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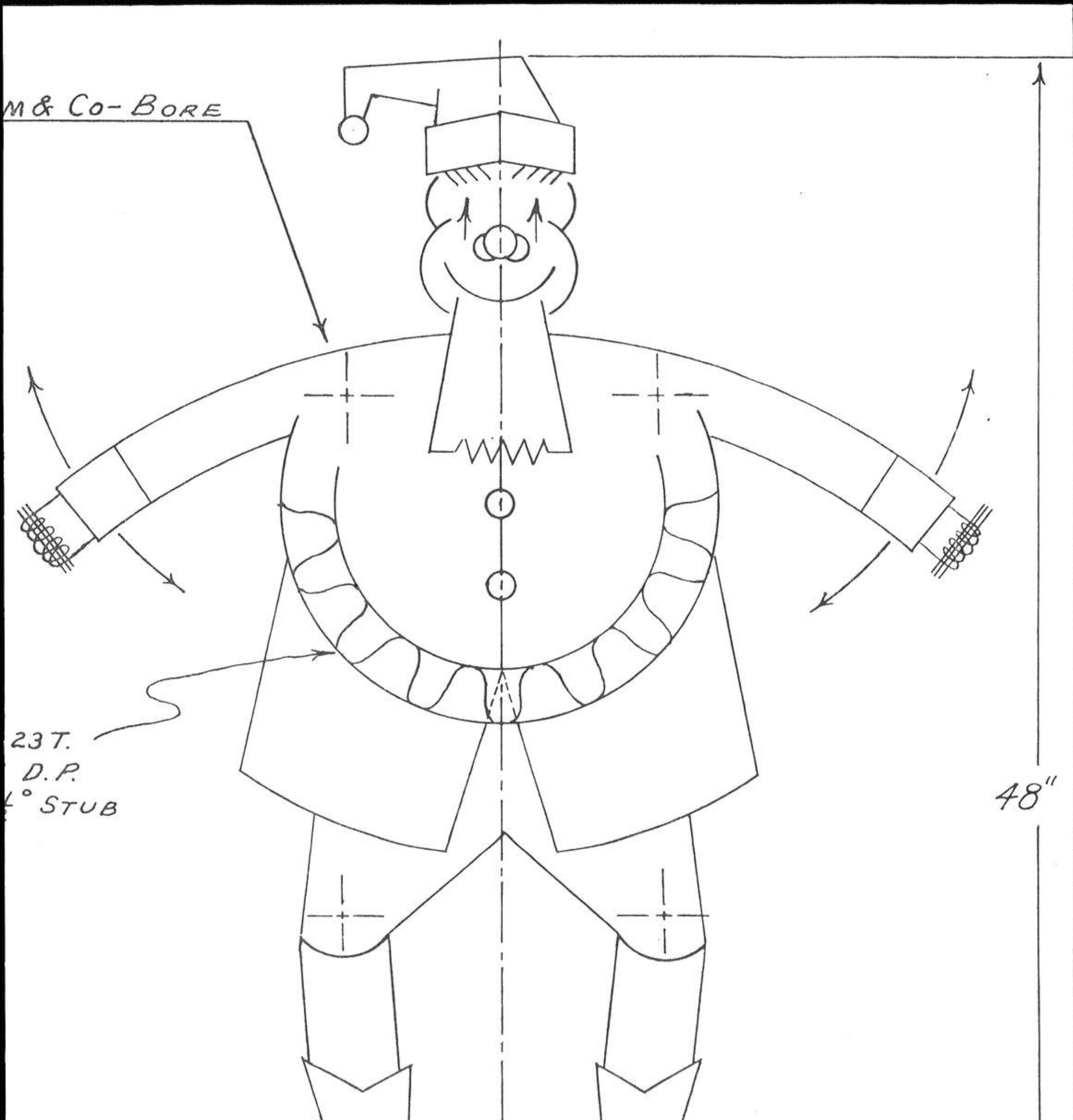
The Wisconsin

engineer

December, 1948

In This Issue:



A Triple-Expansion, Condensing
MERRY CHRISTMAS!

15¢

It's the world's largest coal mine — and it's COMPLETELY MECHANIZED!

• owned and operated by the H. C. Frick Coke Company

• The Robena Coal Mine is currently producing about 12,000 tons of coal a day. And when the mine reaches full operation, it will probably turn out 20,000 tons a day.

Robena is completely mechanized. A flick of an electric switch starts cutters, drillers, loaders, dumpers and conveyors. Workers can stand erect. A powerful blower furnishes them with fresh air. Steel beams protect them from cave-ins. An electric railway with an automatic signal system transports the coal.

Above ground, too, Robena is operated at top efficiency. Automatic blending mixes coal into a uniform grade that will be usable for steel making. At the tipple, coal is loaded into barges on the Monongahela River at the rate of a barge every six minutes.

Engineering coal mines for efficiency and safety has been a continual challenge to the operating and engineering officials of the H. C. Frick Coke Company. They have met and are still meeting this challenge.

Opportunities

The work being done for the Robena Mine typifies the spirit of the work being done in all of the subsidiaries of United States Steel Corporation.

Have you seen "Paths of Opportunity in U. S. Steel?" Ask your Placement Officer for a copy.

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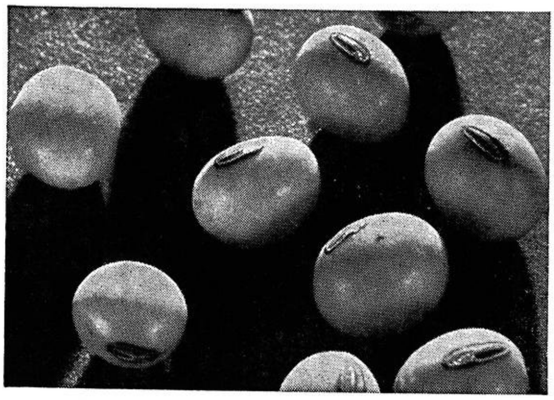
UNITED STATES STEEL

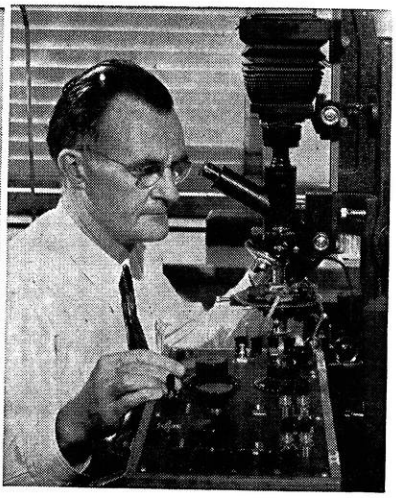
"Chain Reaction"

THE PATTERN FOR TEAMWORK AT P&G

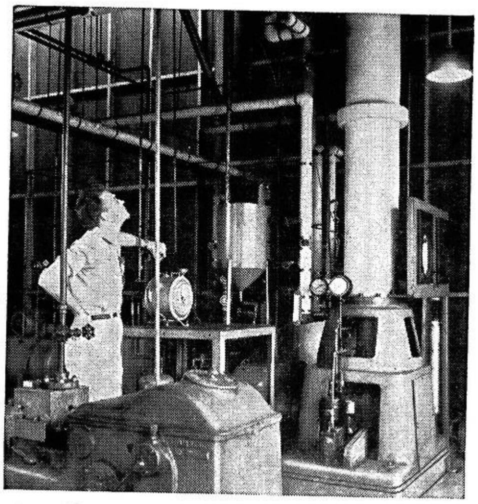


The Versatile Soybean—raw material for many chemical industries — one of many subjects under continuous study at P & G.

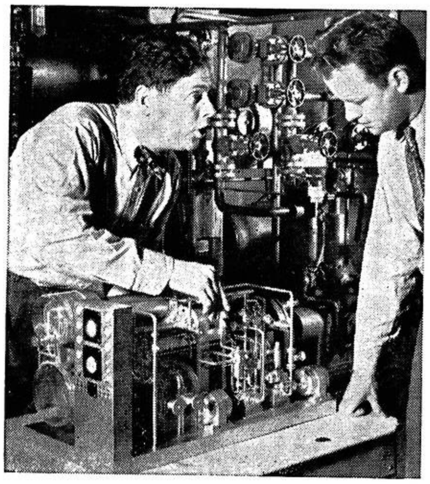
How chemists develop new edible oils . . . and engineers follow through to produce them



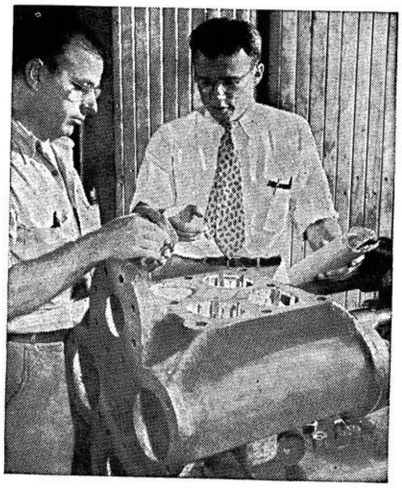
1. Chemists conduct microscopic studies on glycerides . . . to develop new edible oils.



2. Chemical Engineers carry on hydrogenation experiments to improve processing procedures.



3. Mechanical Engineers design full-scale factory equipment, using scale models like this edible oil freezer.



4. Other Engineers plan and supervise production operations.

This is just one example of P & G Technical Teamwork in action; similar developments in other fields call for additional men with technical training. That's why P & G representatives periodically visit the country's top technical schools to interview students. If you would like to talk to a Procter & Gamble representative, ask your faculty adviser or placement bureau to arrange a meeting.

PROCTER & GAMBLE

CINCINNATI 1, OHIO

WISCONSIN ENGINEER

Founded 1896

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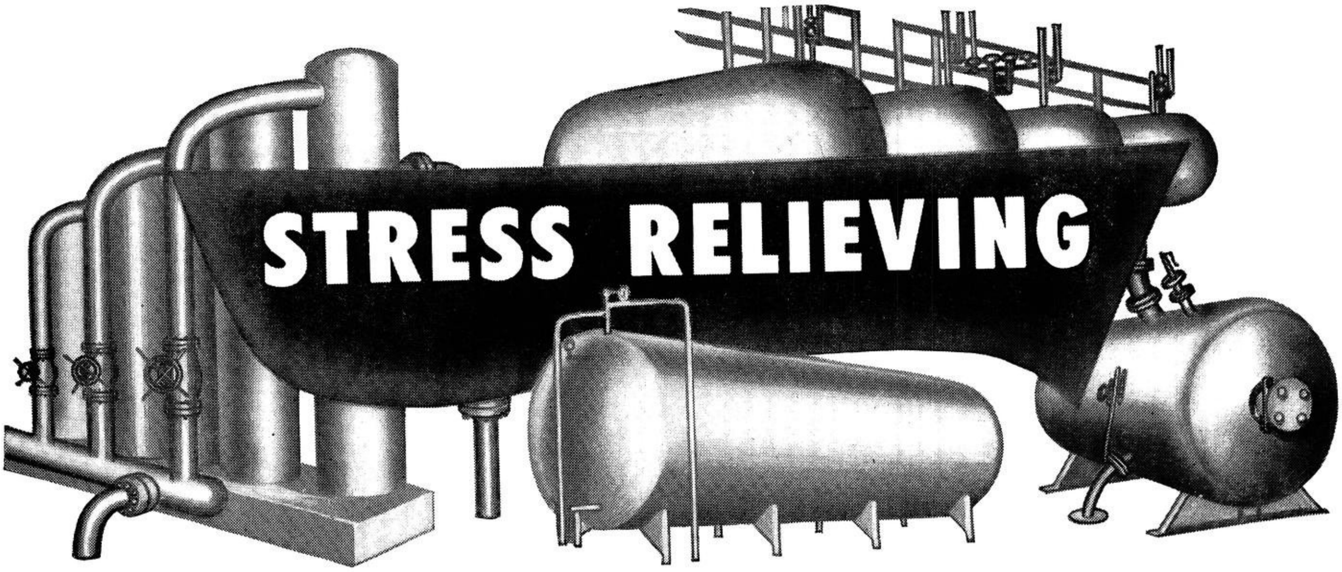
In This Issue . . .

COVER:

And a happy 3-point New Year too.

Articles

Departments



Temperature Ranges Required for Pressure Vessels at BLACK, SIVALLS & BRYSON, Inc. Demonstrate Controllability of *GAS*

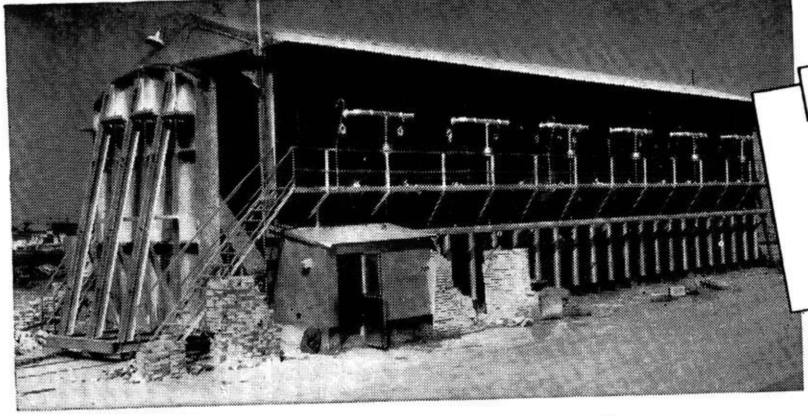
Safety codes govern many of the manufacturing and testing methods for pressure vessels. One of the most important processes, stress relieving, requires precise control of temperatures throughout the cycle—just the type of temperature control to be found in thousands of industrial applications of GAS for heat treating.

Specialists in the manufacture of pressure vessels depend on GAS for heat processing of all types. The pioneering firm of Black, Sivalls and Bryson, Inc., Kansas City, uses GAS in the manufacture of tanks, valves, pressure vessels and safety heads. President A. J. Smith says,

"Throughout the past 25 years we have depended on GAS to provide the exacting temperatures for our work. In many of our plants we have developed special GAS equipment; our large stress-relieving furnace at Oklahoma City is a typical example."

In this large furnace the GAS control system is arranged to provide temperatures up to 1200° F. for any time-cycle required. Automatic regulators and recording pyrometers assure maximum fuel efficiency while the flexibility of GAS is an important factor in maintaining production schedules on vital equipment.

Stress-relieving is just one of the applications of GAS for heat processing. You'll find hundreds of other uses for the productive flames of GAS—they're worth investigating.



One of the largest stress-relieving ovens in the United States, this installation at Oklahoma City is 77' long, 12' wide, 18' high—Gas-fired and equipped with recording pyrometers.

MORE AND MORE...

THE TREND IS TO GAS

FOR ALL INDUSTRIAL HEATING

AMERICAN GAS ASSOCIATION

420 LEXINGTON AVENUE NEW YORK 17, N. Y.

(Photo by Darrow)

A view of one of the many water power dams on the hard-working Wisconsin River. Almost all of the possible dam sites are now utilized, and construction of dams is either contemplated or actually under way to complete the development of this great resource. The dam illustrated is at Wisconsin Rapids, and it is operated by the Consolidated Water Power and Paper Company.

PRINTED ELECTRONIC CIRCUITS

by Harold Mueller e'49

(Photos courtesy Centralab)

The Dick Tracy two-way "wrist-watch" radio is no longer a fantasy of the comics, but together with many other recent developments is a practical application of miniature printed electronic circuits (PEC).

Introduced into mass production early in 1945 in the tiny radio proximity fuse for mortar shells developed by the National Bureau of Standards, printed circuits are now the subject of intense interest of manufacturers and research laboratories in this country and abroad. Manufacturers have made considerable progress in applying printed circuits or printed circuit techniques to the production of such electronic items as radios, hearing aids, television sets, electronic measuring and control equipment, personal radiotelephones, radar, and countless other devices. The first mass production of complete printed circuits was set up at the plant of Globe-Union, Inc., at Milwaukee, Wis., and a subsidiary plant at Lowell, Mass. The circuit was produced by the stencilled-screen process pioneered by the Cenralab Division of Globe-Union.

Other printing processes, such as spraying, chemical deposition, vacuum processes, die-stamping, and dusting have reached the production lines, and today manufacturers are in mass production of whole radio sets or subassemblies by one or another of the printed circuit techniques. A London concern, for example, has designed, and is now using, automatic equipment that starts with a molded plastic plate and turns out a completely wired (printed) radio panel in 20 seconds.

The principal physical effect of printing circuits is to reduce electronic circuit wiring essentially to two dimensions. The effect is enhanced where it is possible to employ subminiature tubes and compact associated components. Just how much space saving may be realized depends on the application. Standard electronic components are now available in such miniature size that complete amplifiers may be built into volumes of less than one cubic inch using standard methods. This is exemplified in modern hearing aid designs. The greater part of the volume of a hearing aid, for example, is occupied by the microphone, transformers, batteries, earphones, etc. The actual wiring occupies only a small fraction of the total volume and, hence, even if the wiring were eliminated completely, it would not represent a substantial further reduction in the total volume of the unit. The development of truly diminutive electronic devices now awaits only the availability of smaller microphones, transformers, speakers, batteries, etc.

Although size reduction is the factor that has attracted the most attention to PEC, there are other equal or more important advantages to be gained from their use, such as,

(1) Uniformity of production.

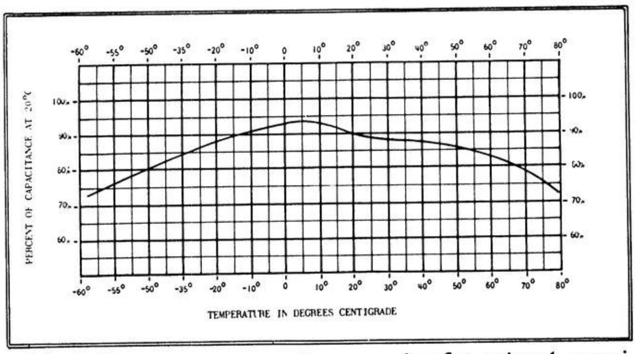
(2) Reduction of assembly and inspection time and costs.

(3) Reduction of line rejects.

(4) Reduction of purchasing and stocking of electronic components and accessories.

(5) Partial elimination of obsolescence of components.

In present assembly-line practices, wiring represents one of the larger items of production cost. Wires must be cut to length, bent into shape, twisted together or around soldering lugs, and individually soldered or connected. As there are over 100 soldering operations in even the smaller radio sets, the cost of labor and materials for soldering alone represents an important item. The new wiring processes eliminate as much as 60 percent of the soldering needed for conventional circuits.



Typical temperature-capacity curve for flat printed capacitor with pure metallic silver electrodes and Ceramic-X dielectric.

All PEC techniques are methods of reproducing a circuit design upon a surface and such fall under the general classification of printing processes. The processes differ mainly in the manner in which the conductors are produced.

PAINTING

Metallic paints for conductors, inductors and shields are made by mixing a metal powder with a liquid binder to hold the particles together and a solvent to control the viscosity. Resistance paints are made in somewhat the same manner, using carbon or metallic powders. The circuit is painted on the surface by brush or stencil, and fired at elevated temperatures.

The painting of conductors in general follows the practice used in pottery maufacture of burning metal oxides containing ceramic fluxes onto hard insulating surfaces. As is well known, pottery is decorated by mixing finely ground metal powders and fluxes with oil and turpentine and applying the mixture to the surface either by brush or through a stencil. It is then baked at temperatures of the order of 450° to 750°C to melt the flux and reduce the metal oxide. The metals are used because of the color they impart to the pottery. Chromium, iron, and cobalt, for example, result in green, brown, and blue colors, respectively. Unfortunately, the silicates or borates of the various metals except the noble metals are poor conductors.

Although it would appear to be a brief step from the pottery methods to those now used in painting electronic circuits, a considerable amount of research has gone into developing paints of sufficiently high conductance and adhesion that may be applied in a practical way.

The paint pigment is the conducting material for the circuit wiring. For the leads, powdered silver, silver oxide, silver nitrate or organic combinations of silver are generally used. Silver has proven to be a most practicable metal for this purpose, since, not only is it highly conductive, but silver films are easily produced. Copper or noble metal powders or salts may also be used effectively. Although salts of other metals might be employed, some form corrosion products that have such high resistance as to make them useless.

