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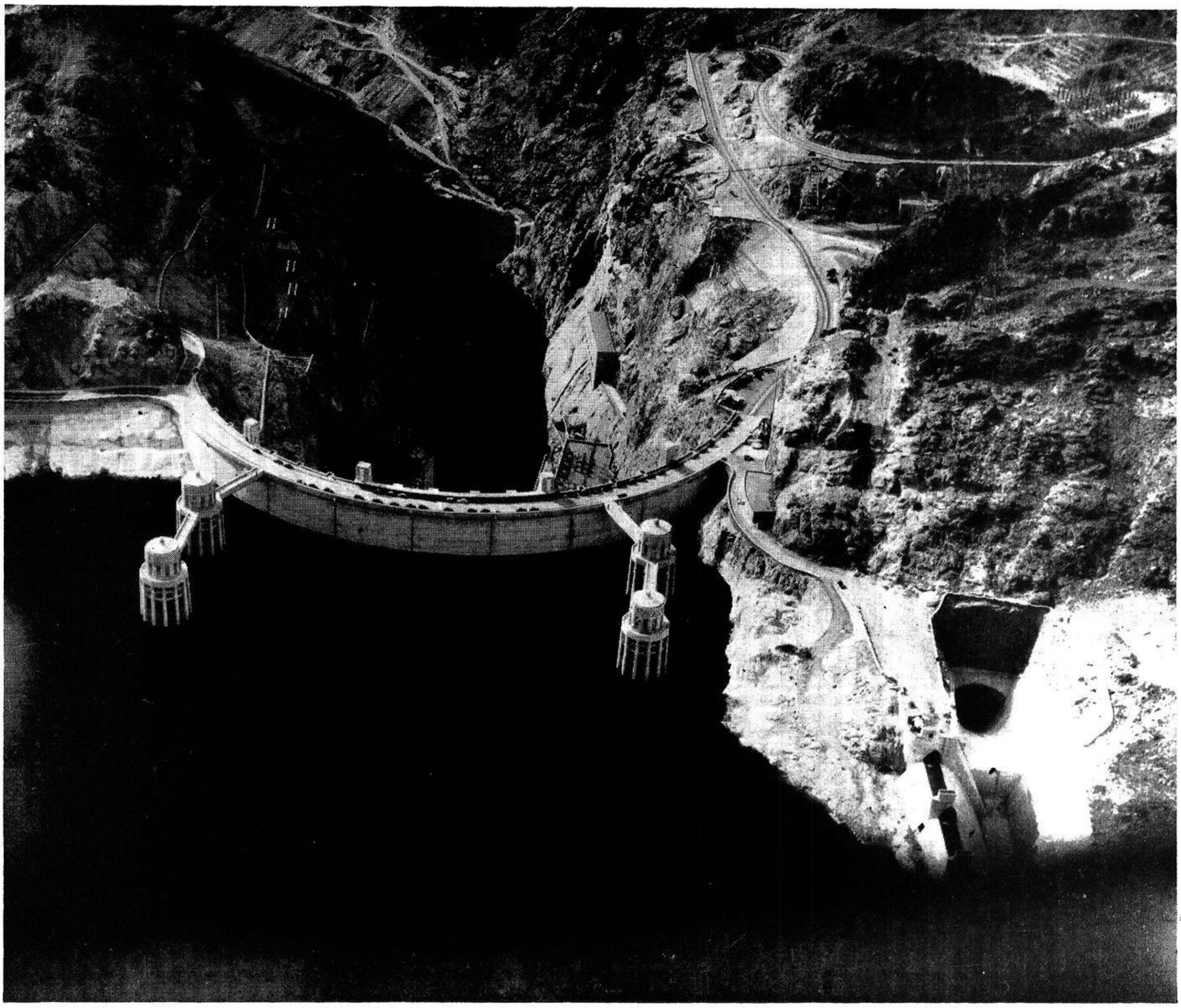

