HIGHLIGHTS OF WARD LEONARD'S SEVENTY-FIVE YEARS OF PROGRESS

1967 marks the Diamond Anniversary of the founding of the Ward Leonard Electric Co. The Company's seventy-five years of steady growth spans the wireless generation, the radio generation, the electronic generation and the beginning of the computer-space age generation. Contributions by the Company to the state-of-the-arts within the electrical-electronic industry and to our nation have been significant and numerous over the years. The following pages briefly highlight some of these developments comprising three quarters of a century of progress for Ward Leonard.

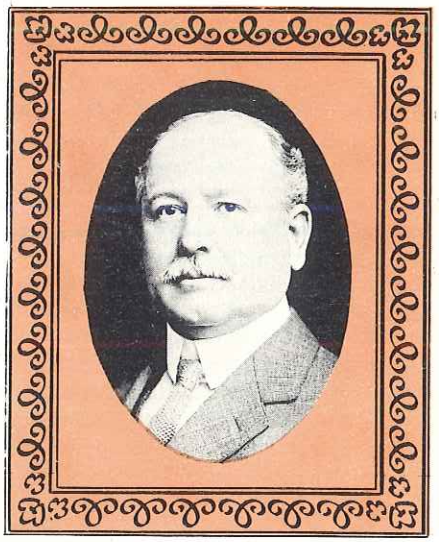
H. WARD LEONARD

H. Ward Leonard, American inventor, electrical engineer, and founder of Ward Leonard Electric Co., was one of the electrical industry's great pioneers. He contended that the rapid growth of our nation and the world would depend on the advancements made in the distribution, efficient control and use of electrical power. Working under this concept, history records that Mr. Leonard's numerous contributions, including over 100 patents credited to him in the electrical and other fields, have played an important part in the world's commercial progress.

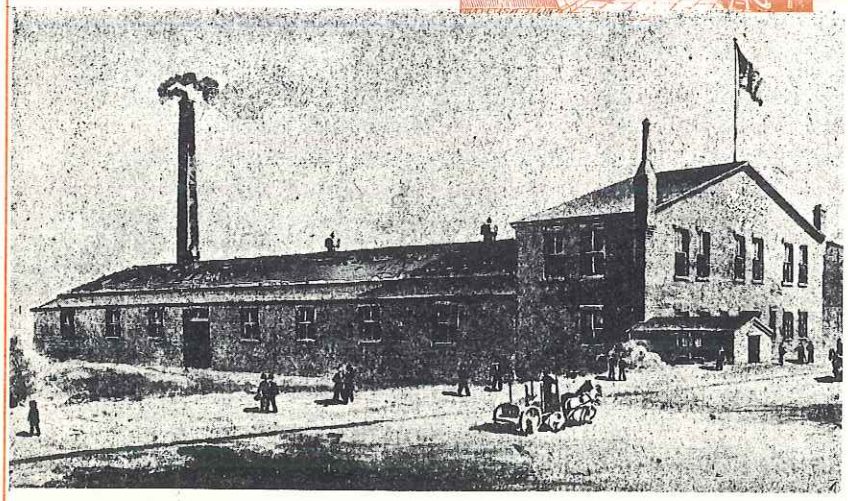
Born in Cincinnati, Ohio on February 8, 1861, Mr. Leonard graduated from M.I.T. in 1883. The following year he became associated with Thomas A. Edison as a member of his staff of engineers.

In 1888 Mr. Leonard was appointed general superintendent of the Western Electric Light Company in Chicago. That same year his first important inventive work, an electric lighting system for railway trains, was put into commercial operation on two trains running between Chicago and Minneapolis.

In 1889 he organized Leonard and Izard, one of the first firms in the United States to engage in central-station and electric-railway construction. This firm was soon bought out by the Edison General Electric Company and Mr. Leonard became manager of the Company's combined interests in the United States and Canada. He resigned from the Company in 1891 to form an electrical contracting firm.



H. Ward Leonard



1892—Original factory located in Bridgeport, Conn.

OTHER HIGHLIGHTS IN H. WARD LEONARD'S CAREER

Mr. Leonard was active in the American Institute of Electrical Engineers serving as manager (1890-93) and vice president (1893-95). He was also a prolific contributor of technical papers and delivered numerous addresses to scientific bodies. For his work in electrical research, the Franklin Institute, in 1903, conferred upon Mr. Leonard the John Scott Medal. A year later Mr. Leonard was awarded a Gold Medal at the St. Louis World's Fair for his System of Control. In 1911 he became a member of "The Inventors Guild", becoming president of the Guild in 1913.