The cost of the silver is usually a small item. In fact, the relatively small amount required makes the cost of the actual silver paint no more than that of copper required for ordinary wiring. One ounce of silver is sufficient to paint as many as 125 average two-stage amplifier sections. Sheet silver, such as that used in the production of Edison cells, properly ground, is an excellent pigment for conductor paints. Flake silver in small particles works very well on most surfaces.

The pigment for resistors is usually carbon black, colloidal graphite, or a "flake" type of microcrystalline graphite. Carbon black and colloidal graphite appear better for screen painting and spraying, whereas flake graphite is used only for brush painting. Lampblack has been tried, but the more common types available apparently do not have the proper physical properties to produce reasonable values of resistance. One of the theories advanced, according to Cledo Brunetti and Roger W. Curtis of the National Bureau of Standards, is that the configuration of the pigment particles must be such that they overlap or bridge one another in the finished resistor.

The binder is the constituent that holds the pigment together so that it may be painted on the surface, and it also serves to bind the pigment to the plate. The conductance and adhesion are determined by the amount and type of binder used. Where the paints are applied to surfaces that are not entirely rigid, the vinylite resins provide needed flexibility. For certain plastics, nitrocellulose or ethyl cellulose lacquers provide quick-drying action at low temperatures. The phenolic resins are usually used to bond resistance paint since they give excellent stability in respect to changes in temperature. Although a stronger bond to the surface is had by firing, the use of ethyl silicate as a binder for silver oxide on glass and steatite without firing, produces a satisfactory bond, according to Dr. Brunetti.

The solvent is used to dissolve the binder if it is in solid form and to adjust the viscosity of the pigment-binder mixture. Most of the common aromatic aliphatic solvents may be used in paints for printed circuits.

A reducing agent is used to reduce the metallic compound to metal when the base material will not stand high firing temperatures (plastics, for example).

The filler is the material used to spread or separate the particles of pigment to increase the electrical resistance. Powdered mica, mineralite, diphenyl, and powdered chlorinated diphenyls are typical types of fillers employed.

SPRAYING

Spraying of conducting films on insulating surfaces, like the spraying of ordinary lacquers and paints, not only has popular appeal but is fairly easy to adapt to production line practice. The practice of spraying metallic and carbon paint onto insulating surfaces through stencils has been used with success. The same paints are used as for the stencilled-screen process. Special equipment is unnecessary, the ordinary lacquer spraying equipment being satisfactory. By using a spray gun with a properly controlled spray pattern and with the work attached to a moving conveyor belt, a good degree of uniformity may be obtained in the spraying assembly.

A novel method of electrostatic spraying may find application in PEC work. In this method, the work is carried on a conveyor belt between electrodes charged to a high potential, of the order of 100,000 volts d-c. The work is at ground potential. Paint is sprayed into the area between the electrodes, the electrostatic force tending to pull the charged, atomized particles toward the work, which is at ground potential and located within the spraying zone. Smooth and uniform deposition of paint over the entire surface is possible with proper design. Very little paint is wasted in this process as paint particles which would normally miss the work change their course and return to it because of the electric charge on them. In the printed circuit application, the plates on which the paint is to be sprayed would be nonconductors. In order to attract the ionized paint particles to the work the plates to be painted would be laid upon an electrically grounded metal mesh belt.

CHEMICAL DEPOSITION

The methods in this classification involve the deposition of metallic films on an insulating surface by the reduction of metallic salts in solution.

One of the principal methods of chemical deposition is that in which a silvering solution is made up by adding ammonia to a solution of silver nitrate. This silvering solution is then mixed with a reducing solution prepared, for example, by dissolving cane sugar in water and adding nitric acid. The mixture is poured over the insulating surface, the latter bearing a stencil with the circuit pattern in it. As the silver precipitates from the mixture, it deposits uniformly over the surface. Removal of the stencil leaves the wiring pattern desired. The stencil should not be affected adversely by the mixture. It should be designed so that it will adhere closely to the surface, and so that it may be removed by peeling off or by evaporation at low temperature.

The films formed are very thin and cannot be soldered to directly. They may be built up by repeating the silvering process as often as desired. The bond between the deposited film and surface is entirely mechanical, there being no chemical combination with the surface; consequently, the adherance is less than is obtained by the firing processes.

VACUUM PROCESSES

Another set of techniques employed to produce metallic layers on nonmetallic surfaces that may be adapted to electronic wiring are those of cathode sputtering and evaporation. The methods are quite similar. In the sputtering process, the metal to be volatilized is made the cathode and the material to be coated the anode. After evacuation, a high voltage is applied between the electrodes. Metal emitted from the cathode is attracted to the plate by maintaining the plate at positive potential. In the evaporation process, the metal is heated in a vacuum to a temperature at which it evaporates onto the work located nearby.

The thin films formed by sputtering or evaporation may also serve as resistors. The approximate resistance may be calculated from the resistivity of the metal evaporated and its dimensions. Stencils are used to confine the metal to the proper position and area desired. Wave guide attenuators have been made in this way by evaporating a very thin film of nichrome on pyrex or soft plate glass.

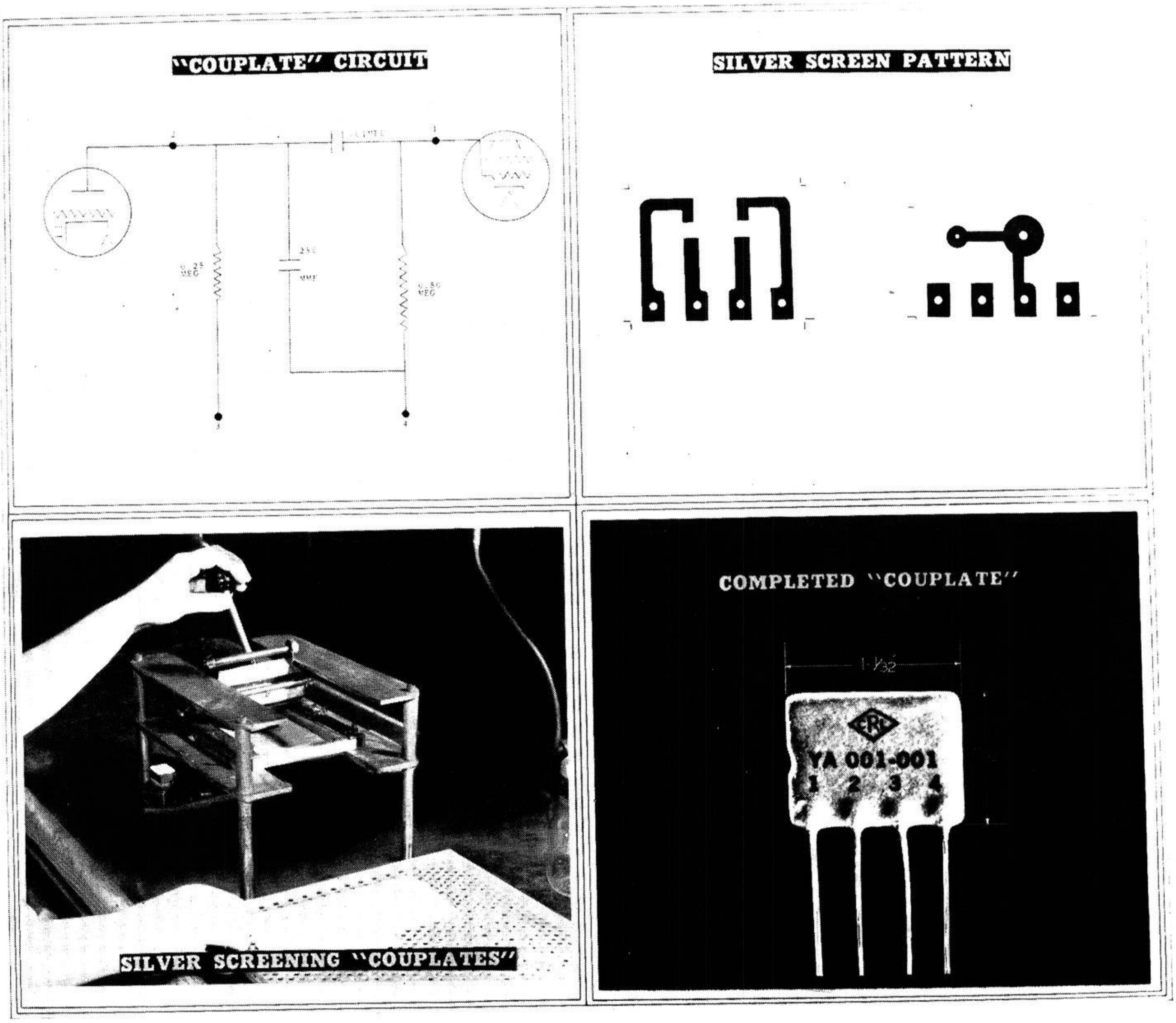
DIE STAMPING

In the production of electronic assemblies for certain types of proximity fuzes during the war, it was found advantageous to preform the connecting wires and component leads. These were dropped into position in a plastic chassis in such a manner that all terminals requiring soldering appeared opposite each other. Soldering of the terminals completed the assembly.

Radio set manufacturers are now employing spiral loop antennas die-stamped from copper or aluminum sheets a few thousandths of an inch thick. Compared with the conventional solenoid or basket-weave types of loop antennas, this stamped-embossed design not only is more economical but has comparable or better electrical performance. For radio receiver application the usual insulation between turns is omitted, resulting in lower distributed capacity and higher effective Q than

(please turn to page 30)

Printed four-element interstage coupling unit in production at Centralab.



C. E. FIELD TRIP

by W. M. Haas c'49

On the foggy morning of October 25, a traditional requirement of the civil engineering course was dusted off again after an absence of several years. During the war, the Senior Inspection Trip requirement was set aside because of difficulties in transportation. With the university getting back to a normal basis, however, these requirements are coming back into effect.

By tradition, the inspection trip is an affair where the students visit various public works installations, a manufacturing plant, several construction projects of various kinds during the daytime, and write their reports and keep up on homework during the evenings. (Oh yeah?)

The trip this fall combined some of the old standby visits with the new points of interest. The first stop the chartered buses made was on Milwaukee's waterfront, where the class took to the water to visit the sewage disposal plant on Jones island. Now Jones island really isn't an island; it is a peninsula. If you don't believe me, go look up somebody from the brewers' capital and get him to explain it. Personnel from the plant escorted the class and explained the various equipment and processes used to prevent pollution of Lake Michigan. It was also pointed out that a commercial fertilizer was produced at the plant both to complete the process and to defray some of the expense by its subsequent sale.

The next stop was at the Allis-Chalmers plant. After a roast beef dinner, on the house, groups of the class were taken through the immense plant. Here the civils saw many of the machines used in practice being made. These included huge boilers, steam turbines, pumps, electrical generators and transformers. And it was here that some poor workman almost lost his toe when one of the handsome collitch boys winked at a lady crane operator. (No, this didn't really happen, but it makes a good story, doesn't it?) We didn't get through all of the plant by any means, but even then we were glad when the trip was over and we boarded the buses to ride downtown to the Wisconsin Hotel, our billet for the night. That lobby sure got crowded in a hurry as about a hundred men suddenly descended upon it. Guess some of the local citizens thought it was an invasion.

(Photo by Darrow)
"Under Construction"—Petenwell Dam

The next morning, while exchanging tales of high adventure, our buses took us to the filtration plant of the Milwaukee water works. At this plant, water is taken from Lake Michigan, filtered and treated, then sent to the distribution system. Our next stop was at the riverside Pumping Station, where this same water was pumped into the mains for use throughout the city. Highlight of this stop was the comparison between the huge, four-story steam pumping engines, and the comparatively small centrifugal pumps, that have about three times the capacity of the old-timers.

Before leaving Milwaukee, we also visited the plant of the Wisconsin Bridge and Iron Company. This is where steel is drilled, punched, machined, riveted, welded, and painted before it is sent out to bridge jobs, building sites, and the like for erection. Probably the most interesting department was the pattern shop, where full size patterns in wood and stiff paper are made up to be used in laying out the work in the shop itself.

Leaving Milwaukee, we visited a few highway projects on our way to Oshkosh, where the second night was spent at the Hotel Raulf. The next morning found us sizing up a bridge at Neenah. Then into the buses again and over to Wisconsin Rapids, a visit to the Consolidated Water Power and Paper Company plant (where they make the paper for LIFE Magazine and the WISCONSIN ENGINEER), and in the afternoon, the visit to the Petenwell dam on the Wisconsin river.

This stop probably was the highlight of the trip for most of the class. The construction work has been under way for over a year now, and it is hoped that the power plant can be put into operation next summer. The earth dam is an immense project in itself, being about nine miles long. Concrete for the spillway and powerhouse section is mixed in a central plant and pumped through a pipe to the point it is needed. Reinforcing steel and formwork made an intriguing pattern in the wilderness setting, and most of the class would have liked to study the project some more, rather than return to Madison and three thousand words.

PRACTICUM

E. E. FIELD TRIP

by John Misey e'49

Herein lies a pictorial review of what over 200 senior electrical engineers saw on their three day inspection trip in the Chicago area.

The inspection trip was as much a class as those given on the campus. The purpose of this class was to show the student how the correlation of theoretical experience gained in the classroom and the practical application of theory in industry is achieved. With this in mind the Electrical Engineering department under the capable direction of Professor Koehler arranged a tour of several plants in the Chicago area.

Carnegie-Illinois Corporation, "South Works"

Like steel, the backbone of American industry, South Works is the backbone of steel production. It is the second largest steel mill in the world, with an annual output of 4,525,000 net tons of steel. The process of making steel from the raw materials to the blast furnaces, through the finishing processes in the open hearth, in the Bessemer Converter, and the electric furnaces, and the final shaping of the steel in desired forms in the rolling mills was shown. All these processes were remotely controlled demonstrating the need of technical experience in supervising the production of steel.

Motorola Corporation

The manufacturing technique of radios and television sets was reviewed. The complicated maze of wires, resistors, and condensers was broken into functional and component units. These individual units were produced in sub-assembly lines and then fed into a main assembly line at strategic points. The role of women in the scheme of production was very much in evidence. Their dexterity in the manipulation of small articles has been useful in this type of work. This also demands careful supervision and calls for supervision by competent and technically trained personnel.

Curtis Lighting Company

As manufacturers of fluorescent lighting fixtures they have the exclusive rights of making reflecting surfaces by the "Alzak process." This process produces a durable, hard, colorless, transparent coating on aluminum, giving a non-tarnishing and stainless surface which is unaffected by heat of the lighting source. This process is not a plating of aluminum, but the formation of a surface coating of aluminum oxide from the aluminum of the base sheet. The finished surface is extremely hard, abrasion resistant, with very high reflecting power. A demonstration of the use of these processed reflectors revealed the reflection characteristics under different conditions of operation.

Commonwealth Edison Company

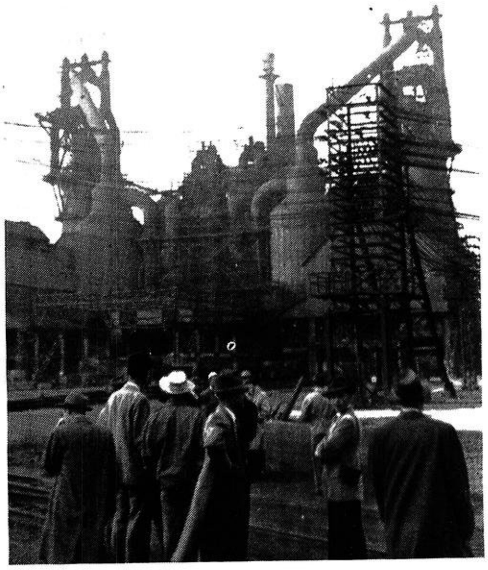
The generation of electrical power for use in industry and homes of every city was displayed at one of its large power plants. The conversion of energy from coal to steam in high and low pressure boilers, and subsequent use to drive large turbine generators which deliver electrical energy to the transmission lines was accomplished by using over 40 tons of coal and a million gallons of water each day.

General Motors, Electro-motive Division

The new diesel-electric locomotives that pull nearly all the new streamliners on the railroad tracks across the country today have been designed and built at the sprawling plant in La Grange, Illinois. A huge machine shop fed the parts, or "guts" as the machinists like to call them, to the assembly line where the diesel engines are built. After many hours of testing the performance of each engine they were laid on the body of the locomotive and auxiliary units added on to complete the job. When completed they were taken out into the yards for another overall check. The finished locomotive is then capable of producing 1,500 horsepower for propulsion at a diesel engine speed of 800 rpm, with surface speed ranges of 50 to 102 miles per hour in eight steps.

Western Electric Company

Service to the world through the medium of telephone communication was shown at this manufacturing company of telephone and telegraph equipment. The technical achievements in rendering facility of conversation over many miles was revealed in an interesting lecture, and the manner in which the mechanical equipment was assembled provided an interesting tour of the plant.



(*Photo by Hacker*)

Some senior electricals looking over the "South Works" of Carnegie Steel Corporation.

ON *the Campus*

NOTICE

All good engineers, buried under their pile of assorted texts, manuals and handbooks quietly dreaming of a white Christmas, won't be particularly interested in this column. Our curiosity, however, got the best of us again this month and we couldn't push our slide rule another significant figure until we found out what's going on in the engineering societies and fraternities.

If your bunch would like a little free publicity, write up the info and put it in the Wisconsin Engineer mailbox in the lobby of the M. E. building.

The commercial's over so here's this month's scoop:

POLYGON BOARD

Polygon Board continued its work in its capacity as an engineering representative group with Arnie Arnaut as President. The following are the important items considered at recent meetings:

1. A telegram was received from the National V. A. Headquarters in Washington answering the letter sent by the Polygon Board concerning the financing of senior engineering field trips. The telegram received merely was notification that the matter had been referred to the rehabilitation and training office in this district.

2. The Polygon Board received an invitation to participate in the coming Campus Carnival on November 20. It was felt that there would be insufficient time to prepare an adequate demonstration. However, in order that the Engineers might be represented, it was decided to contribute $20 and prepare a sign to be posted at the carnival.

3. In the past some difficulty has been encountered in getting engineering news published in the *Daily Cardinal*. Following a suggestion by the *Cardinal* editor, it was decided that the Polygon Board should arrange for an engineering column to be written by an engineer each week.

4. On a suggestion by G. Williams, AIChE, it was decided to participate with the lawyers at the Homecoming football game. Arrangements were made with the Homecoming committee.

HOUSE OF MAGIC

The "truth is stranger than fiction" demonstrations of the General Electric "House of Magic" kept a full house at the Union Theater on the edge of their chairs for two performances on Thursday, November 11. The show was presented by the College of Engineering.

Notable exhibits were in the fields of chemilluminescence, stroboscopic light, high frequency heating and photoelectric units.

TRIANGLE

Fourteen engineers were guests of Triangle Fraternity at a smoker held on October 13. After refreshments were served, Duane Glaubitz entertained the group with his feats of magic.

* * *

Everyone left their cares on the doorstep at the Homecoming Party held by Triangle. More than seventy couples danced the evening away with the "Pause that refreshes" served in the recreation room. Lt. Cmdr. and Mrs. D. L. G. King were chaperons for the night.

A show by the pledges of the fraternity provided an enjoyable break in the party's merrymaking.

* * *

One of the visitors on the campus for the Homecoming festivities was Oscar, the Iron Man. He backed the team by battering a down-trodden Northwestern player at Triangle. Oscar boasted an animated left arm due to the ingenuity of Charles Strasse, ee'50. Oscar has returned to Florida to await the St. Pat's Day dance.

* * *

Eight men became members of Triangle Fraternity on November 21 at formal ceremonies held at the chapter house. Following the initiation, the new men were honored at a banquet at the Union. Prof. Kurt F. Wendt gave the principal address.

Initiates were: Rulon E. Butler, Kenneth G. Frye, Paul R. Greenman, John S. Hanson, Rodney R. Johnson, Hugh H. McCreery, Charles R. Skala.