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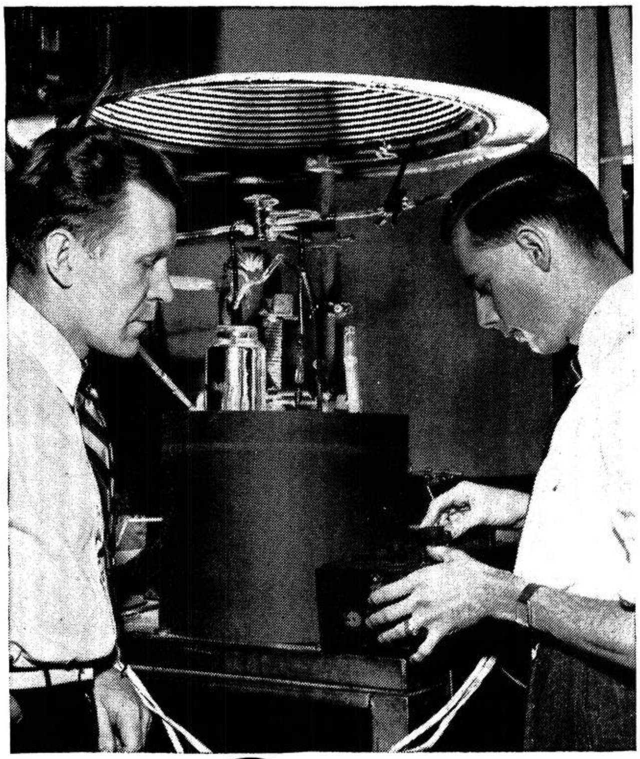

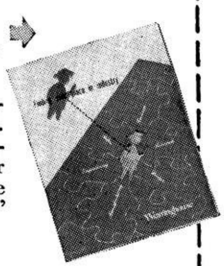

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WISCONSIN ENGINEER

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In This Issue . . .

COVER:

An unusual view of Boulder Dam. This fine detailed aerial photograph was taken from over the reservoir. Submitted by John Butorac me'49.

FRONTISPIECE:

Stoning a burr on the second reduction gear of cargo vessel propulsion unit.
—*Courtesy Westinghouse*

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STANDARD OIL COMPANY (INDIANA)

The Gas Turbine

by R. J. Mitchell m'48

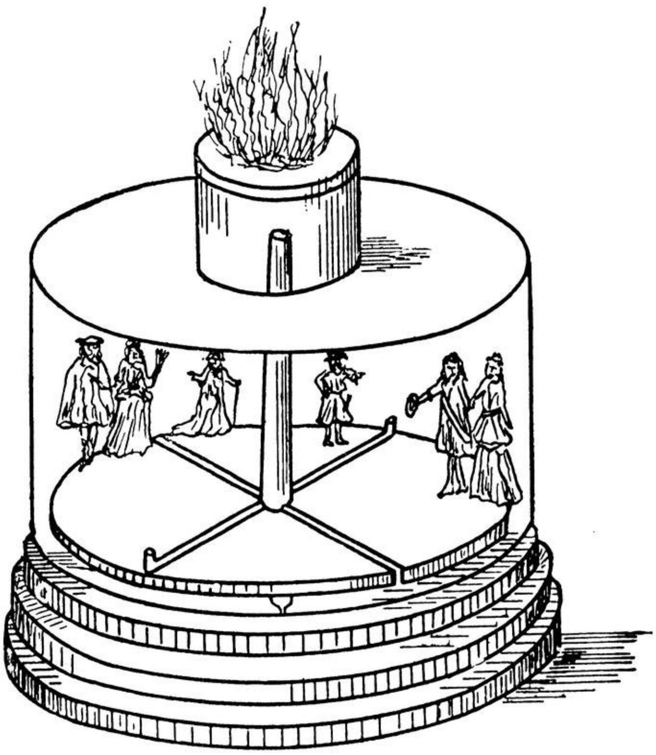
—Photographs courtesy: Allis-Chalmers Mfg. Co.

INTERNAL combustion engines have a rival in the field that is assuming major proportions. More specifically, one should say, reciprocating internal combustion engines. This "newcomer" was conceived before the steam engine itself, but until recently it was not practicable due to basic shortcomings in materials and accessory machines. Hero and Newton pointed out the principle involved, and many archaic drawings are to be seen today as evidence of it. The engine was simply a "windmill" in the course of expanding gases. It was called a "Fire-engine" among other things, but is today called the gas turbine.

