, and could be applied to all types of railroad car trucks.

Figure 4.



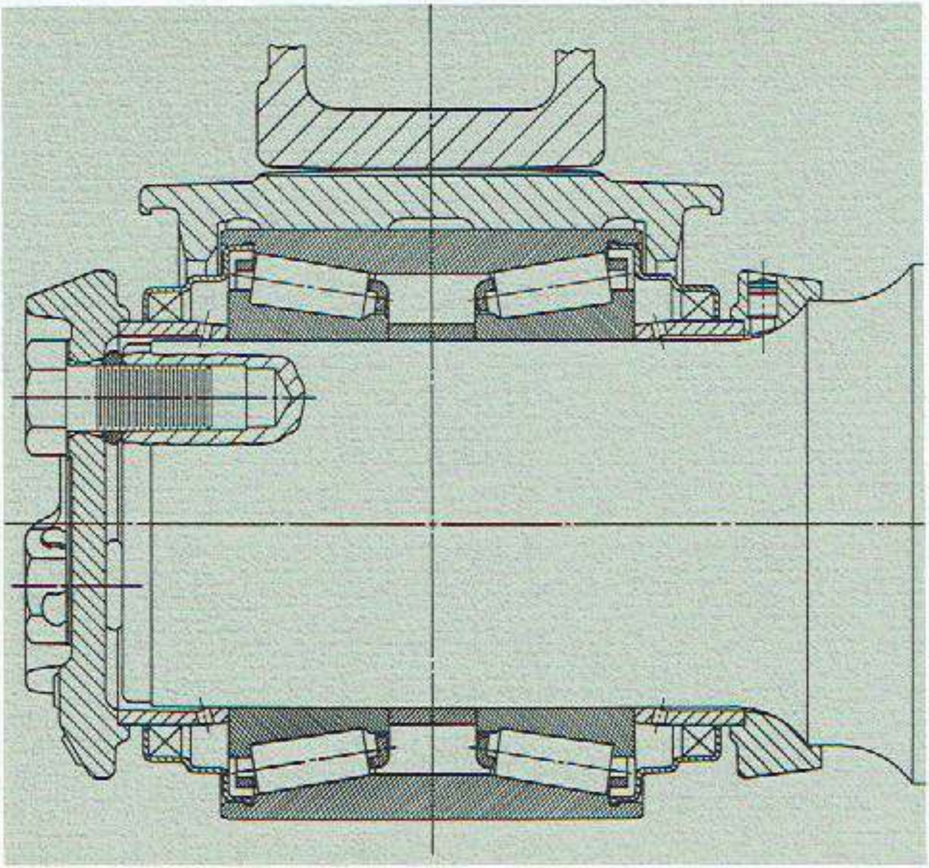


Design Requirements

☐ In 1954, there were approximately 1,990,000 freight cars in service on friction bearings under AAR jurisdiction. The Company decided that the design of the new roller bearing application should be such that the existing friction bearing axles could be converted (Figure 4) without requiring new axles for change-overs. The axle strength had to be considered because the roller bearing axle would be smaller than the new friction bearing axle but would be larger than the AAR shop limit. Stress investigations were

Figure 6. The AAR narrow adapter used in the modified integral box side frame and also used in the AAR narrow pedestal side frame to transfer the load from the frame to the roller bearings.

Figure 7. Sectional view of roller bearing application in narrow pedestal frame showing how the load is transferred from the frame through the narrow adapter to the two sets of rollers in the roller bearing assembly.



made. It was found by axle fatigue tests that the axle design recommended was satisfactory and subsequently became the AAR Standard. The roller bearing axle diameter is approximately 5/16" less than the new friction bearing axle but is 3/16" larger than the road service limit. The roller bearing axle journal length is also shorter than the friction bearing axle. This design allowed the railroads to modify existing friction bearing axles that were partially worn. This resulted in considerable savings to the railroads.

