THE ELMER A. SPERRY AWARD FOR 1957

Presentation of the

THE ELMER A. SPERRY AWARD FOR 1957

to

HAROLD L. HAMILTON . . *Los Altos, California*
RICHARD M. DILWORTH . . *Hinsdale, Illinois*
EUGENE W. KETTERING . . . *Hinsdale, Illinois*

and

THE ELECTRICAL ENGINEERING, MECHANICAL ENGINEERING, LOCOMOTIVE *and* CONTROLS SECTIONS *of the* ENGINEERING DEPARTMENT *of* ELECTRO-MOTIVE DIVISION *of* GENERAL MOTORS, *La Grange, Illinois*

by

THE BOARD OF AWARD

Under the Sponsorship of

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

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At the Fall Meeting of the
American Institute of Electrical Engineers
at Luncheon, October 10, 1957
Morrison Hotel, Chicago, Illinois

THE ELMER A. SPERRY AWARD MEDAL

In the words of Edmondo Quattrocchi, the sculptor of the 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."

Purpose of the Award

The Elmer A. Sperry Award shall be made in recognition of

"A distinguished engineering contribution which, through application in actual service, has advanced the art of transportation whether by land, sea or air."

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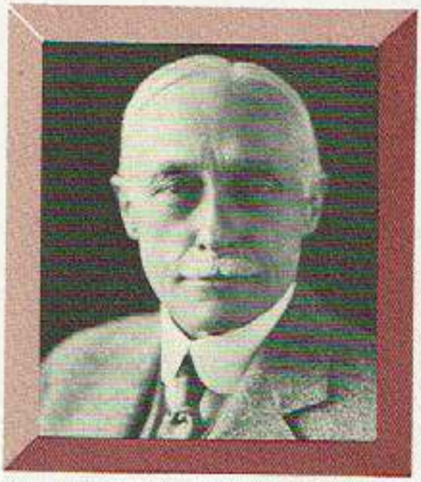


Elmer Ambrose Sperry
1860-1930

Founding of the Award

The 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 in improvement of movement of men and goods by land, by sea and by air.

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

The award of 1955 was given to William Francis Gibbs, engineer and naval architect, and of 1956 to Donald W. Douglas, aircraft designer and founder and president of Douglas Aircraft Company.

Citation

for the Sperry Award for 1957

"...for developing the Diesel-electric locomotive which helped revolutionize American railroading"

It is generally conceded that the most potent single factor in the restoration of health to rail transportation in the United States since the economic debacle of 1929 has been Diesel motive-power.

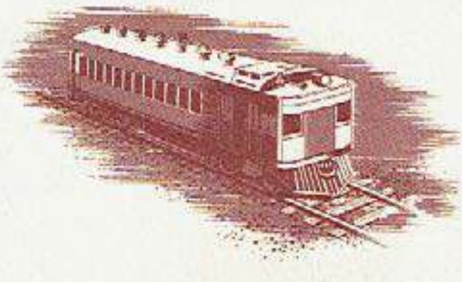
The sudden descent of the great depression intensified a distressing situation into which the railroads had been drifting for several years. Due to continuously publicized competition in the air and on the highways, and to the widely heralded threat of much greater inroads upon income, railroads had not been able to keep up the normal pace of plant rehabilitation. Many locomotives were old and getting more costly to maintain by the day.

But an even worse dilemma faced the rail systems. To meet rising costs it was imperative that the size of trains be increased. To meet air and highway competition it was necessary that both passenger and freight schedules be made much faster and operation more reliable. The dilemma lay in the fact that to get the motive-power necessary to save the railroads meant a steam locomotive longer and heavier than existing road-bed, rails, bridges, structures and curves could take. It was obviously impossible to rebuild the railroads to take more massive locomotives than the ponderous Mallets that were being turned out.