NOTABLE PATENTS OF H. WARD LEONARD

Over one hundred patents were issued to H. Ward Leonard as inventor or co-inventor. Those listed below represent some of his most widely known patents.

1889 – First electric train lighting system (Patents 405-895-6-7 System of electric lighting for railway cars)

1891 – System of motor control (Patent No. 463,802 Electrical transmission of power). The class of patents on this motor control system has been named the "Ward Leonard System" by the Patent Office.

1892 – Electric elevator control system (Patent No. 468,100 Electric elevator)

1892 – Multiple voltage motor control (Patent No. 478,344 System of electrical distribution)

1896 – Motor starting and reversing rheostat (Patents 563,600; 563,693 and other rheostats for electric motors)

1902 – Electrical resistors (Patent No. 691,949 Support for electric conductors and resistances)

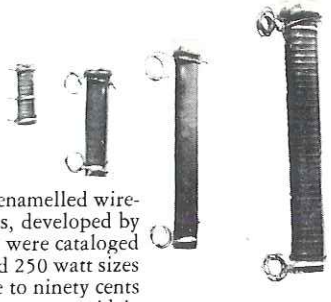
1902 – First double arm circuit breaker (Patent No. 705,102 Electric circuit breaker)

1906 – Resistance element for soldering irons, flat irons and cooking utensils. (Patent No. 827,455 Resistance device)

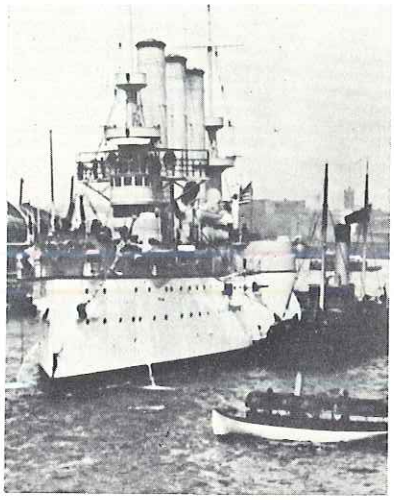
1910 – Manual D.C. starter and speed control (Patent No. 978,173 Electric motor controlling apparatus)

1912 – Gasoline – Electric automobile (Patent No. 1, 042, 698 Electrically propelled vehicle)

1913 – Generator system for automobiles (Patent No. 1,157,011 Electric apparatus for motor vehicles)



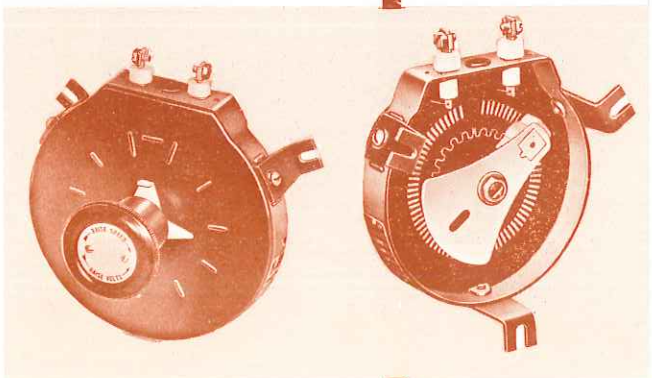
In the early 1900's enamelled wire-wound resistors, developed by H. Ward Leonard, were cataloged in 36, 72, 125 and 250 watt sizes priced from forty-five to ninety cents each. The resistors were widely applied in telephone, telegraph, signal work and motor controllers.



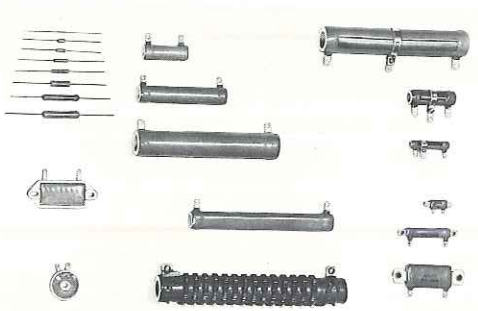
USS BROOKLYN—The first successful use of electricity in warfare as motive power for gun turrets, ammunition hoists and auxiliaries came as a result of H. Ward Leonard's system of control. Installed aboard the cruiser, BROOKLYN, the system was responsible for the destruction of Cervero's fleet at the battle of Santiago during the Spanish American War in 1898.

