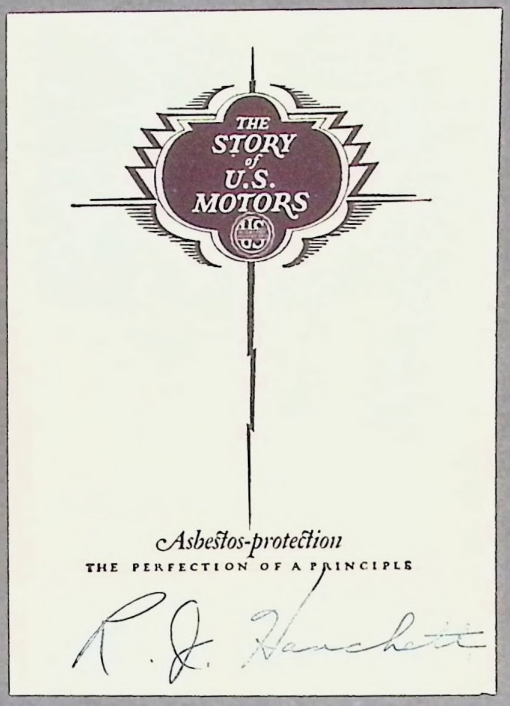
THE STORY of U.S. MOTORS



Asbestos-protection

THE PERFECTION OF A PRINCIPLE

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All works must bear a price in proportion to the skill, taste, time, expense and risk attending their invention or manufacture. Those things called dear are, when justly estimated, the CHEAPEST. *A composition for cheapness and not for excellence of workmanship, is the most frequent and certain cause for rapid decay and destruction of manufacture.*

JOHN RUSKIN

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CATALOG NUMBER 29

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The Story of U.S. Motors

Highlights on advanced motor design....discussion of inherent advantages of Asbestos Protection....the perfection of a principle.... exclusive features of design ....and the story of manufacturing facilities behind the Product.

U.S. ELECTRICAL MFG. CO.

LARGEST MOTOR MANUFACTURERS IN WESTERN UNITED STATES

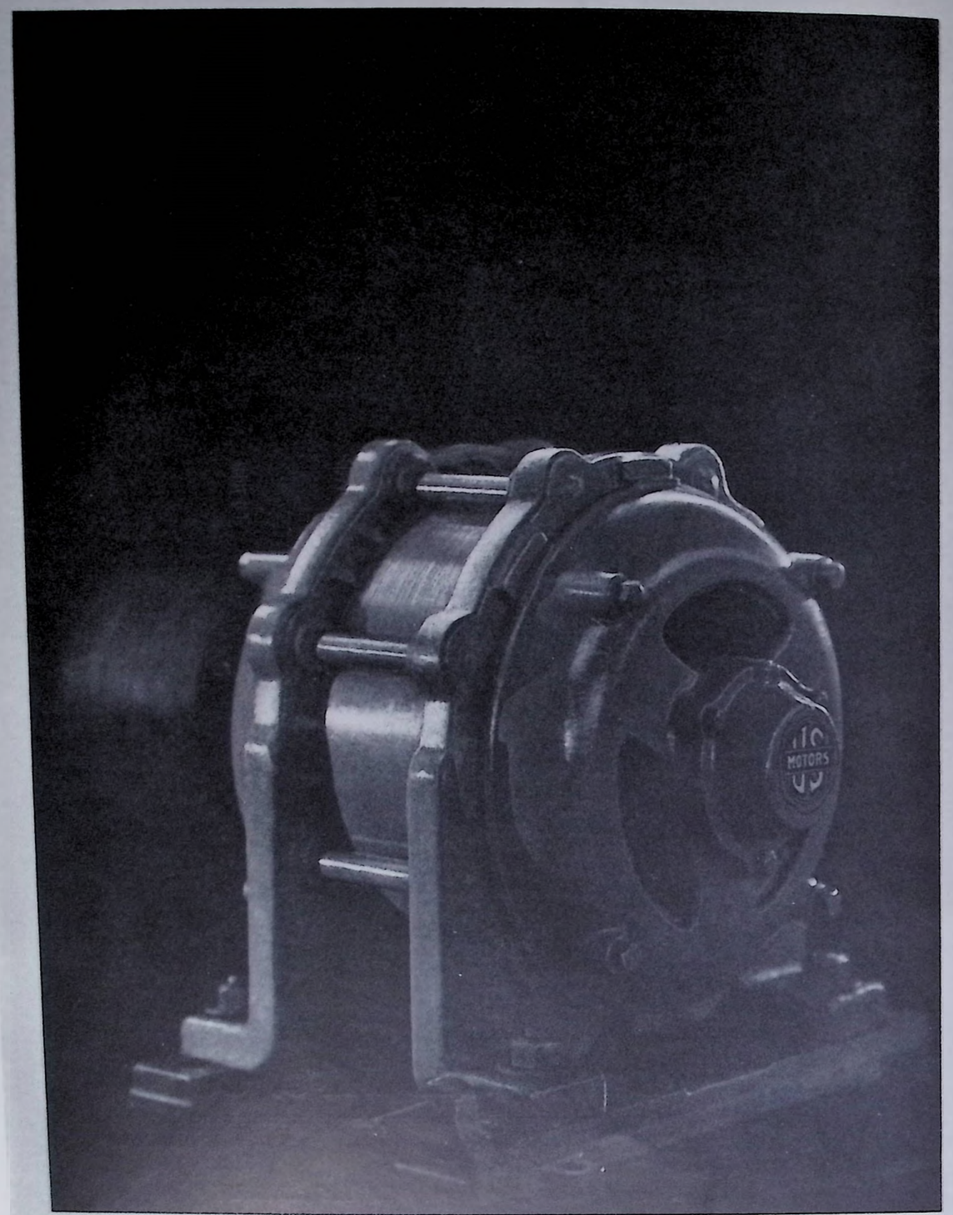
Main office and factory:
200 East Slauson Avenue, Los Angeles, California, U.S.A.

Branch Office and Warehouse:
236 FREMONT STREET, SAN FRANCISCO

Branch Office and Warehouse:
2207 FIRST AVENUE, SO., SEATTLE

Eastern Warehouse:
BUSH TERMINAL, NEW YORK CITY

DISTRIBUTING OFFICES IN PRINCIPAL CITIES



CASTING ASIDE precedent, new principles are reflected in the design of U. S. Motors, of which the outstanding departure is the perfecting of asbestos protection, to prolong the life of the Motor.

Straight-line production IN BUILDING U. S. *asbestos-protected* Motors

TWENTY-ONE YEARS ago, in 1908, the manufacture of U. S. Motors began. The years since, marked with uninterrupted development, have brought a maturity of knowledge and refinement in design that is impressively obvious in the present U. S. Motors. There is an element of pride in the fact that even the earlier U. S. Motors were well built. Today there are U. S. Motors of 1908 origin—in fact, a goodly portion of that charter year's production—still doing their work. An example is the installation of U. S. Motors on the Panama Canal, built years ago, which are at this moment performing faithfully for the United States Government.

The present design is of such an indestructible character, so well built and so consistently manufactured, that a new meaning is given to the term "dependability." Consistent and ever-striving effort, devoted solely to the development, design and production of motors, has brought to U. S. the well-earned recognition as a leader in the motor industry. To the prospective purchaser an investigation will disclose the knowledge that the U. S. establishment is one of the ablest motor organizations in the country, undeniably the largest in Western United States, and with a record of successful achievement in motor manufacture that is altogether unusual and outstanding.

Concentration on One Product

Every successful institution has a standard of merit toward which it strives—a plan of service precedent to profits. This is the very spirit of the business.

This objective permeates the directing personnel of the U. S. organization and inspires a constant, steady purpose to build well the product. And to this end the organization concentrates solely and exclusively on the producing of electric motors. Belief in this principle of intensive effort applied to one product has been justified by the degree of refinement in manufacture and quality in output.

U. S. Motors are an advanced expression of well-conceived ideas. This may be confirmed in any plant where they are operated.

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The Latch-String is out at the U. S. Factory, bidding visitors welcome to witness the manufacturing processes in the making of U. S. Motors.

The Manufacturing Plant of U.S. Motors

SITUATED on a site of over five acres, the U. S. manufacturing plant is the most modern of electrical factories, both in construction, layout and facilities. These new buildings were designed with a definite, predetermined intention of erecting the most highly developed plant of its kind, with all work allocated for efficient input of raw materials and output of finished product, so that each department, coordinated, would function as a unit in perfect relation with *straight-line production* and progressive assembly. From the beginning of the first operation through to the completed motor, crated for shipment, the individual parts move uninterruptedly through the various processing phases and operations in close line to sub-assemblies, and on to final assembly, finish and inspection.

Main Production Building

UNIT NO. 1

The central Machine Division occupies three fifty-foot bays of the Main Building, these bays paralleling the entire length of the structure.

Production of machined parts progresses from one department to the next on the same floor level and in co-ordination without leaving this division until completed assemblies are finished.

Automatic machine tools account for most of the standardized machining operations, reducing time of manufacture and corresponding economic cost. A single operator mans two to four automatic lathes, which is the equivalent of six to nine men operating hand tools and greatly facilitates increased output. Variations in finished parts are eliminated by automatic machining, and hand operations are reduced to a minimum throughout the plant.

Separately housed from the Main Building are the other manufacturing units producing Cast Rotors, Asbestos Insulation, Annealing Operations, etc. The production from these contiguous units flows into the Main Building for fabrication and assembly.

Scientific lighting, both for day and night operations, offer ideal working conditions.

To a visitor in the Machine Division an impressive feature is the fact that as far as the eye can see there is not a single overhead line shaft or belt. Each machine stands apart and is individually driven by its own direct-connected motor, making for efficiency in producing a multitude of parts that daily progress through this section.

In this building are included the Machine Department, Tool Department, Winding and Assembly Departments, also the Electrical Testing Department and the plant Executive Offices.

CONCENTRATED EFFORT

in the development of One Product will earn for any Institution the Reputation for Achievement

Rotor Casting Plant

UNIT NO. 2

Building No. 2 is devoted exclusively to die-casting, and the manufacture of cast parts. Here the U. S. die-cast aluminum rotors are processed completely, through the pre-heating, furnacing, molding, die-casting, and finishing. An improved system of pyrometric heat control, proof against variation, guides the pre-heating, casting and cooling of the die-casting process. Important in the manufacture of U. S. aluminum rotors is the development of various combinations of aluminum alloys which are made use of in this department, and the system has been highly refined for this particular work.

Asbestos Insulation and Asbestosite Departments

UNIT NO. 3

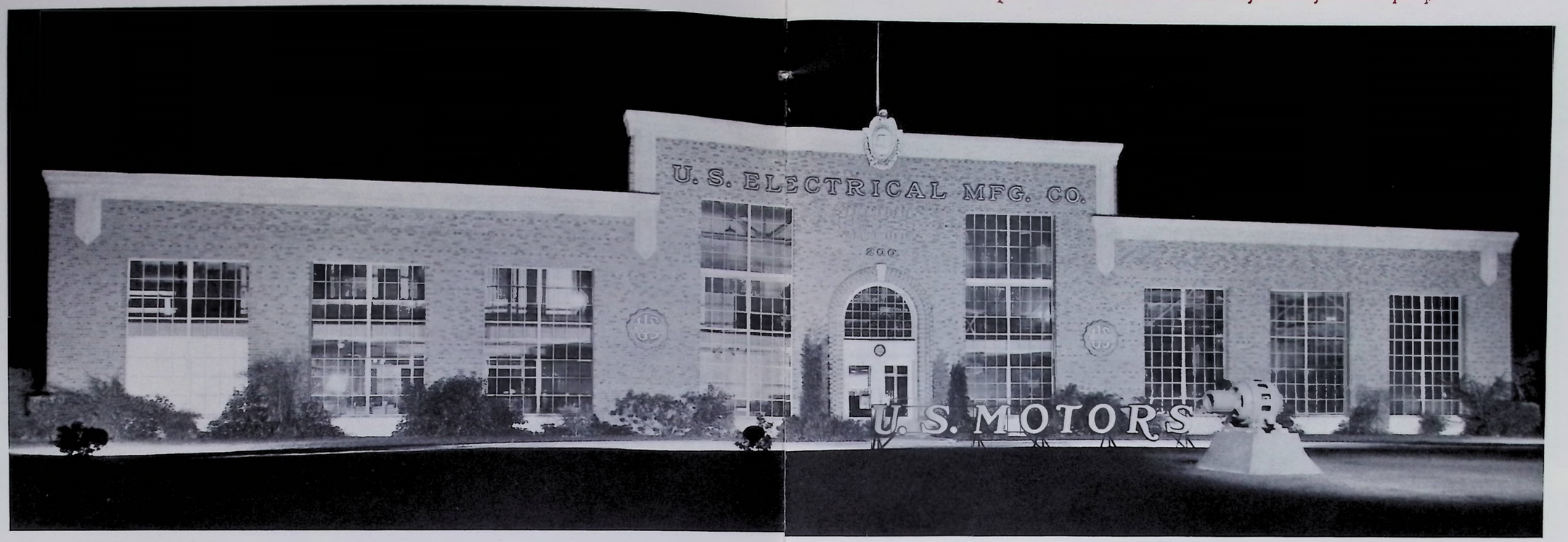
This unit is provided primarily for the manufacture and processing of Asbestosite and asbestos insulation, which is exclusively used in U. S. Motors. The basic material, asbestos, is especially treated, fabricated and finished in the required form for use in the insulation of the motor windings. It was necessary to erect this building to produce asbestos insulation for the reason that the manufacture of special asbestos insulation and Asbestosite had never been developed by any other plant. Starting basically with the raw material, asbestos, it was essential to develop means of preparing and processing it, both in sheet form and in the compound Asbestosite, for application to the motor.

The impregnating compound, Asbestosite, was exclusively a U. S. conception and development, originated by U. S. engineers, and it is used for the purpose of completely isolating each wire in the windings of U. S. Motors, to prevent carbonization.

Compounding, drying and curing equipment is provided. The production of Asbestosite requires the pulverizing of raw asbestos to a powder so fine that it must be mixed into a colloidal suspension to bring it into proper state for use as an impregnating compound. Special moisture-excluding means destroy the hygroscopic attraction in this compound so it is positively moisture proof.

The diluent, used for working Asbestosite, is highly volatile, facilitating permeation of the windings and is driven off in the baking process during hardening of the compound.

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Administrative Offices

—night view of Main Building

Executive, Sales & Engineering Division

Heat Treating

UNIT NO. 4

In this department the scientific annealing of electrical sheet steel and of cast iron parts is carried on. Every gray iron casting in a U. S. Motor is annealed. This seasoning, or ageing, of the iron is accomplished by proper heat treatment to remove internal stresses in the metal, so that perfect alignment of parts is permanently fixed.

Annealing ovens, fired with both gas and oil, are arranged for continuous operation, with doors at each end of the furnaces. Loaded cars of castings enter in one end, pass through the furnaces, and out the opposite end, during a cycle of time predetermined to properly anneal the metal. The furnaces are thus continually "on heat" and never cool except for overhaul.

After removal from the furnaces the cooling of the castings is retarded, so that the complete treatment in the annealing process ages the castings to the equal of, approximately, a year of air-seasoning.

Vertical disc-grinders, stationary and horizontal grinders and flexible grinders are provided in this building for roughing and finishing the gray iron parts.

Here in this department are also located heat-treating furnaces for preparing silicon electrical sheet steel used in the rotors and stators. The temperature of the furnaces during this cycle of treatment of the electrical sheet is indicated and controlled by pyrometers in such a way that nothing is left to the judgment of operators. Design of the furnace equipment is of the indirect type, in order that no flame reaches the "charge," resulting in the metal being evenly heated.

Every pound of silicon electrical sheet steel used in U. S. Motors is annealed twice—once at the steel mill before shipment, and then again *after* the punched discs are finished in the U.S. Plant. This double annealing reduces the electrical losses in the steel to a minimum, which contributes to the good electrical efficiency of the finished motor.