HAROLD L. HAMILTON

It was upon a stage so set that General Motors, through its Electro-Motive Division, in 1934 introduced its version of Diesel motive-power in the Pioneer Zephyr of the Burlington railroad. Its success led to the development of today's separate, mainline Diesel locomotive.

The development program came to flower, and it might properly be said that the American Diesel locomotive really "arrived," in 1940 when Electro-Motive produced a freight locomotive that outperformed steam locomotives. The new freight locomotive brought spectacular savings in operation and maintenance and distinct savings in right-of-way maintenance. The offering of the freight locomotive made the full advantages of Diesel operation available to the railroads in all three major branches of their service — switching, passenger and freight. Improvements were to come in later years, such things as the lengthening of life between overhauls, the addition of the road switcher or general purpose locomotive, the development of export



models with nearly world-wide applicability, and the development of the round-the-world military locomotive. Likewise there was to come the evolution of a production technique which has made it possible to keep the initial cost of the locomotives within attractive economic bounds for investors, without whose cooperation the revolution in railroading centered around Diesel motive-power would not have occurred. But, for all practical purposes, the Diesel locomotive's basic design was set by 1940.

RICHARD M. DILWORTH

Study of the development of the Diesel-electric locomotive leads to the conclusion that there were three most significant phases, namely:

1. Development of the electric transmission.
2. Development of the 567 series General Motors Diesel engine by 1938.
3. Rigid insistence upon coverage of United States standard gauge railroad motive-power needs by less than a half dozen standardized types of locomotives, deliberately designed for mass production.

As IN ALL engineering developments as widespread and as complicated as the Diesel locomotive, a great many individuals and groups of engineers and other planners made contributions. For instance, the Diesel locomotive first appeared on United States railways when General Electric, American Locomotive Company and Ingersoll-Rand supplied a 300 horsepower Diesel-electric switcher to the

Jersey Central in 1925. And, before the Pioneer Zephyr was built, more than 100 Diesel-electric switching locomotives had been put into service in this country. But the most significant contributions to the development of the Diesel *mainline* locomotive, as a whole, and to the three key phrases outlined above were made by three men. They were:

EUGENE W. KETTERING

Harold L. Hamilton, now retired, of Los Altos, California, founder of Electro-Motive Company, later president of Electro-Motive Corporation, and still later Vice President of General Motors assigned to Electro-Motive Division as consultant.

Richard M. Dilworth of Hinsdale, Illinois, now retired, who was chief engineer of Electro-Motive from 1926 to 1948, and in charge of advanced engineering from 1948 to 1953.

Eugene W. Kettering of Hinsdale, Illinois, who participated in the development of the original General Motors Diesel engine and was the project engineer in charge of the development of the 567 series General Motors engine which became the railroad engine.

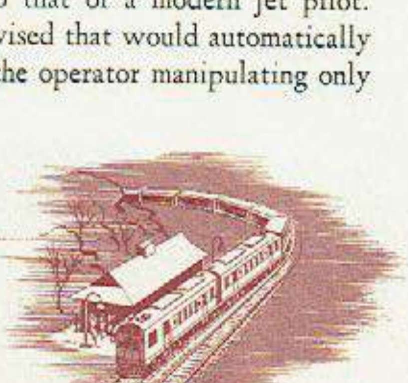
The work of these men was backed up by four particular sections of the Engineering Department of Electro-Motive, namely: the Electrical Engineering Section, responsible for electrical propulsion and auxiliary equipment in the locomotive; Mechanical Engineering Section, responsible for Diesel engine development; the Locomotive Section, responsible for car body, cooling system, fuel and water storage and trucks of the locomotive, and the Controls Section, responsible for all locomotive controls, electrical, electronic, pneumatic and mechanical.

Born in California and orphaned in his youth, Harold Hamilton obtained his early training on the Southern Pacific Railroad. He rounded out the experience that was invaluable to his leadership by spending several years of roaming the eastern half of the country as a "boomer" locomotive engineer.