Today we find very active research in that old field. There are working models of gas turbines and evidence that they are here to stay this time. As is always the case, however, we have discovered just under the basic necessities that have clouded our conception the obstacles to perfected design. Strong buckets in the rotors failed due to high temperature stresses. Partial loads resulted in radical reductions of efficiency. The engine was neither reversible nor self-starting. Early models developed little more power than was necessary to operate the compressors.

Slowly such obstacles are eluded by the persistence and ingenuity of research engineers. The temperatures of the gases in the cycle were reduced by introducing up to 600% excess air into the combustor. A family of alloys containing Cr, Co, and Ni were found to meet the new temperature-stress requirements better than previous metals. A new method of testing (long-run testing at high temperatures) originated with the demands of this new mover. Such testing enabled engineers to determine actually how much a vitallium bucket would warp at 1500° F under various strains. Little-explored qualities of metals were made known, such as the compound results of metal creep at high temperatures.

Blade erosion was found to be a very important factor in determining the fuels and metals used. An infinitesimal tool mark on the surface of the blade set up stress concentrations which effected the performance of the entire bucket. Small scratches on the blade set up surface erosion which eventually caused the failure. These reasons were among those which prompted research on better methods of precision die-casting. Present techniques are led by the "lost wax" method of casting. Machining expenses are eliminated thusly. Materials used in turbine buckets to date have been: SAE 6150, Silichrome #1, K&E 965, 17W, Vitallium. Turbine wheels have been made from SAE 2335, 6150, Silichrome #1, 17W, Gamma Columbium, and Timken. Further refinements may be expected from the metallurgists with reasonable certainty.



Hero's Gas Turbine, 130 B.C.

Blade erosion was the factor which caused coal-burning turbines to fall behind in development. While it is possible to utilize the heat exchanger in expanding the gases, such exchangers are bulky, heavy, and offer little or nothing that the conventional boiler cannot give. In a direct open system, the gases from combustion pass through the blading; obviously, the solids in the products of combustion of coal (such as fly-ash) would badly score turbine buckets.

(continued on page 13)

St. Pat'

CAREFULLY mix three parts soft dance music with two parts concentrated Irish blarney; stir slowly, add a sprinkling of shamrocks under shaded green lighting, and intersperse some bewhiskered engineers as catalysts.

The success of this formula was proved on Saturday evening, March 15, when 560 engineers and their dates gathered in Great Hall of the Memorial Union at the annual St. Pat's Dance sponsored by Polygon Board. The dance served as a climax to several weeks of button-selling campaigns and other events which have become traditional on the engineering campus in observing the anniversary of the great patron saint of Ireland.

As the couples entered Great Hall they saw before them a picturesque pattern of green. On the stage, behind the orchestra, stood a huge silvered poster depicting Saint Patrick bent industriously over a slide rule. On the front corner of the stage stood "Oscar," famed iron man made entirely of pipe, who has weathered seven years of lawyer-engineer fueds. Oscar's pride and stature seemed much enhanced by his red light-bulb nose which blinked on and off throughout the evening.

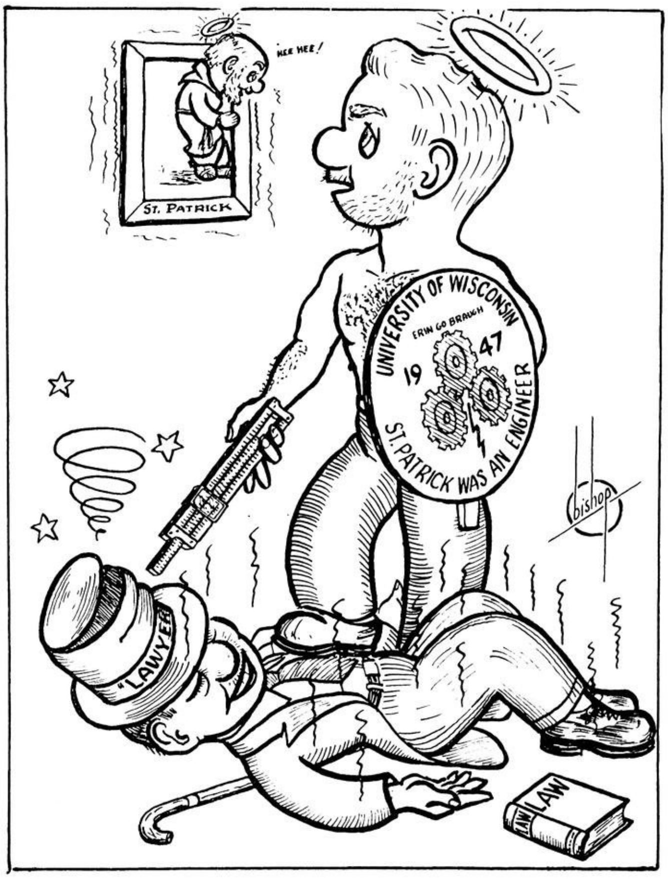
In the corners of the dance floor were placards symbolizing each of the engineering societies. The novel power-driven display of machine gears and levers set up in the lounge adjoining Great Hall fascinated many of the couples.