Courtesy of National Archives—Navy Department

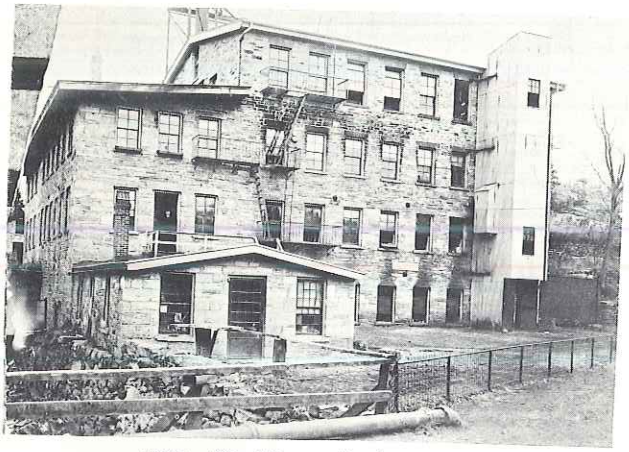
Enamelled cast iron plate rheostat shown above for motor and generator field control and theatre dimmer applications typifies construction of rheostats manufactured at the Bronxville plant during the late 1890's.



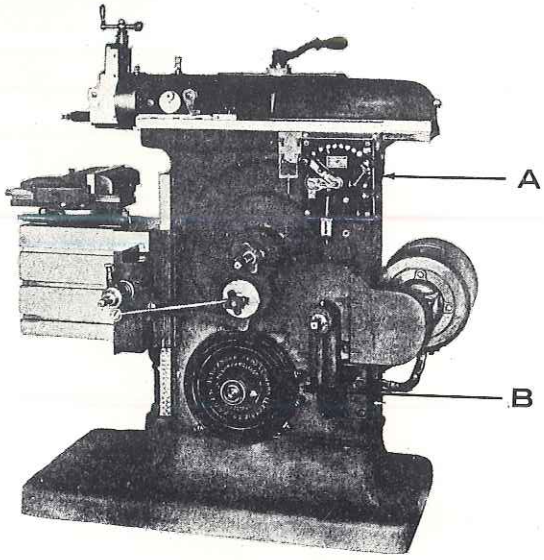
The modern Vitrohm plate rheostat at left incorporates a pressed steel plate and solid rectangular stationary contacts. Construction offers smoother control, more steps of control and lighter weight.



Today's Vitrohm vitreous enamel wire-wound resistors for universal use electronically and electrically are produced in a wide variety of types, sizes and values.



1897—Ward Leonard's plant at Bronxville, N. Y.



Machine tool controls were manufactured at the Bronxville plant in 1905. The motor driven shaper illustrated had a Ward Leonard "SKE" independent, interlocking "overload" circuit breaker and "no-voltage" release motor starter (A) and a 15" enamelled field rheostat (B) for speed control.

Photo courtesy General Lighting Products Co., Kearny, N. J.

During the Paris Exposition in 1900, after many ineffectual attempts to operate the moving sidewalk by other control systems, the Ward Leonard system was installed under Mr. Leonard's supervision. The moving sidewalk became a great success and a feature of the Exposition. Photo shows a scene from the Exposition Universelle in 1889 for which the Eiffel Tower was erected and where Mr. Leonard's firm was represented.

WARD LEONARD'S SYSTEM OF CONTROL

The year 1891 marks the date of Mr. Leonard's best-known invention . . . the Ward Leonard System of Motor Control (Electrical Transmission of Power, Patent 463,802 Nov. 24, 1891). An entirely new use of electrical energy, the system has had a profound effect on all industries using electrical energy. For example, it is estimated that 15% of the cost of rolling steel was saved by replacing steam engines with electric motors equipped with his system. The Ward Leonard System made it possible to obtain smooth speed control; to reverse almost instantaneously, the motor speed from maximum in one direction to full speed in the opposite direction and to reduce to the lowest practical limit the amount of energy when starting, reversing and stopping.

Still widely used today in modified forms throughout all industries, Mr. Leonard's System of Control represents one of the outstanding achievements of the 19th century.

WARD LEONARD ELECTRIC CO. FOUNDED

In 1892, H. Ward Leonard began manufacturing heating devices, rheostats and motor controllers in a former roller skating rink in Bridgeport, Conn., and in 1894 the firm moved to Hoboken, N.J. In June of 1897 a fire completely destroyed the Hoboken plant and operation began anew in Bronxville, N.Y. in September 1897.