Hamilton had watched the development of the automobile and motor truck and was fascinated by the early efforts to apply the internal combustion engine to standard gauge rail transportation. The efforts failed, largely because transmission systems, both mechanical and electrical, were inadequate. But Hamilton couldn't get out of his head the notion that an engine with 20% thermal efficiency offered something better for rail transportation than reciprocating steam locomotives with 5 to 8% thermal efficiency.

He left railroading after he had become a minor road official of the Florida East Coast to sell White Motor trucks. He was western manager, with headquarters in Denver, when the urge to do something about putting the internal combustion engine on rails "took charge." He hired a part time draftsman and plotted some ideas for a gasoline-electric rail car. Finally, in 1922, he quit his rather lucrative job with White, pocketed his life savings of $85,000, went to Cleveland and opened an office as The Electro-Motive Engineering Company. He communicated his ideas for the rail car, including his notions about a successful electric transmission, to General Electric and got an agreement to try to work out the problem if he got some orders for his rail car.

The electric transmission had not worked well before because it was necessary for the operator to synchronize the action of the gasoline engine, the generator and the traction motors. Old time operators say this required skill something akin to that of a modern jet pilot. Hamilton insisted that a system be devised that would automatically synchronize the three elements with the operator manipulating only



one control. Although not a graduate engineer he participated intimately in the study and contributed one of the key ideas that finally solved the problem. He found a clue in a translation of an article in a German publication which he ran across in the course of an intensive search of technical literature.

He sank his $85,000 and talked several persons into investing more before the first rail cars were produced but he sold them and they worked. They worked so well that Hamilton's organization put more than 700 on United States rails before he joined with General Motors in 1930.

The application of the internal combustion engine to train propulsion had reached a peak in 1928 when Electro-Motive had turned out some branch line gasoline-electric freight locomotives for the Rock Island with 800 horsepower. Out of this and other experience had come the realization that because of the cost of fuel and maintenance there was a point where the economy of gasoline-electric motive-power did not exceed that of steam as it had in lower horsepowers. Some more rugged and economical prime-mover was needed.

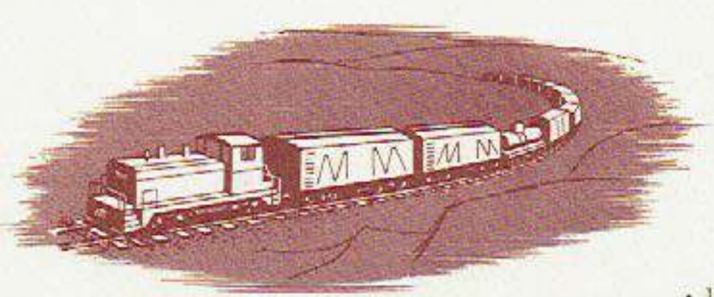
In 1930 General Motors bought Winton Engine Company in Cleveland to provide facilities in addition to General Motors Research Laboratories in Detroit for the development of its version of the two-cycle Diesel engine. Later that year General Motors merged Electro-Motive and its entire organization into the deal, having discovered that Electro-Motive was Winton's best engine customer and that the rail cars might prove a very convenient proving ground and initial market for Kettering's engine, if it ever came through. No one involved had the idea of developing a locomotive at that time.

For two dismal years Hamilton sat in a small office at Winton, describing himself as the "real forgotten man." Late in 1932 Ralph Budd, president of the Burlington railroad, came to Hamilton seeking a power plant for a three-car articulated streamlined train. Hamilton

offered to introduce Budd to C. F. Kettering at Detroit to discuss using the new Diesel. Budd went to Detroit and was shown the two-cylinder experimental two-cycle engine which represented progress to date. It took Budd until late Spring of 1933 to talk Kettering into agreeing to let him use the new engine in the Pioneer Zephyr and then only on the basis that Budd would share the headache if the engine was not successful. Ralph Budd gave Electro-Motive the contract for developing and supplying the power plant for America's first Diesel-powered streamlined train. The train went to work in 1934 and was successful. The Diesel parade was started. Pressure from other railroads for a non-articulated locomotive that would make the advantages of the power plant pioneered in the Zephyr available for other than fixed consist trains came to General Motors in such strength that Electro-Motive was given a half million dollars with which to build an experimental 3600 horsepower locomotive. The concept of the separate Diesel locomotive capable of taking its place alongside steam in mainline service at last was beginning to take form.