During the intermission Master of Ceremonies Wally Harris presented Harry McMahon, EE 2, as winner of the contest to choose St. Pat of 1947. McMahon, the electri-

Dance

by John Tanghe e'grad

—Photographs by Art Rezin c'48



cal engineers' representative, was given a loving cup, a Gillette travelling kit, and a carton of cigarettes in reward for his successful campaign. The other contestants and the societies they represented were: Frank Walker, A.S.M.E.; Bill Hershcopf, A.I.M.M.; George Zuelke, A.S.C.E.; and Gordon Merchant, A.I.Ch.E.

Badger Beauties Marilyn Moevs, Beverly Sidie, and Betty Lami then served as judges to pick the winner of the beard-growing contest. Claiming "It was hard to decide," the girls selected Frank Walker, ME 3, as having the best of the beards. Walker was given an Engineers' Handbook, and runnersup Leonard Snyder, EE 2, and Allan Aikens, EE 1, were given a $5 merchandise certificate, and travelling kit, respectively. The gifts were made possible through donations from the Gillette Safety Razor Company, Brown's Book Shop, University Co-op, and Liggett and Myers Tobacco Company. The Union barber shop offered free shaves to St. Pat and the winners of the beard-growing contest.

The dance, and all of the season's St. Pat activities, were organized and carried out by Polygon Board. Ed Ansell, EE 4, was general chairman of the dance; working under him were Ed Brenner, ChE, promotions; Jack McKenna, EE 3, and Jack Crow, EE 3, decorations; Harvey Nienow, ME 4, publicity; Ed Hammer, ME 2, arrangements; Fred Pitschke, ME 4, buttons and tickets; and Glen A. Shaw, ChE 4, finance. Ed Hillery, ME 3, is president of Polygon Board.

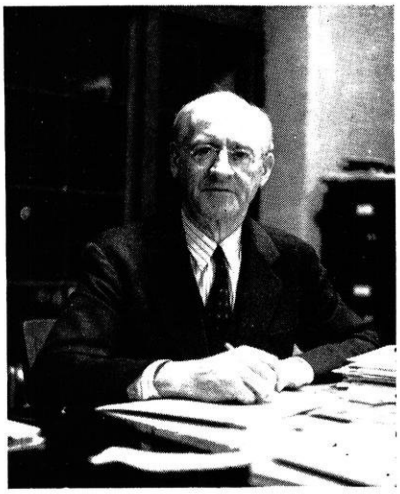
Meet Your Department Head

Gustaf L. Larson

Mechanical Engineering

by Jack Strohm ch'48

GUSTAF Ludwig Larson, head of the Mechanical Engineering department at the University, was born in Sweden on June 30, 1881. After coming to America he attended the University of Idaho, and in 1907 received a degree in Electrical Engineering. He was active in college athletics while at Idaho, playing left tackle on the Northwestern Conference championship football team of 1905 and competing in the shot put and hammer throw for the track team. In 1906 he was chosen captain of the Idaho football team. Professor Larson is a member of Tau Beta Pi, Sigma Xi, Phi Kappa Phi, Phi Delta Theta, Gamma Alpha, Triangle, and was national president of Pi Tau Sigma from 1926 to 1929.



G. L. Larson

Upon graduation he worked as a test engineer for General Electric, and after two years returned to Idaho to become a Professor of Mechanical Engineering and manager of athletics. In 1914 he came to Wisconsin and became an Assistant Professor. In 1915 he was promoted to Associate Professor, and again in 1920 to full Professor and department head.