THE FIRST ENAMELED RESISTOR

It was during the first year in Bronxville that Mr. Leonard began developing the ceramic base enameled resistor that was to play a vital role in the Company's future. He reasoned that the basic principle of embedded resistance wire construction which had proved highly successful in enameled cast iron plate rheostat manufacture, producing a smaller, more reliable unit, also could be applied to power resistors.

In 1902, after several years of experimentation, he was issued a number of patents pertaining to resistor construction which formed the basis for the first vitreous enamel wire-wound resistors.

By winding resistance wire on a porcelain tube (used as insulators by the electrical trade) and embedding the wire in vitreous enamel, the entire surface of the tube was available for emitting heat energy instead of merely the small surface of the wire as with unembedded types. This principle, now known as Vitrohm® construction, increased the watt capacity of a given size tube and protected the resistance winding against damage.

WARD LEONARD MOTOR CARS

Through Mr. Leonard's inventive genius and able guidance, the Company from 1899 to 1903 manufactured gasoline driven motor cars that had the best features of the finest French automobiles plus many detailed improvements. Ward Leonard cars won two blue ribbons in the Long Island Automobile Club 100 mile endurance contest in 1902 and they held the American road record for least gas consumption (4⅔ gallons for 100 miles) in the 1 to 2000 pound class.

By 1903 the Company's product line had expanded to include not only field rheostats, motor starting rheostats and resistor units but also motor speed controllers, circuit breakers, theatre dimmers and battery charging rheostats. Two years later the Company began building motor starting panels for the U. S. Navy.

In 1904 Mr. Leonard resigned as president of Ward Leonard to devote more time to his experimental work and his inventions and Leonard Kebler became the Company's second president.

During the next decade, the Company's electrical control business continued to grow. In 1908, the Company built the first electric lighting system for motor cars and in 1911 marketed the first electric starting system for motor cars.

At the time of Mr. Leonard's death in 1915, the number of Company employees had grown to 200 and annual sales were about one half million dollars a year.

COMPANY MOVES TO MOUNT VERNON, N. Y.

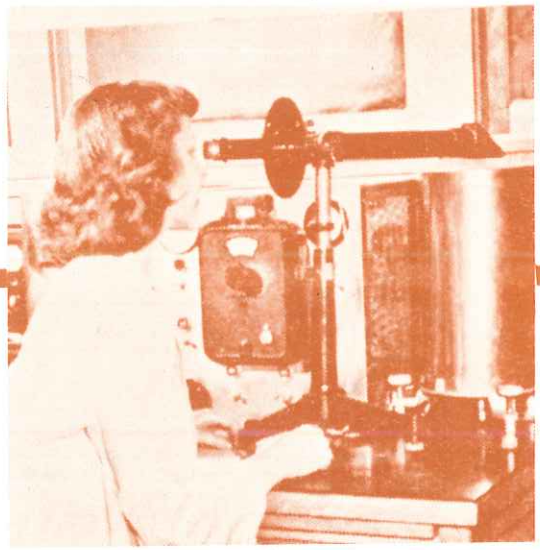
In 1916, to provide more adequate production facilities, the Company moved into a newly built plant in Mount Vernon, N. Y. where the main plant is located today.

WORLD WAR I ACTIVITIES

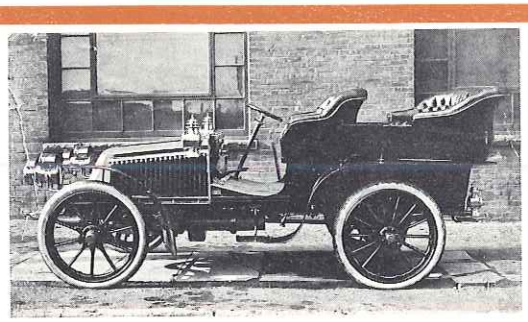
During the first World War the Company's entire facilities were turned over to the U. S. Navy and U. S. Army Signal Corps for the production of special resistances, charging panels and controls. An urgent demand during the war for resistors exceedingly light in weight fostered the development of Ribohm® resistors, made of metal ribbon, channeled and bent into a "V" shape. Ribbon resistors were first applied on portable battery charging panels designed for the U. S. Signal Corps for charging radio batteries used along advanced lines of communications. In 1920 Ribohm construction was applied on the Navy standard rheostats for controlling searchlight high intensity arcs and later, in the early days of motion pictures, as project arc regulators and for charging vehicle batteries.