Another consideration was given to existing integral box type side frames used with friction bearings. The overall roller bearing size was selected so that it could be applied inside the existing friction bearing integral journal box after appropriate modifications as shown in Figure 5. However, it also required a filler or narrow adapter (Figure 6) between the roller bearing and the integral box which distributes the load over the two sets of rollers (Figure 7).

The bearing had to have sufficient capacity to provide satisfactory bearing life and also, within size limits, to fit into the integral box side frames with the minimum amount of modifications. In addition to designing the double cup, or outer race, and the other auxiliary mounting parts, the design of the tools and fixtures needed to make the modification to the integral box side frames had to be provided. Tooling was designed and procedures were established so that railroads could make the necessary modifications in their own shops.

For new cars using the "AP" bearing, the original approach was to use new, modified integral box side frames which could be cast to suit (Figure 8). However, a new narrow pedestal side frame, uniquely suited to the roller bearing design, was conceived (Figure 9) to use the same narrow adapter as used in the integral box. The new design allowed for the change of wheels without the necessity of disassembling the freight car truck which was required with the integral box side frame.

The narrow pedestal side frame was adopted by AAR in 1958 as the alternate standard for use with roller bearings and practically all of the new roller bearing freight cars built since then have used this frame design.

Manufacturing Developments

Although double cups had been made for many years in the tapered roller bearing business, it was necessary to work with the equipment manufacturers as well as The Timken Company development group to be able to produce the double

Figure 8. Front view of the modified integral box side frame with the "AP" bearing in place

cup with the extensions on each end to accommodate counterbores with undercuts. The counterbores and undercuts are required to retain the two enclosure seals. This design permitted the bearing assembly to be preadjusted, prelubricated, and packaged by the bearing manufacturer.

The developments necessary for the newly designed double cup and mass production of the bearing as a whole, were under the direction of Harley J. Urbach.

Harley J. Urbach graduated from the University of Nebraska in 1933 with a Bachelor of Science Degree in Mechanical Engineering. He started with The Timken Company in 1933 in Railroad Engineering and progressed through the Diesel Fuel Injection Department, Mechanical Engineering Department, and Works Engineering. In 1951 he was named Executive Engineer.

Although the "AP" bearing was first placed in service in 1954, the earlier bearings were not produced on high production equipment because of lack of sufficient volume. However, the demand for roller bearings for freight cars accelerated from introduction in 1954. In 1958, to meet this increasing demand, The Timken Company opened the first roller bearing plant for exclusive production of railroad "AP" bearings.

Figure 9. Front view of the AAR narrow pedestal frame with the narrow adapter and "AP" bearing.