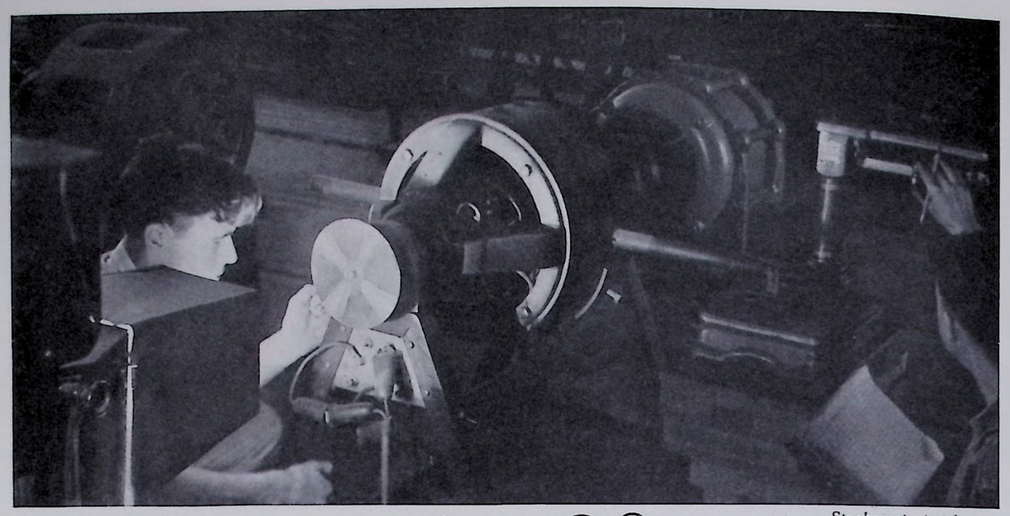
Inter-connected Buildings

Basic raw materials, such as electrical sheet steel, shafting, gray iron castings, etc., are stocked in storage houses adjacent to the Main Building.

While most manufacturing plants endeavor to keep surplus material stocks within reasonable limits, it is nevertheless necessary to carry a reserve of raw materials to feed production without danger of interruption where straight-line production is planned. Therefore, to forestall delay in any department, sufficient raw materials are maintained in storage to operate the plant for a minimum of three months.

Buildings are inter-connected with concrete runways for quick and easy movement from one department to another. Specially designed steel platforms and containers are provided for semi-finished and finished parts, so that these materials may be moved with a minimum of labor and a maximum of speed in handling.

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Stroboscope test in U. S. Laboratory.

Research & Experimental

SEPARATELY located from the Engineering, Designing and Production Divisions, a department is maintained for experimental and laboratory developments and observation tests.

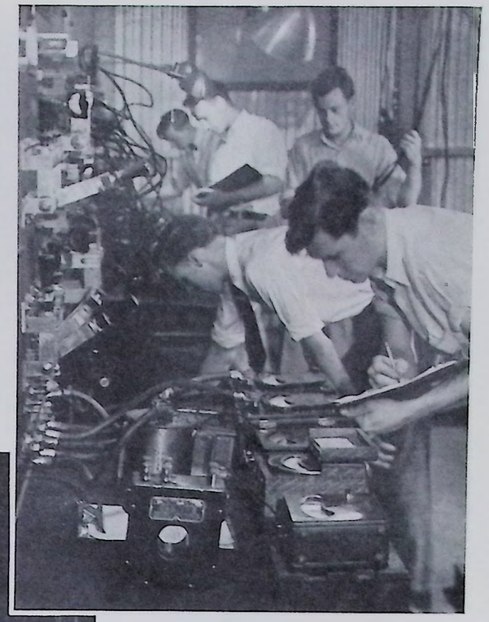
To this division is accredited the conception of such epochal developments as the AutoStart Motor, Cast Aluminum Rotors, asbestos-protected windings, the impregnation compound, Asbestosite, and other U. S. contributions to motor science.

Part of the work of this division includes study of ball-bearings, the chemical tests and observations of insulation composition, the development of asbestos windings, study of silent type motors for heating and ventilating work, the limits of fatigue and the hardness of metal used in the product, life tests of new motor construction, the technical checking and testing of changes in standard product, etc.

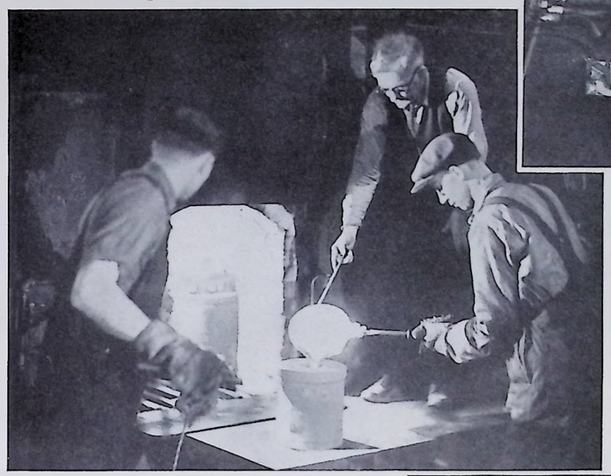
No new design or change in standard product is released to the manufacturing division until complete observations and life tests are finished, and final approval has been given by the Engineering Committee.

An interesting example of the work of this department is illustrated in a series of life tests recently completed for the purpose of determining the quality of Asbestos insulation in stator windings. This particular subject extended over a period of many months, during which time 93 motors were placed on test under extreme loads. Overloads were increased steadily day after day, until each motor finally failed. Observations were recorded of the behavior of each motor. When failure occurred, inspection disclosed the point of weakness; then new stators were wound, the weak points of the dielectric or mechanical parts rectified, and another life test repeated for observation. Ultimately a motor was produced which withstood a temperature of *608° F.* Although 93 motors were destroyed in this research, a conclusive result was secured that advanced the quality of asbestos-protected motors to such an extent that the time and cost of the work were fully justified.

Another example may be referred to which suggests the value of experimental study. A performance run was completed requiring 24-hour continuous operation for eight months. In this instance ball-bearing testing machines were set up, each equipped with mountings for the retention and loading of different test bearings. Tension devices imposed on the bearings a predetermined overload. A driving motor was applied to the testing machines to cause bearing rotation. Once started, the bearings under test were rotated without cessation for weeks, until failure occurred. Thus the performance and life of each bearing was established, data tabulated and compared, which determined the best bearing for production use in the various ratings of U. S. Motors.



Recording observations during experiments.



Making sample casting of aluminum rotor.

Other developmental work includes the study of special insulating mediums to resist deterioration in unusual installations. A case in point is the production of motors to withstand atmosphere permeated with raw caustic. These motors were mounted over lead ore melting caldrons where the ambient temperature was 250° F. Caustic fumes arising from the molten lead made it impossible to operate motors with ordinary insulation. Protective insulation was created to withstand these extraordinary conditions.

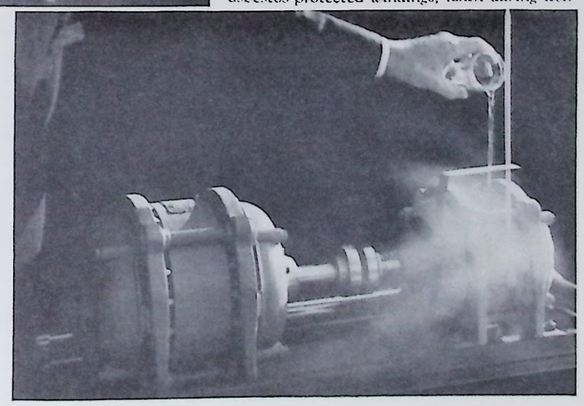
Laboratory Studies

Experimentation with various alloys of aluminum, to secure special characteristics in the cast rotor of the AutoStart motor, is carried on in this division.

Composition of lubricants and their practical application in motor bearings is proven out with life test to ascertain the best materials for such use.

The work of the Research and Experimental Department is supplemented by laboratory studies and the research facilities of the California Institute of Technology.

Popular demonstration of heat-resisting quality of asbestos-protected windings, taken during test.



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Experienced tool-makers check manufacturing gages with Johansson Gage Blocks. Every manufacturing gage is periodically compared for accuracy.

The Refinement of accuracy

ENGINEERING exactitude in design is ably supported by precision methods in the U. S. Plant. Given good design in product and high quality in materials, the remaining link in the chain of production is *accuracy*, without which the product hazards its life.

Good design is a matter of engineering policy, experience and ability; but quality of materials and accuracy of production are elements that must be daily and hourly guarded, else the finished product is not consistent year in and year out. The U. S. gaging and inspection system is highly organized, constantly checking against error—human or mechanical. Throughout the making of U. S. Motors the finished parts are insured by fixed gaging.

Automatic machine tools guarantee a standard of machined parts and furnish an unbroken flow of production, invariable as to dimensional accuracy and consistently economical. Much of the machinery was especially designed for the particular manufacture of U. S. Motor parts.

Johansson Gage Blocks —the Master Guide to Accuracy

Practically the only possible variation in dimension in any finished part produced by automatic machines is in the wear on the edge

of the cutting tools. To guard against such variation each finished piece and part is checked with fixed limit gages.

A portion of the work must, of necessity, be performed on hand-operated machines. Here the human element enters. The skill and judgment of different machinists varies with the man, and there is always the possibility that some finished piece may not be a duplicate counterpart of other similar pieces.

To obviate error, each machinist is provided with production fixed limit gages, for practically every operation. These fixed gages are set with tool-maker's accuracy. Once set they are not adjustable by the operator. Each part is checked by an inspector with duplicate limit gages, guaranteeing against variation. Go and no-go gages, snap gages, limit gages, height gages, internal and external gages, are checked periodically with Johansson Gage Blocks.

Johansson Gage Blocks are universally recognized as the standard of precision measurement. They have no counterpart in science or industry. They measure accurately in millionths of an inch. As an indication of the accuracy standards maintained in U. S. fixed gages, the subject of Johansson Gage Blocks is quoted from the 12th Edition of the Encyclopedia Britannica, Volume 31, as follows:

"The decade 1910 to 1920 saw a noteworthy development in every branch of machine-tool engineering. In no branch was the progress more marked than in instruments for precise measurements. Their perfection has made possible the production of interchangeable parts in commercial quantities. Without means of accurate gaging the making of automobiles in great numbers would be impossible. For accuracy and almost universal application, the gage blocks made by C. E. Johansson, Eskilstuna, Sweden, stand high. The first combination set on his system was made in 1897. They are also in constant use at the National Physical Laboratory, London; the National Bureau of Standards, Washington; the Bureau International des Poids et Mesures, Paris, and similar institutions of all the principal nations."



A typical set of JohanssonBlocks used for checking U. S. manufacturing gages. These Blocks are the standard of precision measurement.

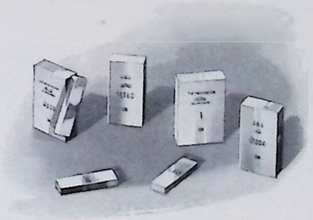
The men trained in the U. S. Plant to check manufacturing gages with Johansson Gage Blocks are instructed in the use of these highly precise standards of measurement. Working gages are checked to a tolerance of 1/100,000 of an inch.

The U. S. precision refinement goes a step further, and these master gage blocks are checked by the most delicate measurement of dimension known—the light wave interferometer—which is capable of detecting gage inaccuracies of 1/1,000,000 of an inch.

Testing of Individual Parts and Assembled Motors

Before machining operations begin each casting is thoroughly annealed and seasoned to relieve internal strains and stresses, so that once machined and finally finished the dimensions are fixed permanently for the life of the motor: Otherwise there would be a possibility of warping or distortion which, even slight, might impair the motor's durability.

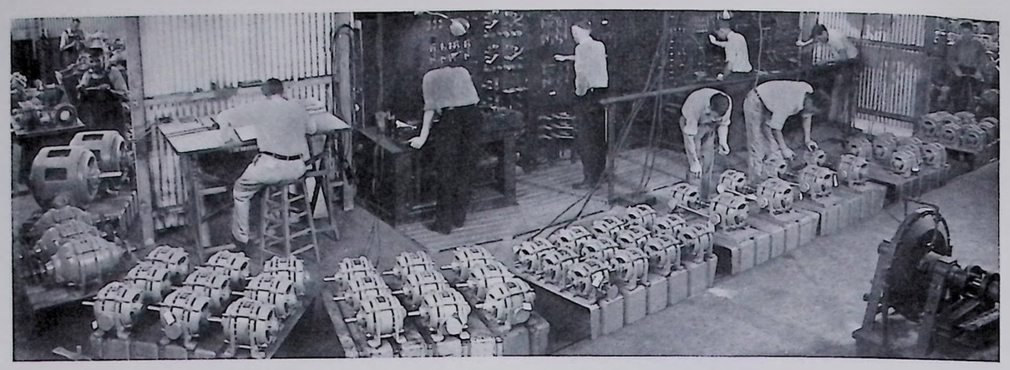
Certain parts require materials in which hardness of metal is vital. Steel shafting, inner and outer races of ball-bearings, bearing locks, molds for die-casting rotors, cutting tools, key stock, etc., must be treated for hardness and homogeneity of composition.



Surface hardness tests are made with direct-reading scleroscopes. Hardness through the body of the metal is tested with Brinnel hardness-testing machines. Electrical testing of electrical sheet steel is standardized and the Epstein method is accepted, by mill and manufacturer alike, as authoritative. (For illustration, refer to Page 34.)

Maintaining accuracy in the manufacture of U. S. Motors, as explained above, every finished part passing inspection is a duplicate and counterpart of its kind, standardized and interchangeable.

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Motors passing through electrical test. Each unit progresses through a fixed routine for observation and recording.

Electrical Testing

No Manufacturing plant may hope to keep pace with the developments and demands of industry in these days, unless equipment and engineering talent are maintained to carry on vigilant research and to constantly test product going into the daily output.

Standard tests are made on every U. S. Motor to prove correctness in winding and connecting, to observe core loss and exciting current, to check air gap clearance, to ascertain that speed is normal in R. P. M., and to guarantee that insulation dielectric strength is up to or above A. I. E. E. requirements.

All designs and ratings are individually tested for performance in efficiency, power-factor, no-load saturation, locked saturation, speed-torque, insulation and temperature rise.

Final electrical tests and mechanical check-up are made on all motors as they pass through the Testing Department. The test tag must be certified before any motor can be passed into stock.

Detail of Tests

Temperature Rise. U. S. Motors are designed to a standard of 40° C. rise, in accordance with the A. I. E. E. rules. Thermometers are applied to the hottest accessible parts of the motor. Motors are run at rated load until temperature is constant. Ambient temperature is measured by placing several thermometers at different points around and half way up the machine at a distance of one or two meters and protected from drafts and abnormal heat radiations. These latter thermometers are located in the path of the cooling air.

Running Tests. Each motor is checked with a tachometer for speed. Stethoscopes are used to detect possible bearing fault and to observe any unusual rhythm tone or beat which might be caused by misalignment of bearings.

Speed Torque Tests. These tests determine the ability of the motor to exert its torque at different speeds from zero to synchronous speed.

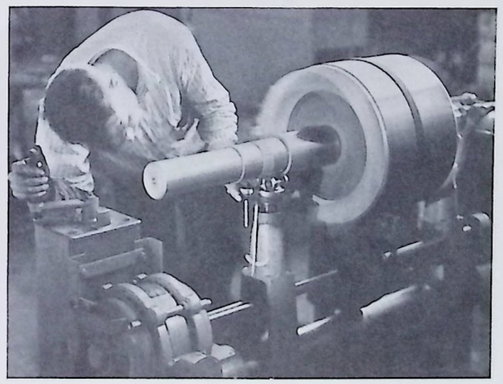
No-load Saturation Tests are made to observe core losses, copper loss, friction and windage losses. The results are required to calculate the efficiency of the motor under the rules of the American Institute of Electrical Engineers. Dynamometers are used to indicate the power output at different loads.

Locked Saturation Tests disclose the amperes flowing and watts consumed, the foot-pounds torque exerted by the rotor when locked on predetermined various test voltages. The ampere readings indicate the starting current taken by the motor when thrown on the line. The watts consumed, together with the amperes observed, are factors to determine the performance of the motor under the circle diagram method.

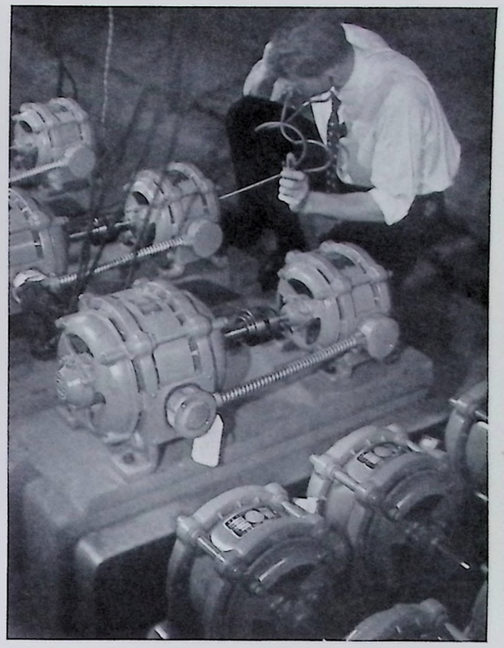
This test also establishes the starting torque—the ability of the motor to start its load.