LIGHTING CONTROLS IN THE '20's AND '30's

Improvements in lighting controls since the Company's introduction of the first plate type (resistance) dimmer for carbon lamps in 1892, and the first 110 step circular dimmer for Mazda lamps in 1910 were many. By 1920 the vast majority of theatres and auditoriums throughout the country were equipped with Ward Leonard dimmers. That year the Company introduced the first 1000 to 2000 watt resistance dimmer, the first dimmer plate with make-and-break switch and the first installation of reactance dimmers. In 1935 the Company developed the first single tube electronic dimmer and two years later introduced the first interlocking autotransformer dimmer.



In 1928 at Ward Leonard's R & D Laboratory the first practical use of an interferometer, an instrument for measuring the precise temperature coefficient of expansion of various resistor materials, was made.



Ward Leonard 24-30 H.P. Motor Car built at the Bronxville, N. Y. plant in 1903. Other popular models were the award winning 3½ H.P. Century-Tourist and the 5 H.P. Knickerbocker.

1921—Automatic cut-outs for automobile battery-generator systems undergoing assembly and test. Manufacture was later discontinued when major auto makers produced their own devices.

EARLY R&D PROGRAMS

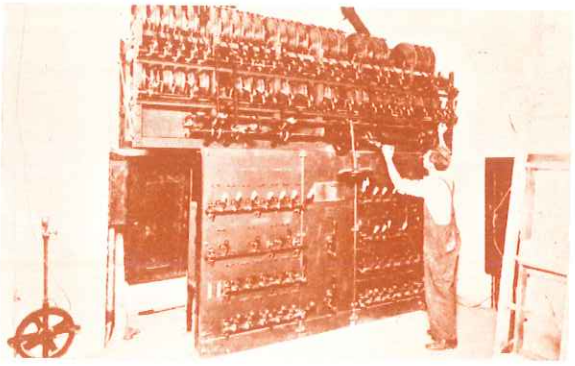
In the late 1920's the Company embarked on a research and development program on ceramics and enamels for resistive and other products. In 1928 two significant developments took place. At the Mount Vernon plant the industry's first continuous kiln for firing ceramic resistor tubes was installed. The continuous kiln increased production greatly over the older batch kilns and provided closer control and product uniformity.

The second important development was the industry's first application of a special interferometer, an instrument used to determine the exact temperature coefficient of expansion (to within one ten-millionth of an inch) of various resistor materials. This marked the beginning of a scientific approach to developing and producing the highest quality resistors.

In 1934 Ward Leonard became the first major resistor manufacturer to produce all of its own ceramics and enamels. Continuous investigation and research in enamels, ceramics, gas-free resistance wires and alloy terminals led to the development of the "green" Vitrohm resistor in 1939. (The basic patent 2,179,212 was issued to Charles Gancinow head of the Company's research laboratory.) The green Vitrohm resistor, superseding the brown enamel resistor, was the forerunner of the industry's first axial lead power resistor (introduced in 5 and 10 watt sizes in 1951) which today is produced in miniature sizes from 1 to 12.5 watts for computer, space age and a wide variety of other electronic equipment.

WARD LEONARD ENTERS REGULATOR BUSINESS

In 1927 when A.C. operated radio receivers were adopted as standard by the radio industry, superseding D.C. types, the Company began developing an efficient means of controlling line voltage fluctuations. Two years later the Potar,

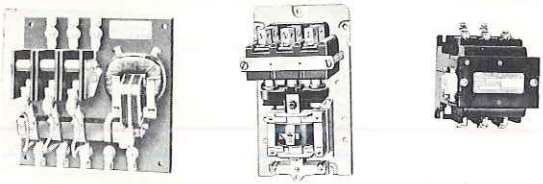


Ward Leonard resistance dimmers for stage and house lighting control were installed in virtually all theatres and auditoriums until the mid 1930's when the more efficient autotransformer and electronic types came into use. Electrician at the Loew's 83rd Street Theatre, New York City in 1921 is shown operating the dimmer bank, mounted above the switchboard to save space.

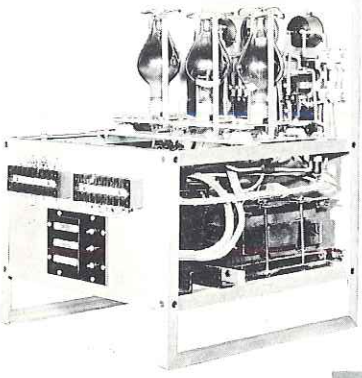
an entirely new type of A.C. magnetic voltage regulator was made available to manufacturers, replacing power transformers in radio circuits. In 1933 the Company marketed one of the first electronic voltage regulators for A.C. and D.C. generators for application in municipal power stations and independent power plants. The electro-mechanical regulator for Navy hi-shock service developed in 1939 was followed by the static or magnetic amplifier regulator in 1942 for generator and main propulsion regulation aboard T2 Maritime Commission tankers and Navy submarines.