KAPPA ETA KAPPA

Sixty KHK alumni were feted by the present actives of the professional electrical engineering fraternity during the Homecoming weekend. The alumni and members went to the game and followed it with a banquet at the American Legion Hall. After the banquet the group danced to the music of Bob Arden's orchestra. The good time enjoyed by everyone present calls for hats off to Ted Zatrowski and Lon Nordeen, social chairmen.

S.A.E.

"Gas Turbines and Jet Propulsion" was the subject presented at the recent S.A.E. meeting by Dr. J. T. Rettaliata, Dean of Engineering at Illinois Institute of Technology and consultant to the Allis-Chalmers Mfg. Co. The 140 men present found Dr. Rettaliata both interesting and entertaining as he discussed theory, development, and application of gas turbines. He illustrated his talk with slides.

* * *

The S.A.E. fall field trip was taken on December 11 to the Gary, Indiana, plant of Carnegie - Illinois Steel Corp. Seventy men made the all-day excursion and felt the trip very rewarding.

FUEL MEASUREMENT
for
Internal Combustion Engines

by J. M. Katzfey m'50

The accurate measurement of the amount of fuel burned during a specified period in an internal combustion engine is of the utmost importance in determining the efficiencies of the engine. In line with this thought Drs. Myers and Uyehara hired the author during the summer of 1948 to build an electronically controlled apparatus to weigh fuel that was to be both accurate and easy to operate.

The thermal efficiency of an internal combustion engine is the ratio of work output to heat input. The work output is measured in horsepower converted to heat units by a suitable factor. The heat input is determined by measuring the fuel into the engine and converting it into heat units by multiplying it by its higher heating value. The ratio is then put on the basis of a horsepower and on the time basis of one hour. Therefore, the thermal efficiency:

$$e = \frac{2545}{W_F Q_H}$$

where 2545 is the number of Btu's per horsepower-hour, Wf is the fuel rate in lbs. of fuel per horsepower-hour and Q_H is the higher heating value of the fuel in Btu's per lb. of fuel.

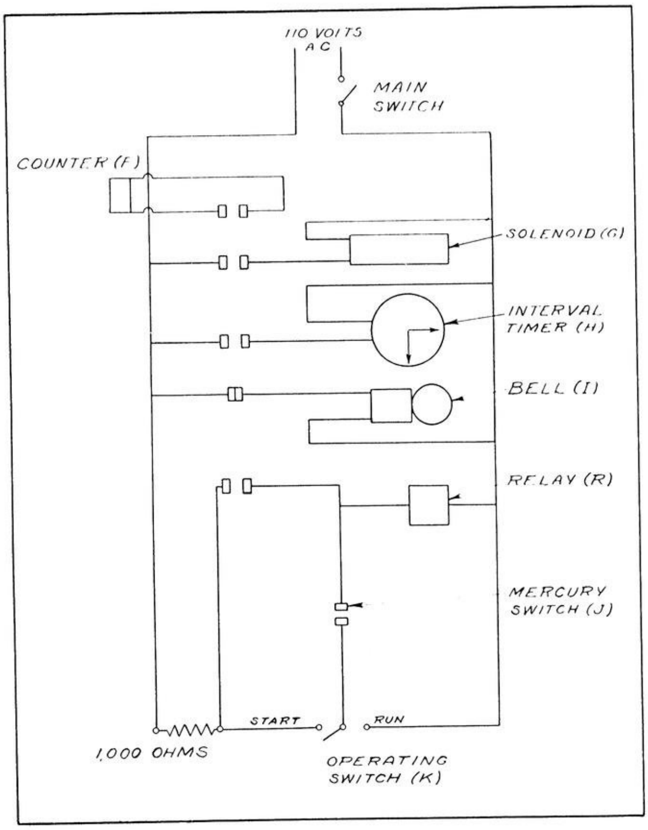
In practice, the fuel rate is measured in lbs. of fuel per indicated or brake horsepower-hour. The brake horsepower is determined by the use of a dynamometer, prony brake or similar arrangement. By running the engine cold to determine the friction horsepower and subtracting it from the brake horsepower the indicated horsepower is found.

From the thermal efficiency the engine efficiency can be calculated if one knows the ideal cycle efficiency, for the engine efficiency equals the actual thermal efficiency divided by the ideal cycle efficiency. Now the indicated engine efficiency is a good indication of what the losses due to fluid friction and incomplete combustion are and their magnitude. The brake engine efficiency indicates also the magnitude of these losses as well as the losses due to mechanical friction.

Therefore, if one compares the engine efficiencies of an engine he has just designed with another engine of the same type he will have an indication of how much better or worse his engine is. Even more important is the comparison of various fuels in the same engine which is one of the jobs for which the apparatus to be described was designed. This, then, shows the importance of accurately determining the fuel consumption per indicated or brake horsepower.

The fuel weighing apparatus as designed by Drs. Myers and Uyehara is a semi-automatic, portable, Rube Goldberg contraption that sounds vaguely familiar to those who operate pin ball machines, although any resemblance between it and a pin ball machine is purely coincidental.

The wiring diagram is shown in the illustration. The contact points represented as A, B, C, D, and E are part of a relay (R). The mercury switch (J) is located on the scale so that when the scale tilts the points make contact. Now, to run the apparatus the beaker full of oil is mounted on the right scale pan and balanced so that the right pan



Schematic diagram of the fuel weighing apparatus.

is just off the rests. The flow is then started through the flowmeter, and out into the engine. The main switch is then closed with the operating switch (K) in start position. Immediately a bell (I) starts to ring announcing that the test is ready to start. Then as the fuel is admitted into the engine the right pan begins to rise until at a point when it is level with the left pan the mercury switch (J) closes causing current to flow through the relay (R) closing

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Alumni Notes

by Al Nemetz e'50

Ch. E

Kenneth M. Watson, who received his Ph. D. degree from the university in 1929, and is now Professor of Chemical Engineering, will be given this year's William H. Walker award of the American Institute of Chemical Engineers. The William H. Walker award is an annual distinction given for outstanding contribution in the field of chemical engineering literature.

(Cut courtesy of Wis. Alumnus)

Kenneth M. Watson

The award committee of the American Institute of Chemical Engineers stated that Dr. Watson's many books and publications, of great importance to the chemical engineering profession, were the principal determinants in selecting him for this honor.

After becoming Assistant Professor at the university Dr. Watson went to the Universal Oil Products Company, where he became director of engineering research. In 1941 he became chairman of the technical committee of the Neches Butane Products Company, Gulf Oil Corporation. This committee made preliminary surveys which were important in the production of butadiene for the wartime synthetic rubber program. From 1942 to 1945 he was a consultant to the War Production board, as well as a Professor of Chemical Engineering at the university.

Following is a partial list of '48 graduates and the jobs which they have taken.

Merrill J. Aderman is now with the Falls Paper and Power Company of Oconto Falls, Wis.

Peter P. Bishop is employed by the Phillips Petroleum Company in the Industrial Division, Chicago, Ill.

Bennie Burrish is with the Badeo Paper Company, Peshtigo, Wis.

Daniel B. Devondorf is employed by the National Aniline Company, Buffalo, New York.

Robert C. Farnsworth is now in the Plastics Division of the Consolidated Power and Paper Company.

Lyle T. Larson is employed by the Minnesota Mining and Manufacturing Company of St. Paul.

Robert A. Mohr is with the Gulf Oil Company, Port Arthur, Texas, in their training program.

Frank C. Pasch has accepted employment with the Thompson Aircraft Products Company, Cleveland, Ohio.

Floyd Witzel is with the Pittsburgh Plate Glass Company, Milwaukee, Wis.

Robert H. Zabel is in the Pigments Division of the Du Pont Corporation, Newark, N. J.

E. E.

Clifford W. Humphrey, ('00), president of the Sayre and Fisher Brick Company, died recently in New Jersey. Following his graduation from the university he was in charge of the engineering department of the Denver (Colo.) Gas and Electric Company. From 1905 until 1914 he was a consulting engineer. Then he became vice-president of Utilities Power and Light, a company that he helped organize. He operated his own laboratory until 1926, when he became vice-president of the Empire Brick Company, of New York.

He was a member of AIEE, ASME, and the American Chemical Society.

Robert I. Howes, ('34) of Santa Fe recently designed a new type of reactor with applications in the civilian use of atomic energy.

Howard S. Knopow, ('43), has established his own firm, and is now president of the Milwaukee Transformer Company.

Dr. John Bardeen, who received his master's degree here in 1932, is co-inventor of a new radio tube involved in a recent type radio set which plays immediately upon being turned on. The new tube is the size of a match head, and uses less electricity than a flashlight. The new set was demonstrated recently in New York by the Bell Telephone Company.

M. & M. E.

Irvin Rubow ('37) is now superintendent of the Walker Mine, Canisteo District, Coleraine, Minn. Virgil Huff ('47) is Mining Engineer for the same concern.

Robert E. Dustrude, ('48) is Mining Engineer for the U. S. Gypsum Company, Heath Mine, Lewistown, Mont.

George Schucknecht, ('40) has been appointed Mining Engineer for the W. H. John Manville Company, Lompoc, Calif.

Robert B. Hendy, ('47) is now Mining Geologist for the W. H.

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ULTRAFAX

A Million Words A Minute Communication

by R. H. Pipkorn me'49

(Photos courtesy RCA)

Unheard of speed in the transmission of documents was demonstrated in the Library of Congress by the Radio Corporation of America late last October. A relative idea of the speed of transmission can be gained from a sample of the experiment performed, that of transmitting the entire text of the novel "Gone With the Wind"—1047 pages—by Ultrafax in two minutes and twenty seconds. The overall system is a development of RCA Laboratories, in cooperation with Eastman Kodak Company and the National Broadcasting Company. Engineers stated that the radio-television-photography combination forms the basis for a system of graphic communication which can be extended from city to city across the nation.

Main Steps in the Operation

Ultrafax's remarkable speed is possible because full pages of information are transmitted as television pictures at the rate of fifteen to thirty a second. The principal steps in transmitting and receiving by Ultrafax are:

1. Preparation of data to be transmitted, to assure a continuous flow at high speed.
2. Scanning of this data by what is known as a flying-spot television scanner, at the sending terminal.
3. Transmission of the television image as ultra-high radio-frequency signals over a microwave relay system.
4. Reception on projection-type television kinescope, or "picture tube," from which the incoming messages are recorded on motion picture film, or ultimately directly onto photographic paper.

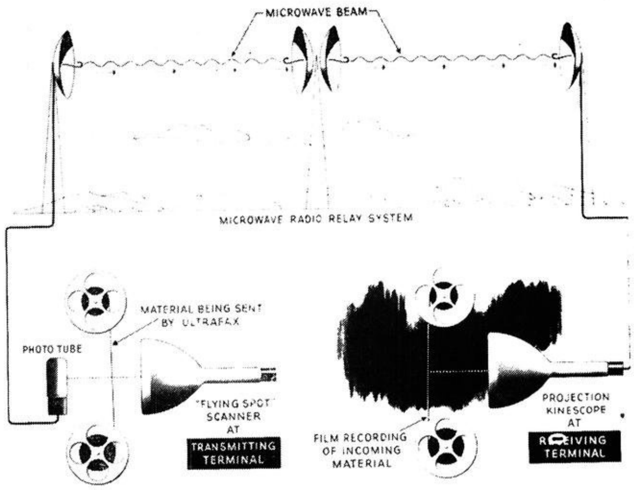
When fully developed the Ultrafax system would be very simple. Communications centers would be placed strategically in metropolitan and suburban areas. The message would be placed before the flying spot television scanner. Here the message is transformed from its visual status into electrical impulses, by means of an RCA phototube, then is flashed by wire to a radio transmitter which would flash it through the air to a radio relay station. In point-to-point operation these relay stations would be spaced twenty-five to fifty miles apart depending on the terrain, and each would "bounce" the signals on to the next station. The radio relay system for Ultrafax would use the wide bandwidths used in television transmission which can handle 500,000 words a minute but broader bandwidths of still higher frequencies have a capacity of a million words a minute. Signals reaching the receiving terminal are transformed into light images on the face of the projection kinescope where it is photographed as it arrives. The total time elapsed from scanning to photography—regardless of whether the distance travelled is twenty-five miles or across the country—would be as short as one-thirtieth of a second.

High Speed Photography

When huge volumes of material, such as full length novels, full newspapers or magazines are to be transmitted it is desirable to photograph the material page-by-page on microfilm. This rapid initial photography and that required at the receiving station has been made possible by the developments of Kodak Research Laboratories. The process uses a continuous flow of heated photographic chemicals and heat resistant film, either 16 mm. or 35 mm. motion picture film. When full-size copy is to be reproduced from Ultrafax, especially built continuous enlarging and processing machines are used.

Flying Spot Scanner

At the heart of the electronic scanner unit is a cathode-ray tube or kinescope. By means of it, each tiny area of the message is examined and tiny electrical impulses generated to indicate the degree of light appearing on its surface. The funnel-shaped tube has a flat glass end or screen coated with flourescent material that glows intensely as the electron spot strikes it. This spot of light is deflected by electrical means back and forth thousands of times a second.



RCA ULTRAFAX SYSTEM

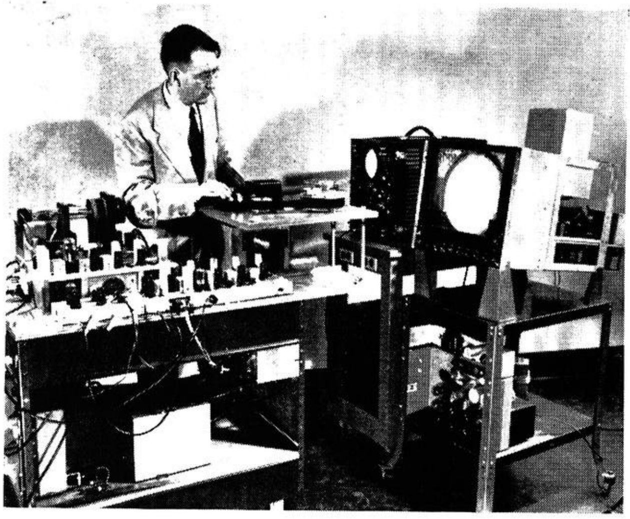
Schematic drawing of the actual operations which take place between transmitting terminal and the receiving terminal.

The name—flying spot scanner—is derived from this dancing spot of light. By means of a lens, it is imaged on the copy to be transmitted. When film recordings are used, the spot of light passes through the lens and film to strike the phototube in a light-tight housing. This tiny vacuum tube responds to the variations in light intensity by generating electric currents which become radio signals at the transmitter and flash through the air to points of destination.

The Ultrafax signal can be radiated by either a broadcast-type television transmitter or by the microwave radio relay circuits already mentioned. The antenna for the transmitter must be mounted at high elevation with a clear view of the receiving point because these very short radio waves have the faculty of travelling in line-of-sight from the antenna. Installed near the top of a specially constructed steels towers, the antenna reflectors send and receive equally well when handling Ultrafax, television programs, or other radio services requiring wide band widths.

Receiving Messages

Ultrafax signals reaching the receiver antenna at the point of destination can be fed down from the towers by coaxial cable to the receiver. This apparatus converts the electrical wave into a modulated light spot on the face of the receiving kinescope. Adjustments to the deflection circuit, setting of gain and brightness are made by the operator. It is just as important to have sharp focus electrically as it is optically. The electron spot moves back and forth over the sensitive screen producing a single bright line trace. The intensity varies from instant to instant in exact synchronism with the light and dark portions of the picture at the distant transmitter.



The principal elements of the sending terminal of RCA Ultrafax. At the left is a cathode ray tube for scanning messages on film as they pass through the unit on the center table. The instruments at the right are monitoring units.

With the lens opened, the camera beneath the receiving kinescope can be adjusted as an ordinary camera to focus incoming images on the film inside. It is possible to remove the camera from the receiving panel in order to load it with film. The Ultrafax camera itself is much simpler than the type generally used for motion pictures. It requires no mechanism to produce an intermittent motion. When the motor is started, the film comes up immediately to its proper operating speed, moving unexposed film continuously from the supply spool past the lens system.

At the end of transmission, the exposed film can be transferred quickly to the rapid processing unit in which, under darkroom conditions, it is passed through the miniature developing tank. In this machine, the film is developed and fixed in less than fifteen seconds and dried in twenty-five seconds more. The unit as employed in experimental Ultrafax transmission has processed film at a rate as high as 320 messages a minute.

By means of an Airgraph enlarger, these messages, recorded on 16 mm. film can be enlarged up to a full-page letter size. The film is threaded through an optical projection unit of this continuous-process machine, and sensitized paper moves on a roll within focusing distance. The image of each message or frame is projected down on the gate beneath which the photopaper passes. The exposure is lightening fast, making possible the recording of thousands upon thousands of words every second.

Development of Ultrafax

Credit for contributing early suggestions as to how Ultrafax could employ radio relaying and television techniques goes to C. W. Hansell of the RCA Laboratories, a pioneer in developing ultra-high frequency radio-relay systems. Advanced engineering and development work is under the direction of Donald S. Bond, also a member of RCA Laboratories staff.

Together with associates in RCA Laboratories and NBC, Mr. Bond devised the required electronic equipment, and in cooperation with engineers of the Eastman Kodak Company, added high-speed film processing apparatus. The system than was tested and refined jointly by the various groups.

Future Uses

The first message ever publicly transmitted over the Ultrafax system was a handwritten letter by Brigadier General David Sarnoff, president and chairman of the board of RCA, congratulating RCA scientists and engineers who created and developed this new method of radio communications and concluded: "May Ultrafax, as swift as light, open a new and useful service for mankind everywhere." During the demonstration at the Library of Congress, messages, technical drawings, and other material in foreign languages were among the numerous items transmitted by Ultrafax directly from the tower of the National Broadcasting Company's television station WNBW at the Wardman Park Hotel to the receiving terminal on the stage of the Library of Congress, a distance of three miles.

General Sarnoff foresaw many possible developments and summed them up briefly as follows:

1. The exchange of international television programs achieved on a transoceanic basis.

2. A service of television and Ultrafax by which the same receiving set would bring various types of publications into the home, or a newspaper for that matter, without interrupting the program being viewed.

3. A system of world-wide military communications, for this country, scrambled to the needs of secrecy, which with ten transmitters could carry in sixty seconds the peak load of message traffic cleared from the Pentagon Building in twenty-four hours during the height of World War II.

4. The establishment of great newspapers as national institutions, by instantaneous transmission and reception of complete editions into every home equipped with a

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MORE POWER . . .

by R. H. Pipkorn me'49

The demands and competition in the field of small internal combustion engines, say below 150 horsepower, has turned manufacturers to new ideas and principles. One manufacturer, the McCulloch Motors Corporation of Los Angeles, Calif., has employed the idea of the opposed piston engine. This engine has two pistons operating in the same cylinder, each connected to its own crankshaft on opposite sides of the engine. This principle is not new, since it is now used on a Diesel engine being built for various applications.

This principle was turned to in order to meet the demands of the present day market—the demand for better performance—because of the possibilities of improving the power-weight ratio, with good fuel economy and low manufacturing costs.

The Principle of Operation

Each cylinder contains two opposed pistons connected to separate crankshafts at each side of the engine. The power received from the pistons is transmitted through the connecting rods to the individual crankshafts. These crankshafts carry pinions which mesh with a larger gear on the power take-off shaft. The actual combustion space is the cylindrical volume between the two pistons at the center.

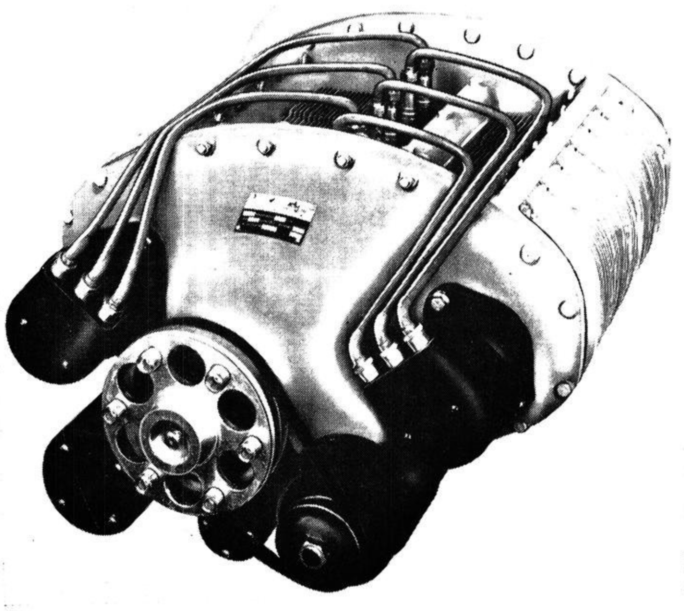
The inlet port is at one end of the cylinder and is controlled by the inlet piston, and the exhaust port is at the other end of the cylinder and is controlled by the other piston. This provides a uniflow arrangement, giving an orderly flow of gases. The exhaust crank is given a lead in order that the exhaust ports are well open to blow down the burned charge to a low pressure before the inlet piston permits entry of the fresh charge. A gear driven supercharger forces the new charge through the inlet port in a manner to provide rotation about the cylinder axis, which is believed to aid stratification or separation of the fresh charge from the products of the previous combustion.