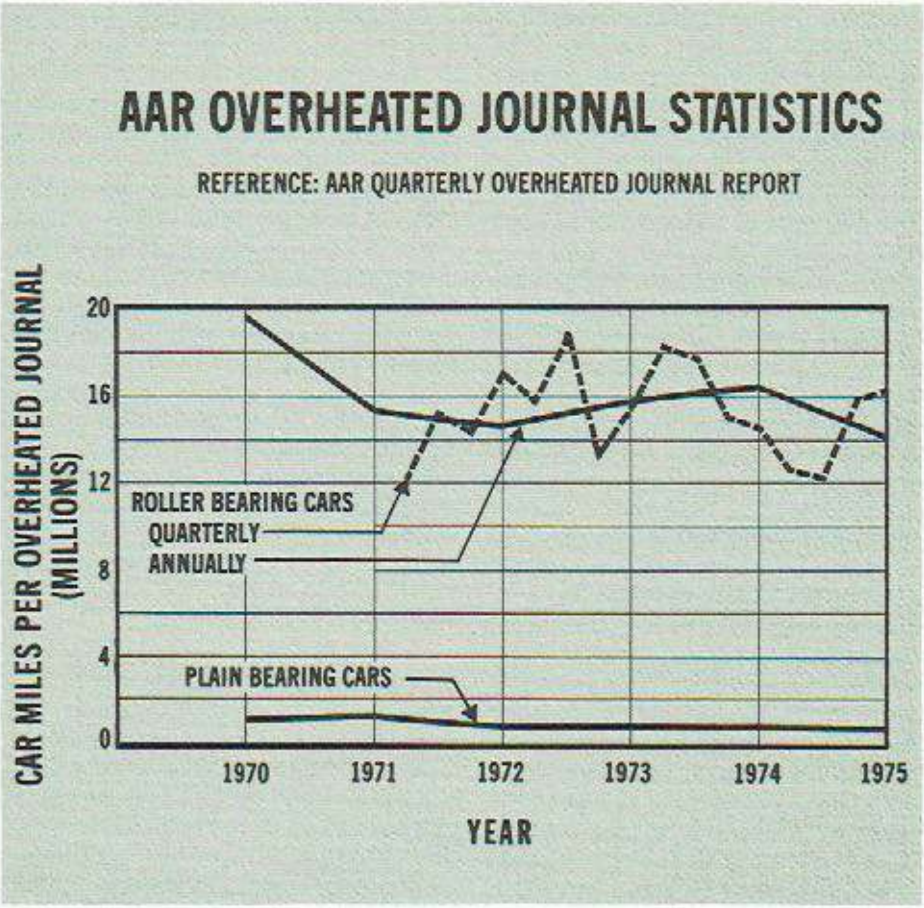


Figure 10. Curve showing performance of plain bearings and roller bearings.

AAR Standardization

☐ Based on the increased interest of the American railroads, the AAR adopted the first roller bearing specification in 1956. The specification has been updated and at present it is AAR Specification M-934. Other bearing manufacturers around the world have applied for AAR approval and according to the latest information AAR has issued certificate numbers for 22 bearings. In some cases, a bearing company has received more than one certificate number because of internal design changes.

All bearings that have AAR approval are required to be designed to fit on the AAR roller bearing axle, the AAR narrow adapter, and AAR narrow pedestal frame.

In 1966, roller bearings were made mandatory by AAR on all new or rebuilt freight cars of 100-ton capacity and larger. In 1968, they became mandatory on all new cars, and in 1970, on all rebuilt cars.

The AAR through railroad reports kept

statistics on the performance of roller and friction bearings. Based on AAR data from 1970 through 1975, a comparative performance plot (Figure 10) shows the car miles per overheated journal. In 1976 the friction bearing performance was 600,000 miles/hot box, whereas the roller bearing was 155 million miles/hot box.

Based on AAR latest information, about 63% of the cars operating under AAR are equipped with roller bearings. Not only has the design of the roller bearing been used in the United States under AAR jurisdiction, it has also been adopted by many railroads throughout the world.

Economics of Roller Bearings

☐ During the 1950's, many detailed economic studies were made comparing costs of operating a fleet of roller bearing equipped cars versus a fleet of plain bearing equipped cars. Calculated rates of return on investment demonstrated the advantage of roller bearings. The return on investment increases as labor rates increase. This is due to the reduced maintenance requirements for roller bearings compared to plain bearings. The maximum advantage is obtained with a 100% roller bearing equipped freight car fleet.

One example of savings for the railroad industry is in the cost of oil for the friction bearings as compared to the cost of grease for the roller bearings. Based on an AAR study "Comparative Economics of Journal Bearings" in November 1955, the cost was $5,667,195.14 for journal box oil used for periodic repacks and free oiling for the friction bearing cars. Assuming a 2% rate of repacks due to derailments, floods, and miscellaneous causes, the total cost for journal box oil in 1954 was $5.7 million. At 1976 oil price levels this would cost $18.6 million.