Nation-wide test results of this locomotive indicated that Electro-Motive was on the right track. A plant was built at La Grange in 1935. Five years later Hamilton saw the fulfillment of his original dream, the advantages of the internal combustion engine applied across the boards in standard railroad operation. Great names and powerful forces weave in and out of the story, but Hamilton remained the directing genius until the irrevocable die was cast for Diesel.

THROUGHOUT practically all of this movement another remarkable figure stood with Hamilton. Richard M. Dilworth was one of the engineers at General Electric who participated in the development of the equipment Hamilton desired for his earliest rail cars. Dilworth, self-educated like Hamilton, had come to General Electric after a youth spent as a roving mechanic, a seaman on miscellaneous



craft and finally a chief petty officer in charge of electrical equipment on a U. S. battleship. He had participated in the work on gasoline-electric rail cars General Electric did prior to World I but had abandoned in 1914. He, like Hamilton, had a strong conviction that the internal combustion engine had great possibilities on the rails. Hamilton made him Chief Engineer of Electro-Motive in 1926.

Dilworth brought into the combination several attributes of character and several design convictions which were of tremendous force in the final Diesel achievement. One of these was a highly effective but homely ability to convey engineering ideas to others. Perhaps one single illustration will illuminate this quality. He kept an ordinary under-the-counter roll of brown grocery wrapping paper at one end of his huge work table. When he worked out or explained an idea he tore off a length of paper. With a heavy carpenter's pencil he drew large, rough sketches or diagrams. Some of his pictograms still are treasured by friends.

Through the period from 1933 to 1940 the original concept of control as used in the rail car was drastically changed in response to experience. In addition, Dilworth directed the design of a new generator and traction motor. In 1938 an addition to the Electro-Motive factory was built for manufacture of the electrical equipment and the new engine. Hamilton and Dilworth finally had under their specific local control the design and manufacture of all major locomotive components. The plant later grew into not only the world's largest producer of heavy duty Diesel engines, but also the world's present largest producer of direct current electrical propulsion equipment. Dilworth had at his disposal, as he developed the freight locomotive, the advantages of a Diesel engine deliberately designed to drive a generator designed with equal deliberation to be driven by a Diesel engine (evolved by Eugene Kettering's group), with traction motors specifically designed for operation in the combination.

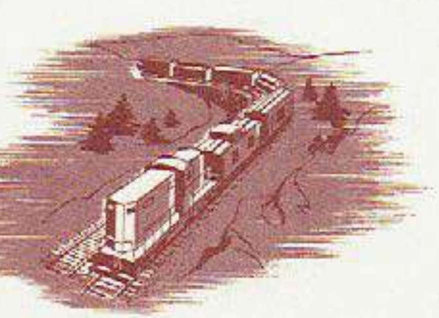
Dilworth supplied the major resistance to an effort that came from the railroads in the formative days to specialize Diesel locomotives. He simply refused, through the direst kind of pressure—even to the point of knowing he was to blame for losing an order — to work a customer-favored alteration into the locomotive unless it was an "extra" that could be hung onto the standard product. If it was a distinct improvement to the general design, he worked it into the standard product from then on. But woe to the pet gadget made by someone's brother-in-law.

As a result, the railroads, for the first time in their history, had standardized motive-power with the enormous advantage of low cost mass produced replacement parts, low parts inventories, money-saving maintenance routines, and the like.