Fuel injectors discharge fuel into the inlet manifold through individual nozzles for each cylinder. All engine bearings are lubricated and cooled by oil under pressure and a generous supply from the upper end of the connecting rod insures adequate cooling of the pistons. In the air-cooled version, aluminum fins are provided for the full length of the liners with space between the cylinders for suffcient air flow.

Original Tests on a Single Cylinder Engine

The original research on this engine was performed on a single cylinder test engine which was built large and rugged to simplify construction and obtain reliability. The arrangement was such to accommodate various combinations of bores, strokes, and crank centers, but the majority of the tests were conducted on a 3 inch bore and 2.5 inch stroke at each crank, giving a total displacement of 35.3 cubic inches. The engine tests were made at 4000 rpm. using 80 octane fuel. Results were observed at 29.2 to 29.7 inches of mercury barometric pressure and 200 degrees Fahrenheit inlet manifold temperature before fuel injection.

A summary look at the results of the various tests show some interesting data. The power output was approximately proportional to the breathing capacity of the engine. Air consumption in percentage of piston displacement indicated that air was not being wasted, which was remarkable since a flow of 75% of the piston displacement represents an output of one brake horsepower per cubic inch. The most important factor affecting scavenging efficiency and manifold pressure was found to be exhaust blowdown. Exhaust blowdown is the product of the exhaust port area and the time interval from exhaust port opening until the inlet port opened. With the shape of the ports used, an accurate approximation was one-half of the total exhaust port area in square inches at the end of the blowdown times the interval in crankshaft degrees. Low pressure, 6.5 inches of mercury, at full power required only moderate impeller speed and consequently



(Photograph courtesy of McCulloch Motors Corp.)

Photograph of the McCulloch Motors three-cylinder engine as described in the article.

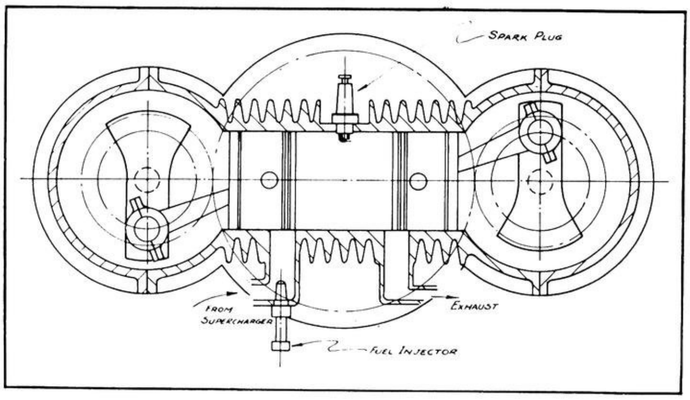
resulted in a greatly simplified supercharger.

Design Consideration of the Multi-cylindered Engine

The design of the multi-cylindered engine took into consideration numerous factors to gain many advantages, among which were lightness, compactness, good efficiency and smooth operation. These were gained by designing the various parts using moderate stresses and simple design.

The two cycle engine has advantages in the cycle itself, since a given power can be produced in a two cycle engine having more than twice the number of firing strokes with less piston displacement and a lower brake mean effective pressure than is necessary in a four cycle engine. Optimum crankshaft speeds are higher due to the elimination of valve arrangements. Displacement keeps piston velocity on a par with other small aircraft engines.

The lower bmep, together with the small displacement, greatly reduces the mean and maximum forces on all parts from pistons to propeller. The total maximum load on the connecting rod is approximately one-third the value obtained on current engines developing the same power per piston. Added to this, there is practically no reversal of load, further reducing the fatigue stresses. This permits the use of smaller parts and also reduces the maximum bearing loads to only about one-half the usual values.



Schematic drawing of the opposed piston engine. Note that the exhaust port is open before the intake port is uncovered.

The opposed piston engine is almost in complete balance for any number of cylinders. For two or more cylinders, crankshaft counterweights are not necessary, and in fact, tend to increase rather than decrease the maximum main bearing loads. A small unbalance couple exists when the two crankshafts are out of phase, but this can be reduced, if necessary, with counterweights at each end of the crankshafts.

As is expected, the engine will give exceptionally smooth power due to the fact that the firing impulses will be as frequent as those in a twelve cylinder, four cycle direct drive engine running at the same propeller speed. This should also simplify the mounting of the engine for its operation.

Description of the Multi-cylindered Engine

The original engine was designed to operate as an aircraft engine. The displacement is 100 cubic inches, developing 100 horsepower at 4000 rpm. crankshaft speed and 2000 rpm, propeller speed. For these specifications the weight is 1.52 pounds per brake horsepower. Ignition is produced by dual, radio shielded magnetos. Fuel is supplied to the cylinders by injection. Provisions were also made for a starter and a generator drive. The maximum overall width is 21 inches, 30% less than usual; this improves visibility and cowling in tractor installations. The overall length, including the starter and generator installed and including accessory removal clearance is 32 inches. The height, including the wet oil sump, is 19 inches.

The main structure is the integral cylinder block, an aluminum casting which includes cylinders, the inner half of both crankcases, and the front and rear housing flanges. This casting requires no external cores and is easily cleaned and inspected. Liners are shrunk into the cylinder bores and finished in place. The through bores simplify the finish boring oepration and honing operation. Cast cooling fins cover the entire length of the barrel, consequently a relatively large fin area is obtained without excessive fin length and attendant foundry costs. The cooling factor compares favorably with that of larger engines using machined fins. The crankcases have unusually large exposed surfaces with cast fins both inside and outside, for integral cooling of the oil. All other castings, including the remaining large parts—the front and rear housings and supercharger housing—are designed to be made in two piece molds, consequently adaptable to permanent molding or die casting.

A liquid cooled model has also been designed with all coolant passages permanently fastened, eliminating the usual plumbing. With the coolant pump, the dry weight is slightly less than the air-cooled model and the rated power is increased.

All screws are easily accessible, and except for the spark plugs, only one wrench is needed to assemble the entire engine. Through bolts have been used wherever possible to eliminate threads in light metal castings. While this method increases weight slightly, it reduces cost and service problems.

Because of the low pressure required, the centrifugal supercharger is driven from the rear of one of the crankshafts through two spur gears. The rotor tip velocity is less than 700 feet per second. This low impeller speed means low stress and consequently simplifies manufacture. The supercharger is available to provide a very desirable improvement in engine performance at moderate altitudes.

The oil pump with the tachometer drive is mounted at the rear of the other crankshaft and is driven at one-half the crankshaft speed. The oil sump is a separate unit and is mounted underneath the center of the engine. Oil is forced under pressure to all rotating bearing surfaces through drilled passages.

The magneto, fuel injector, starter, and generator are mounted in the nose section where they are accessible for inspection, adjustment or removal. The magnetos are driven from each crankshaft at a point of minimum torsional vibration. The injector is driven through a spur

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URANIUM

OPPORTUNITIES FOR PRIVATE PRIVATE PROSPECTING

by John Warner m'50

(*Photos courtesy Popular Science Monthly*)

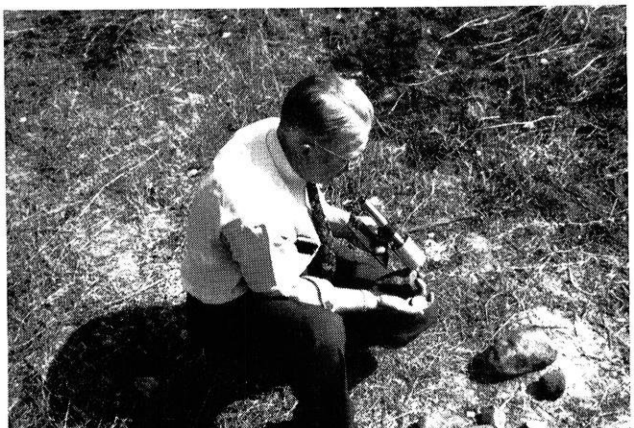
Known reserves of uranium-bearing ores in the United States.

JULY 16, 1945, the first atomic bomb was exploded, officially ushering in the atomic era. It was the end product of a $2 billion gamble by the scientists of the United States and allied countries. With it came not only the means of ending the war more quickly, but countless peacetime uses of the products . . . radioactivity.

But what of the resources that make these new discoveries possible? From what materials, by what processes are these resources converted, and finally, most important, what amount of these resources exist; for the theoretical life span of the newly created atomic era is dependent upon the quantity of basic supply.

The answers to these questions, some of them, are known only to a handful of scientists. The answers to others, by a larger group. Just what is and can be known by the public?

The processes by which radioactivity and fission are utilized to produce atomic energy are of course secret. It would hardly be understandable to the layman anyway, so it shall be disregarded. Our concern will be with the raw materials, their location, methods of detection, and government regulations concerning private prospecting.



Determining radioactivity, an investigator times his electroscope's reaction.

Occurrence

Ironically, in this country, the producer of the energy, there are relatively few known good deposits. The original supplies came from pegmatites in New England and North Carolina as well as from abroad. At present, attention is being given primarily to the Colorado plateau area, Utah, Arizona, and New Mexico. Here, the ores being dug are carnotite, and roscoelite type ores. A less productive source, but one which is being utilized is mine tailings from vanadium mines. The AEC (Atomic Energy Commission) has reserved an area of 115 square miles in southwestern Colorado and southeastern Utah. The commission, with the help of the U. S. Geological Survey, is making a comprehensive study of these areas and testing for uranium bearing ores. Those lands found to contain uranium will become available for development by private interests under arrangements with the government. As of last July, no further withdrawals were contemplated until this one was completely examined.

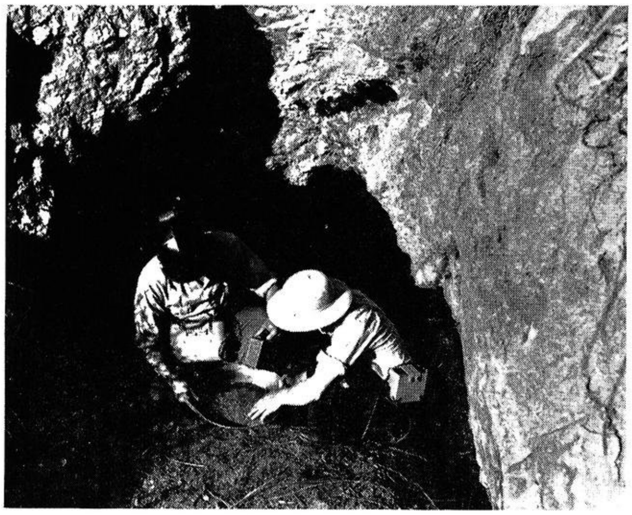
Of considerable interest are the recent discoveries on the northern shores of Lake Superior. Here, high grade pitchblende finds have been verified by leading Canadian geologists. Heretofore, the only known deposits were in northern Canada and the Belgian Congo. In the area of this new find, claim seekers have been filing claims in true gold-rush style, even though the extent of the deposits is not yet known. Great opportunities appear to exist there.

With this and other recent discoveries, it would seem that there are still large areas as yet unprospected. Uranium is found in widely varying climates and geological areas as well, from Colorado to northern Canada, southern Canada to New England.

Uranium Bearing Minerals

The fact that this valuable and much sought-after element is found in such different areas and under such different conditions leads one to inquire about its makeup, its characteristics, and compounds. Just how and in what form does uranium present itself?

Uranium is a metal, and as such will be found in many states comparable to other metals, such as the oxide U_3O_8. It is very active, for it is known to be present in over 100



Testing panned gravel for telltale glow, under ultra-violet light.

minerals; however only two have produced the bulk of the supply to date:

Pitchblende, or uraninite, is a very heavy, dark brown, hard, glossy mineral that occurs in well defined veins. These veins usually are found among gold, silver, iron, zinc, or cobalt deposits. A prospector can be quite confident that his find of pitchblende will yield not only uranium but other valuable metals as well.

Another form occurs in carnotite and autunite, which are soft and powdery and a bright canary yellow in color. Torbernite is similar, but bright green. These oxidized minerals occur as incrustations on surface rocks or as disseminations through them, and in near surface open fractures, in sandstone or shale.

Acting much the same as uranium is thorium, which is equally as valuable. Thorium occurs in monazite; the chief commercial deposits of this mineral are placers.

Methods of Detection

Uranium bearing substances virtually shout for recognition, as through the earphones of a Geiger-Muller counter. As such, the counter is one of the most valuable tools of the prospector. The Geiger counter has a gas-filled glass tube containing a hollow metal electrode, with a tungsten wire in its center. Radioactive rays cause a discharge from a battery in the circuit, which produces a click in the earphones. The frequency of the clicks determines the amount of radioactivity present in the area.

Clicking is always heard, due to random gamma radiation and cosmic rays, therefore the first and most important step with the counter is to establish the background count. This background count will vary for different instruments, and will not be the same at all times on the same instrument. Temporary variations will arise from several factors: Some types of bedrock contain more radioactivity than others. Limestone is usually inert, while granite often will contain some radioactive minerals, therefore crossing from limestone to granite would jump up the count.

Sometimes depressions in the earth blot out the incoming cosmic rays, decreasing the count. A fairly large area of weak activity may be confused with a small crevice of high-grade ore. With experience, the prospector will become familiar with these changes and be able to allow for them.

Too rapid movement of the counter, overhanging, or overbearing rock, and wall rock are all liable to decrease or completely cut off any radiation. Generally, the count must be 3 or 4 times the usual background count, to indicate radioactive ores.

A number of different companies manufacture Geiger counters at prices ranging from $100 to $300. These portable field units are built to stand a normal amount of abuse. Very humid conditions are not good, such as a very wet mine, but they may be operated in the rain on the surface where air circulates freely. Normal careful care is sufficient to keep the counter in good condition. No license is required to use the counter or prospect for radioactive materials.

Another scientific instrument that has found use with prospectors is the familiar electroscope. The electroscope is charged as usual and the leaves separate. When brought near uranium bearing ores, the radioactive rays ionize the atmosphere and cause the charge to leak off, thus allowing the leaves to come together. First, the operator must determine the normal length of time required for the charge to leak off. With this as his base, he can judge the intensity of the radiation that he receives. Modern portable electroscopes have tiny gold plated quartz hairs that are viewed through a magnifying eyepiece. These are available at less cost than the more sensitive Geiger counter.

The counter and electroscope are not the only means by which ores can be located. Night prospecting is sometimes important in that some radioactive minerals glow under ultra-violet light. With the ultra-violet light flashed on them, they glow with a characteristic greenish yellow tint. At night or in mines, this method can be used to more definitely locate the ores themselves with more accuracy than the Geiger counter would have indicated.

It is unfortunate that the two primary uranium supplying minerals, pitchblende and carnotite, do not glow when under ultra-violet light. However, uranium in the absence of rare-earth elements can be identified by fusing the uranium bearing material with lithium or sodium fluoride in a loop of wire. The bead thus produced will glow under ultra-violet light, even if only a minute amount of uranium is present.

Fluorescence alone is not a test for uranium, for some non-uranium bearing minerals will glow under ultra-violet light. Scorpions, horned toads, lizards, and snakes fluoresce gold or cream. Fossil teeth, shells, bones, etc., are likely to glow, as well as petrified wood. Radioactive substances are sometimes carried in solution and end up in these substances. In Colorado two impregnated petrified wood logs yielded 100 tons of ore with enough radium, uranium, and vanadium to pay the finder nearly $250,000. Other substances like antlers and jaw bones glowing weirdly in the dark, have led to rich discoveries.

If samples of these minerals are desired, it is possible

(please turn to page 32)

A Prophecy - - -

KWH DEMAND

by Robert Johnson e'50

The future growth predicted for the electrical power industry in the United States is phenomenal. Even the conservative estimates of authorities concerned directly with the field show that by 1957 the energy load on the electric power systems in this country will be almost double the peak capacity output of the present generating equipment. Mr. G. A. Price, the president of Westinghouse Electric Company predicts that in order for the industry to meet these tremendous demands, the existing generating capacity will have to be increased at least eighty per cent. This expansion will probably require the power companies to spend in the next ten years an amount of money equivalent to all of their presently invested capital. These estimates coupled with the high expectations of many of the engineers and businessmen in the field promise busy, prosperous years for the electric power industry.

The growing use of electrical energy is shown in Chart I. All of the curves show how the demand for electricity has jumped upward in recent years, and the dotted portions of the curves represent the conservative estimates of the future power requirements for industry and the general public. Curve A shows that the electrical power generated by utilities has increased 400 percent in the past twenty-two years, and that within the next decade the generative capacity of the utility companies is expected to be almost double its present rating. Curve B represents the power generated by industry within itself, and Curve C shows the total amount of electrical energy generated in the country. The rise in the total industrial use of electricity is illustrated by Curve D. Domestic, commercial, and farm loads make up the difference between curves C and D.

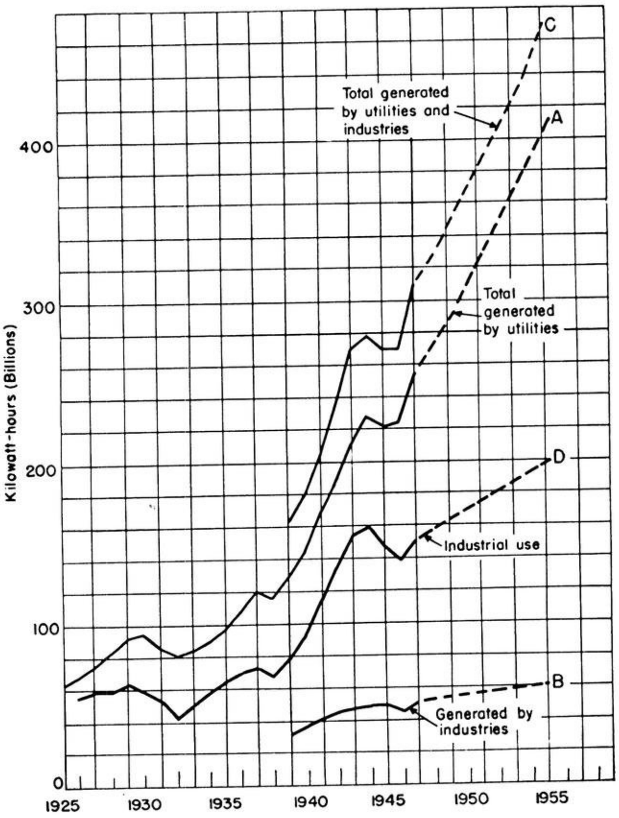
FUNDAMENTAL FACTORS

Three basic factors act cumulatively to result in the rapidly growing demand for electric power according to a paper presented to the Adirondack Industrial Power Sales Conference by Mr. L. A. Umansky, the assistant manager of the Industrial Engineering Division of General Electric Company. It is his belief that the limit of industrial application for electric power and equipment is sky high.