In 1915 he married Marion Frances Anthony. The Larsons have two children, Dorothy and Foster.

Since 1915 Professor Larson has acted as a construction engineer for the University as well as for other clients. He designed the heating, ventilating, and air conditioning systems for many buildings in Wisconsin, including the University Union and Field House, the Wisconsin General Hospital, the Wisconsin Light and Power Co., and high schools in the cities of Madison, Stevens Point, and Janesville.

Professor Larson was appointed by the Wisconsin Industrial Commission to assist in drafting a heating and ventilating code for the state of Wisconsin in 1925, and in 1936 an air conditioning code. He was a member of the late President Roosevelt's Conference on home building and ownership held in 1931 at Washington, D. C.

Other societies to which Professor Larson is a member include the A.S.M.E., the American Association of University Professors, the Society for the Promotion of Engineering Education, and the National Association of Power Engineers. He is a past president of the American Society of Heating and Ventilating Engineers, and of the Engineering Society of Wisconsin.

He has contributed many papers to the American Society of Heating and Ventilating Engineers, and in 1936 was editor of the Heating and Air-Conditioning Guide.

Professor Larson has always participated in athletics; at present his chief sports are camping, fishing, and golf. Not being content with ordinary fishing stories that are politely listened to but not believed, he has taken many striking movies of his many jaunts into the lonely wilds of Canada.

Lost-Wax Casting

The Revival of An Ancient Art

by John Drnek e'47

—Cuts courtesy: Westinghouse

ONE of the more interesting and intriguing of the myriad wartime developments is the lost-wax process. Out of the depths of antiquity it has come, like a spectre of the past, materializing into one of the most outstanding foundry developments to be made in recent years. The name "lost-wax" is derived from the fact that the wax pattern is expended or lost in the process. It is also called the investment process, since the molding material completely enrobes or invests the expendable pattern. In the Middle Ages, the process became known as "cire perdu", meaning, literally, "wax-lost".

The wax pattern is coated with fine slip, such as a silica flour suspension, to provide a fine finish on the mold interior, and then encased in molding sand. The mold is air dried and then heated and the wax melts and burns out. After the mold hardens the molten metal is poured into the mold in the space left by the "lost" wax. Upon cooling the mold is broken away from the casting. The casting has a fine finish, is free from parting lines due to the one piece mold, and duplicates the finest detail of the original model, with tolerances as high as .001 inch, and finishes as fine as 3 micro inches, with the normal about 65 micro inches.

The origin of the lost-wax process is lost in time. The ancient sculptors perfected the art when they turned from solid bronze castings to hollow castings for their statues to save expensive metal and reduce weight to permit more graceful support of the figures. An alternative method, a complex sand molding process, was also used occasionally.

In regard to hollow casting, the Encyclopedia Britannica says:

> The Greeks and Romans attained to the greatest possible skill in this process. Their exact method is not known but it appears probable that they were acquainted with the process now called "a' cire perdue"—the same as that employed by the great Italian artists in bronze. Cellini, the great Florentine artist of the 16th century, has described it fully in his Trattato della Scultura . . .

Excellent bronze statues made by the Greeks as far back as 600 B.C. are believed to have been made by the cire perdu process. The process fell into disuse or was lost during the Dark Ages and appears to have been revived by Cellini in the 16th century.

Little or no use was made of this process except for monumental bronze works until comparatively recently when dentists and jewelers adopted the process for their work in casting solid articles. It is now used in the manufacture of dentures and other structural elements required in modern and highly precise orthopedic surgery.

The wax pattern is placed in a "jig" and fused to a crossbar.

War-time developments, such as the turbo supercharger and gas turbines, required use of small parts such as the blades, having complex shapes, made of alloys of high metallurgical properties which are impractical or impos-

(continued on page 20)

Metal Coating of Plastics

by R. J. Karabinus m'47

—Photographs courtesy: Modern Plastics

THE process of plating a cheap base metal with a precious metal, or one that can resist the elements of nature is commonly known. Since plastics are relatively weak and will swell and distort when in contact with moisture or solvents, products formerly of metallic construction by necessity are now made with metal coated plastics.