WORLD WAR II

At the outbreak of the second World War, Company employees numbered nearly five hundred. Production facilities were rapidly converted entirely to manufacturing control

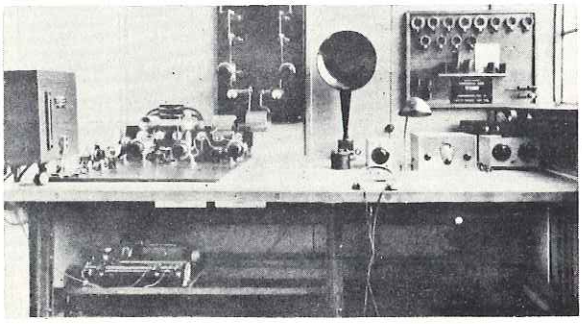


1930—A.C. magnetic contactors of the clapper type (left) were developed for motor control applications. In 1947 the clapper design was replaced by the solenoid type (center). Today's 50 ampere Series 5000 contactor (right) features modular design, longer life and space saving.

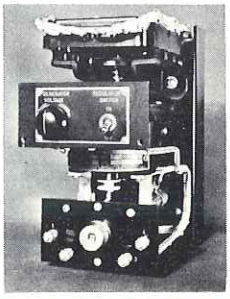


One of the first electronic generator regulators built by Ward Leonard in 1933 for the U.S. Navy.

Experimental radio station W2XBF was operated at the Company's Mount Vernon plant by the engineering-development staff during the early 1930's.



Ward Leonard mechanical voltage regulator (direct acting, rheostatic type) developed in 1939 for small and medium size A.C. and D.C. generators for shipboard, mobile and stationary installations.



In 1942 Ward Leonard was one of the first Westchester firms to win the Army-Navy "E" pennant for its excellent record of production during World War II. Accepting the pennant is Leonard Kebler (standing at right) Company president from 1904 to 1944 and afterwards chairman of the board until his death in 1961.

SOLITROL Lighting Control System for theatres, schools and TV Studios was first introduced in 1961 at the American Educational Theatre Association's Silver Anniversary Convention, Waldorf-Astoria, N. Y. The master and preset consoles shown remotely control the solid state dimmers.

White room within the Mount Vernon plant is air-conditioned, humidity controlled, dust-free and dirt-free and is designed for producing high reliability power resistors. Photo above shows oceanic telephone cable resistors undergoing test on a hot resistance bridge designed and built by Ward Leonard.

equipment and components for the war effort. Motor controls and electronic regulating equipment for Navy and Maritime vessels were turned out in vast numbers. By 1944 the number of employees had risen to 3500 and the Company occupied twenty-nine buildings in the City of Mount Vernon, N. Y.

RETURN TO THE INDUSTRIAL MARKET

With the return to peacetime activities following World War II, production and marketing efforts were diverted from military to industrial fields. Dimmers for theatre and school lighting control, virtually unobtainable during the war years, provided an excellent market. At the 1946 National Power Show in New York, the Company introduced a new reactance type dimmer circuit with electronic control. This system, the predecessor of today's Solitrol solid state system, featured faster response, simplified circuits and fewer parts than previous Hysterset models.

In 1947 as a result of experience gained in design of Navy contactors and starters, the Company introduced the 4450 line of A.C. solenoid operated contactors and starters for industrial control purposes. This was followed a year later by a Centralized Motor Control System, tradenamed Multitrol, for central air conditioning systems, machine tool control and auxiliary drives in generating stations. During 1950 a D.C. line of solenoid operated contactors, replacing the older clapper design, was added to the control products line.

In 1951 production facilities were increased by 18,000 square feet; materials handling facilities were improved; more modern ceramic and laboratory equipment was obtained; a new 85 foot tunnel kiln for resistor manufacture was installed and office facilities were enlarged.

By 1953, automation in the mass production industries and the materials handling and production machinery fields made demands on control manufacturers for components capable of furnishing a service life in excess of 10 million operations. Design changes; and redesign in some cases, in Ward Leonard's line of relays and other components were made to meet industry's latest challenge.