In the first place, the population of the United States is as shown in Chart II. From 1790 to 1890 the population in this country grew approximately according to the following relationship:

$$n = 3.9\ e^{0.028y}$$

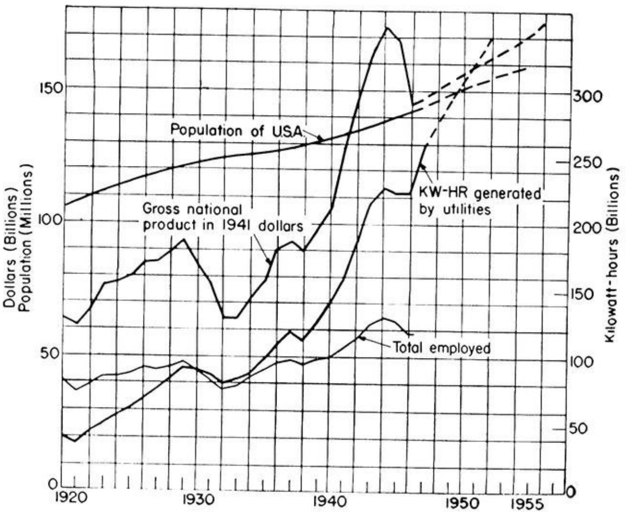
where n is the population in millions, y the number of years after 1790, and e the base of the natural logarithm system. Although this relationship no longer holds exactly, the population of the United States has increased 35 per cent in the last twenty-seven years. By 1955 there should be about 160 million people inhabiting this country, and every one of them will contribute in innumerable ways to increasing the demand for electric energy. As is seen from the chart, the proportion of those people employed in good years to the total population is almost constant during the period of time covered. The relationship between the total national product and the total electric power generated is illustrated by the two remaining curves on the third chart. During the period shown, the value in 1941 dollars of all goods and services rose 230 per cent while the total enere gy generated in the country



(Cuts courtesy General Electric)

increased by more than 600 per cent. The effect of business cycles is not the predominant factor in the overall demand for electricity.

The only method of improving the standard of living of America and the world is through the production of material goods. The second factor contributing to the widespread use of electrical power states that only by using more power per man can more goods be produced. Increasing the power at the disposal of each worker increases correspondingly his ability to produce more goods. Man alone is highly impotent; but with the control of powerful tools and machines, man becomes a mighty creature. In fact, since there appears to be no natural limit to the amount of power a man can control, there should be no limit to his standard of living. At least this is one way of improving his economic position. For example, between 1900 and 1940 the power at the disposal of each production worker in the United States was more than tripled; and in that same period the working time put in by each hourly employee was cut by one third, and his real wages were more than doubled. For the period from 1927 to 1947, Chart III shows how the manufacturing industries increased their employment by 50 per cent, and at the same time nearly doubled the amount of electric power used per worker. Consequently the output



per man hour has risen, the workers' real wages have risen, and the number of working hours per man per week has fallen. Therefore fundamentally the way to increase production is to increase the amount of power at the disposal of each worker.

Here the third factor enters in. As each worker produces more due to the greater utilization of power, it is found that each unit of production contains more electrical energy. Chart IV illustrates the increase in energy content per unit of production. Since 1939 the chart shows that the use of electric power per production unit has risen by ten per cent. This increase is because electricity is not limited to acting merely as a source of mechanical power to replace manpoower; electrical energy is an excellent chemical and thermal agent in many industrial processes and is rapidly replacing many old techniques.

NEW USES FOR ELECTRICITY

The general reasons for the expanded usage of electrical energy are many. New products require new factories which in turn will add either directly or indirectly to the power system load. Large amounts of steel, building materials, equipment and apparatus all utilize a large amount of electric power in their processing. In the end, new products generally require additional electricity either to make or to run, or possibly both. The diminishing grades of many of our natural resources such as iron ore will require future purification processes and undoubtedly entailing a considerable use of electric power. Rising labor costs and the efforts for greater productivity are powerful levers at work pressing for greater efficiency through electrification. Residential uses are expected to continue to increase with the continued production of household gadgets. Mr. W. E. Schubert, president of the Wisconsin Utilities association, reported that in Wisconsin alone the residential use of electricity had increased 118 per cent with the last ten years with twenty-one per cent of this increase occurring in 1947. All of the many new ideas of, and developments for, health, comfort, and convenience will lead to a vastly expanded national use of electricity.

In addition, the fields in which electricity is being put to use are constantly expanding. Electronic devices for the control of industrial machinery present tremendous possibilities. For example, the electronic control of cutting tools and the automatic handling of work surfaces was one of the features displayed at the machine tool show in Chicago. Increased production through electricity is illustrated in the new steel strip mills that operate at speeds over 5000 feet per minute on their processing lines. Heavy kraft paper nineteen feet wide is being made at 2000 feet per minute in one mill; and textile, tin, and glass plants are all trying to improve the speed on their processing lines. These production records are doubly important because they require electrical power and equipment far in excess of the proportionate increases in production.

New applications are constantly being found for induction and radio frequency heating. Dielectric heating for example is being used to speed the manufacture of plywood, and infrared light is being used in countless applications to dry paints and enamels rapidly. Arc furnaces for melting are already in widespread use, but radio frequency heat for melting, tempering, and welding is just coming into adolescence. Even the many new uses for electronic air cleaners in such traditionally dirty places as steel mills promise to add to the power load of the future.

WESTINGHOUSE PREDICTIONS

Gwilym A. Price, the president of Westinghouse Electric Corporation predicted in a speech at the convention of the Edison Electric Institute at Atlantic City that the annual load on the power systems in the United States would increase at the rate of 30,000 kilowatt-hours per minute for each of the 5,250,000 minutes in the next ten years.

To as large an extent as possible, Mr. Price has based his estimates on facts and not on mere extrapolations of curves of past performance. He feels that "large as these charted increases are, there are good reasons for thinking that these prognostications are on the conservative side. This is because of numerous intangible but inexorable trends that are difficult to reduce to concrete figures; some may be calculated with a fair degree of accuracy, and some are quite intangible." In his speech he cited several of the major changes in the industrial scene which will contribute heavily to the large future demand for electric power.

One such change is the synthetic-fuel program sponsored by both the government and private industry. The original plans call for plant installations to provide two million barrels of liquid fuel a day; such a program would require about 700,000,000,000 horsepower-hours a year to produce with the synthetic fuel plants now being constructed. A large part of this power requirement would be satisfied by mechanical drive turbine compressors using heat liberated in the chemical process, but a very large part would also have to be electric power. In fact the electrical energy requirements of this program call for more than twice as much power per year as is now being generated by all the utilities.

The Westinghouse executive also pointed out that large as the new and expanded industries will be, there will yet remain the huge job of modernizing existing facilities. He stated that in the Westinghouse corporation itself, the plant planning department recently made a survey of all the company's operations and found that if the new processes and machines were added which were actually justified by the volume of production, the electric power consumption of the corporation would increase by 35 per cent!

MODERNIZATION OF INDUSTRY

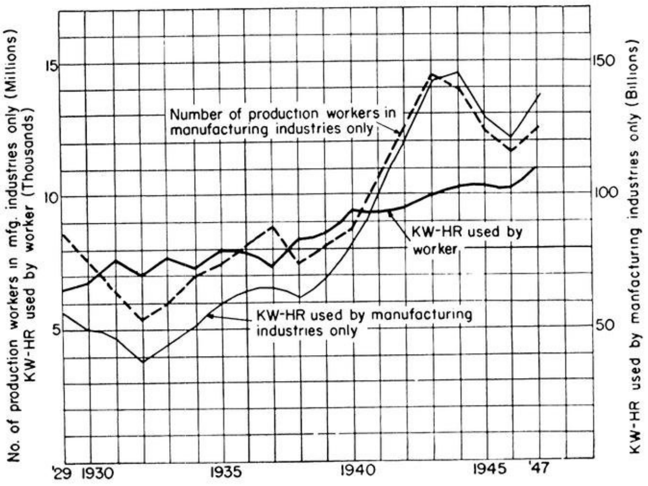
Electrification of industry is a cumulative task far greater than any mere increase in electric power consumption. Mr. Umansky explains in his paper on future industrial power requirements that a plant "which many would call 100 per cent electrified may be the most fertile ground for additional or new electrical equipment. This so-called modernization or electrification is never complete; in fact, its tempo is mounting from year to year."

Modernization may take hundreds of different shapes and forms; industrial processes become outmoded, equipment grows obsolete, or just general improvements may be made. The modern trend is to operate the processes continuously, reduce material handling, increase operating speeds, substitute automatic controls, and eliminate the danger of human errors. Modernization of one factory may so improve conditions, reduce costs, and raise wages that competing concerns are forced to modernize. This process continues and continues as long as science and engineering develop new and better processes and equipment.

Electrical equipment itself is rapidly becoming more complicated as various complex mechanical operations are taken over by electrical controls. The elaborate equipment on many of the automatic machine tools now being manufactured raises the cost of these machines, but as usual the increased production, decreased maintainance, and improved operation of the better equipment bears out the additional investment in cost. Electrical power generally operates the improved equipment, and so the power consumption is increased by both the construction and operation of every new machine.

WESTINGHOUSE SURVEY

The market development department of Westinghouse Electric recently conducted a survey for the guidance of the company's long range production planning. The facts produced by this study were so encouraging that the results were published in a booklet entitled "The Electrical Industry by 1957".



Working on the assumption that use of electrical energy gives an excellent indication of the use of electrical equipment, the Westinghouse engineers studied the long term power demand trends for four major classes of consumers:

1). Residential
2). Farm
3). Small industrial and commercial
4). Large industrial and commercial

RESIDENTIAL CONSUMPTION

The study shows that residential users have been using more and more power, and the prediction is made that by 1957 the utility companies will be supplying some thirty-four million customers with electric power.

"People conserve during tight periods by delaying the purchase of a new suit or car, but they do not stop using their electrical ranges, vacuum cleaners, lights, or refrigerators." The booklet stated that, "We are rapidly tying home operations so closely to electricity that any interruption of electric service becomes almost a crisis."

New appliances, and the availability of many other pre-war devices have contributed heavily to the present increase in domestic power consumption.

An exerpt from the July 1948 **Westinghouse Engineer** states that "The home, power-wise, appears to be a bottomless pit, which there is no chance to fill to the brim with kilowatt-hours. There are many well appreciated load builders such as improved lighting, home freezers, air-conditioners, dishwashers, electric bed coverings, radio and television sets, and the changed 'power habits' that have resulted from the automatic cycle dishwasher and its companion, the dryer." For instance, one simple unit like the little bactericidal Sterilamp, which has such large sanitation possibilities, installed in each wired house in the country would increase the nation's power load by 500,000 kilowatts. That is with only one lamp per house!

Other household gadgets, each adding their small yet

(please turn to page 46)

Science Highlights

by Howard Traeder m'48

STRATOVISION

Television pictures of the Republican National Convention were beamed as far west as Central Ohio in the first public demonstration of "Stratovision." This demonstration of the world's first airborne television station was put on by the Westinghouse Electric Corporation and the Glenn L. Martin Company, co - developers of "Stratovision." The Stratovision plane, experimental station W10WXB, picked up broadcasts from WNBW, Washington, D. C., and WMAR-TV, Baltimore, while circling over Pittsburgh at 25,000 feet and rebroadcast on Channel 6 over an area approximate 525 miles in dimeter surrounding the city. The broadcast covered nine states.

A modified B-29 was used in this first test but Ben A. Carroll, Martin's Stratovision engineer, has outlined plans for a special airplane especially designed to meet the needs of this type of operation and equipped for all - weather flying. Present plans call for a Martin 2-0-2 with a gross weight of 39,000 pounds, powered by two Pratt and Whitney R-2800 engines. The 2-0-2 will require 32 minutes to reach station altitude and cruise for three hours in a 3½ mile radius circle at a reduced speed of 180 miles per hour. Seven thousands pounds of equipment including a four-man crew will be required in each airplane which will carry 1,250 gallons of fuel for cruising plus reserves, climb and descent requirements. The cabin on the commercial Stratovision plane will be pressurized and dual equipment will be used wherever practicable for reliability. Heat anti-icing on all wing and fuselage leading edges and windshield are standard on the 2-0-2. Blind landing equipment and navigational radar will be included on the Stratovision plane.

Television and FM radio waves travel in a straight line and for all practical purposes stop at the horizon. This means that television broadcasts from the highest practical tower erected on the ground can be received only 35 to 50 miles away. The Stratovision system simply puts the antenna and transmitter in an airplane flying in lazy circles high above the earth, beyond the sight of ground observers. The short waves sent out from this airborne antenna blanket the earth's surface like a great inverted ice cream cone and cover an area approximately 500 miles across or equal to about the combined area of New York, Pennsylvania, and New Jersey.

First studies of the Stratovision system were made late in 1944 and early in 1945 by C. E. Nobles, 30-year-old Texas-born engineer and originator of the airborne television transmission system. Full scale development was begun by Westinghouse and the Glenn L. Martin Company in the fall of 1945. The first flight tests were made that fall and in early 1946. Current test results indicate that the preliminary estimate of coverage in a circle of 400 miles diameter was conservative. The top record achieved to date at 25,000 feet altitude is coverage of an area 525 miles in diameter.

Although at present, operation of only one Stratovision station has been requested, a coast-to-coast network linking New York and Hollywood broadcasting four television and five FM network programs and requiring only eight planes flying about 400 miles apart has been projected. By adding six planes to this system for added coverage in the Southeast and Northwest, service would be provided over 51 per cent of the nation's area, which includes 78 per cent of the population. A network of ground stations spanning across the country but covering a much smaller area would re-

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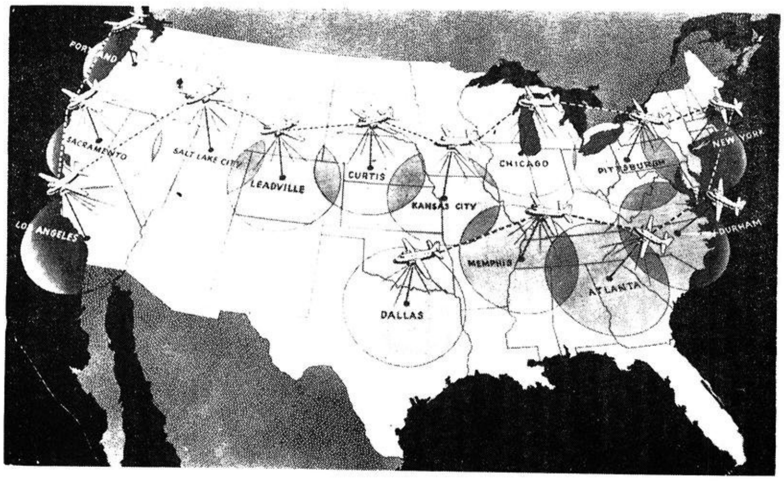

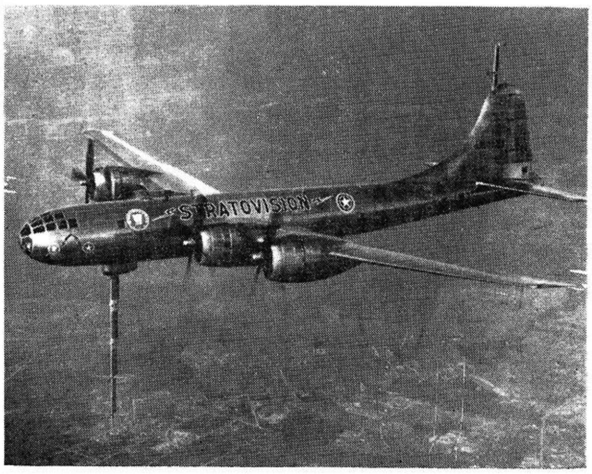

Cuts courtesy Westinghouse

Shown here is a B-29 converted to Stratovision use and a map to indicate the areas that could be covered.

CONTROLLED CONDITIONS--

Regulation of Humidity
Light
Temperature
Dust
Noise

(Photos courtesy The Austin Co.)

by Eugene Haupt m'49

One of the relatively new developments in the building field has been the "controlled conditions" plant. While there are a number of these plants in operation today their broad scope and true significance are not fully understood. A "controlled conditions" plant is one in which the principal conditions affecting efficient operation—such as light, temperature and humidity—are under full control and independent of the natural sources.

Only a few notable "controlled condition" plants were built until the demands of World War II for precision products immediately focused attention on this new type of plant and plant operation. Its control of light, temperature and air quality made possible the most effective production of such precision products as bombsights, aircraft engines, radar and electronics devices—to name a few.

Some of the handicaps which conventional plants are operating under which are more or less taken for granted are—

a. Lack of uniform operating and working conditions.
b. Lack of flexibility to meet varying production demands economically.
c. "Straight-line" production that is not straight.
d. Lack of uniform light of proper intensity and quality.
e. Lack of uniform atmospheric conditions.
f. Excessive noise.
g. High machinery obsolescence factors.

It was to overcome these and other handicaps that a fundamentally new kind of industrial plant was developed, the "controlled conditions" plant where a scientific approach was employed in analyzing basic problems.

"Controlled conditions" have previously been used to a limited extent because they were absolutely indispensable in the manufacturing processes of such items as food products, textiles, tobacco manufacturing, paper and printing, chemicals, and wood working. While "controlled conditions" can still improve production in many instances because of their effect on the materials themselves, the possibilities of increased profits through industrial comfort, resulting in less breakage, fewer "seconds" and rejects, less waste, and generally improved products, are practically unlimited.

Operating and working conditions vary widely in conventional plants, and their effects upon quality of product and employee relations are frequently underestimated.

In conventional plants every effort has been made to employ straight line production methods to the greatest possible extent. Nevertheless it was considered impractical to house all operations in a single main manufacturing building because of waste heat, fumes, noise, dust, and temperature requirements.

In the "controlled conditions" plant each operation and each process follows the others like links in a chain in a direct line and in a single building. Group control reaches its greatest degree of efficiency. Each production line is controlled as a group by new and simplified methods of supervision, enabling management to nip losses and waste in the bud instead of periodically holding post mortems over cost analyses.

Every square foot of floor space pays a maximum return. The "controlled conditions" plant provides large, clear unobstructed floor areas which permit the most desirable layout entirely independent of the lighting required for specific operations because there are no dark spots.

This close interlocking of all operations into one complete unit, previously practically impossible, has developed the "controlled conditions" plant into a mammoth machine in which these new achievements in straight line production have reduced costs from 10 to 25 per cent in certain types of operations.

Group control with simplified supervision and low inventories effect tremendous reductions in the expense of cost keeping.

The "controlled conditions" plant makes possible lower costs through reduction of fatigue, decreased sickness, fewer accidents, and lessened labor turn-over.

In heavy physical labor, the New York State Commission of Ventilation found that the work accomplished was 15 per cent less at 75 degrees Fahrenheit with 50 per cent relative humidity than at 68 degrees with the same humidity, and 28 per cent less at 86 degrees with 80 per cent relative humidity. Stale air was found to reduce the amount of work performed by 9 per cent.

In office work the change is even more pronounced. An

increase in efficiency of 51.4 per cent was accomplished in an office by merely moving into a new office building which was air conditioned.

Natural lighting as secured through the use of sash in side walls, monitors, skylights, and sawtooth roof construction has not solved the problems of heat, glare, and variation from day to day, and from hour to hour during the day. In the "controlled conditions" plant which does not rely upon sunlight for the light source, illumination is uniform.

The quality of light is very important. Good quality of light results when such factors as the following are provided: (a) uniform illumination, (b) good vision, (c) absence of glare, (d) adequate intensity.

In the "controlled conditions" plant good quality of light can be attained at all times; fixtures can be used containing a combination of daylight, white, and mercury lamps; and daylight vagaries are eliminated. Since most manufacturing plants should be designed to operate on at least a two-shift basis, the conventional plant should have the same installation of lighting as the "controlled conditions" plant. Furthermore, in the majority of conventional plants, the lighting system is often in full operation, but during the daylight hours the conventional plant suffers from such unfavorable factors as glare and heat rays. Lighting can be controlled within 2 or 3 footcandles in a "controlled conditions" building, but may vary as much as 75 footcandles in a conventional plant when daylight is supplemented by the artificial lighting system.

A combination of natural and artificial lighting controlled by photo cells to maintain uniform lighting could be used. This would be a satisfactory method of overcoming the objections to daylight and might meet with general acceptance if it were not for the fact that lighting is only one of the problems of control. The windows still permit heat loss in winter and heat gain in summer, admit glare, transmit outside noises all year round, and furthermore dirt and fumes readily filter through conventional factory sash.

The intensity of space utilization and variety of work performed in the main manufacturing area at Western Electric Company's new electronics plant in Allentown, Pa., is indicated by this view.