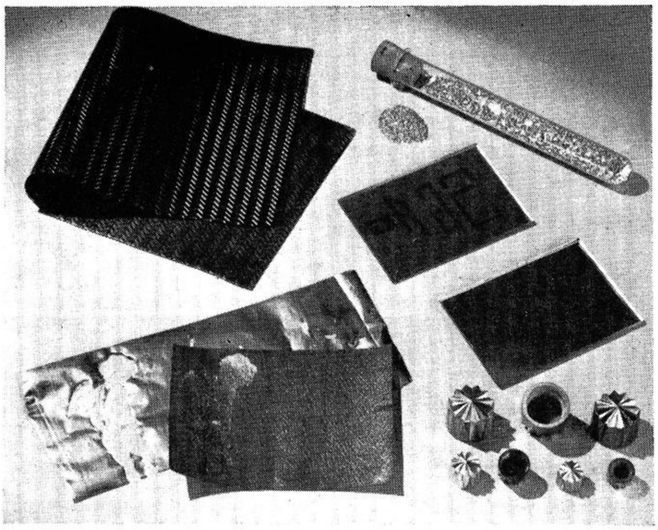
With metal as conductors and pastics as insulators, innumerable electrical parts—shielded housings, condensers, switches, etc.—were made with costly metallic inserts before the metal coating of plastics became a reality. Some other electrical products are light weight aircraft antenna masts, direction finding loops, high frequency wave guides, and piezo electrical crystals. However metal coated plastics are not limited to the electrical field.

In costume jewelry, eye appealing pins, brooches, clasps and bracelets made of metal coated plastics are of particular interest to women. One distinct advantage is that

Plastic based jewelry which has been metal coated by spraying.

it lacks the weight and awkwardness of most solid metal jewelry. Also the color combinations possible with plastics and metal coating combinations are infinite.

Decorative home and automotive hardware has entered a new era with metal coated plastics. Plastics are easily molded into any desired shape or size without much difficulty. The metal coating increases the tensile strength of the parent plastic body ten to thirty per cent depending upon the thickness of the coating. The absorption of moisture and solvents is reduced almost to nil, and in almost all cases is eliminated completely. The metal coating pre-



Even the plastic dust in the test tube has been metal coated.

vents localized overheating and improves the conductivity and radiation properties of the plastic sufficiently to allow an increase of working temperatures of from fifty to one hundred per cent. If the metal surface should be broken, the electrolytic potential found between dissimilar metals which would cause deterioration of the surface in the case of plated metals in a relatively short period of time is absent.

The coating of plastics with metal is not new. The silvering of glass mirrors and electrotyping in which process a wax impression is impregnated with graphite and then covered with a layer of electrodeposited copper have been known for years. But the big obstacle with coating the more common plastics was getting the metals to adhere successfully to the plastic. The difference in the

(continued on page 22)

The Gas Turbine

(continued from page 7)

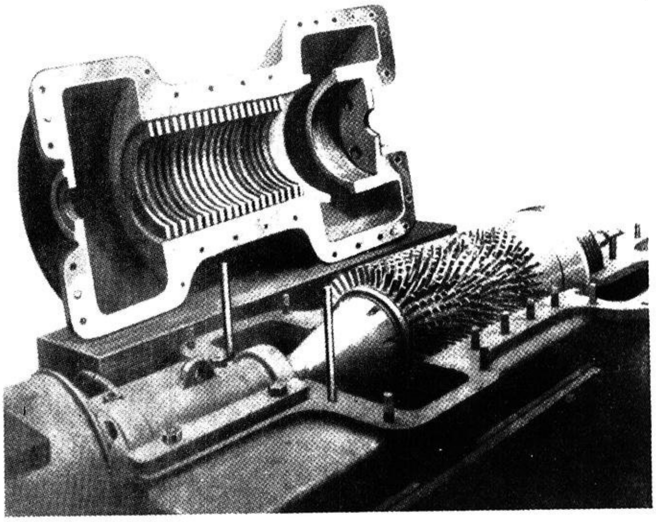
In choosing the best compressor for gas turbine cycles, the engineer encounters four major requisites. It must have a sustained high capacity with high thermal efficiency. It must have a wide operating range at the acceptable efficiency. In aircraft installations, in particular, the overall dimensions must be limited. At the present, the compressor most acceptable is the axial-flow type compressor. By embodying many pressure stages in the cycle, the tangential acceleration and high local Mach numbers, which result from attempting rapid compression in one stage, may be held down. The immediate result is the limitation of boundary-layer separation and shock. The high overall efficiency of this unit is maintained while attaining high pressure ratios. Future refinements in other compressors, the centrifugal type in particular, might well rival the axial-flow.