Tests for Silence. Certain applications require Silent Type Motors. Such motors are tested by mounting on a sounding booth. Inside the booth the operator uses an Oscilloscope to duplicate the tone and thus determine the natural frequency of the motor's note. Knowing this, the cause of undesirable tone can then be rectified.

Mechanical Check-up. As motors pass through the electrical test, observation is made of bearing alignment and end-play to make certain that mountings and bearings are perfect. Air-gap gages check the running clearance between rotor and stator laminations. The rotating unit, consisting of the bearings and rotor, with its shaft and key, is tested for balance.



Dynamic balancing machines provide means for determining accuracy of balance.



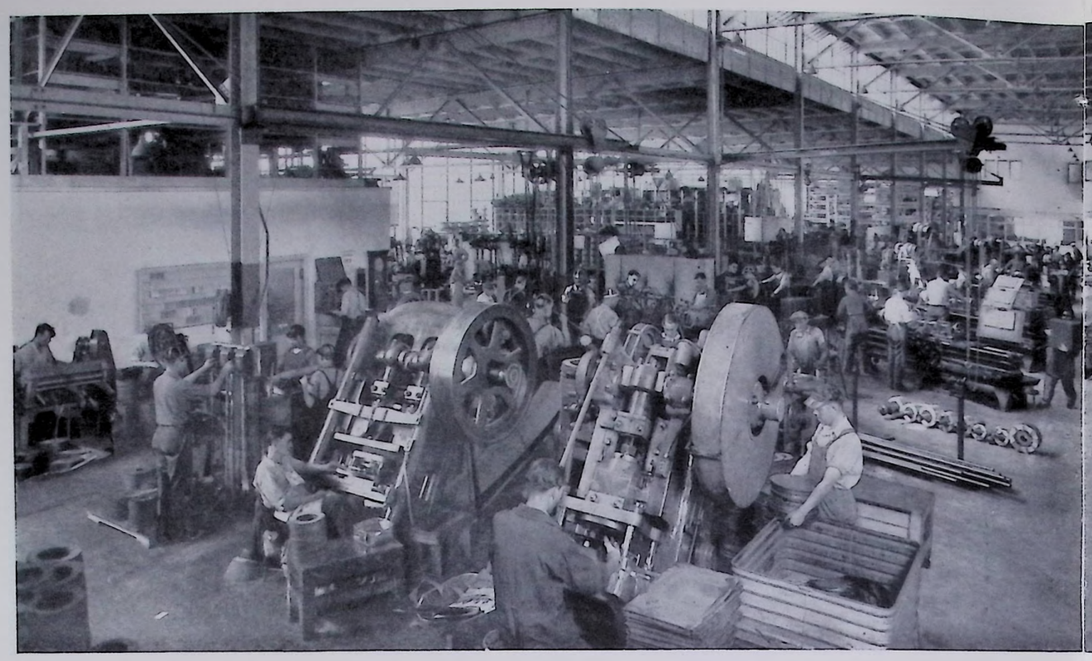
Stethoscope testing of motors to detect any unusual rhythm, tone or beat.

Testing Equipment. Complete facilities are available for thoroughly testing all types and ratings of motors. The standard production motors are conveyed to and pass along a specially-designed switchboard, which is laid out for quickly connecting, disconnecting, switching and testing. Every motor must go through this routine of tests in a predetermined system before it can be released to the Shipping or Stores Departments.

The A. I. E. E. Rules for
ASBESTOS INSULATION

The rules of the A. I. E. E. approve Asbestos insulated windings for operation at 70° C. rise. This is authoritative recognition of the superior quality in Asbestos (non-carbonizing) insulation. Although U. S. Motor insulation qualifies according to the A. I. E. E. rules, safely for 70° C. rise, the motors are designed so that the temperature rise is less than 40° C. This is proof of the additional safety factor in U. S. Motors, which gives years of additional life and lessens the risk of failure in operation.

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Central bay of the Machine Department. Three similar bays parallel the length of the building.

Production *Operations at a glance*



Gaging boring mill operation.

Machining Stators

Because of the fact that the stator is the mechanical foundation of the motor, the process of machining operations should follow the best mechanical procedure. There are several methods of performing this work. The best practice is to finish the bore as the last operation to assure its concentricity with the rotating element.

U. S. stators are machined according to this correct practice.

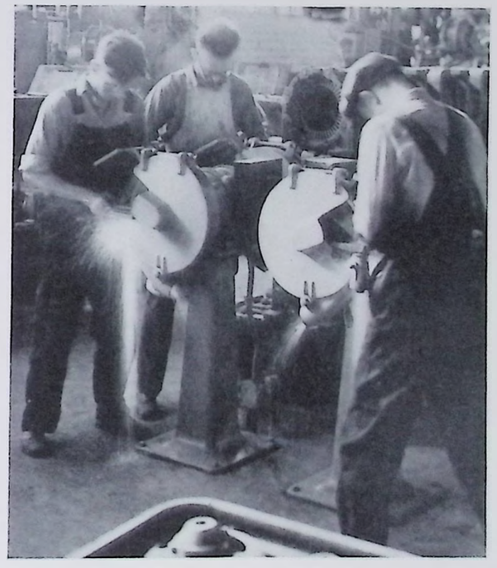
The stator of a motor is a combination of cast iron frame parts plus a collection of many steel disc laminations, and all of these separate multi-parts must form a solid, self-supporting foundation.

Ordinary rudimentary practice would machine these parts separately, then assemble them, trusting to accuracy of machine cut and perfection of labor operations in assembling. But any error in machining, even though slight, or any variation, which is always possible in assembly, results in an imperfect structure.

Correct procedure is to assemble the parts, then clamp them under heavy pressure and thus form a solid unit. Final machine operations follow to complete the stator. This is just an example of correct mechanics in the manufacture of U. S. Motors, which indicates the care in constructional detail.

Parts and Sub-assemblies

Passing along from machine to machine, the various pieces are either completely finished or collected into sub-assemblies. Sub-assembled units, such as the stators, are finally machined as a unit. In the progress of machining, each piece is checked by an inspector to determine the operator's work.



Pedestal-mounted direct-driven Grinders for dressing castings

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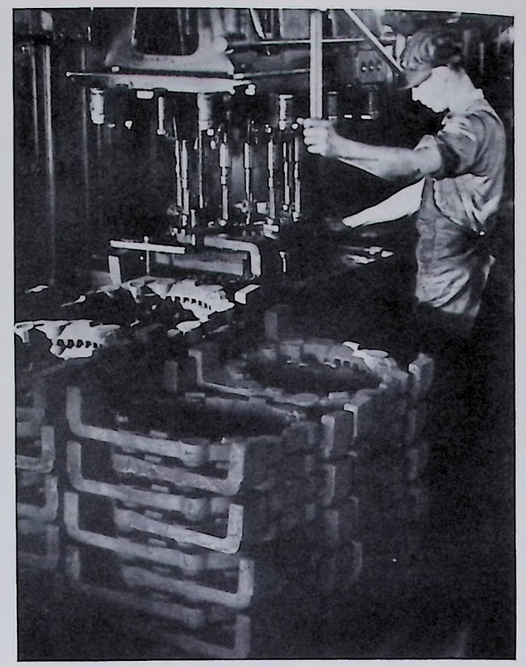
Incidental Views of several Production Stages

The photographs on these pages show the progress of parts and sub-assembled units during processing. Indication of the refinement of design is shown in the illustration of the internal grinding of the stator bore and the sensitive dynamic balancers for perfection of balance in the rotor. Grinding of laminations guarantees accuracy of air-gap dimension. Ball-bearings insure permanency of uniform air-gap.

Drilling Operations

For the rapid production of drilled parts this department is equipped with multiple spindle high-speed drilling machines.

Since all castings are annealed before reaching the machine division, it is possible to make use of high-speed drilling for economy as well as to increase capacity for output.



Multi-spindle drill press operation.

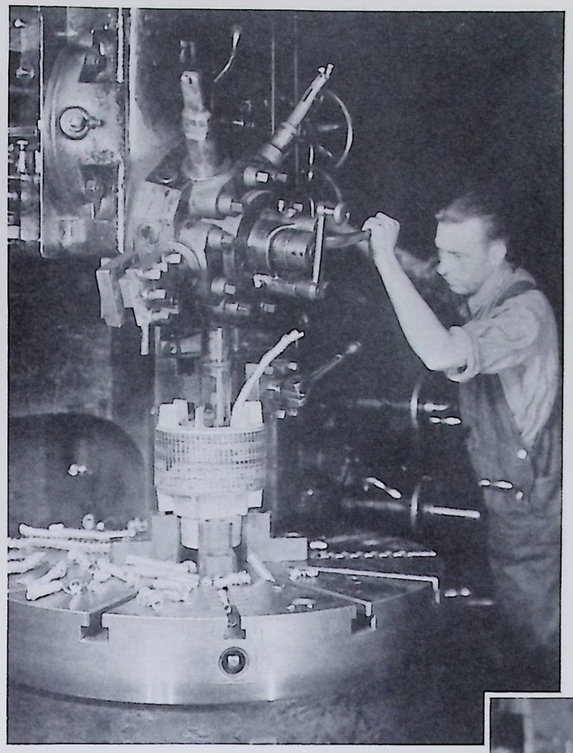
The view to left shows internal grinding of stator laminations. The internal bore of the stator laminations is machine-ground to establish perfect air gap dimension between stator and rotor.



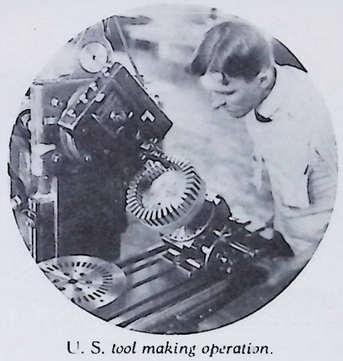


Vertical disc grinding of rough finished parts.

These machines were designed and built in the U. S. *Factory. They are equipped with high-speed vertical motors, with chrome nickel shafts for heavy duty, to rough off many parts simultaneously.*



Boring Mill removing aluminum risers from rotor preliminary to finishing the periphery of the rotor laminations.



U. S. *tool making operation.*

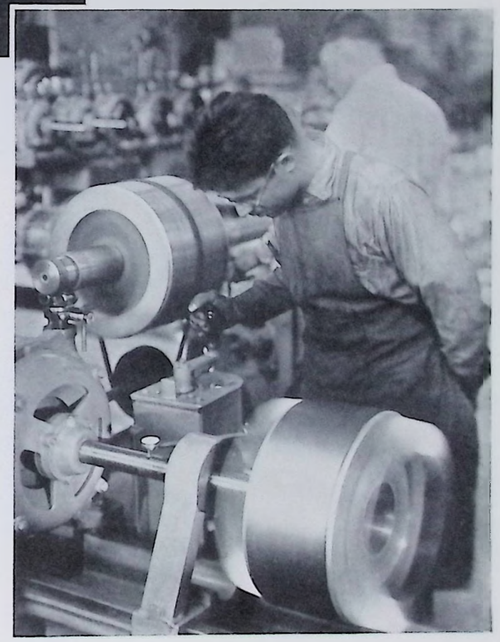
Dies, tools, jigs and fixtures required in the manufacture of U. S. Motors *are designed and constructed in the* U. S. *Tool Department. Tool makers—veteran experts in the design of dies, jigs and fixtures—work under the supervision of a master tool and die expert.*

Rotor Finishing

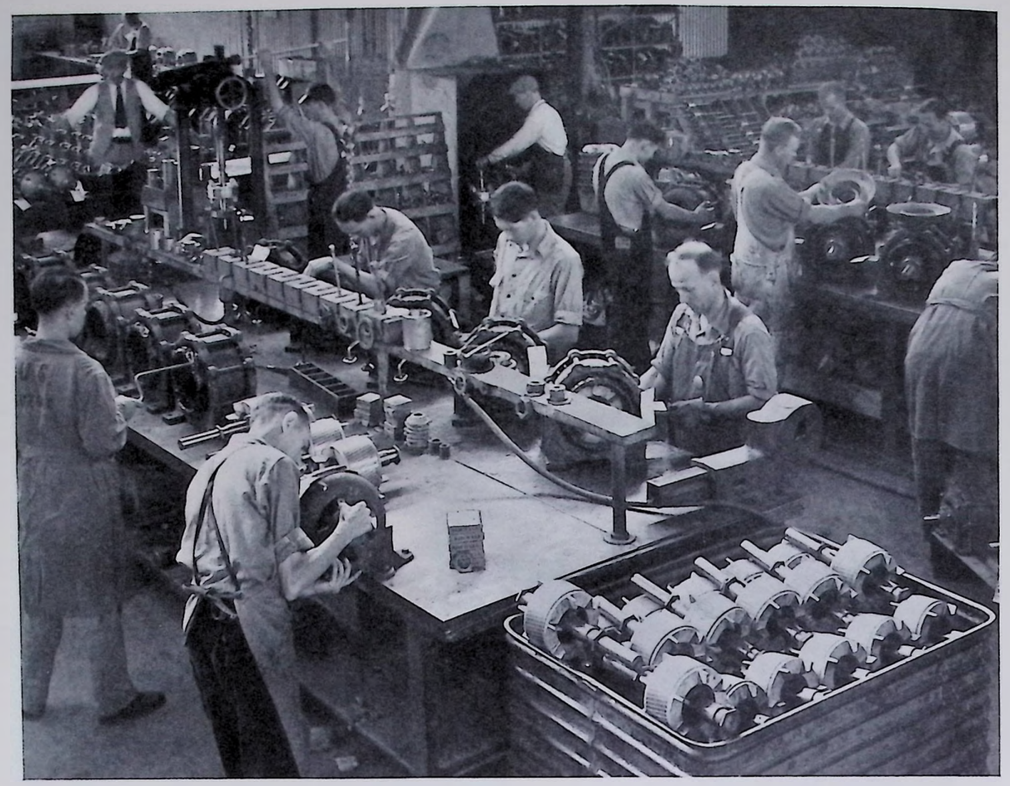
The view to the left shows a cast rotor immediately after removal from the Die-casting Department. The only operation necessary is to cut away the aluminum risers and finish the outside periphery of the steel laminations.

A common cause of rotor failure is due to high resistance spots opening the bars or rings. This is effectively eliminated by the U. S. process of casting the squirrel-cage rotor in one piece. Loose bars are unknown, for this casting process completely anchors the squirrel-cage windings into the laminations. There are no joints of any kind in the one-piece cast U. S. squirrel-cage rotor.

The view below shows rotors mounted in dynamic balancers equipped with indicators.



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Close-up view of one of the assembly benches in the Assembly Department.

The Assembly of U. S. Rotors and Stators

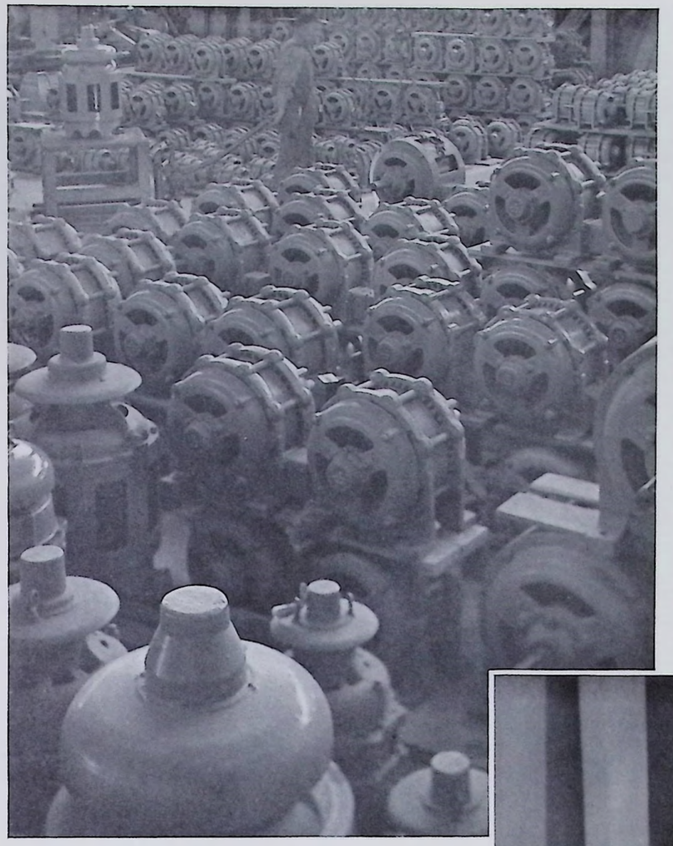
When the rotors and stators are completed into a sub-assembly, they are then conveyed to the Assembly Department. Here the first operation consists of air-pressure cleaning to remove any dust or dirt, after which ball-bearings are mounted on the shaft of the motor.