Although the conventional plant does permit ventilation to some extent through the use of hinged windows or sliding sash, here again it is subject to the whims of the elements with erratic changes in outside temperatures and humidity, and with added fumes and dust it leaves much to be desired, both from the standpoint of manufacturing processses and employee comfort and efficiency.

In wide buildings with over 100,000 sq. ft. of floor surface the central areas are stagnant even with the use of roof monitors. Supplementary systems are added to offset this condition often at a cost which exceeds the cost of this item in a "controlled conditions" plant as original equipment.

Heating in the winter time costs more in a conventional plant than in a "controlled conditions" plant due to the large heat loss through the windows. Furthermore, the uncontrolled sash loss is depended upon to provide a supply of fresh air in the conventional plant while in the "controlled conditions" plant the supply of fresh air is controlled summer and winter.

Little appreciated is the heat emitted by lights, motors, process equipment and the surprising amount contributed by the employees themselves. In a building with 100,000 sq. ft. of floor area, having a high concentration of machinery and employees, this may equal the heat output for a 200 horsepower boiler. In summer this appreciable heat gain aggravates working conditions. In winter this would be a desirable source of heat, but because of rapid heat dissipation through conventional roofs and walls, its benefit is practically nil.

In the "controlled conditions" plant, this internal heat gain becomes a decided asset in winter. While the cost of equipment to absorb this internal heat gain is an appreciable item during hot humid weather, in winter this heat source permits a smaller boiler capacity and lower operting costs because of the inherent insulation of the building structure required for summer cooling.

In precision work and quality control, now a factor in many branches of the metal working industry, "controlled conditions" are very important. Tolerances of plus or minus 0.0002 inches are not uncommon in instrument work and instrument components. An increase in temperature of 30 degrees causes a piece of aluminum only 1½ inches long to expand nearly 0.0006 inches. Yet, temperature changes of 30 degrees are common many days of the year and in most industrial sections of the country.

Controlled conditions can contribute to the quality production of any product sensitive to temperature and moisture. Wood furniture and other wood products, textiles (cotton, wool, rayon, linen), ceramic products, confectionary and chewing gum, pharmaceuticals (coated pills, salts, capsules, infant goods), films, lacquers, varnishes, leather goods, linoleum, paper and paper products, rubber and rubber products, soap and food products. A sheet of paper stock may shrink one-eighth of an inch in an hour's time, when brought from cool storage to a heated pressroom. Paper shrinks and curls, inks need driers, printers must use summer rollers, and are troubled

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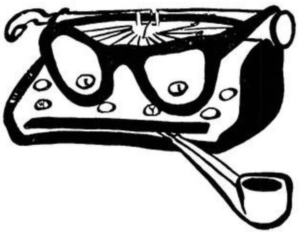


UNIVERSITY "INSTRUCTORS"

A Guest Editorial

The Way We See It

IN WISCONSIN high schools and grammar schools the requirements for teachers are set by law. These prerequisites include, among others, both psychology and teaching methods. When a new teacher is engaged, someone, usually the principal of the school, audits a number of the teacher's classes. In fact, in Milwaukee high schools every teacher has some of his or her classes visited by the principal every semester. At the end of the year, each teacher is given a report card on which he is rated on various qualifications. These qualifications include the following: personal appearance, teaching ability, cooperation with others, ability to handle students, etc. On the basis of this confidential rating a teacher is able to judge his or her work and the newer teacher can follow suggestions for improvement from his more experienced colleagues. Of course, this is not always followed to the letter in practice, but the results have been so good that the procedure provided is followed rather closely.

On the university level during the war years and immediately afterwards, the only requirements for instructors seemed to be a high grade point average. While an excellent general indication of attainment, this average most definitely is not any criterion of a person's ability to transfer that knowledge to others. At the present time, it is necessary to be a candidate for an advanced degree or a holder of such a degree. Once more no attempt seems to be made to ascertain anything about the teaching qualifications of the "instructors." The quotation marks are used advisedly.

In my college career I have enjoyed and suffered both from instructors worthy of the name and from "instructors." One of the enjoyable experiences was a beginning course. The instructor in this particular course had both the knowledge and the ability to teach others. One of his outstanding qualications was his ability to explain a difficult problem in several very different ways. **He did not simply repeat an explanation which had failed to put the problem across the first time.**

Thermodynamics is supposedly one of the more unpleasant courses in any engineering curriculum. One of the younger instructors made my term of suffering quite pleasant. He knew his subject, and what's more, he could explain it well. However, his outstanding characteristic, to my mind, was his ability to say, "I don't know, but I'll find out." What makes this an asset rather than a liability is the fact that he always had the answer the next class period. He never just forgot about it the way most "instructors" seem to. Remember, "Fools can ask questions that wise men cannot answer."

There are other "instructors" in my past, such as one who could not answer two-thirds of the questions put to him. He could not keep to the schedule of assignments. He did, however, know his subject. He just was not a teacher, and most of the students believe that he never will be.

Others I have suffered with had neither the knowledge nor the ability to teach. Remember those finals that made you wonder if you were in the right place?

Some instructors seemed to have the knowledge, but just could not put it across, although they really tried. These men, with a little help, would make excellent instructors.

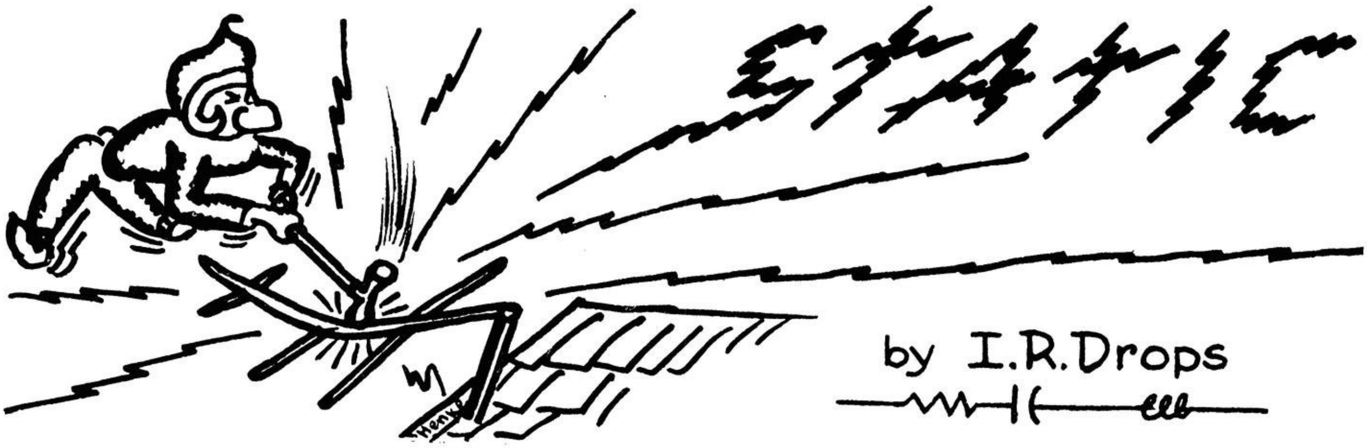
Several of the senior professors have not yet learned how to present an efficient series of lectures. Their students complain very generally that he disturbs their sleep with nothing worthwhile.

My suggestions for correcting this situation are as follows:

1. Formulate requirements for all university instructors. By this I mean, put them into words which everyone can read and understand. Of course, these requirements should be adhered to once they are adopted.
2. The head of a department and certain selected faculty representatives should audit, without advance notice, classes taught by all instructors. This would provide an opportunity to make suggestions for improved teaching methods and to insure the same coverage in all classes of the course. This audit would provide the basis for replacement of "instructors".
3. Lastly, a tentative suggestion. Perhaps qualified faculty members of other departments, such as psychology and education, could conduct classes or seminars to aid in improving the teaching methods. The practicability of this is beyond my limited experience, but it would seem that university students are entitled to trained teachers just as are high school students.

Remember, the wisest man is not necessarily the best instructor.

W.O.B.



by I.R.Drops

VACATION

A Christmas tree
For you and me,
And presents
For us both.
Bring some beer
And pretzels,
And we'll have
A little toast.

* * *

WOMEN

Ashes to ashes, dust to dust;
If it wasn't for paint,
Women would rust.
Thanks — Dukengineer

* * *

Why does a certain M.E. instructor receive a copy of the National Brewers' Code? — Chug-a-lug.

* * *

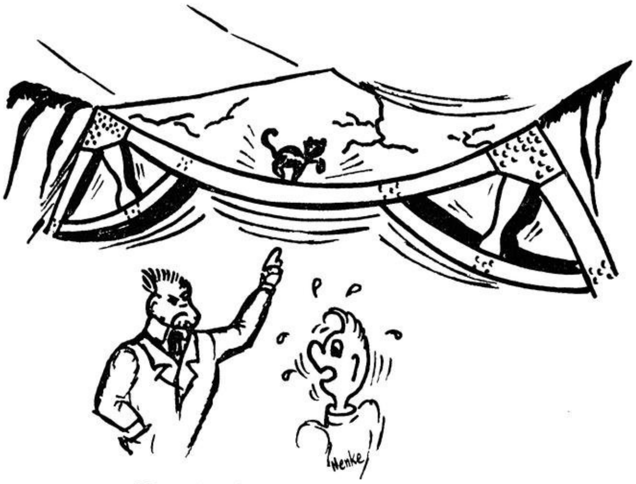
"Do you neck?"
"That's my business."
"Oh, good! A professional."

* * *

Waitress: "We have practically everything on the menu."
S. S.: "Yes, would you please bring me a clean one?"

* * *

Drunk in a phone booth: "Number! Hell I want my peanuts."



"But sir, the handbook said, . . . "

Then there was the young bride who didn't know what to answer, "I do," "I have," or "I will."

* * *

She reminds me of a stale glass of beer, no body and no head.

* * *

"Your husband looks like a brilliant man—I'll bet he knows everything."
"Don't be silly—he's a lawyer and doesn't suspect a thing."

* * *

WIN $15
St. Pat Button Contest
Work on your design during
Christmas vacation.

* * *

Mother to daughter: "If I'd had a bathing suit like that when I was a girl, you'd be six years older."

* * *

Sorority sister: "The only thing a sweater does for her is make her itch."

* * *

MEN

The bachelor is a happy guy,
He has a lot of fun.
He sizes all the cuties up,
And never Mrs. one.
Thanks — Iowa

* * *

"Just between the two of us, you should remember to pull your blinds down. When I passed last night I saw you kissing your wife."
"Ha, that's one on you! I wasn't home last night."

* * *

"Let's cut EE.2 today John."
"Can't, I need the sleep."

* * *

"Please close the top drawer of your bureau. It reminds me of my old girl friend, wearing a sweater."

* * *

The Mech. I instructor who says every couple has its moment hasn't been out with my girl!

(*please turn to page* 42)

"Will this course help prepare me for a telephone job?"

"Yes, it will. And that would be true of almost any course you'd name.

"That's because varied abilities are required. The telephone system has mechanical engineers, electrical engineers, civil engineers, and so forth. Some are in development or research, and make contributions in these fields. More are in the operating end. They deal with economic as well as technical problems, handle personnel, and assume other responsibilities gained as their careers progress.

"In other words, telephony has many interesting jobs. To prepare for one of them, learn your particular branch of engineering and gain as much all-around knowledge as you can."

BELL TELEPHONE SYSTEM

PRINTED CIRCUITS . . .

(*continued from page 9*)

the other types.

DUSTING

The dusting techniques lend themselves favorably to the printing of electronic circuits. Tungsten and molybdenum powder have been used to metallize ceramic bodies by dusting the powder and binder on the surface and firing. In electroplating conducting materials, metal powders have been used to form a conducting film for the plating. An initial layer of bonding material or adhesive ink holds the powder in place. It is applied with a rubber stamp or by similar printing means.

One way of dusting an electrical circuit onto a nonconducting surface is to sprinkle a thin layer of metal powder through a thin noninflammable stencil. The metal is melted by flashing a flame over the stencil.

An electrophotographic method has been developed to hold the powder to the surface in the proper pattern prior to flashing. It is applicable to any of the usual nonconducting surfaces, including paper. The surface is first coated with a one mil layer of photoconductive material such as sulphur or anthracene, then placed under an electrostatic charging device. The electrostatic field introduces a charge on the photosensitive material. Exposure to light through a positive photograph of the circuit desired removes the charge from that portion of the photosensitive material illuminated and leaves an electrostatic latent image. A mixture of leafed silver powder and a binder dusted onto the surface adheres only to the charged image. Flashing with a flame melts the silver into place, completing the wiring.

APPLICATIONS OF PEC

Experimentation at the National Bureau of Standards, Centralab Division of Globe-Union, Inc., and others, has proven the practicability of applying the new methods to the manufacture of radio and electronic sets, and small radio transmitters and receivers made in the Bureau's laboratories have shown performance qualities comparable to equipment built along conventional lines, as well as improved miniaturization and ruggedness. Complete circuits may now be printed not only on flat surfaces but on cylinders surrounding a radio tube or on the tube envelope itself.

Now actively being developed by various laboratories are printed circuits for electronic controls using gas-filled tubes, electronic units for hearing aids, I.F. strips for radar and UHF equipment, subminiature portable radio transceivers, electronic circuits for business machines, electronic switching and recording equipment, including telephone apparatus and devices such as the radio sonde. Other activity includes manufacture of special components such as antennas, interstage coupling units, microwave components, shields, etc., and the printing of graphs with conducting lines over which contacting arms move to select answers to functions of one or more independent variables.

URANIUM . . . (continued from page 20)

that mineral dealers would have them. One firm is "Ward's Natural Science Establishment, P. O. Box 24, Rochester 9, New York. Further information about common radioactive minerals are described in such books as "Handbook of Uranium Minerals," by Jack DeMent and H. C. Dake (1947), published by the Mineralogist Publishing Company, Portland 15, Oregon ($1.50). Also, briefly indicated in this booklet are areas in which radioactive ores have been found.

Government Regulations

These then, are the problems and promises of the private prospector. Another factor that enters into the picture, is the value of these minerals when found. What is their worth, who buys, and how much will be paid?

The Atomic Energy Act of August 1, 1946, reserved all uranium deposits on public lands in the United States subject to mineral rights established prior to the act. However, the Commission has expressed the desire that private enterprise prospect, establish claims, and work the mines. John K. Gustafson, Director of the AEC Division of Raw Materials, believes that, "Development and production of uranium ores can be stimulated most effectively by the types of private operations responsible for the growth and efficiency of the American mining industry."

Portable ultra-violet lamp, with transformer, makes radioactive substances glow.

The AEC plans to continue and expand its exploration and development, as mentioned previously. This is not in competition, but rather in collaboration with prospectors. New discoveries made by AEC will be publicized and private enterprise will be expected to take over and get production under way.

In line with these ideas, the Commission has established the following price and bonus program:

1. **Ten year guaranteed minimum price** of $3.50 per pound of recoverable uranium oxide, minus the cost per pound to refine to necessary purity as determined by AEC after assay of a representative sample. If already refined, they will pay $3.50 per pound, upon delivery to it. These prices are minimum for small lots. Higher prices may be established by negotiation if conditions warrant. The Commission will also give consideration to the presence of recoverable gold, silver, radium, thorium, and other valuable constituents of the ore, depending on the cost of recovery.
2. **A bonus for discovery** of $10,000 is being offered by the AEC upon delivery to it of the first 20 short tons of uranium ore. This ore must assay 20% or more uranium oxide. It must come from any lode or placer on public land that has not been previously worked. The bonus will be paid only once for each area, but one person may receive it for each newly discovered location. This offer does not apply to carnotite or roscoelite type ores of the Colorado Plateau area. However, an allowance in addition to the basic price has been provided to encourage discoveries of such ores.
3. **Three year minimum guaranteed price** of $1.50 per pound of uranium oxide, in ores assaying 0·20% plus a development allowance of 50 cents per pound. These apply to the carnotite and roscoelite ores of the Colorado Plateau area. More than $1.50 will be paid for higher grades and less for ores of lower grades, with no payment for ores assaying less than 0.10%. In addition, a haulage allowance of 6 cents per ton mile will be given for transporting the ore to the purchase depot and an additional 50 cents per pound of uranium oxide contained in ores assaying 0.20% or more. The 6 cent and 50 cent additional allowances will be in effect for one year, and if insufficient to stimulate private enterprise, will be raised. It is somewhat of a trial and error method, to determine the most equitable conditions. The AEC's two main buying depots are at Durango, Colorado, and Monticello, Utah.

   Any further details concerning prospecting or regulations may be obtained from: U. S. Atomic Energy Commission, P. O. Box 30, Ansonia Station, New York 23, New York.

These are the opportunities and challenges of private prospecting. An individual could outfit himself for about $500 and just start out. Any experience of a geological nature would of course be valuable, but not absolutely essential. The methods of prospecting and identification are fairly simple.

It should be noted that the prices guaranteed by the AEC are dependent upon delivery to it, which would require transportation; however, an allowance is given for that.

New discoveries are being made every so often, and old sources are being continually worked. There appears ample opportunity here for earnest prospectors to not only aid in the development of the new era, but richly reward themselves at the same time. •

Electron microscope, perfected at RCA Laboratories, reveals hitherto hidden facts about the structure of bacteria.

Bacteria bigger than a Terrier

Once scientists, exploring the invisible, worked relatively "blind." Few microscopes magnified more than 1500 diameters. Many bacteria, and almost all viruses, remained invisible.

Then RCA scientists opened new windows into a hidden world—with the first commercially practical electron microscope. In the laboratory this instrument has reached magnifications of 200,000 diameters and over. 100,000 is commonplace . . .

To understand such figures, picture this: A man magnified 200,000 times could lie with his head in Washington, D. C., and his feet in New York. . . . A hair similarly magnified would appear as large as the Washington Monument.

Scientists not only see bacteria, but also viruses—and have even photographed a molecule! Specialists in other fields—such as industry, mining, agriculture, forestry—have learned unsuspected truths about natural resources.

Development of the electron microscope as a practical tool of science, medicine, and industry is another example of RCA research at work. This leadership is part of all instruments bearing the names RCA, and RCA Victor.

• • •

When in Radio City, New York, be sure to see the radio, television and electronic wonders at RCA Exhibition Hall, 36 West 49th Street. Free admission. Radio Corporation of America, RCA Building, Radio City, N. Y. 20.

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RCA **RADIO CORPORATION of AMERICA**

ULTRAFAX . . .

(*continued from page* 16)

television set.

5. The transmission of a full-length motion picture from a single negative in the production studio simultaneously to the screens of thousands of motion picture theaters throughout the country.

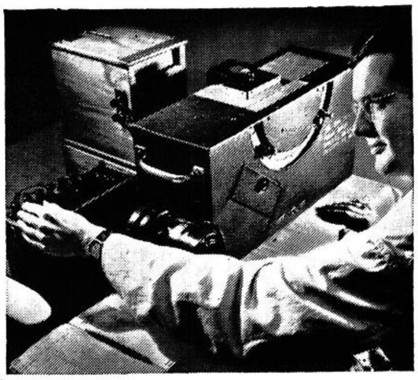
6. The possibility of a new radio-mail system with the vast pickup and delivery services of the Post Office Department.

The status of the development of Ultrafax is such that the process is not only in the blueprint stage, but with further developments is ready for general use. This was brought out in a statement by Elmer W. Engstrom, vice-president in charge of research at RCA Laboratories. In pointing out the significance of the demonstration with respect to the construction at this time of nation-wide radio-relay networks which are capable of transmitting both television and Ultrafax, he said: "We have succeeded in obtaining results which show that Ultrafax can now promise practical commercial use, and at a time when demands are greater than ever for speed, speed and more speed in communications."

It is not difficult to visualize other possibilities for this system of rapid communications and even as it stands today with certain improvements in television channels the home of the future will probably have some of the apparatus depicted only in the minds of dreamers.

DU PONT *Digest*

For Students of Science and Engineering



Mark P. Morse, *B. S., Physics, Washington College '40, measures specular and diffused reflection of a sample paint surface with a goniophotometer, a Du Pont development for obtaining data on gloss and brightness.*

Science paints the future

41 of every 1,000 U. S. chemists are engaged in production of paints, lacquers, varnishes and colors

Modern paint making is an outstanding example of chemistry at work—of the way the scientific approach has replaced rule-of-thumb methods.