The importance of high efficiency in the compression stage might best be illustrated by noting the results of an experimental model of the simple gas open cycle type. For every 3.95 hp. developed, 2.95 hp. went into compression work. Earlier experimental models frequently had no applicable work left after tendering the needs of the compressor alone. Improvements in gas turbines as a whole might well be indexed by the improvements in their high-capacity compressors.

The applications of the turbines were once limited by their inability to maintain high efficiency at partial loads. This was corrected by using a two unit set. One turbine is attached to a compression unit which supplies air to both the movers. The secondary engine delivers power to the driven machine—such as an alternating current generator—which requires constant speed. The primary engine operates the compressor at varying speeds as the load on the generator fluctuates. The utilization of such a scheme yields good partial load—and very good full load—operating efficiencies.

The applications of gas turbines will increase as bulk, weight, traditional, and economic barriers break down. As soon as metallurgists produce a high-temperature alloy capable of functioning at over 1500°F, we can expect to see smaller gas turbine units which will operate at higher temperatures and speeds to yield the same power that larger units give today. The smaller engine will save in material and production costs, which are extremely high at present. Better methods of precision casting will cut down the high blade-machining costs. These steps, though easy to state, are going to be difficult steps to actually take. Time, money, and engineering intelligence will surely make these perfections.

Factors making jet turbine units and gas turbines adaptable to aviation are the low frontal area offered and the high power utilization at high speeds. Large initial costs of such power are offset by the increased tariff miles which one airplane can fly in an interval of time. These and further points on this application will be more fully discussed in a later article.



First commercial axial flow compressor, 1901.

Less spectacular than the fast aircraft driven by gas turbines are the locomotives and stationary power plants. There are working installations of both these in European countries at present. The results of long-time tests indicate that similar units will follow in other locals. The featuring of turbine-generator units as standby power in central power plants is superior to the use of auxiliary steam sets since starting the former requires no preparation worthy of mention. As soon as adequate heat exchangers are made available, it will be possible to operate coal burning power plants with gas turbines. This does not seem particularly practicable to the author, however, since the size of this exchanger would exceed that of the boilers in steam installations. Very high efficiencies are now being turned in by steam plants that would be hard to exceed with a gas turbine unit of large size.

Deviations from the simple cycle have been made in efforts to create a large gas turbine plant to compete with existing steam installations. Reheaters, intercoolers, and regenerators have been introduced into the cycle, and marked improvements were noted. Elaborate closed and combined cycles have been proposed and some of these are shown in this article. Lower tolerances were allowed for blade tip clearance, and as a result of this the hollow blade came into use. (Such blades wear quickly away without doing any permanent damage when they strike the turbine casing.) At temperatures above 1100°F, the efficiency of the large closed gas cycle is expected to excel the steam power units of similar capacity.

Considerable attention is being given the possibilities of a gas turbine in the marine power field. This has the advantage of eliminating the steam generator and condenser—both of which take up precious space aboard ship. The disadvantage is that the gas turbine is not reversible, and therefore a reversible propeller must be used. This is at present a rather expensive apparatus. The efficiency obtained from experimental plants is equal to the best marine steam installations. Something to look for is a Navy vessel with gas turbine power and the new "egg-beater" reversible propeller.