In the mounting of ball-bearings scrupulous care is taken to prevent the intrusion of dust, dirt or foreign matter. Bearings are not removed from their cartons until the operator is ready to make the installation. Immediately thereafter the rotor and bearings are assembled into the stator bearing housings, which are sealed tight against contamination from the outside. In addition to the usual felt washers recessed into the end brackets, the U. S. bearing housings are designed with an extra grease groove cut around the inside periphery of the mounting. This forms a second grease seal for the retention of lubricant and the protection against foreign matter from the outside.



Annealing furnace for heat-treating cast iron parts.

Annealing of castings is an unusual operation for treatment of motor cast parts, for it is generally thought unnecessary to add this course of refinement to the work. However, in U. S. Motors this is done to make certain that castings will not warp or skew in the finished product. The lower illustration on page 18 shows charge of castings entering heat-treating furnace.



Finished motors ready for crating.

Finishing and Painting

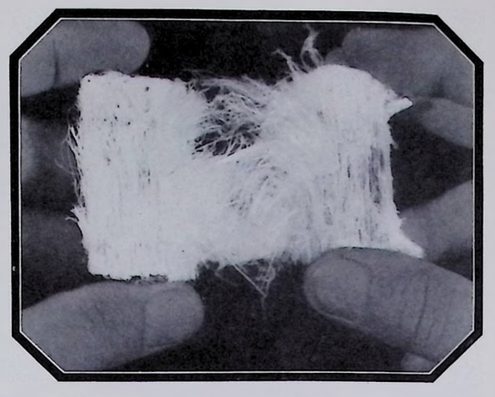
While electrical motors are not primarily designed to attract the eye, U. S. Motors do present a most pleasing appearance when mounted on any driven machinery. The motor castings are first given a coat of filler, after which two coats of Battleship Gray are sprayed on in the final operation of painting.

In the production of U. S. Motors *the operations are allocated for the efficient flow of raw materials through to the finished product. Each department is co-ordinated as a unit in relation to all other departments for the purpose of rapidly and accurately securing* straight-line production.



Final application in the Painting Department. Spraying motors with a finishing coat of gray enamel.

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Asbestos is a fibrous rock that has not changed in character or formation for thousands of years and is the only known fibre that is absolutely incombustible. *This is the protecting element in* U. S. Motors.

Building Asbestos into U. S. Motors

THE LIFE of a motor is proportional to the life of the insulation protecting the windings. As carbonization progresses, the insulation chemically and physically changes from an insulator to a conductor, and thus destruction of the winding is threatened from the failure of the very thing that was originally designed to protect it.

Heat originates from two sources in a stator—(1) from the steel core and (2) from the windings. Windings imbedded in the slots of a stator core are subjected to heat from both elements. Therefore, it is necessary to provide a barrier-shield of insulation between the windings and steel core. This barrier should be designed primarily for heat resistance and mechanical strength. *The problem is heat, not voltage.* This insulating shield is sandwiched between two heat sources—buried in the hottest part of the motor with no chance for ventilation. It is hidden. It cannot be inspected. So if this barrier *carbonizes* the insulation value is gone.

Rewinding electrical motors costs approximately 60% of the price of a new motor. The interruption to service is often more expensive than the cost of rewinding.

Materials commonly used for insulation include varnished cloth, oiled linen, paper, press-board, fibre, fish-board and insulating varnish, but *all of these will carbonize*. Not one of them is fireproof.

Any of these materials, even the best, will deteriorate under the temperatures at which motors are often called upon to operate. The many repair shops rewinding motors furnish proof of the continuous carbonization of motor windings.

Asbestos Insulation

While there is no way of protecting motors to guarantee perpetual life, there *is* a method of insulating the windings so that the life will be infinitely increased and the danger of breakdown minimized.

Casting aside precedent, U. S. engineers developed Asbestos insulation to replace carbonizing materials. Asbestos is the greatest of all pliable, heat-resisting materials, *because it cannot carbonize*. Being soft and flexible, it is an insulation that can be folded and worked into the windings.

Producing Asbestos Insulation

When asbestos insulation was developed for U. S. Motors there was no manufacturing plant in the country which offered the facilities for processing asbestos fibre suitable for U. S. Motor application. No manufacturer of ordinary insulation was equipped, either with machinery or knowledge, to make asbestic material of the kind required, so it was necessary for the U. S. organization to devise means for producing this material.

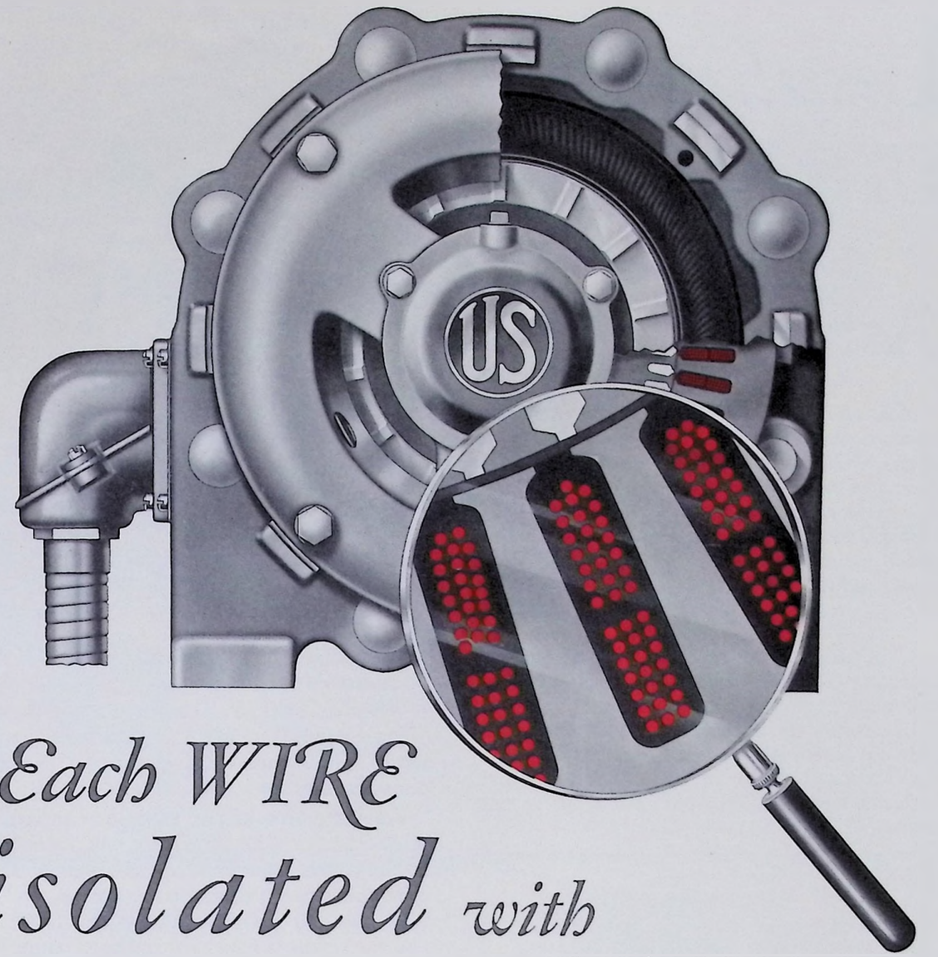
The pure asbestos is first treated to render it moisture-proof. Sheet asbestos is cut and molded to conform with the perimetrical shape of each stator slot. Die-cut shapes are made to fit between coils and between phase windings where coil ends are nested.

Separators are formed from thick asbestos plate-board, for insertion between coil sections of every slot.

The impregnating compound Asbestosite is produced by reducing asbestos fibre rock to a very fine powder. This asbestos base is held in colloidal solution with high volatile diluents which are driven off after the compound permeates the windings.

Through baking and particular curing means, the Asbestosite is hardened and forms a solid, intimately attached to and isolating every turn of windings.

The patented means for introducing Asbestosite into the wound stator is more fully described on the following page.

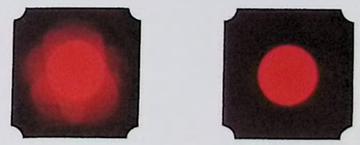


Each WIRE isolated with Asbestosite

To POSITION the individual wires inside the stator slots, so that Asbestosite may be introduced around each wire, the U. S. patented method of coil separation was conceived. An interrupted current is passed through windings *while the Asbestosite impregnates them*.

The individual wires of the windings oscillate and vibrate gently, which accomplishes two results. The movement agitates and churns Asbestosite into the windings. Each wire separated from its neighbor becomes encased in Asbestosite. All interstices between wires are displaced with the compound.

This relative movement of the wires with respect to one another is the means of permitting the Asbestosite to be forced into the windings and around every wire in the slots.



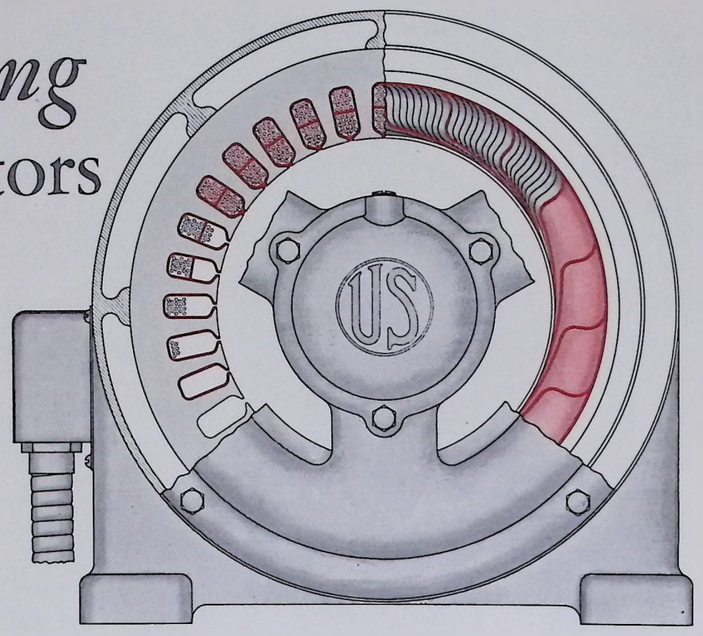
Distributing Asbestosite throughout windings

Photographic interpretation showing cross-section view of a wire in vibration, as produced by the U. S. patented method for inductively creating this action.

Photographic interpretation of the same wire after the inductive movement has ceased. These two views are illustrative of the principle of gently vibrating the wires.

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Insulating U. S. Motors *with* Asbestos

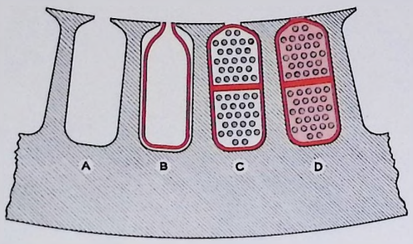


Asbestos is built into U. S. Motors *for protection of the electrical windings. The progressive drawing on this page is a graphic delineation of the Asbestic Process, showing in detail the employment of asbestos and Asbestosite.*

The progressive steps of winding and insulating U. S. Motors may be followed by reference to the drawing to the right.

An empty stator slot is shown at the lower left portion of the above illustration.

The first operation of the winder is to insert a barrier wall of asbestos insulation in the slot.



Asbestic Process

A—Empty stator slot before insulating and winding.

B—Formed cell of asbestos providing a heat-proof wall of insulation inside the full length of the slot.

C—Cross section showing wires inserted, with asbestos cell covering the entire winding. In the center of the slot is shown Asbestos plate-board separating and insulating between coils inside every slot.

D—Asbestosite (indicated in color) forced into the slot windings, penetrates every interstice, sealing off the windings with a non-carbonizing insulation. The U. S. patented process for inductively isolating each wire during impregnation is described on the following page.

Then a few turns of wire are threaded into place, as shown.

When half the slot is filled, a coil separator of Asbestos plate-board is positioned to insulate and provide a heat-proof wall between coils in each slot.

Then the lips of the asbestos barrier, between the wires and the steel, are overlapped at the tooth tips. This forms a cell of sheet asbestos between the copper windings and the steel core. Now the windings are completed and the stator is ready for impregnation. The stator is placed into the impregnating tank.

The U. S. Patented means for gently vibrating the wires in the slots was conceived to permit the Asbestosite to penetrate the winding and surround each wire with a coating of asbestos compound. Asbestosite is indicated with color in the drawing. The right side of the above illustration shows the outside surface of the finished windings.

The solid colored lines indicate sheet asbestos, which is placed between coil sections.

The light colored surface indicates the exterior of the stator windings completely encased in Asbestosite.



No. 1675419

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas THOMAS G. MYERS, of Los Angeles, California, assignor to UNITED STATES ELECTRICAL MANUFACTURING COMPANY, of Los Angeles, California, a corporation of California, presented to the **Commissioner of Patents** a petition praying for the grant of Letters Patent for an alleged new and useful improvement in

PROCESSES OF INSULATING MOTOR WINDINGS,

a description of which invention is contained in the specification of which a copy is hereunto annexed and made a part hereof, and complied with the various requirements of law in such cases made and provided, and

Whereas upon due examination made the said Claimant is adjudged to be justly entitled to a patent under the law.

Now therefore these **Letters Patent** are to grant unto the said

United States Electrical Manufacturing Company, its successors or assigns

for the term of SEVENTEEN years from the date of this grant

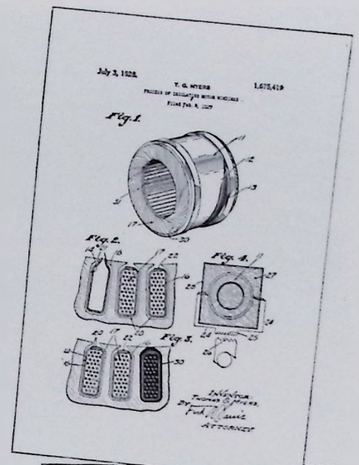
the exclusive right to make, use and vend the said invention throughout the United States and the Territories thereof.

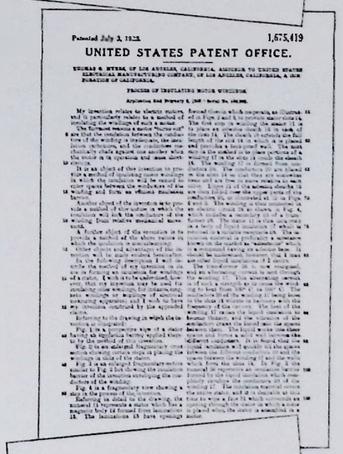
In testimony whereof, I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington this third day of July, in the year of our Lord one thousand nine hundred and twenty-eight, and of the Independence of the United States of America the one hundred and fifty-second

Attest:

Law Examiner.

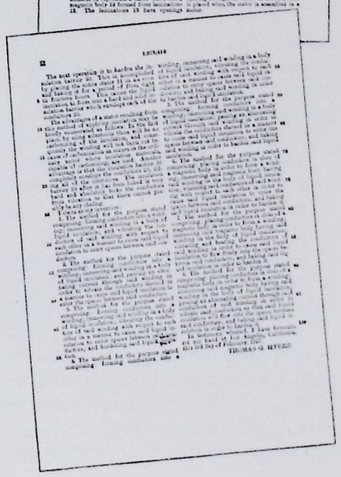
Thomas E. Robertson
Commissioner of Patents





Patented July 3, 1928. 1,675,419

UNITED STATES PATENT OFFICE.



The process of insulating motor windings with Asbestosite is covered by Patent No. 1,675,419, the facsimile of which is reproduced on this page.