Impending changes in military specifications (Navy), involving vibration and extreme tilt requirements, resulted in the development of a new line of solenoid contactors and starters for Navy service in 1959.

ELECTRONIC DISTRIBUTOR DIVISION FORMED

To obtain nationwide distribution of products on an "off-the-shelf basis, Ward Leonard, in 1945 established the Electronic Distributor Division with headquarters in Chicago, Ill. In 1960 operations were moved to Mount Vernon, N. Y.

Today in principal cities throughout the country there are more than fifty Authorized Industrial Distributors franchised to stock Ward Leonard products.

OUR CANADIAN SUBSIDIARY

The Company's subsidiary in Canada was purchased in 1955 from D. M. Fraser, Ltd., a Canadian manufacturing concern established in 1925, and became Ward Leonard of Canada Ltd. in 1956. The Canadian subsidiary has shown marked growth in the past decade. Manufacturing facilities for resistors, rheostats, lighting controls and other control products have been enlarged through the years to meet growing industrial demands in Canada. The firm has expanded in other areas and today the Company also markets emergency lighting units using nickel-cadmium batteries and a line of submersible pumps for sewage systems and drainage control.

THE 1960's

The period from 1960 through the present 75th Anniversary Year was one of further expansion, diversification and development programming.

METAL FILM DIVISION ESTABLISHED

In the summer of 1960, the Metal Film Division was formed and construction was begun on a modern plant in Hagerstown, Md. for producing highly reliable metal film resistors for space age, military and industrial electronic use. The plant became fully operational in 1961 and has a "clean" atmosphere through air conditioning, dust, humidity and other controls essential to maintaining a high degree of product reliability and accuracy. During the past six years, the Division has grown to become one of the nation's leading manufacturers of precision metal film resistors.

THE NEW MANAGEMENT

A new management team in 1962 undertook the task of reorganizing and rebuilding objectively to keep the Company abreast of the fast moving industry, to sustain and improve its position in the market and to assure the Company's continued future growth.

REGULATORS INC. ACQUIRED

As part of the Company's continuing diversification program, a controlling interest in Regulators, Inc., Wyckoff, N. J. was obtained in 1963. Specialists in custom design and manufacture of static controls and power equipment, Regulators, Inc. produces highly complex power systems, regulators, control and power supplies and inverters. This equipment is used in computers, communication networks and missile ground support equipment. Military program participation by Regulators, Inc. has included equipment for Project Mercury, Telstar, Titan and the Minuteman.

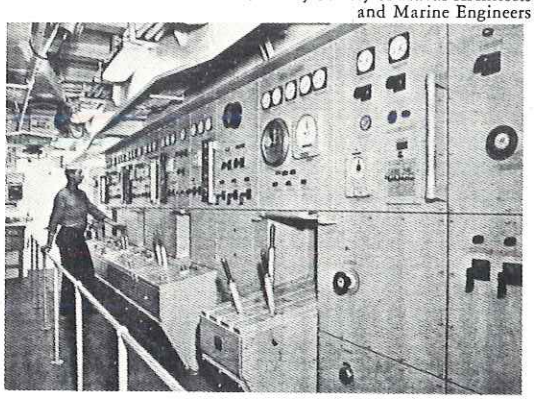
MILRO CONTROLS COMPANY, INC. PURCHASED

In 1964 the Milro Controls Company, Inc., a small firm in Saddle Brook, N. J. producing specially designed electronic components and highly specialized solid state equipment for industry and government, was acquired. Two years later, to achieve greater efficiency, operations were transferred to the Mount Vernon plant.

The plant of Ward Leonard of Canada Ltd. in Toronto where this subsidiary produces electrical-electronic control components systems and other products for Canada's fast growing industrial and commercial market.

The Mount Vernon R & D laboratory employs sophisticated equipment in development, investigation and quality control of electrical-electronic components. Photo above shows the x-ray diffractometer being used by research scientists for analyzing component materials.

Photo Courtesy Society of Naval Architects and Marine Engineers

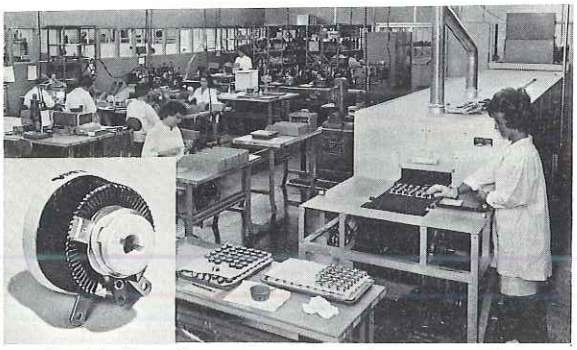


The propulsion control panel illustrated was built in 1962 by Ward Leonard for the USS HUNLEY, a submarine tender designed for support operations of Polaris ballistic missile submarines. The vessel's propulsion system is the second and largest diesel electric A.C. marine installation ever made in this country. The panel controls six diesel A.C. generators supplying power to a single 15,000 HP, 3,300 volt, 3 phase A.C. main propulsion motor.