Considering 1974, which is the latest year for which complete operating data is available, approximately 50% of the freight car fleet was on roller bearings and 50% on friction bearings with a total car fleet of 1,720,573 freight cars. The total oil consumption for friction bearings was 35.5 million liters which, at 1976 prices, amounts to $7.98 million. As a comparison for the other half of the fleet equipped with roller bearings, the grease consumption was 774 thousand kilograms at a 1976 cost of $519 thousand. This indicates a ratio of oil consumption between friction bearings and roller bearings of almost 50 to 1. This is a significant savings in the cost of roller bearing grease used versus friction bearing journal box oil.

World Market

☐ Because many countries throughout the world follow the AAR standards, the "AP" bearing has been used on many overseas properties. With other standards, such as in England and Europe, it has been found desirable to design bearings similar to the "AP", but with variations so that they will fit British Standards or, with other variations, to meet the UIC Standards in Europe.

Other Than Railroad

☐ The "AP" bearing is a self-contained unit and does not require the user to assemble, adjust, and lubricate it at the time it is applied. These features have allowed for use on industrial applications other than railroads. The bearing has been used on crane wheels, sheave wheels, table rolls, line shafts, ingot cars, and many other types of miscellaneous equipment.

Harley J. Urbach

☐ Urbach was born in Lincoln, Nebraska June 26, 1911 and attended a number of primary schools during the time his father was moving around on the Chicago, Burlington and Quincy Railroad. He graduated from Lincoln High School in Lincoln, Nebraska in 1929. He received his BS in Mechanical Engineering from the University of Nebraska in 1933. In 1953 he completed the Harvard Business School Advanced Management Program of Harvard University.

He started with The Timken Company in 1933 in Railroad Engineering and progressed through the Diesel Fuel Injection Department, Mechanical Engineering Department and Works Engineering. In 1951 he was named Executive Engineer and in 1960 Director — Engineering. He was elected Vice President — Engineering in 1962 and was named Vice President — Engineering and Research in 1964. He was elected a Director of the Company in 1966.

Urbach served as a trustee and vice president of The Timken Company Educational Fund, Inc. He held or is holding memberships in the American Ordnance Association, The American Society of Mechanical Engineers, the Society of Manufacturing Engineers, the National Society of Professional Engineers, the Ohio Society of Professional Engineers, and the Society of Automotive Engineers.

Urbach retired from The Timken Company on June 30, 1972 and remained a Director until 1974.

Clifford L. Eastburg

☐ Eastburg was born in Keithsburg, Illinois March 11, 1897 and attended Davenport Lincoln primary school from 1902 to 1912. In 1912 he entered Davenport High School and graduated in 1916. He attended the University of Illinois. Eastburg has completed the self-development business course offered by the Alexander Hamilton Institute.

From 1916 to 1919 he worked as a draftsman for the U.S. Ordnance Department, Rock Island Arsenal in Rock Island, Illinois. From 1921 to 1927 he worked for Bettendorf Company of Bettendorf, Iowa as a Design Engineer and then as Estimator for Freight Car and Steel Casting Division.

He started work for The Timken Company in Canton, Ohio in September, 1927 as an Industrial Engineer in the newly formed Railroad Division. Because of the interest in applying roller bearings to steam locomotives, he designed and followed through the shop and in the field, the bearing applications to the axles, crank pins, main and side rods, and the reciprocating parts. He designed the bearing applications on the Timken steam locomotive Four Aces, which was the first locomotive equipped with tapered roller bearings.

In April, 1940 he was made Assistant Engineer — Railroad Division and in May, 1945 Assistant Chief Engineer — Railroad Division.

Because of his experience in designs for the railroad applications, he spent time in 1946 and 1952 in England, France, Belgium and Germany helping with the design of bearing applications for locomotives, passenger cars and freight cars.

He has 16 patents relating to various parts connected to the application of bearings for railroad equipment.

He retired from The Timken Company, March 31, 1962.

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 Volkswagen 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 ignitron 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 RICHARDS 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 commercially useful Hovercraft.

1969 to DOUGLAS C. MACMILLAN, M. NIELSEN 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 commercial 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 JT3 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.