Asbestosite—The Heat-Resisting Compound

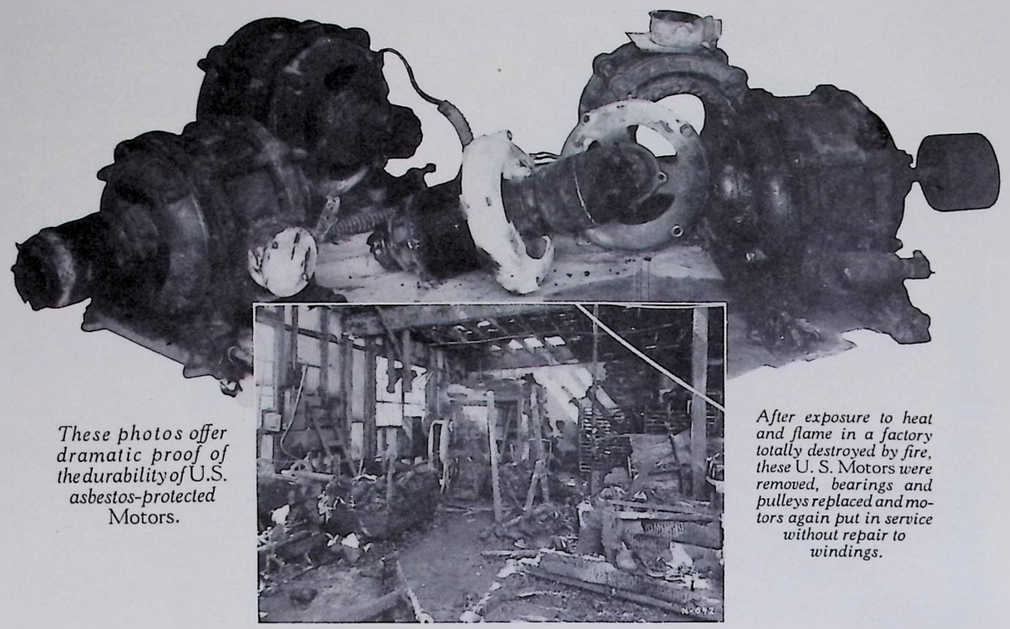
Asbestosite is a heat-resisting compound developed especially for impregnating the windings of electric motors. It was perfected by intensive experimentation in quest for a non-combustible medium of insulation for individual wires. The basic solid of this compound is asbestos.

The asbestos fibre is reduced to a powdered consistency, and chemical liquids are introduced. Asbestosite is so processed that it is rendered absolutely non-hygroscopic.

The diluent used, for the purpose of working it, is highly volatile, to facilitate permeation of the windings. This diluent is driven off in the baking process.

Asbestosite will not soften, slough out, or run at any temperature commonly encountered in motor operation.

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These photos offer dramatic proof of the durability of U.S. asbestos-protected Motors.

After exposure to heat and flame in a factory totally destroyed by fire, these U. S. Motors were removed, bearings and pulleys replaced and motors again put in service without repair to windings.

Little Journeys with a 40-degree Motor

THE REASON for a 40° standard in electric motors is to prolong motor life, by slowing down carbonization of the insulation.

72°

To a layman, familiar only with Fahrenheit temperatures, 40° seems rather cool. But the Electrical Engineer's thermometer reads in degrees Centigrade, and 40° C. rise means 72° F. rise. Keep in mind that motors are rated in temperature

99°

rise above the surrounding air—not operating temperature. And remembering that there is an addition of 15° C. (27° F.) for internal hot-spots which cannot be reached for thermometer measurement, it becomes apparent that the actual guaranteed rise is 55° C., which is 99° F.

Suppose the motor is located in a factory with a comfortable air temperature of 70° F., then the operating temperature affecting the insulation in a 40° motor is actually 169° F. One hundred sixty-nine degrees Fahrenheit is hot enough to start carbonization; and note that this motor is operating under ideal conditions.

Consider another instance of a motor operating in an air temperature of 90° F., which is often encountered during summer months, and

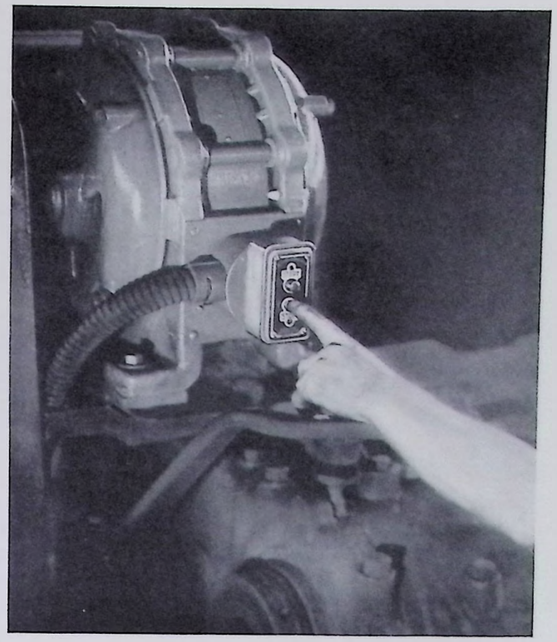
189°

it will be found by adding the rise of 99° F. that the insulation is now subjected to a temperature of 189° F. *Carbonization is speeding up.*

Still another example where very hot atmospheric conditions prevail—perhaps as high as 120° F.—and the motor is subjected to an overload which causes the rise to go above its guarantee and reach 117° F. This motor is actually operating at 237° F., and *carbonization of the insulation is becoming acute.*

237°

These conditions *do* exist, and ordinary insulation cannot withstand them. Deterioration from carbonization progresses constantly—often rapidly.



Just Press the Button!

A simple push-button switch is all that is required with U. S. AutoStart Motors. *The human element is replaced with automatic action by* AutoStart, *the revolutionary improvement that eliminated compensators and other current-reducing motor starters.*

AutoStart---the improved self-starting Motor with NO MOVING PARTS

[*In Starting Mechanism*]

THE AUTOMATIC push-button era for large squirrel-cage motors was ushered in by the development of the U. S. AutoStart Motor.

With the old method of hand-starting a motor the operator had the choice of starting as he pleased, and many operators misused the control because hand-starting means human-starting, and human judgment varies with the individual. When the operator grasped the handle of a compensator he had to decide how to start. He could throw into *starting* position or into *running* position. If he threw it into *starting* position as instructed, then he had to judge how long to wait before throwing into *running* position. Often he was governed only by his experience with fuses holding, and decided that so long as the fuses stood up he need not wait until the motor came up to correct speed.

And how could he know the correct speed? *He surmised by guess.* Frequently the guess was wrong and he over-waited, losing time in starting.

Then again, in starting a heavy load the operator became impatient because the motor was slow in coming up to speed. Consequently, he learned to throw quickly into *running* position. This caused serious, heavy over-load on the motor, permitting abnormal inrush current, and he thus unwittingly abused his motor, risked temporary shut-down and perhaps interrupted transformer service.

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But even when the operator *did* his best and followed instructions, time was lost in waiting for the motor to gather speed in *low voltage starting* position; and finally, when he did throw into *running* position, he could "slam it over" or "ease it in." Some operators thought that "easing it in" was better, while others decided to "slam it in." Of the two, it was worse to "ease it in," because that caused burning of contacts inside the compensator, which meant early repairs.

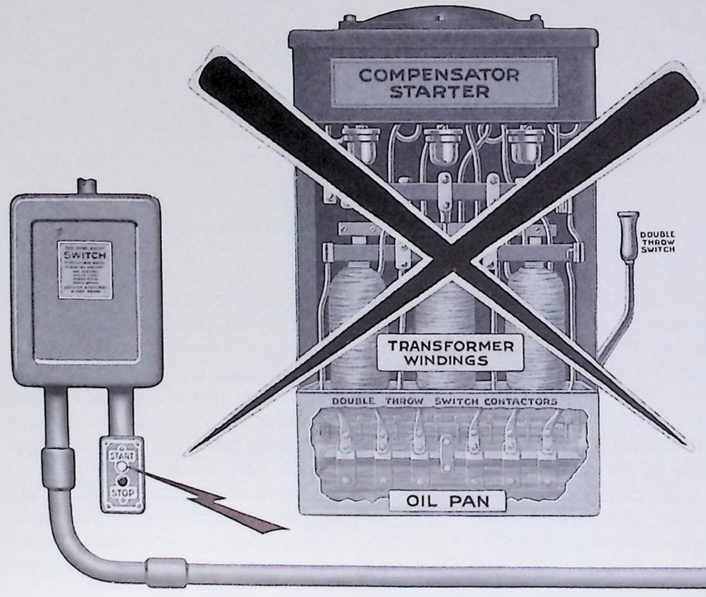
Finally, the two actions—*starting* and *running* positions—forced the motor to "hit the line" twice. This caused concern to the power companies because of surging, due to inrush current occurring twice.

A push-button
starts the U. S. Motor *instantly* ---*automatically*, right across the line!

Now contrast compensator starting with push-button starting. Is it not better to remove the cause of human misjudgment by giving the operator one simple push-button to press?

The button does the rest. It closes a contact which permits current to flow through a simple switch. This switch passes the current on at full line voltage to the AutoStart motor. The motor does not "hang back" because of "low voltage taps"; it begins rotation at the right speed and increases momentum properly and steadily. Its torque is constant, superinduced from the full line voltage, and there is no interruption in the current supply by changing from starting to running position of the control. Because of the inherent design of AutoStart there is no abnormal inrush current. And no second surge on the line. *No time is lost.* The operator and other men working on the machinery do not have to wait.

Starting is accomplished automatically when the button is pressed. Guesswork is removed by positive automatic action.



The U. S. AutoStart Motor *eliminates current-reducing compensators and starters with their many moving parts, including transformer core and windings, starting levers, dash pots, sump pans, oil, etc. The simple push-button switch replaces these.*

The Perfected
Automatic *self-starting* squirrel-cage Motor

In 1924 the U. S. AutoStart Motor was introduced. Up to that time U. S. Motors, in common with squirrel-cage motors of all other makes, 7½ H.P. and larger, required a compensator for starting. But with the advent of the U. S. AutoStart Motor, industry recognized the fact that compensators were unnecessary. There was prompt response to this new development. It was an outstanding achievement in motor design.

The U. S. AutoStart Motor provides simple, positive, automatic self-starting which entirely eliminates the human element in operating motor.

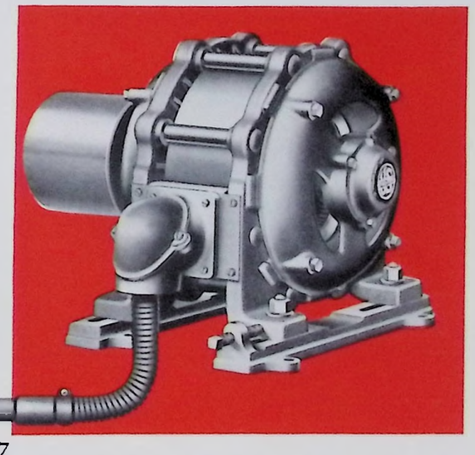
The AutoStart Motor is not to be confused with the term "across-the-line" type motors. It is the perfected product originally conceived and introduced by the U. S. Electrical Manufacturing Company.

It is a simple matter to design a motor with sufficient resistance and reactance to reduce starting current within standard limits. This was done twenty-five years ago when Boucheret in France produced a multi-cage rotor with low starting current. The ordinary high-torque motor with high-resistance rotor has a characteristic of low inrush current, which is also common to the "double-cage" or "double-deck" across-the-line motor. But the high-torque, high-resistance motor has low efficiency, while the double-cage type has too much torque for general purpose application. Torque is increased abnormally, making the motor start suddenly with a jerking effect, which is destructive to belts, gears and driven mechanism. Temperature is increased, due to losses, and the capacity of such a motor is affected.

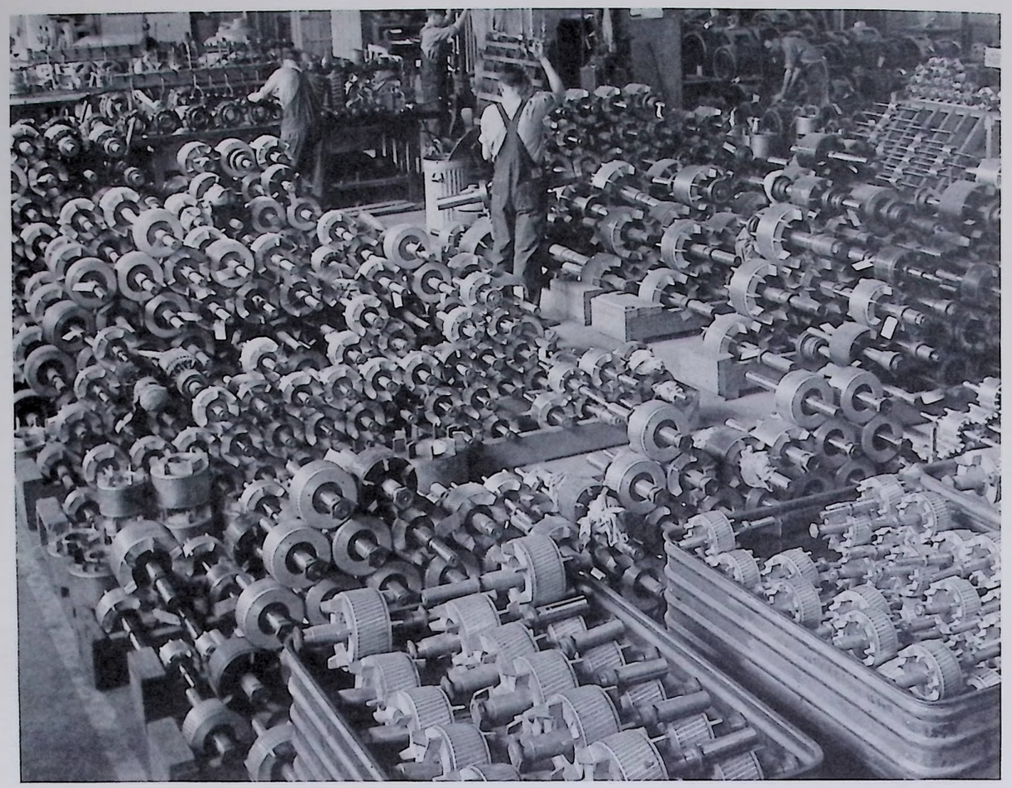
Thus, while it is simple to produce an "across-the-line" motor by increasing resistance and reactance of windings, it has been a real achievement to develop AutoStart Motors with low starting current, low power losses, high power factor, high efficiency and normal torque. All of these favorable characteristics are embodied in the U. S. AutoStart Motor. At the same time the inrush current is kept down without the use of a current-reducing starter.

U. S. AutoStart Motors have made remarkable history in motor development through the elimination of complex internal and external starting mechanisms.

STARTING *is accomplished magnetically; a time-proved electrical principle utilized to achieve a result of very definite and practical benefit.*



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Section of Rotor Department where the assembled units complete with shafts are stocked.

U.S. Rotor
Solid *die-cast Aluminum*

THE ROTOR is the most active mechanical part of the motor. In rotating at high speed dangerous mechanical strains are set up. Alternately heating under load and cooling when idle, the rotor must withstand these strains without fatigue or failure, year in and year out.

Holding together a hundred or more laminations under compression, with 40 to 60 rotor bars and end rings, subjected to centrifugal forces, requires absolute rigidity and strength to maintain original structure. Obviously the rotor with fewest parts is the simplest mechanically.

There are two distinct types of rotor construction—one of assembled copper, and the other of cast aluminum.

In the copper construction there are many individual bars to which are fastened separate end rings. The average copper rotor has from 40 to 60 bars, necessitating 80 to 120 joints at the points of contact where the bars

are attached to their end rings. Joints are always potential sources of weakness. For years attempts have been made to eliminate these joints. Brazing, welding, and casting-on the end rings were steps toward improvement. Attempts to cast the entire rotor, bars and end rings, of copper resulted in failure.

The U. S. Rotor is an improved type of cast-aluminum one-piece construction. It is the simplest in mechanical structure, requiring the fewest number of parts, and is the embodiment of perfection in mechanical design.

Integral Die-cast Aluminum Replaces Multi-part Assembly

This rotor cage is die-cast solid, one piece, right into the rotor slots. Bars and end rings are one mass of homogeneous metal. Every part of the rotor slot is filled flush with aluminum alloy. Interstices, misfitting or vacant spaces are impossible. The 40 or more pieces necessary in a copper rotor are reduced to but one piece in this cast-aluminum type. It is a rotor of *indestructible* construction. It cannot wear out, because there is nothing to loosen, no joints to part. Such design constitutes the best that engineering ingenuity has developed.

All Capacities

The problem of casting aluminum rotors increases in proportion to the size of the motor ratings. For several years small size motors have been made with cast aluminum rotors. But by the U. S. process the very largest sizes are die-cast of aluminum alloy.