PRODUCT HIGHLIGHTS OF THE 60's

Developments made in all Ward Leonard product lines from miniature resistors to large complex power control systems have been numerous and varied in the past seven years. Some of the more important developments contributing toward Ward Leonard's continued growth and progress for the period are listed below.

1960 – Tiros, the world's first weather satellite, was launched carrying miniature Axiohm® resistors in the converter for transforming solar cell output to proper voltage. ■ Metohm® precision metal film resistors were first announced. ■ "Reel-Packs", a new form of bulk packaging axial lead resistors for automated assembly, were developed.



Partial view of our rheostat-potentiometer manufacturing operation located at our Hagerstown, Maryland plant. Insert shows finished component widely applied for electronic controls.

1961 – White Room at Mount Vernon plant was established. ■ Silicone wire-wound power resistors were introduced. ■ Axiohm® resistor line was expanded from 3 to 7 sizes. ■ Solitrol solid state lighting controls for theatres, TV studios and schools were announced.

1962 – High reliability Axiohm resistors were used in Telstar, the first communication satellite. ■ Ballistic Missile Early Warning System used Barohm® high current resistors in power supply. ■ 1/10 watt metal film resistor was marketed.

1963 – Non-inductive Axiohm resistors were announced. ■ Conformal coated metal film resistors were developed. ■ Solitrol Controlette "packaged" solid state controller was marketed. ■ 3.6 KW Radiastat autotransformer dimmer was introduced.

1964 – Series 5000 compact, modular NEMA Sizes 0 and 1 A.C. magnetic starters-contactors were announced. ■ Bi-pole high reliability relays were introduced. ■ Surgeohm® high current resistors were developed. ■ 1/20 watt "mighty-mite" metal film resistor was announced.

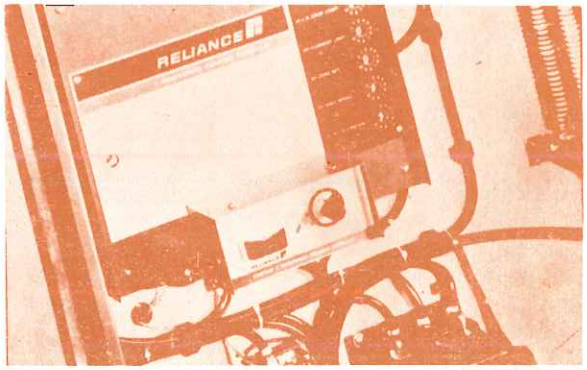
1967—Ward Leonard product lines on display at the Institute of Electrical and Electronic Engineers show held in March at the New York Coliseum.

1965 – Solitrol lighting controls were specified at Metropolitan Opera House, Ball State University and Allied Chemical Corp. headquarters. ■ Low cost Solitrol II dimmer was announced. ■ NEMA Size 2 was added to Series 5000 A.C. contactor-starter line. ■ D.C. mill duty relays and contactors were introduced.

1966 – Regulators, Inc. developed a new static inverter. ■ Automatic solid state battery charger was announced. ■ NEMA Sizes 3 and 4 Series 5000 A.C. contactors-starters were marketed. ■ Underwriters' listings were obtained for Solitrol II and motorized autotransformer dimmers.

1967 – Series 300 A.C. Multipole Magnetic Relays for machine tool and other control applications was marketed. ■ Series 4480 Reversing Contactors were introduced. ■ Series 5000 Definite Purpose Contactors, 30 to 260 amps., for drives and S.C.R. switching were announced.

Photo courtesy Reliance Electric and Engineering Company



Series 5000 modern motor controls find wide application throughout all industries. Closeup view shows a Reliance rectifier power module with a Series 5000DP 110 ampere contactor installed at lower right.

Ward Leonard trademarks of progress through the years. The symbol (at left), indicative of resistance products, was the first trade mark used. In 1946 the center mark was adopted. Today's modern mark (at right) associates Ward Leonard with both the electrical and electronic industries.