Today, paints are formulated by chemists to meet specific needs. In their search for better finishes, these highly trained technical men are aided by the electron microscope and infrared spectroscope. A variety of goniophotometric and spectrophotometric devices are used by the physicist and physical chemist in the study of gloss and color.

Du Pont men have produced many superior finishes. One of them, "Dulux" nitrocellulose lacquer, made mass production of automobiles possible by shortening paint drying time from weeks to hours.

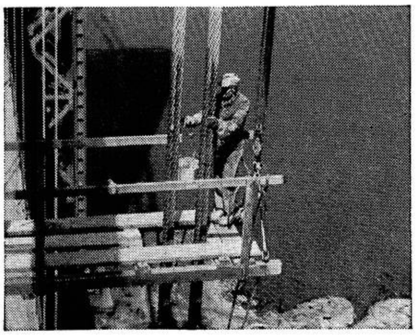
Finish failures — chipping and scratching—were costing manufacturers of home refrigerators a million dollars a year before Du Pont chemists developed "Dulux" synthetic resin enamels, based on alkyd resins. A "Dulux" coating on metal or wood dries into a film that even a hammer blow won't break. Tests with mechanical scrubbers prove it outwears old-style enamels by more than five times. "Dulux" enamels now guard boats, large and small, as well as petroleum tank farms, machinery and other industrial installations.

At Du Pont's paint laboratories, a wide range of materials is under study. Where the colloid chemist, the physical and organic chemist, the analyst, physicist and other technically trained men leave off, the chemical engineer, mechanical engineer and metallurgist stand ready to design equipment to make better commercial production possible.

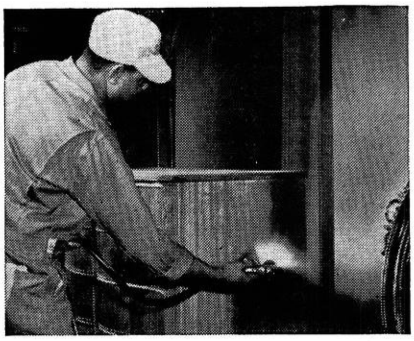
Modern equipment speeds research

Many of today's research tools are complex and expensive. The modern research worker may use a $30,000 mass spectrometer installation which can make an analysis in three hours that formerly took three months. High pressure equipment, ultra centrifuges, molecular stills, and complete reference libraries are other tools which speed research and enlarge its scope.

Young scientists joining the Du Pont organization have at their disposal the finest equipment available. Moreover they enjoy the stimulation of working with some of the most able scientists in their fields, in groups small enough to bring about quick recognition of individual talent and capabilities. They find here the opportunity, cooperation and friendly encouragement they need. Thus they can do their best work, both for the organization and themselves.



Rust would quickly weaken *this structure. Because "Dulux" resists salt water and salt air, it has for years protected many famous bridges.*



Satin-smooth beauty *and outstanding durability are properties given by "Duco" or "Dulux" to furniture, trucks, buses and trains.*

Paints are tested *by exposure to weather at paint "farms." Research men interpret results as guide for development of improved paints.*

Send for your free copy of this new booklet

The 40-page, fully illustrated brochure, "The Du Pont Company and the College Graduate," answers your questions about opportunities at Du Pont. Describes openings in research, production, sales and many other fields. Explains the plan of organization whereby individual ability is recognized and rewarded. Write today. Address: 2518 Nemours Building, Wilmington 98, Delaware.

DU PONT

REG. U. S. PAT. OFF

BETTER THINGS FOR BETTER LIVING

. . . THROUGH CHEMISTRY

More facts about Du Pont — Listen to "Cavalcade of America" Monday Nights, NBC Coast to Coast

Alumni . . .

(*continued from page* 14)

Johns Manville Company at Lompoc, Calif.

Warren D. Jensen, ('47) has been chosen Mining Engineer for the Walker Mine at Virginia, Minn.

C.E.

Ross C. Cornish, ('97) is now a consulting engineer with the Gas Machinery Company of Cleveland, Ohio.

George P. Stocker, ('09) who has been Dean of Engineering at the University of Arkansas for many years, has retired as Dean Emeritus.

Gordon H. Jaehnig, ('43) who has been an instructor in Civil Engineering at this university for two years, from 1945 to 1948, resigned at the end of summer camp to accept a position with the National Advisory Committee for Aeronautics at Langley Field.

Gordon G. Robeck ('44) has accepted employment with the U. S. Public Health Service at Los Alamos, New Mexico.

Calvin A. Knoke ('46) was married to Ruth Lust on July 22 at Richland, Washington. He is working on construction at the Hanford plant.

Jack A. Borchardt (Ph D. '48) has accepted the position of Assistant Professor of Civil Engineering and research assistant in Sanitary Engineering at the University of Michigan.

M. E.

Bruno Rahn ('07), formerly president of the Milwaukee Gas Light Company, died recently. He was a registered professional engineer in Wisconsin and a member of the American Gas Association.

Leonard Velander, Jr. ('43) obtained his master's degree at the University of Minnesota recently.

George E. Hlavka ('45) was awarded his master's degree at Cal Tech in Pasadena, Cal. He is working for Northrup-Hendy in Hawthorne, Cal.

FUEL MEASUREMENT . . .

(continued from page 13)

points A, B, C, and E and opening point D. As can be seen the bell (I) will stop ringing, the counter (F) will start counting revolutions of the engine, the interval timer (H) will start and a solenoid (G) will lift the weight (W) off the scale causing the right pan to lower opening the mercury switch. The opening switch (K) is then flicked over to run. As the fuel is used up the right pan will again rise until at the point the weight of fuel (W) is used up the mercury switch will again close causing the relay to be shorted out. Of course when this happens the counter stops counting, the interval timer stops, the solenoid drops the weight back on the scale and the bell starts ringing. (I only wish Drs. Myers and Uyehara would have let me put a light on it somewhere that would flash on and off.)

All one has to do then is to record the weight, the time, and the revolutions on a data sheet provided on the apparatus. To start another test one returns the interval timer and counter to zero and rebalances the scale with the right pan slightly heavy and the apparatus is ready again.

The apparatus is mounted in a welded angle iron frame enclosed with plywood panels. It is made portable by hard rubber casters. When the stand is leveled, three rubber tipped door stops drop down to hold it in place.

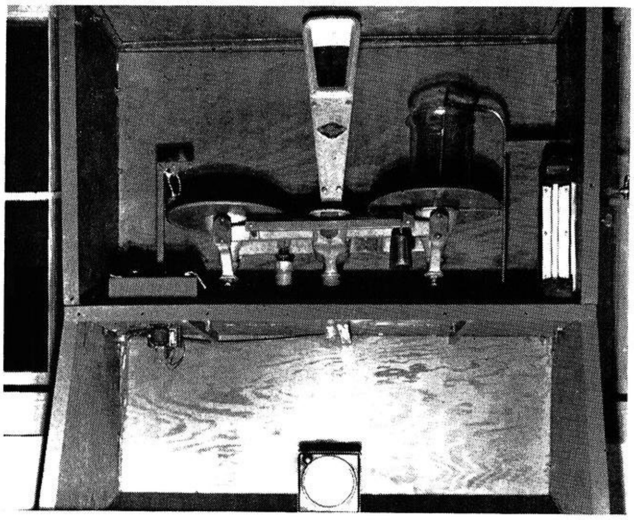


Photo by Wahlin

The complete fuel weighing apparatus.

The relay, bell and most of the wiring are placed in a drawer that opens from the back.

Great pains have been taken to make the instrument as accurate as possible. The copper tube that is immersed in the fuel and through which the fuel is withdrawn was turned down to a few thousandths wall thickness in order that the pressure of the fuel upon the area of cross section might not introduce any errors. This pressure, though small, varies directly as the distance from the bottom of the tube to the surface of the liquid.

The scale used is a Fairbanks Morse pan scale picked up from war surplus. It is not as sensitive as an analytical beam balance but it is reproducible. That is, when it is disturbed it returns to its original position.

The mercury switch that is used is a sealed glass tube similar to the design used on furnace controls. The switch used on older apparatus consisted of two steel points that dipped into mercury pools to make the contact. Exposure to air together with the arcing of the points corroded them so that sometimes they wouldn't make contact at the same position of the scale, thereby introducing serious error.

As the revolution counter is part of the panel of the dynamometer a female plug is located on the side of the cabinet where the counter can be plugged in.

By now you are probably asking if there are other ways to measure fuel. Many of these methods measure the fuel much more simply by means of volumetric measurements. The most popular method is to use a device known as a flowmeter or flowrator which consists of a long, graduated, glass tube in which a float slides up and down. This float then indicates the flow in cc/min or G.P.M. directly.

Probably the simplest method is used at the LeRoi Company in Milwaukee. They use a long glass tube a few inches in diameter. The tube is filled with oil and as the oil runs out the top level of the oil descends slowly. As the top passes a graduation in the tube, the stop watch is started manually. When the oil level passes a second graduation the stop watch is stopped recording the time. By knowing the volume contained between the two graduations, and the specific volume of the fuel, a determination of the fuel rate can be made.

The major complication caused by using the flowmeter or other volumetric means is that the specific volume of the fuel varies with the temperature. Therefore a calibration chart is necessary to determine the actual specific volume at the temperature at which the test is being made.

The flowrator which is used on the Myers-Uyehara apparatus, because of its small rate of flow (87 cc/min), comes with the note that it is not viscosity-immune. This of course means a calibration chart for each fuel of different viscosity. Although not bothersome when only one fuel is run, it gets quite troublesome when tests of many fuels are made with each fuel being of a different viscosity.

The type of fuel weighing apparatus now used in the M.E. laboratory is a much more awkward device with the exception of a new set-up that has been made. Eventually, perhaps they all will be changed. Anyone who has run a test on the 50 hp diesel especially will agree that a change should be made.

The Myers-Uyehara apparatus has not as yet been tested in actual operation although it has been run. What if it doesn't work? Well, a janitor who spent many years with a carnival said, "It shore would make a swell illusion box. I can see the yokels gawkin' at the head floating around in it now."

DID WE STICK OUR NECK OUT IN 1930?

Look How Alcoa Aluminum Extrusions Have Helped Our Prophecy Come True!

On June 21, 1930, this advertisement appeared in one of America's great national magazines. "Aha!" chortled a lot of people. "Look at Alcoa sticking its neck out!"

Now, in 1948, there are many aluminum trains to ride. In the past three years alone, 450 passenger cars have been ordered in Alcoa Aluminum. 103 freight cars. 412 tank cars.

One reason for the railroads' swing to Alcoa Aluminum is typified by the big extrusion press shown above. Squeezing out intricate aluminum shapes like toothpaste from a tube, it permits big assembly savings in car structures . . . without sacrifice of strength. From the massive but lightweight beam, 80 feet long, that serves as a car side sill, down to the satiny fluted moldings around the windows, Alcoa Aluminum Extrusions find wide use.

Getting metal where it's wanted, in the most intricate of shapes, and in gleaming, lightweight, corrosion-resistant Alcoa Aluminum—these advantages have helped many an industry to production short cuts, better products.

The story of aluminum is still being written. New developments are in the making that promise as much for the future of aluminum as the promise we made about aluminum trains back in 1930. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM 1888 1948 60 YEARS OF SERVICE

Alcoa ran the advertisement above before being able to make big aluminum beams for railroad cars—in fact, before the railroads even showed much interest in aluminum. Believing the idea was sound, Alcoa took a chance, built costly machinery to make beams, then went out and sold them. *Result:* these days you *do* ride on aluminum trains.

This is typical of the history of Alcoa. In 60 short years, Alcoa Aluminum has found its way into thousands of useful things: utensils that cook better, buildings that last longer, planes that fly faster. But this is only the beginning. New developments, now in the laboratory stage, are pointing the way to even wider uses for aluminum tomorrow.

Science . . .

(*continued from page 24*)

quire more than 100 separate relay points.

EARTH LOSING TIME?

The National Electronics conference in Chicago was recently told that scientists are beginning to doubt their knowledge of the Earth's accuracy as humanity's master time piece. Harry A. Meahl of the GE General Engineering and Consulting Laboratory, declared that the earth's rotation, by which time standards are set, may vary more than a second every four years, judging from studies made at the U. S. Naval Observatory. He pointed out that the frequency standards now being used to check radio frequencies are timed by the slightly erratic revolution of the earth and so could be in error by more than one part in 100 million.

Mr. Meahl said that the minor variations of the earth as a timekeeper were no longer a matter of mere academic interest. "With extremely high-frequency equipment such as radar becoming more and more commonplace, and with objects radar might be tracking moving faster than sound, the earth's error could cause serious miscalculations," he declared.

Mr. Meahl also said that no other frequency standard has been fully accepted by science as yet, in lieu of the earth's timing.

TITANIUM

Titanium metal, something completely new in the world, one of the basic chemical elements, a metal that rivals steel and aluminum, was announced recently by the DuPont Company. This new metal is silver-white and, when polished, feels like silk. It is about half the weight of steel, less than twice the weight of aluminum, but much stronger than aluminum. It is said to be as strong as stainless steel.

Titanium, because of the difficulty of extraction from its minerals, has never been available, except as a powder. This powder makes the white paint that hides best what is underneath. It makes the wartime smoke screens. The dark patches in the milky way are gas clouds that are rich in titanium.

This new metal is the seventh most common among the metals in the earth. There is more titanium than copper, silver, or lead, yet a few years ago it was considered rare.

EMERGENCY POWER

If one of its regular engines failed, a twin-engine plane equipped with the auxiliary air-propulsion system patented by R. P. Martin of Seattle, Washington, could still maintain smooth flight. Air is scooped in through the nose and fed to air turbines that drive the propellers, keeping the plane from yawing and preventing the bad engine from completely stalling.

"EARTH-SHOCK ACCELEROMETER"

A new instrument, which measures the intensity of explosion shock waves passing through the earth, has been developed by General Electric Engineers.

The "earth-shock accelerometer," about the size of a can of baby food, is so designed that it can be buried near the scene of test explosions. It enables engineers to determine the underground velocity and acceleration of shock waves, caused, for example, by the use of high explosives on large construction projects. The instrument can register shocks up to 1500 times the force of gravity and as many as 10,000 impulses per second. The device contains crystals which generate a voltage when stresses are applied to them. These signals are carried through cables to amplifiers and delicate recorders above ground.

Four of the instruments survived their first test recently on the site of the Watauga Dam, near Elizabethton, Tennessee. The accelerometers gathered data on what sorts of shocks occurred 130 feet below one-half million pounds of high explosives which were set off by the Tennessee Valley Authority in constructing the new earth dam.

He's a Square D Field Engineer . . . his full-time job is working with industries of every kind and size in finding "a better way to do it." He talks less about theory, more about proven practice. He has a tremendous amount of actual experience to back him up.

Through a staff of such Field Engineers located in more than 50 offices in the United States, Canada and Mexico, Square D does this three-fold job: Designs and builds electrical distribution and control equipment in pace with present needs—provides sound counsel in the selection of the right equipment for any given application—anticipates trends, speeds development of new methods and equipment.

If you have a problem in electrical distribution or control, call in the nearby Square D Field Engineer. He makes a lot of sense in finding **"a better way to do it."**

For many years ADVERTISEMENTS SUCH AS THIS ONE have appeared regularly in leading business magazines. Their primary purpose is to build acceptance for Square D Field Engineers, practically all of whom come to us from leading engineering schools such as yours.

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D CANADA, LTD., TORONTO, ONTARIO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

CONDITIONS . . .

(continued from page 26)

with offset and faulty register—all because of temperature and humidity.

Dust control is also important depending upon the type of manufacturing involved. Dust spoils assembly line materials by smudging and scratching. It obscures vision causing poor workmanship and increasing lighting costs. It causes production delays because of equipment breakdowns and increases maintenance costs by gumming up belts, causing undue wear of gears and bearings, and by creating serious explosion hazards in some cases. In attacking the problem of dust control in a "controlled conditions" plant it becomes an integral part of the air conditioning system and is more efficiently accomplished than is possible in a conventional type of plant.

Absenteeism, which is one of the most important and costly forms of personnel loss to management, when due to colds, minor illnesses, and other types of physical maladjustment of the worker has been materially reduced through the use of air conditioning. Air conditioning accomplishes a 28 per cent reduction in those illnesses which cause an office employee to stay home from work.

Noise in industry is a by-product that is sheer waste. The type of construction used in the "controlled conditions" plant lends itself very readily to soundproofing and other methods of controlling and suppressing noises. Sometimes only a comparatively small reduction in noise accomplishes the desired results. For example a reduction of only 5 or 10 decibels in noise intensity seems to make offending noises disappear and workers become no longer noise conscious.

In a "controlled conditions" plant the noise level directly above four drop hammers is 102 decibels while the noise level is 117 decibels for only one drop hammer in a similar conventional plant. Furthermore in the "controlled conditions" plant the noise intensity drops to only 97 decibels at 25 feet from the drop hammers and all noises are so controlled that by the time the sound waves reach other parts of the plant, the noise level is reduced to the comfort level.

In the "controlled conditions" plant it has become possible for the first time to control effectively many sources of industrial accidents. Better visibility, better atmospheric conditions which promote alertness, the scientific use of color on machines and moving parts, the reduction in noise level, all contribute to a much better accident record.

For example when the intensity of illumination in the punch press department of one company was raised from 1.5 to 19.0 footcandles at the working level, the frequency of minor accidents quickly dropped 54 per cent.

The increase in cost of the "controlled conditions" plant over the conventional one is small varying from 16 to 21 percent on construction and from 0.3 to 0.6 percent per man hour on maintenance.

S-T-A-T-I-C . . .

(continued from page 28)

Please try honey, all the birds do it, and even little bees do it."

"But I don't want to learn how to fly."

* * *

"If there is anyone in the congregation who likes sin, let him stand up. Heaven have mercy, Sister Ruth, do you like sin?"

"Oh, excuse me Reverend, I thought you said gin."

* * *

"I hear your girl works in a grocery store."

"No, for a jeweler."

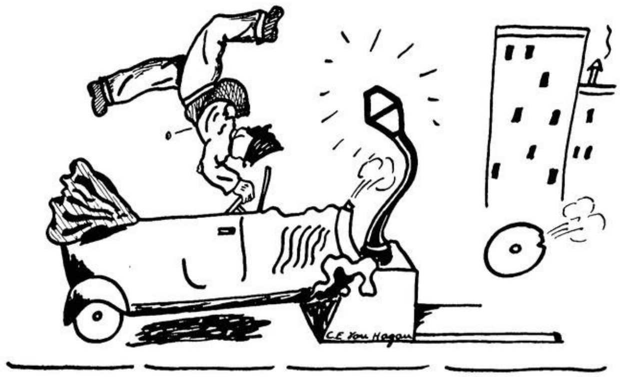
"Same thing, she still sells carats."

* * *

An M.E. the other day was seen trying to calculate the fiber stress in the cross member of a Wheatstone bridge.

* * *

A person who claims that absolute zero is impossible to obtain hasn't taken a quiz in thermo. yet.



"Darn that FLUID drive!"

"Where did you learn to kiss like that?"

"I love spaghetti."

* * *

St. Pat says:

Make vacation an occasion,
Start your beard when you get back.

* * *

Engineers! Back
Marie Fraser
for Badger Beauty

* * *

Heard in Mech. 53 class:

Student Pollard: "What are those holes in the wood?"

Instructor May: "They're knot holes."

S. P.: "Well then, what are they?"

* * *

Did you notice this advertisement in the newspaper by the gas company?