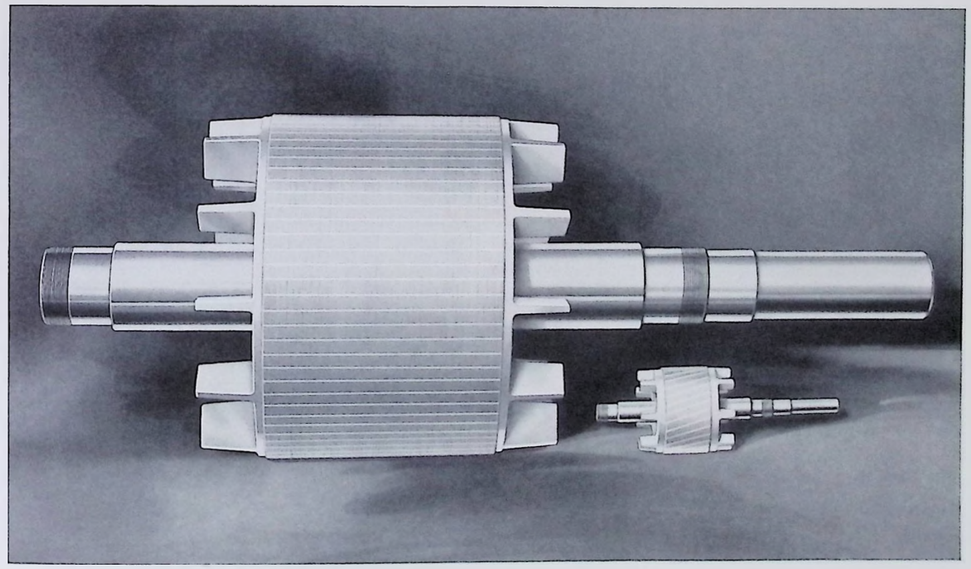
In U. S. motors it is possible to secure die-cast aluminum rotors in capacities up to 150 H. P.

U. S. Patented Processes for Producing Cast Rotors

The fundamental method for producing U. S. cast aluminum rotors in all ratings from the smallest to the largest sizes, is covered by the following U. S. Patents:

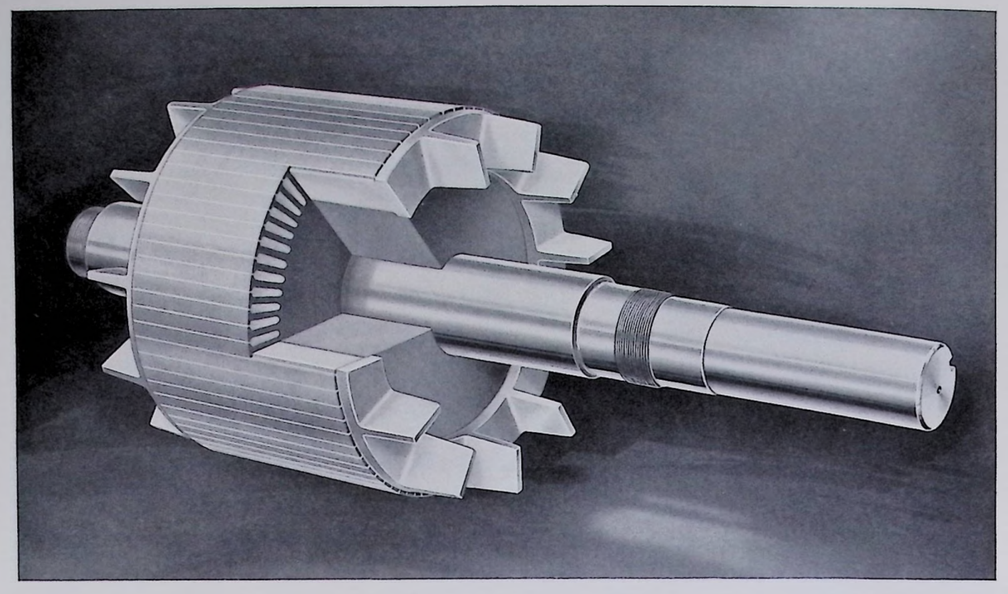
1,637,613	1,659,795	1,603,545
1,639,456		1,603,544

The U. S. processes permit a uniformity of product, free from defect in the cast squirrel-cage and so rugged that failure mechanically is practically unknown.



Comparison of the smallest and largest U. S. cast aluminum rotors. The large rotor is 150 H. P. capacity, while the smaller unit is of 1 H. P. size.

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View of U. S. rotor partly cut away, showing interior construction.

Indestructible Construction

The laminated core and its die-cast squirrel cage are held permanently rigid against centrifugal rending forces. This is accomplished by the cast construction which reduces the number of parts to one piece, a web of aluminum, cast in, through and around the laminations. Forty or more solid cast bars pass through the rotor core and integrally form their own end rings. This web of metal constitutes the rotor winding. Nothing else is needed to mechanically support the laminated core, removing the necessity of a multiplicity of parts such as bolts, nuts, rivets, spiders, flanges, etc.

The alloy compositions worked out for each particular requirement contribute to the favorable characteristics that are obtained in efficiency, power factor, starting current and torque of U. S. AutoStart Motors.

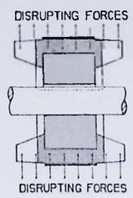
Balance

The U. S. die-casting process forms the squirrel cage with such accuracy, that, after removing risers, the static and dynamic tests indicate minimum adjustment for perfect balance.

Fan fins are cast integral with the rotor, eliminating the possibility of fan parts coming loose in service. Integral cast fans increase the heat radiation of the rotor core.

THE MANY BARS *and end rings of a rotor are subjected to tangental centrifugal forces during the period of rotation.*





Rending forces present in all revolving rotors, tending to disrupt the structure.

THE ELIMINATION *of multi-parts by reduction to one-piece construction, as embodied in the cast aluminum rotor, removes risk of failure.*

Die-cast Squirrel-cage of a U. S. Motor

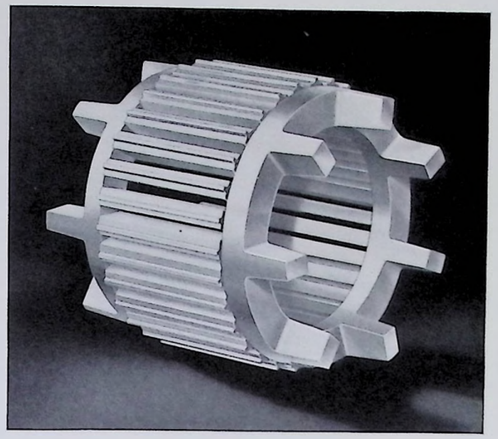
PERFECTION of product may rarely be claimed in the manufacture of any machinery, but without question this standard has been accomplished in the squirrel-cage of the U. S. Rotor.

A study of the photo-print shown on this page, which reproduces a view of the die-cast squirrel-cage removed from its rotor by milling away the steel core, presents a masterpiece of mechanical art.

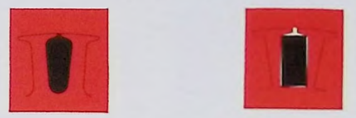
Reduction to one-piece construction of a unit ordinarily made up of multiple parts, is the ultimate in simplicity and justifies the premise of perfection in this unit.

The design is possible because molten aluminum flows into every space and fills the rotor slot completely to the tooth tips. This is readily comprehended by close examination of the illustration. Such compact cast construction makes it possible to achieve a reduction in amplitude of vibration at the rotor tooth tips. In the copper-bar design the slots cannot be entirely filled with metal, and the tooth tips are left more or less free to vibrate from variations in reluctance of the flux path as a rotor tooth passes from a stator tooth to a stator slot. This rotor structure combines three functions into one unit. It is not only the current carrying medium of the rotor, but because of shape and arrangement it interlaces the laminated steel core intimately and serves as the mechanical support of the unit. And thirdly, the air blast created in the motor finds its source from the integrally-cast fan fins which are component parts of this rigid member.

Thus the cast aluminum rotor is clearly an improved mechanical structure as compared with other forms requiring welded, brazed or cast copper construction. In addition to the mechanical advance, however, there is gained in the use of cast aluminum rotors the flexibility of varying the electric circuit by different compositions of aluminum alloys to secure special characteristics in the motor. Electrical results can be predicated in the design and controlled in the manufacture of cast rotors.

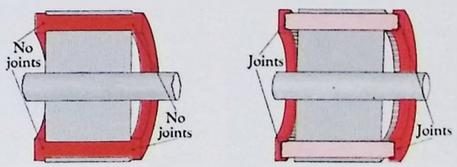


Die-Cast Aluminum squirrel-cage of a U. S. rotor. The steel laminations are milled out to reveal construction.



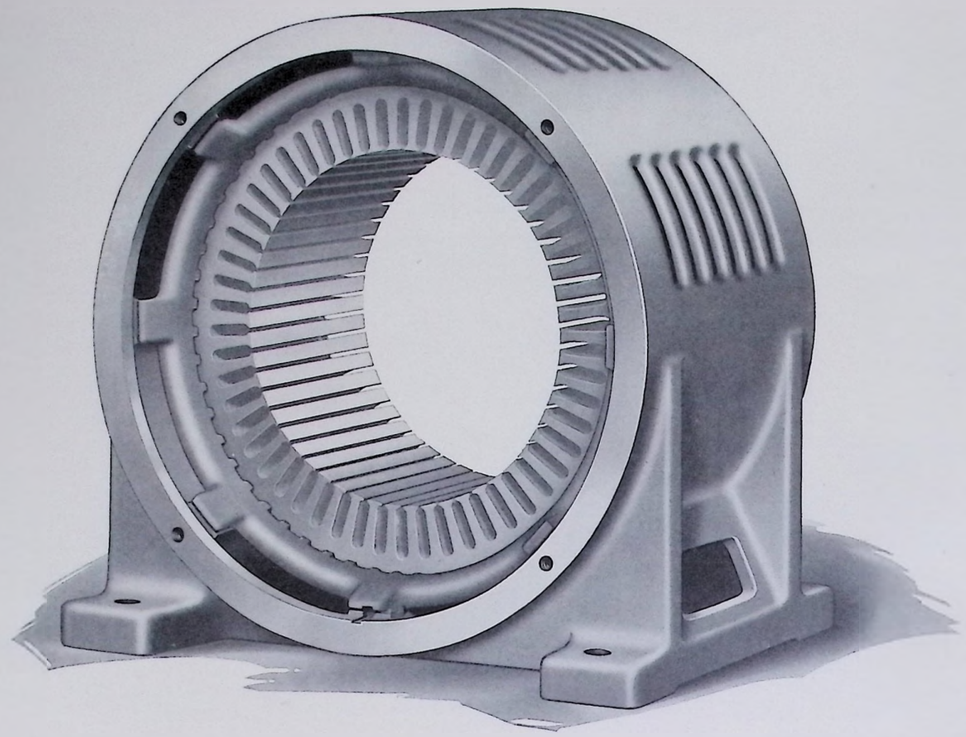
Comparative illustration showing the entire slot area filled with aluminum, including the space between rotor tooth tips. Rotor teeth are thus securely supported, which prevents vibration.

Illustrating a rotor bar in the slot of a copper constructed squirrel-cage rotor, showing the possibility of imperfect alignment and inability to support the tooth tips.



To the left above, is shown the Die-Cast Aluminum construction. A one-piece aluminum casting comprises all of the bars and end rings Note the entire absence of joints between bars and end rings. To the right is shown the joints at every bar in a copper rotor. A rotor with 57 bars causes 114 joints.

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Elements of ADVANCED Stator Design

THE MECHANICAL and electrical foundation of a motor is the stator. The frame must be designed to support the laminations, windings, end brackets and revolving rotor so that its rigidity will be permanent for the life of the motor. The supporting members must not warp or skew, and should be absolutely immovable to assure service throughout years of operation. The laminated electrical sheet steel core should be up to definite specifications to minimize electrical losses and be proof against deterioration by aging.

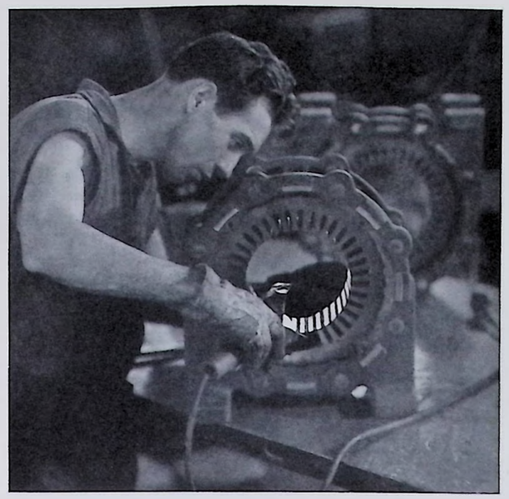
The stator windings should be so insulated that they will have a permanency of life comparable to other integral parts of the unit.

U. S. stator construction embodies all of these requisites.

U. S. Stator Construction

The frames and end brackets are gray cast iron. Each casting of a U. S. stator is annealed in a heat-treating furnace which removes internal stresses, so that alignment of stationary and rotating parts can never change, and warping is impossible.

Cast end plates lock the steel laminations which are compressed under hydraulic pressure, and heavy rivets are fitted, pressed and headed into place. Larger size stators are encased in shell-type frames, to which the compressed laminations are securely keyed. The feet are machined and bolt holes located and



Inspecting finished stators.

drilled while clamped to a fixture, giving an accurately aligned base. End bracket ball-bearing chambers are sand-blasted to avoid scale mixing with lubricant. A dust and moisture-proof housing excludes all foreign matter from reaching the bearing and prevents lubricant seepage.

The fitting surfaces for end brackets are machined after the stator is mounted on an arbor to guarantee alignment of rotor supports. Automatic machine tools perform these operations so that parts are perfect duplicates.

Inspectors check each finished stator for accuracy of machine operations and to guard against defects in material and workmanship.

The inspector's approval is registered with an identification mark on stator.

Laminated Core

The stator core punchings are made from silicon electrical sheet steel. This sheet is manufactured to standard specifications, scale free and guaranteed non-aging. It is annealed twice to reduce electrical losses, hysterisis and Eddy current losses. The first annealing is at the mill, and then again when the punchings are finished at the U. S. plant. Epstein tests are made with samples taken from each heat. These tests are repeated and checked when the steel is received, and all tests are referred to the Engineering Department for approval or rejection.

Stator Windings

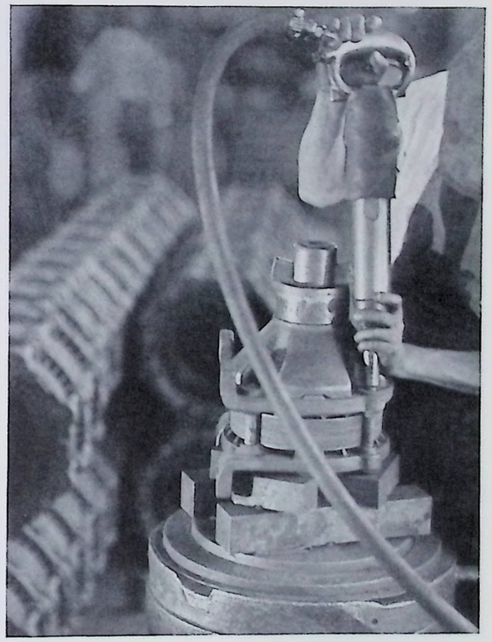
Coils are formed on multiple winding machines which continually wind groups of six to eight sets of coils, reducing the number of connections and joints between coils.

Every joint in an electrical winding is a possible source of weakness. These have been reduced to the minimum in U. S. windings.

Nine leads are brought out so that motors may be reconnected externally for 220 or 440 volts, easily and quickly. A connection diagram is placed inside terminal plate.

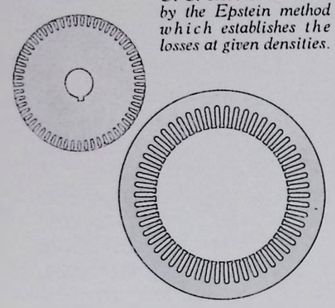
Stator windings are insulated with asbestos and impregnated with Asbestosite. U. S. stator windings will withstand temperatures that rapidly deteriorate ordinary insulations.

The stator windings and laminated core are held immovable by heavy cast frame construction. The assembled stator laminations are ground on cylinder grinding machines, assuring an absolutely precise and accurate air gap between rotor and stator.