Dilworth also stuck through thick and thin to the principle of covering the major requirements of the domestic railroads with the fewest possible models. He and Hamilton were willing to leave the highly specialized motive-power jobs to someone who would have to design many different machines if he could cover the bulk of day by day requirements with a handful of broadly capable models which could be mass produced.

ONE OTHER MAJOR element of the success of the Diesel movement remained missing, even after the concepts, experience and abilities of Hamilton and Dilworth were added to the abilities and facilities of General Motors. This missing element was an adequate Diesel engine.

Two major truths became evident in the early streamlined train experience in 1934 and 1935. The fact that an articulated, sub-standard-sized train was not the answer and that the original GM Diesel engine was not the engine that could take over steam's total



job was finally understood. Among the first to recognize this was the engine's impresario, Charles F. Kettering. So a project was set up by General Motors in Detroit in 1936 to completely redesign the engine to meet the rigors of railroad service.

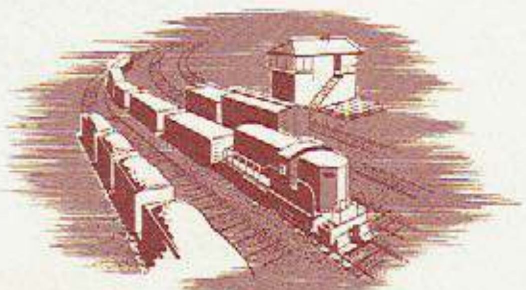
This project was put in charge of Eugene W. Kettering. His list of qualifications for the job was headed by the fact that he had been intimately connected with the development of the original GM two-cycle Diesel engine since 1930. Fresh out of Engineering at Cornell University he had gone to work for Winton in that year. The project, under the direction of Kettering, Sr., at that time consisted of a program to develop two single cylinder engines at Cleveland, one of which would be kept at Winton and the other would be sent to General Motors Research Laboratory in Detroit. The Research Laboratory would work on the two-cycle principle and Winton would work on the unit injector. Gene Kettering stayed at Winton. The unit injector project came along very well and the crew of which Gene was a part was called upon to aid in the work assigned to the Detroit group.

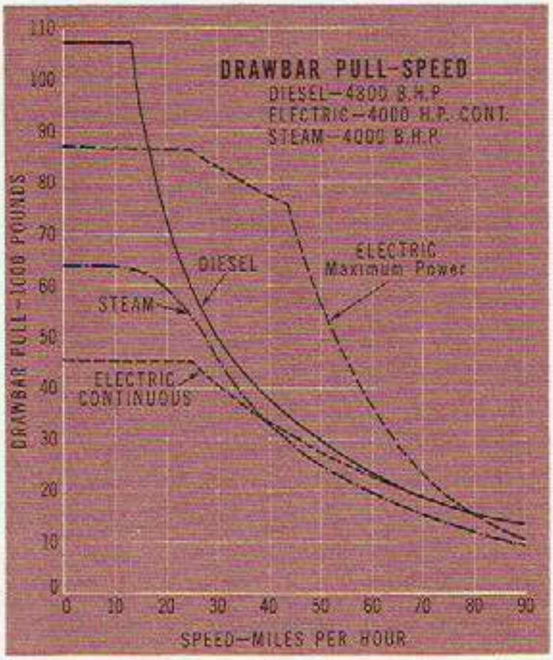
Ultimately, two eight cylinder engines were completed and made part of the power plant for the GM exhibit building at the Chicago Century of Progress Exposition in 1933. The Navy, meanwhile, had become interested and ordered an engine because it offered a distinct reduction of weight in submarine power plants. This, with Ralph Budd's insistence on a railroad engine, resulted in redesign in the light of the Century of Progress experience. Gene Kettering participated and was a part of the engineering group that followed the redesigned engine, known as the 201A, through both the submarine and early articulated train applications. His staff for the development of the 567 or "railroad" engine was made up of men who had worked with him at Cleveland and some of those who had worked in the GM Research Laboratory group. They finished their work in 1937. In