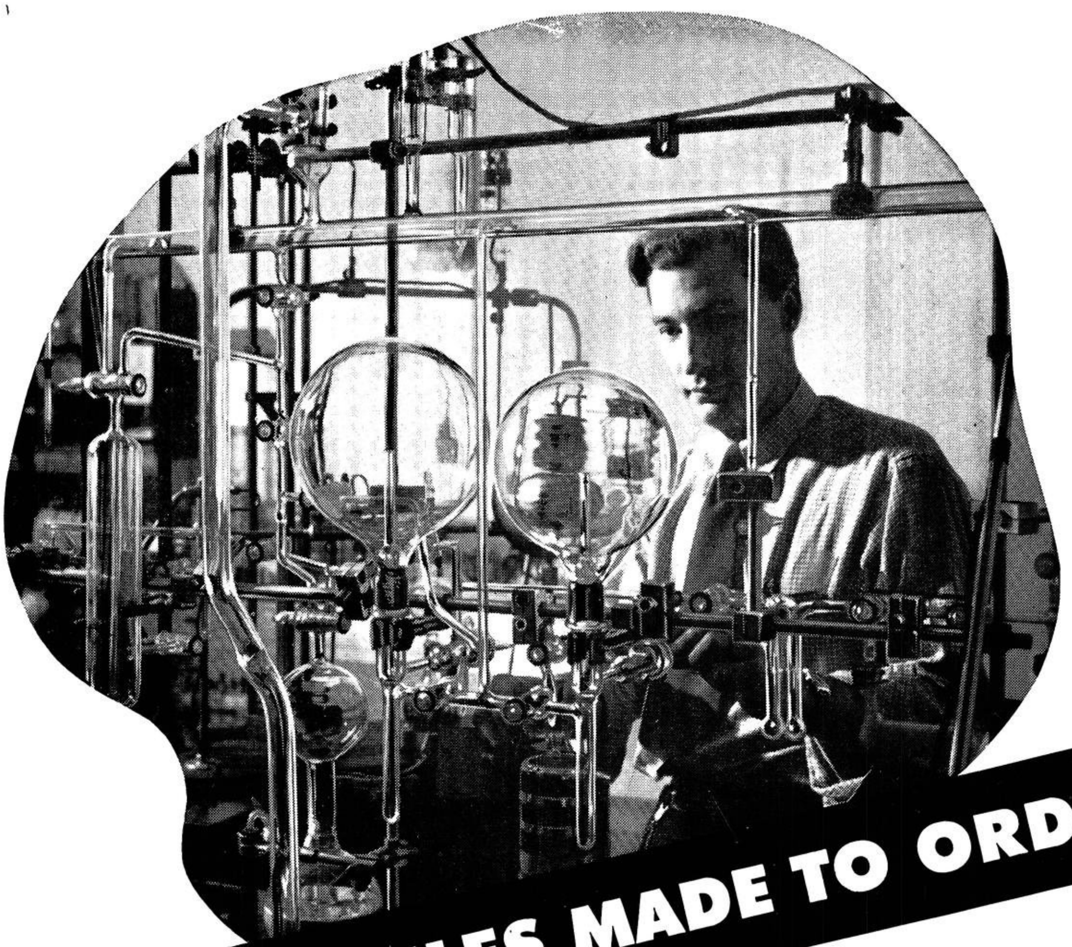
Wanted: Hard-boiled, beauty proof man to read meters in sorority houses. We haven't made a dollar in two years.

* * *

Though her eyes flash fire and her protests blister,
Never apologize AFTER you've kissed her.

* * *

This is no joke: MERRY CHRISTMAS.



MOLECULES MADE TO ORDER

Year by year, month by month, oil industry chemists find new, fascinating possibilities in the hydrocarbon molecules that make up petroleum. They have learned many ways to convert them into new and more valuable molecules.

One result of this experimentation has been a flexibility that permits stepped-up output of whichever petroleum products are most urgently required. When the primary need was for vast quantities of aviation gasoline to help win the war, research showed how it could be produced. In a peace-time summer, the great demand is for an ocean of automobile gasoline; in winter, less gasoline and more fuel oil are needed. Research tells the industry how to make petroleum serve the public more efficiently.

Standard Oil is a leader in petroleum research. Many remarkable developments have come from our laboratories; many more are sure to come, in the future, if we continue to attract good men, furnish them with the most modern equipment, and provide an intellectual climate in which they can do their best work.

We *are* continuing.

Standard Oil Company

(INDIANA)

910 S. MICHIGAN AVENUE, CHICAGO, ILLINOIS

STANDARD

STANDARD SERVICE

MORE POWER . . .

(*continued from page 18*)

gear on the propeller shaft; this also serves as a starter gear. The generator used is a 12 volt, 25 ampere model and is driven from the propeller shaft through a V-belt.

As can be seen from the description, all of the parts, particularly the engine block, are designed to be made by high production methods. This analysis shows that it could be produced at competitive prices. Although this model includes a supercharger and reduction gearing, a saving is made in the elimination of valves, valve mechanism, accessory drive gears, and cylinder heads.

The engine has been used as a generator engine on a U. S. Signal Corps unit. For this application the speed was reduced to 1800 rpm. at the drive shaft. Standard accessories were used, including an Excello fuel injector and a special Bendix magneto.

The Future of the Opposed Piston Engine

The tests that have been conducted on the engine of this design were so far of an exploratory nature to determine the effects of major variables on performance, and much is yet to be learned about the engine under various conditions and circumstances. However, the best conclusion can be found in the words of the designers. "The repetition of results from the tests conducted proves the possibilities of the opposed piston engine and opens the way for a major step forward in the development of better engines for light aircraft."

"Energy and persistence conquer all things"—BENJAMIN FRANKLIN

Why power now serves us better

When it comes to *power*, the dreams of our childhood are fast becoming a reality. For no matter what our needs, special motors or engines are now designed to meet them.

From the tiny thumb-sized motors in electric razors—and the surge of the engines in our cars—to the pulsing turbines that propel our ocean liners . . . today's power is better, more dependable than ever before. And these advances were brought about by research and engineering . . . and by today's *better materials.*

Examples? Better metals for giant turbines and generators, improved transformers and transmission lines. Stainless steel, resistant to rust and corrosion. Better plastics that make insulation fire-resistant, and more flexible and wearproof . . . for the millions of miles of wires it takes to make power our servant.

There is a promise, too, of even greater, more concentrated power. *Atomic* power harnessed for industry and the home . . . approaching man's dreams for the future through research and engineering. This also takes such materials as carbon . . . from which the all-important graphite, used to "control" the splitting atom, is made.

The people of Union Carbide produce materials that help science and industry improve the sources and uses of power . . . to help maintain American leadership in meeting the needs of mankind.

FREE: *You are invited to send for the new illustrated booklet, "Products and Processes," which shows how science and industry use UCC's Alloys, Chemicals, Carbons, Gases and Plastics.*

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ELECTROMET ALLOYS AND METALS • HAYNES STELLITE ALLOYS • PRESTONE AND TREK ANTI-FREEZES • SYNTHETIC ORGANIC CHEMICALS

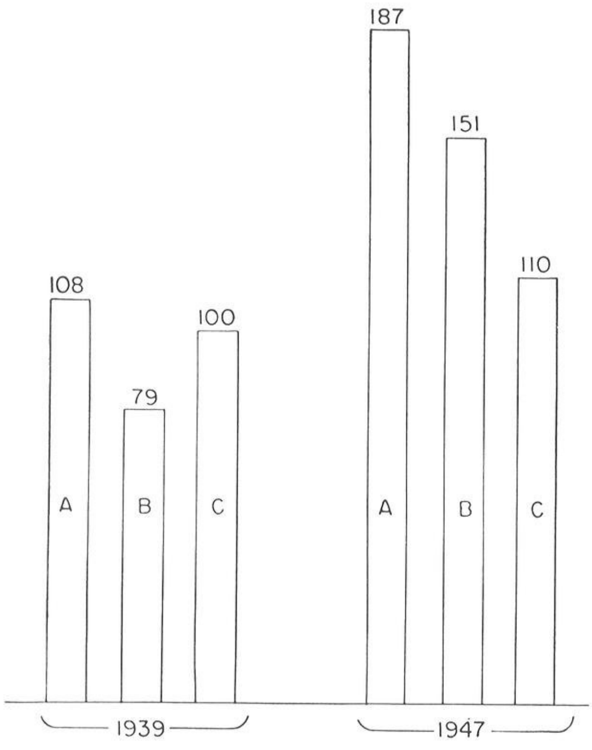
KWH DEMAND . . .

(continued from page 23)

significant push to the turn of the watthour-meter disc in the basements of many homes, may soon add considerably more to the power load across the country. Wire recorders, home movies, slide projectors, facsimile machines, television machines, and many other possible load builders are all on their way into the American home of tomorrow.

FARM USES

As a result of the large number of farms that have been



electrified during recent years, the Westinghouse survey shows that the farm use of electricity has risen very rapidly. Despite the acute shortages of equipment and distribution facilities during the war, power consumption in rural areas grew by leaps and bounds. In fact, it is expected that within ten years the annual load per farm will be double its present load. Although this would require but 5.7 per cent of the total consumption of electrical energy in this country, the increased load would still require a considerable expansion of the present generating and distributing systems.

SMALL INDUSTRY

The growing demand in this category led the survey to state that by 1957, small industrial and commercial users would account for 15.5 per cent of the total power load. At that time, the total residential load would be but 21.8 per cent of the total power generated.

LARGE INDUSTRY

It is forecast that within ten years the large industrial and commercial users would require 51.8 per cent of the total power produced. The fast growing chemical industry increased its power load 44 per cent from 1939 to 1946, and many of the rapidly expanding manufacturing interests are showing the greatest gains in electrical power requirements.

In addition, the prevailing high costs of hand labor led the report to assert that there was ample justification for increased investments in labor saving equipment, such electrical apparatus, to reduce manufacturing costs.

In studying the effect of the depression years on the electrical industry, the Westinghouse survey found that in the general the sales of electricity fell off only one-half to one-third that of the entire national economy, and then added optimistically:

"A significant characteristic of electricity is its inability to be stored. This requires generating equipment geared to handle peak loads."

INDUSTRIAL OUTLOOK

Mr. W. C. Johnson, the executive vice-president of the Allis-Chalmers Manufacturing Company, and the president of the National Electrical Manufacturer's association, recently predicted a glowing future for the electrical industry. He asserted that atomic power was nowhere near the stage where it could compete commercially with hydro or steam generating plants, and that the rising industrial demand for electric power was only in the rudimentary stage.

"To appreciate what is before us," Mr. Johnson said, "we must think in terms of entirely electrical chemical plants, of completely electrical oil refineries, and of many other fields where the broadening use of electric power will continue to add burden to power systems for years to come."

—IN THE STEEL INDUSTRY

A staggering total of 17 billion kilowatt hours of electrical energy were consumed by the steel industry in 1947 to rival the electro-chemical industry as the largest user of electricity. Thousands of pieces of electrical equipment are used in the many processes of steel production, and the expansion plans of the steel industry indicate the vast quantities of new and improved electrical products will be required. Millions of dollars worth of electric controls, auxiliary motors, transformers, and switching and lighting equipment have been ordered to meet the expansion programs, and all of these products will demand large increases in electrical power generation either by the industry itself or by the electric utility companies. In the steel industry, the annual tonnage production is growing, the electrical energy per ton is increasing, and the percentage of purchased electrical power is growing. This means more profit for the steel manufacturers, the electrical equipment manufacturers, and the utility companies.

(please turn to page 48)

KWH DEMAND . . .

(continued from page 46)

—IN THE PETROLEUM INDUSTRY

Today petroleum and natural gas supply more energy for the wheels of industry and commerce than does coal. Oil resources, however, are being rapidly depleted and petroleum is becoming more valuable. This means that more coal will have to be burned in the boilers of the electric utilitiy companies to replace the more expensive petroleum. As the oil reserves in the United States draw near exhaustion, there will have to be a transition in industry from natural petroleum products to synthetic ones. This country has enough coal and oil shale to provide the synthetic equivalent of two billion barrels of crude oil a year for at least one thousand years, but the industrial facilities necessary to produce such a vast quantity will involve enormous quantities of energy. In the chemical processes involved, about forty per cent of the original fuel is spent to convert the coal or natural gas into a liquid fuel. This heat energy will contribute to satisfying the total energy demand, but the remainder must be obtained through electricity.

Other applications of electric power in the petroleum industry range from electric oil well drilling rigs and well pumping equipment to pipe line pumps and the extensive electrical equipment in the oil refineries. As oil becomes more scarce, many new uses for electrical equipment and energy will become apparent that will economize by substituting for expensive petroleum operated apparatus.

—IN INDUSTRIAL HEATING

Hundreds of new applications for the use of clean, controlled electric heat are constantly being discovered. A list of the present electrical heating equipment would include resistance and arc furnaces, induction melting furnaces, induction and dielectric heaters, low temperature ovens, and many forms of industrial and domestic heaters. One noteworthy application of electric heat is for the commercial production of glass where the glass is melted by using the molten glass itself as the heating unit. The conversion of the entire glass industry to electric melting furnaces would require a tremendous addition to the presently available generating equipment. An interesting observation shows that although the large industrial heating equipment is quite spectacular and requires large amounts of electrical power per unit, the total energy absorbed by the many small industrial and domestic heating units exceeds by several times the total power load of the large apparatus.

Heaters and devices rated at about one million kilowatt hours were manufactured in 1947, and a considerable amount of this equipment was designed for new installations. This apparatus alone will constitute a probable addition of some two billion kwh. to the annual electric power load, and the manufacture of new and improved equipment is proceeding at a rapid pace.

—IN THE MINING INDUSTRY

With more than seven million horsepower of electric drives utilized in the mining industry, it is easily seen why this field stands at the top of all the major industries in electric power consumption. The task of obtaining our many raw materials from the earth and refining them constitutes an electrical energy load of some ten billion kilowatt hours per year. This power load is 40 per cent higher than it was only ten years ago, and the upward trend is expected to continue as the purity and quality of our natural ore resources steadily decline. Future operations promise to involve practices necessitating a much more extensive use of electric power than in the past. It appears that only the more complete utilization of electric power in the mining industry can increase production to satisfy the enormous demands for minerals expected in the next few years.

WISCONSIN'S OUTLOOK

Mr. W. E. Schubert, the president of the Wisconsin Utilities association, asserted that the demand for electric power in Wisconsin is expected to double within the next ten years just as it did during the last decade. Speaking to a convention of the accounting section of the association, Mr. Schubert explained the critical electric supply situation now facing Wisconsin. A severe drought, the lack of new generating plants due to wartime restrictions, and labor and material shortages have all contributed to the inability of the power companies to meet the tremendously increased demands made upon them for electricity.

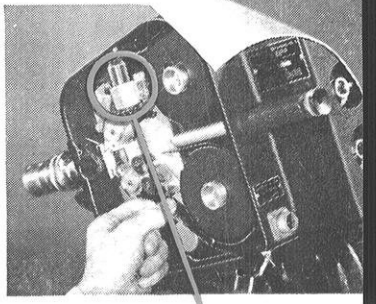
In looking forward, the executive explained that, "We will have more than doubled the 1947 load by 1957. This means that our program of planning for the future will have to be on a very much revised basis from that of the past. Distribution for residential and rural services will very definitely have to be given a 'new look'."

Schubert, vice-president and general manager of the Wisconsin-Michigan Power Company, said that approximately sixty-five per cent of the power generated in the state went to industrial and commercial users, twenty per cent to residential consumers, ten per cent to rural areas, and five per cent for other uses. Of this total load, in 1947, seventy-six per cent was generated in steam plants, twenty-two per cent in hydroelectric plants, and one and one-half per cent by other means such as diesel plants.

In estimating the future demand for power in the state, Mr. Schubert considered the many industrial expansion plans, new factories, and new processes which have or will come into use within the next ten years. He found that more and more kilowatt hours are being put into the production of each ton of paper, ore, and ice cream manufactured in the state; and because of its efficiency and widespread adaptability, he asserted that "Electricity has become industry's best single bargain."

Kodak

Argon "timer" on Kodak High Speed Camera puts edge marks on film, as shown below, for externally fed rectangular pulses.



Splitting a second of action into 3000 measured parts

The Kodak High Speed Camera . . . a precision instrument that gives you exact visual answers to complex industrial time-motion problems.

WHEN high speed machinery doesn't work as it should or wears out too soon . . . when you need to know how fast-moving liquids behave . . . when any complex time-motion problem confronts you . . . try motion analysis with the Kodak High Speed Camera.

By taking pictures up to 3000 frames a second and showing them at regular speeds . . . you visually slow down action almost 200 times! And flash marks which the camera puts along the film edge time any phase of action in fractions of milliseconds.

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Send the coupon for a copy of the booklet "Magnifying Time." It will tell you how this instrument is being used advantageously in many industries.

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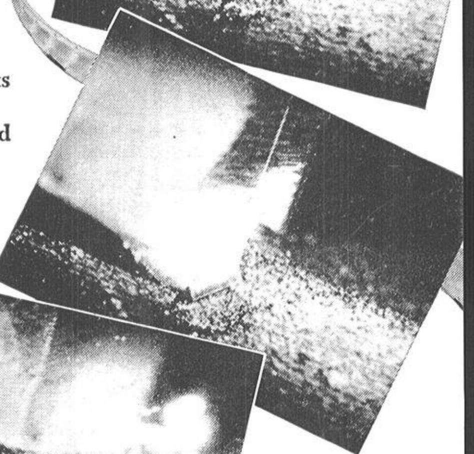

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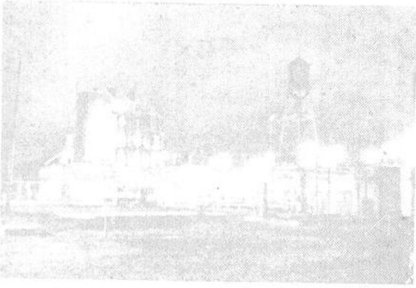
UNIQUE PLANT PRODUCES G-E SILICONES FOR INDUSTRY

On the outskirts of the little town of Waterford, N. Y., is one of the most unusual plants in the world.



New Waterford plant works night and day to produce silicones.

Where other new industrial structures may be impressive because of their physical size or tremendous productive capacity, the Waterford Works of General Electric is of interest because of the

Silicone oils are excellent mold release agents.

rare nature of the materials being produced there, and because of the new chemical processes involved in their manufacture.

Silicones from Sand

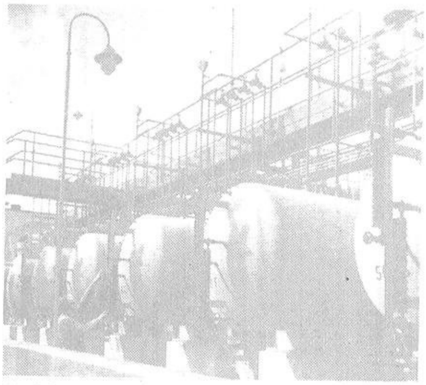
The primary raw material from which silicones are derived is sand. This basic ingredient is modified at Waterford through a complex series of pipes, tanks, stills, and reactors which are operated in a nearly automatic production system.

The most amazing property of silicones is that, like quartz, they are relatively unaffected by heat, cold, water, chemicals, and weather. But instead of being rigid, like quartz, silicones are flexible—they may take any form from liquid to solid! This flexibility permits them to be used in many

Silicone centers add new zip to U. S. Royal golf balls.

places where rigid materials with similar properties could not serve.

The finished silicone products are already being widely applied in industry, and new uses are constantly being found for them. Silicone rubber is being used for heat-resistant gaskets for aircraft and diesel engines, oven doors, and laboratory equipment. Silicone oils are excellent mold release agents for rubber and tire molders. Silicone resins promise to make possible paints and finishes of exceptional durability. Another product



Tank farm stores liquid raw materials which automatic process converts to silicones.

of G-E silicone research is called DRI-FILM*—water repellents that can be used on a variety of materials.

Put Waterford on Map

You'll be hearing a lot about G-E silicones. They're really going to put that little town of Waterford on the map.

Of course, silicones are only one of the products produced by the various divisions of the General Electric Chemical Department. It also manufactures Glyptal* alkyd resins, insulating materials, permanent magnets, plastics molding compounds, and is responsible for the plastics molding operations that have made G. E. one of the world's largest plastics manufacturers. For more information, write to the Chemical Department, General Electric Company, Pittsfield, Massachusetts.

*REG. U. S. PAT. OFF.

A message to students of chemistry and chemical engineering from

J. L. McMURPHY

Manager, Chemicals Division, G-E Chemical Department

"The new world of organo-silicon chemistry is a fascinating one—and one which promises an interesting future for a young man who wants to make chemistry his career. We at General Electric are expanding our silicone research and production to meet industry's growing need for silicones."

GENERAL ELECTRIC

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