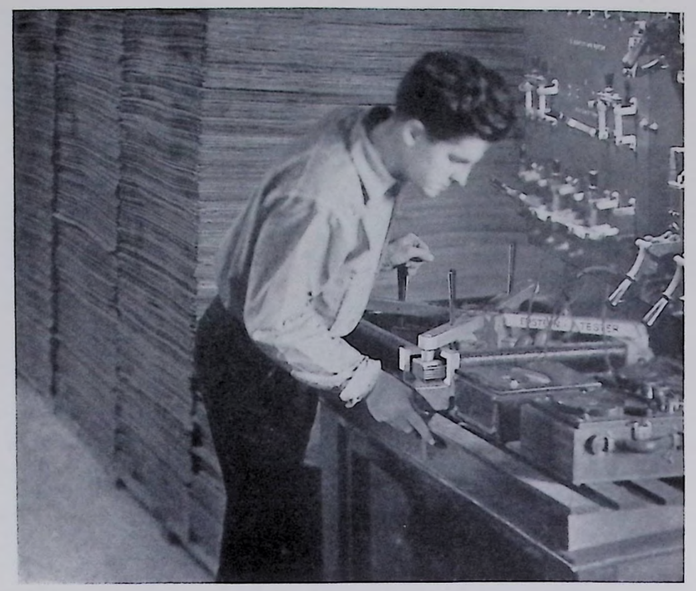


The disc laminations of the stator core are compressed under heavy hydraulic pressure while rivets are set and headed.

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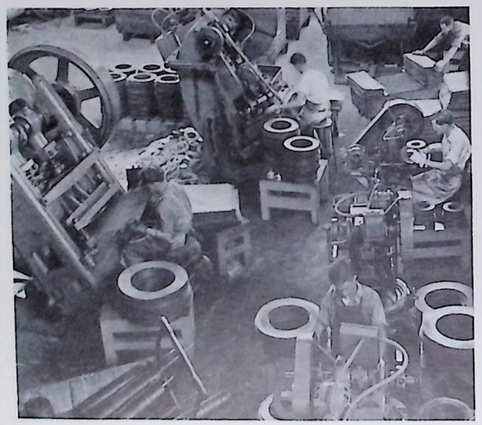


Electrical steel used in U. S. Motors is tested by the Epstein method which establishes the losses at given densities.



Electrical SHEET-STEEL

Uniform quality in electrical steel constitutes the foundation of electrical design in a well-made motor. In discussing the requirements of electrical sheet steel for producing disc laminations used in rotors and stators the comparative merits of carbon steel and silicon steel may be mentioned.



A corner in the blanking section of the Punch-press Department.

The older text books instructed the electrical designer that the best magnetic steel was "a soft carbon steel." And for a quarter of a century, during which the electrical industry grew at great pace, motors, generators, transformers, etc., were designed and built with soft carbon magnetic steel.

The electrical losses of this steel were relatively high, and the steel depreciated in use by "aging"; *i.e.*, the core losses increased in service so that a motor gradually decreased in efficiency and power cost increased proportionately.

The Introduction of Silicon in Electrical Steel

About 1901 an Englishman, Robert Hadfield, proved that by increasing the silicon content in soft steel the electrical losses were materially reduced, thereby making an important saving in power. Silicon improved

carbon steel as tungsten improved incandescent carbon lamps—in a relative sense. Also another quality was gained. Silicon steel could be made non-aging—the electrical losses fixed permanently.

The permeability of silicon steel is lower than the old carbon steel, but the densities at which the electrical sheet is worked in any well-designed motor is much below the saturation point.

So the text books changed, and today the student of electrical design is advised that "steel with a relatively high percentage of silicon improves the electrical losses of motors, and prevents aging."

U. S. Motors are manufactured with silicon steel in the rotors and stators. The steel comes from the mill guaranteed to definite specifications, scale-free, uniform and within a minimum tolerance in watts loss per pound.

Steel Testing

Each shipment of steel is tested at the steel plant and the losses furnished to the U. S. Engineering Department in a report by the mill. When the shipment is received at the U. S. Factory, samples are taken from a representative selection of sheets. One-half the samples are cut with the grain, and one-half across the grain, to give average losses in observance tests.



Special punching machine for progressively die-cutting the slots in stator discs.



Blanking operation on multiple-die press.

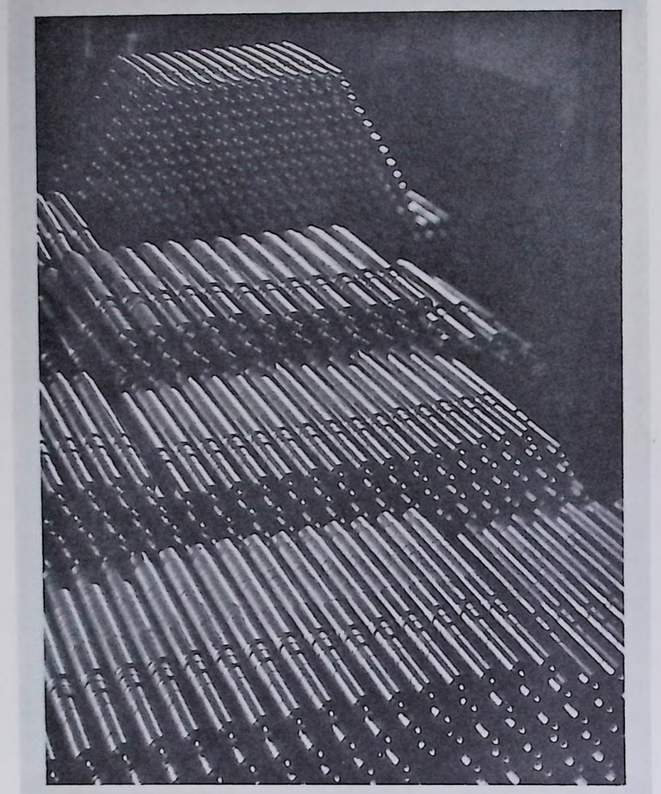
Steel Processing

The whole sheet is sheared into square blanks, then taken to the blanking and notching presses in order. When the final punching operation is completed the rotor and stator discs are removed to the Annealing Department. Here the discs are placed in furnaces and annealed for 24 hours. This annealing process further reduces the core losses to the practical minimum. During this processing a fine oxide is created on both sides of the steel discs. This oxide is a non-conductor and prevents Eddy current losses in the finished motor. Finished discs are then passed through steel rolls for straightening, so they will stack uniformly.

A final test of the quality of the electrical sheet steel is made by taking wattmeter readings after motors are completely assembled.

Thus from the receipt of the raw material, and throughout processing, the quality of the electrical steel is checked and re-checked right through to the finished motor.

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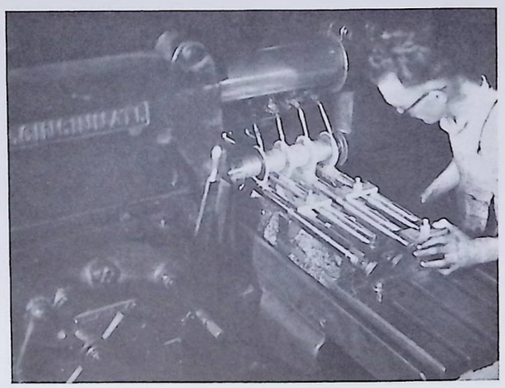
High Carbon *Manganese* Shafts

The quality of a shaft is not always recognized when purchasing motors, because it is taken for granted, until interruption occurs. The right quality of steel stock combined with careful design is engineered into the making of U. S. shafts, and rigid inspection furnishes assurance of consistent reproduction.

Consider the work of a shaft. Day in and day out the radial load is constantly tending to deflect the shaft out of line. The slightest distortion will change the *air-gap* between rotor and stator. Resulting unbalance quickly multiplies the strains, causing bearing trouble and perhaps failure of the entire motor.

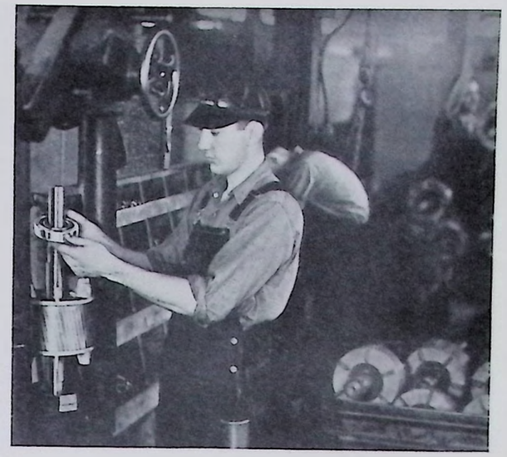
Shaft Rigidity

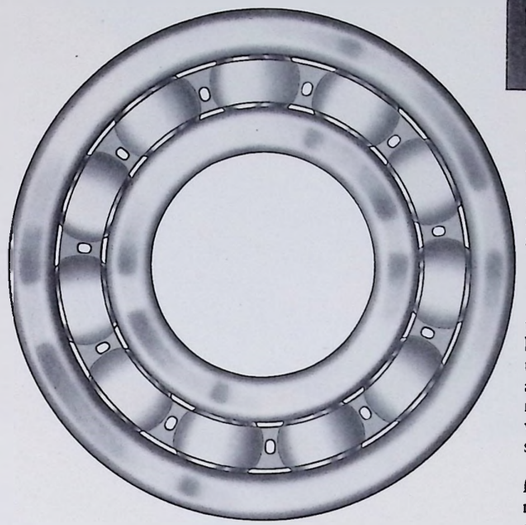
The steel in every shaft used in U. S. Motors is furnished under specifications calling for open hearth production with relatively high carbon and manganese content and a minimum of phosphorus and sulphur. S. A. E. 1045 open hearth carbon steel is used for U. S. shafting stock.



Keyways in shafts are cut, four at a time, in groups of eight on a milling machine.

Ball-bearing application





Fifteen years ago U. S. Motors began furnishing ball-bearings as standard equipment, optional with sleeve bearings. Long experience with anti-friction bearing application is responsible for the successful standards in U. S. engineering practice relating to the adoption and use of types and sizes for varied motor ratings.

Testing for Bearing Selection

Ball-bearing testing machines in the U. S. Laboratory provide means for determining the quality of bearings, indicated by load-carrying capacity and life tests at definite overloads. These tests require weeks and months of continuous operation to reach determination. The knowledge gained, however, avoids guess work as to the capacity and life of every bearing standard adopted.

The recommended applications of the bearing manufacturers are made use of as advisory information. Such recommendations are checked and must be proven by actual life tests under the supervision of the Engineering Department before a bearing is adopted as standard.

One of the basic principles of design rigidly required in U. S. Motors is to provide means for *holding the inner race tight* against a shoulder on the shaft. Forced fits are not tolerated. It impairs the life of the bearing to "force-fit" the inner race, because the delicate clearance between balls and races is destroyed.

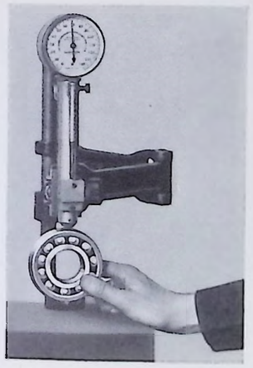
Creepage of inner races causing scoring of shafts in U. S. Motors is practically unknown.

Access to bearing housings is made convenient for the operator to inspect the bearings.

Ball-bearings are standard in size so that in an emergency new bearings may be secured immediately out of local stock in every city in the United States.

Bearing housings are dust-proof, double-grooved and fitted with one-piece die-cut felt washers, which prevents leakage of lubricant and excludes dirt.

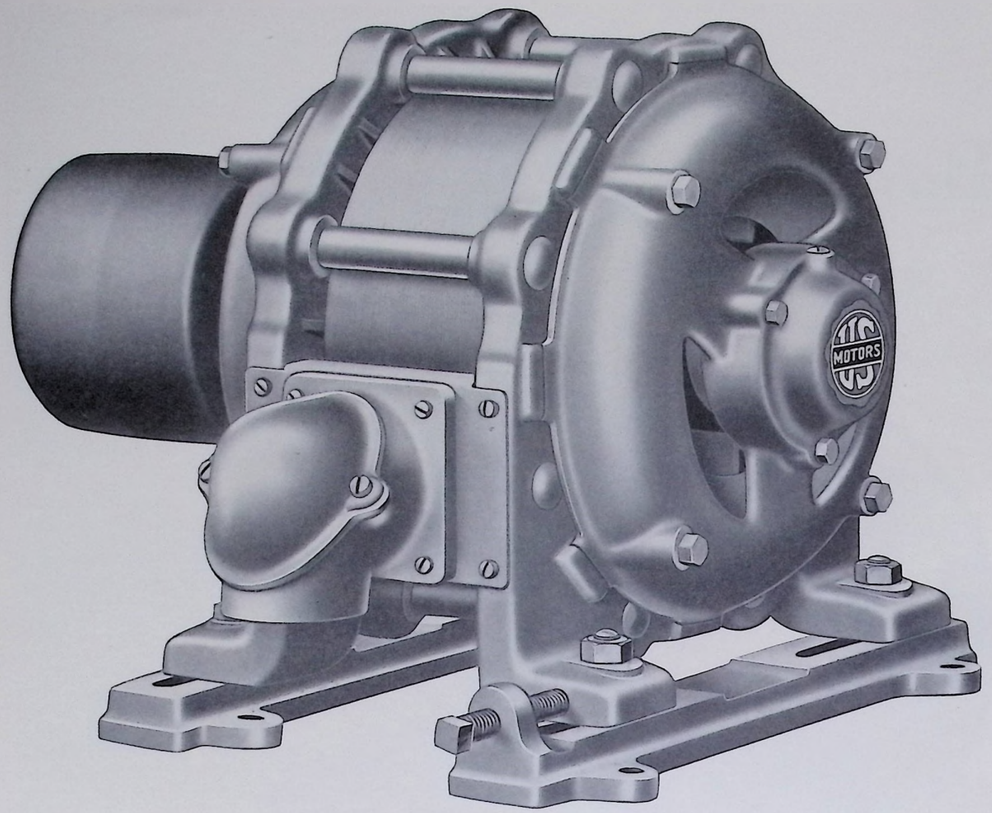
The housings are unusually large, for the accommodation of an ample supply of lubricant and to encourage the radiation of what little heat is generated within the compartment.



Scleroscope checking ball-bearing races.

Meticulous care in installing bearings upon the shaft prevents intrusion of dust or minute particles of abrasive material within the bearing. Each bearing comes to the Assembly Department encased with greased paper and packed in a separate carton. Not until the operator is actually ready to fit the bearing to the shaft is it removed from its original packing. Immediately after being mounted the end bells and bearing cap are fitted and set up. Bearing chambers are large enough to hold sufficient lubricant for at least one year in operation.

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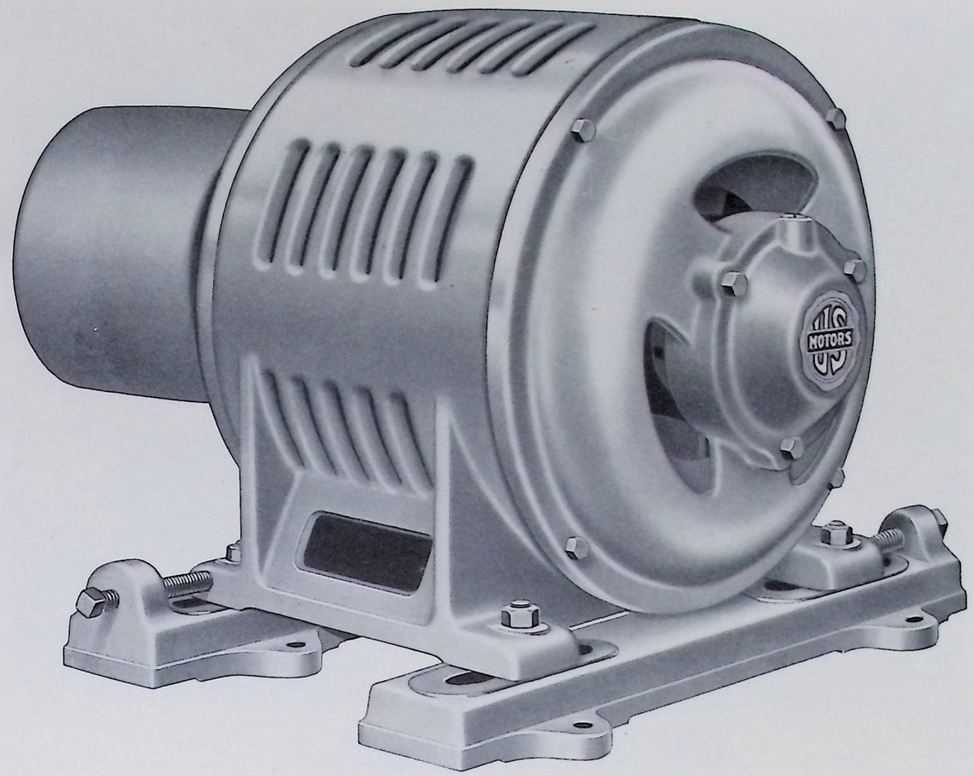


U. S. Horizontal Motor

RIVETED OPEN TYPE

¼ H. P. TO 35 H. P. RATING · 1800 R. P. M.