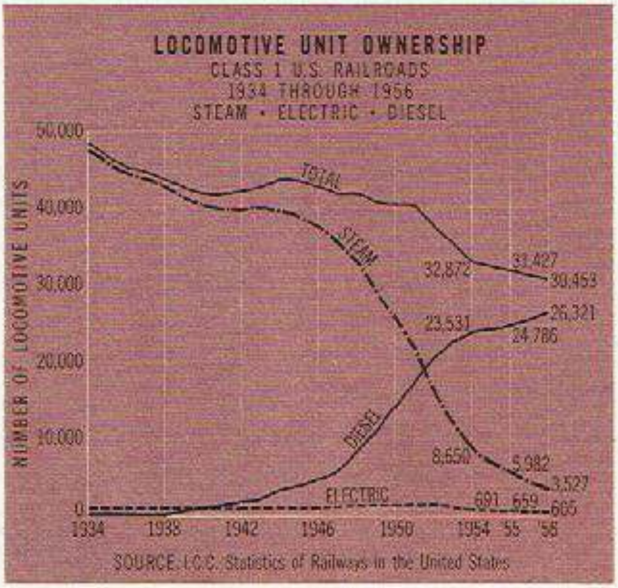
1938 the new engine was assigned to Electro-Motive for production in a newly built wing of the plant. This was the engine that not only beefed up the Diesel passenger and switching locomotive in performance and reliability standards to levels the steam locomotive had never touched, but also made possible the Diesel freight locomotive. Gene Kettering went with the engine to head up the Mechanical Engineering Section of Electro-Motive. He later succeeded Dilworth as chief engineer and then became head of the Research Department of Electro-Motive, which is his present assignment.

As HAS BEEN SAID before in this record, the Diesel locomotive's success stemmed from the work of many men and among those in addition to the three singled out for the 1957 Sperry Award who made the most telling contributions were the four groups of engineers comprising the Electrical Engineering, Mechanical Engineering, Locomotive and Controls sections of Electro-Motive between 1933 and 1940. The individual contributions in these groups are, as usual in such cases, untraceable, but the sum total of their effectiveness in the ultimate success of the enterprise must be rated as vital.

The work of the individuals and the groups recognized by the 1957 Sperry Award undoubtedly was a major factor in vastly improving public transportation service. The economic welfare of a nation in this mechanized age is so closely keyed to the quality of its mass transportation facilities that it is scarcely necessary to point out the enormous importance of United States railroads. The continued health and the continued improvement of the transportation service provided by the railroads is essential to national well being. It follows that in providing a tool which has proved of such value in helping the railroads to meet the rapidly increasing needs of the nation, those recognized today have made a great contribution to the integrated advancement of their country.




DRAWBAR PULL-SPEED
DIESEL—4800 B.H.P.
ELECTRIC—4000 H.P. CONT.
STEAM—4000 B.H.P.
DRAWBAR PULL—1000 POUNDS
SPEED—MILES PER HOUR
DIESEL
STEAM
ELECTRIC Maximum Power
ELECTRIC CONTINUOUS
0 10 20 30 40 50 60 70 80 90
110 100 90 80 70 60 50 40 30 20 10 0


LOCOMOTIVE UNIT OWNERSHIP
CLASS 1 U.S. RAILROADS
1934 THROUGH 1956
STEAM • ELECTRIC • DIESEL
NUMBER OF LOCOMOTIVE UNITS
50,000 40,000 30,000 20,000 10,000 0
TOTAL
STEAM
DIESEL
ELECTRIC
32,872
31,427
30,453
23,531
26,321
24,786
8,650
5,982
3,527
691
659
605
1934 1938 1942 1946 1950 1954 55 56
SOURCE: I.C.C. Statistics of Railways in the United States