Never-ceasing advancement represents the spirit of progress. It is necessary, therefore, in every manufacturing industry, that careful study be made of Today's standards and vigilant research maintained to assure continued approval.



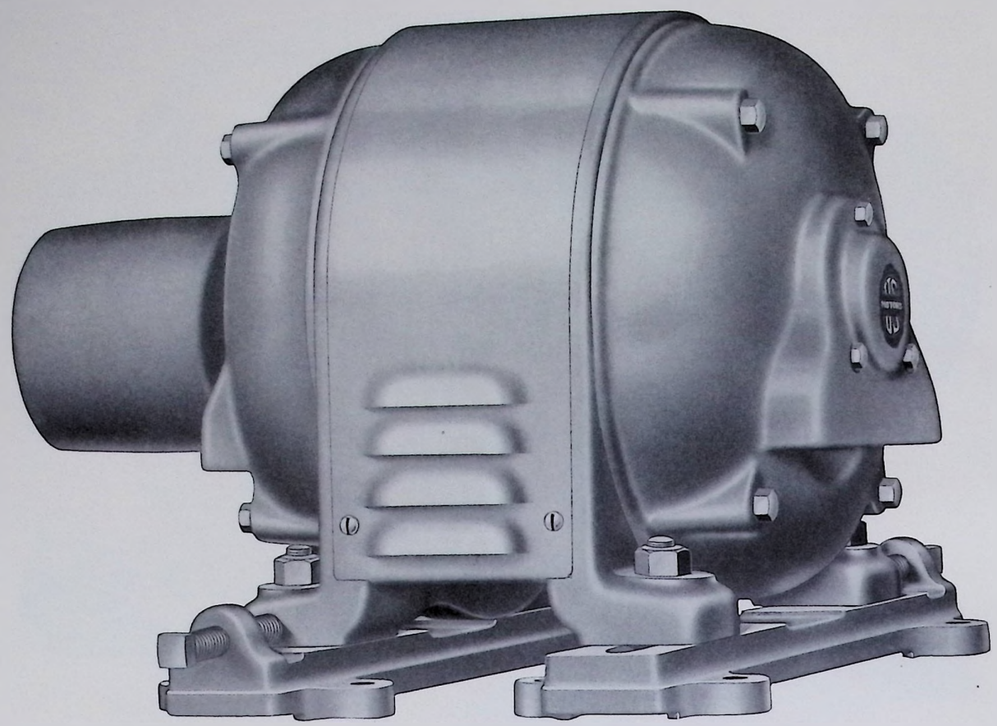
U. S. Horizontal Motor

OPEN SHELL TYPE

40 H. P. TO 150 H. P. RATING · 1800 R. P. M.

Good design in any machine is largely a matter of engineering policy, experience and ability. But underlying such design are the vital elements of quality in materials, skill in craftsmanship and accuracy in production.

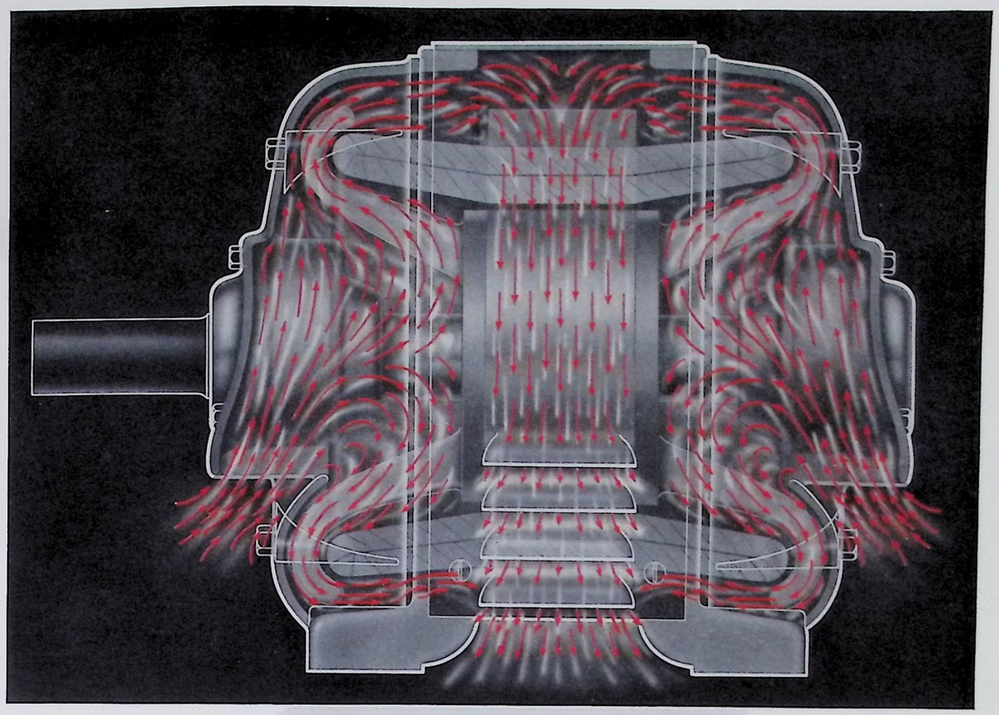
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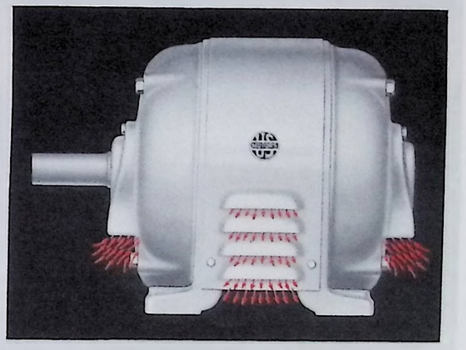
U. S. *Uniclosed* Motor

DUAL FANBLAST DUAL EXHAUST

The Uniclosed Motor, companion to the other types of U. S. Doublenclosed and Singlenclosed motors, provides a closed, covered motor at an economical cost. Windings, rotor, stator, bearings and shaft are completely housed by the Uniclosed frame, protecting these active parts from extraneous substances, such as water, iron or steel chippings, etc. The universally approved engineering principle of cooling both halves of the motor, equally and evenly, is retained in this closed frame. Uniform ventilation is accomplished by the design of dual-fans and dual-exhausts.



Exhaust louvres at the center of the frame prevent HEATED *air from passing over any part of the electrical windings. The downstream of warm air is outside of the laminated stator core.*



The pressed-steel cover of the frame is removable for inspection and cleaning of the interior parts when necessary.

Air circulation is evenly distributed by dual fanblast. Two fans, located individually at either end of the revolving rotor, draw in cool air through louvres on both bearing brackets. Each fan creates an air stream which meets at the middle of the frame, where the heated air is directly expelled through dual exhaust louvres.

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U. S. Turbo-Pump Motor

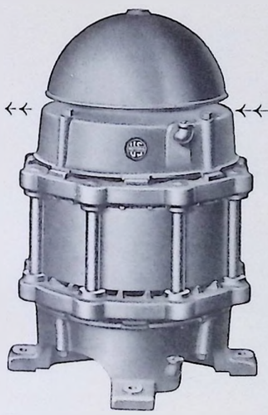
WEATHERPROOF

There is an element of beauty in the ensemble of a well-built machine. Symmetry in design and skillful dimensioning suggest the maturity of experience in the building of U. S. Motors. The Weatherproof Turbo-Pump Motor is specially designed for vertical deep well turbine pumps, and is protected against atmospheric conditions.



U. S. Turbo-Pump Motor

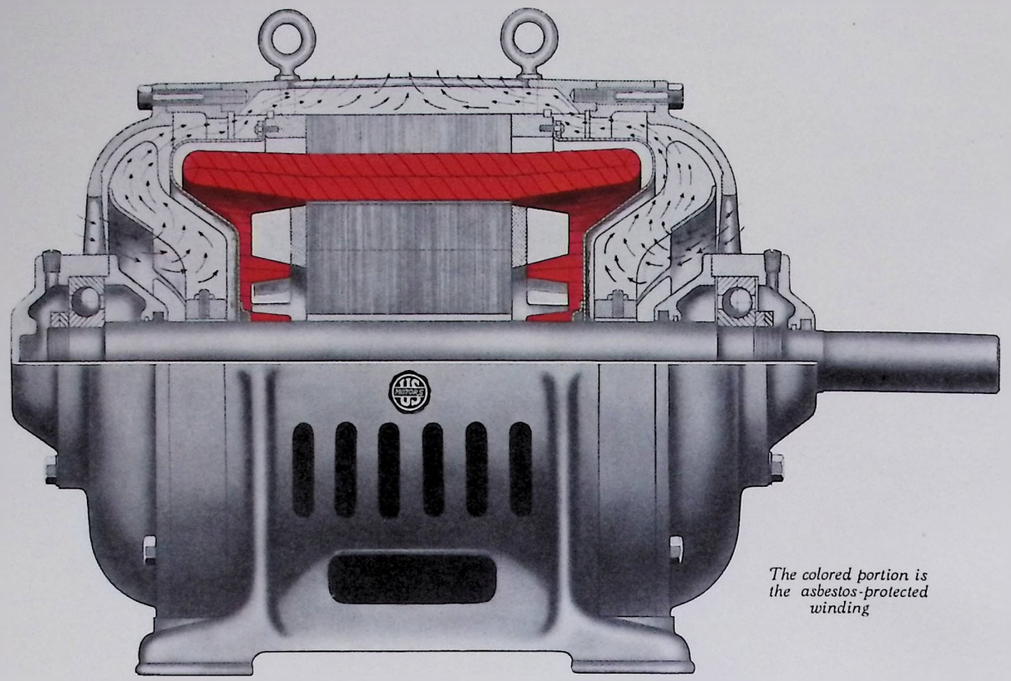
OPEN TYPE



The smaller vertical sizes have riveted frames; the larger have shell frames.

A reputation for Leadership is a desirable but hard-earned asset. It must be proved and reproved. It must be born of a well-defined, conscientious desire to render service precedent to profit. U. S. Motors are the expression of advanced design.

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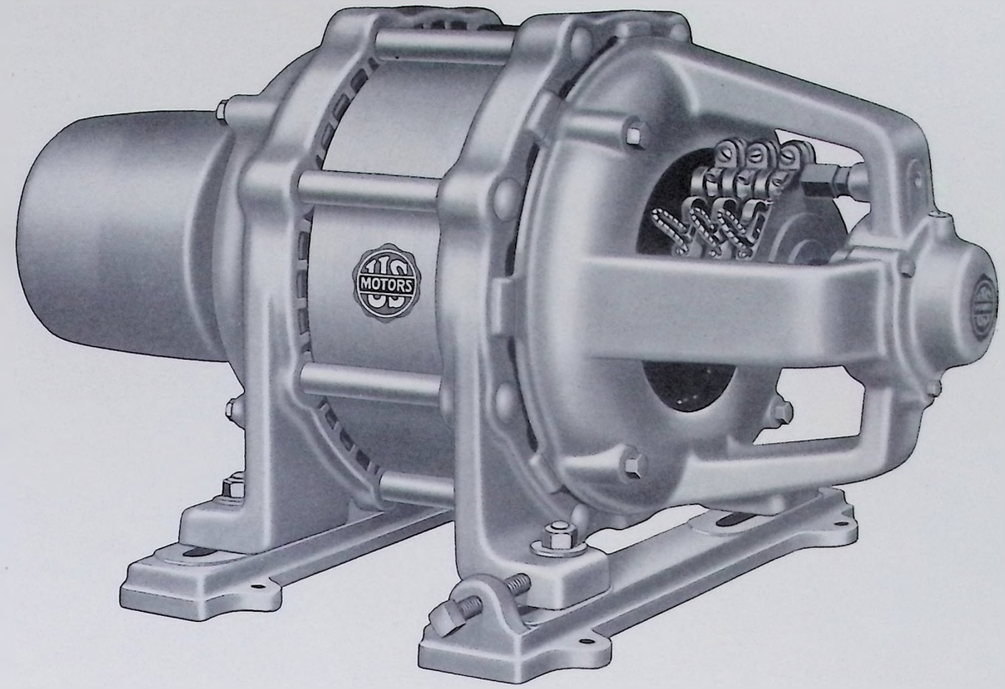


The colored portion is the asbestos-protected winding

U. S. Doublenclosed Motor

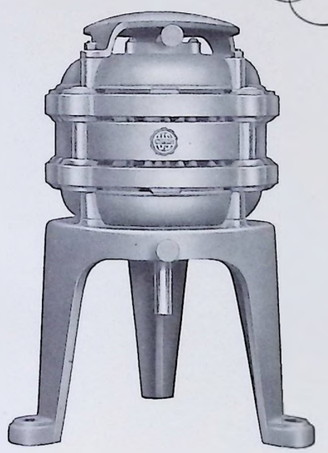
HORIZONTAL

Impressive evidence of advanced construction is offered in the U. S. Doublenclosed Motor. It has all the advantages of a fully enclosed motor, at less cost. The motor is encased within a sealed metal housing, outside of which is a chamber that is air-blasted by positive fan action. Any dust, dirt, moisture or deteriorating element is immediately expelled from the outer chamber —not a particle of foreign matter can enter the inner chamber. No outside element reaches the windings because they are fully enclosed.



U. S. Variable Speed Motor

SLIP-RING TYPE



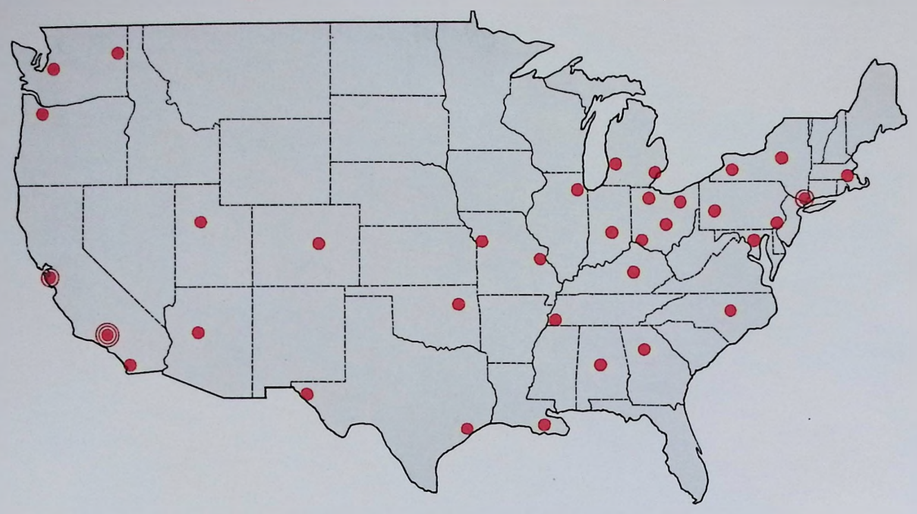
For duty requiring characteristics inherent in slip-ring design. The stator is of similar construction to the squirrel-cage type. The wound rotor is supported on heavy outboard ball bearings mounted in a rugged end bracket.

U. S. Sump Motor

SQUIRREL-CAGE TYPE

A specially adapted motor for sump pump service. Simple, sturdy and compact.

U.S. Electrical Mfg. Co.: The Story of U.S. Motors (1929)
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Nation-wide distribution

For the purpose of providing immediate service to motor users, complete warehouse stocks are maintained in all centers of distribution throughout the United States. Distributing offices in every important city are available for sales, engineering and service requirements on U. S. Motors.

Immediate attention will be given inquiries addressed to the nearest office. Distributors' addresses are given below, and also the location of company Branch Offices.

U. S. ELECTRICAL MFG. CO.

LARGEST MOTOR MANUFACTURERS IN WESTERN UNITED STATES

Main office and factory:

200 East Slauson Avenue, Los Angeles, California, U. S. A.

Branch Office and Warehouse:	*Branch Office and Warehouse:*	*Eastern Warehouse:*
236 FREMONT STREET, SAN FRANCISCO	2207 FIRST AVENUE, SO., SEATTLE	BUSH TERMINAL, NEW YORK CITY

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Buffalo, N. Y.	*41 Elm St.*	New Orleans, La.	*527 St. Joseph St.*
Chicago, Ill.	*360 W. Superior St.*	New York City, N. Y.	*71 Eighth Ave.*
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