In summation of the preceding discussion, we have:

(1) Gas turbines have high thermal efficiencies

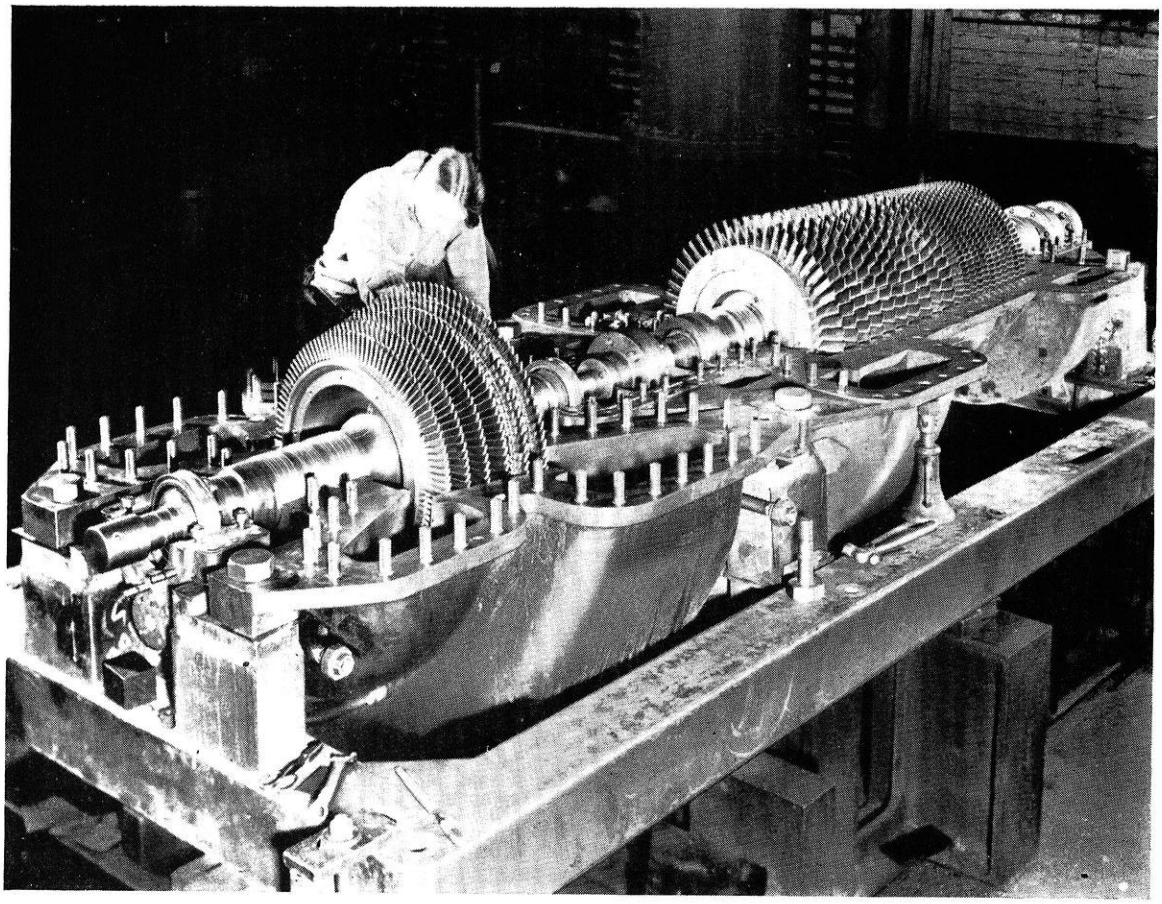
(2) At high temperatures and speeds

(3) Which can be increased with new high-temperature alloys and compressors

(4) To give long-life units with a low weight/hp. ratio

(5) Which indicates increased use as portable prime movers.

In the preparation of this article, the author has attempted to avoid the contention that the gas turbine is the answer to all prime mover troubles and that it itself is perfected. While there are great potentialities present, there is much to do before they may be realized. Once attained, the world will have a lightweight (low weight/power ratio), high speed, efficient, simple power unit of moderate cost. The group who will probably attain most of these perfections would logically be the engineers now in training who are unladen with traditional limitations.



A modern 23,000 cfm. gas-turbine axial compressor unit.

S-t-a-t-i-c

by our guest columnists, the dean's secretaries

In a quiz given History students recently, one of the questions was:
"Name two ancient sports"
A freshman wrote:
"Anthony and Cleopatra"

•

When a pretty girl got on the crowded bus, a pale-looking fellow started to get up. But she pushed him back in the seat, and said she preferred to stand. Again he tried to get up and again she pushed him back. Finally he yelled, "Now, listen, lady! I passed my stop two blocks back—let me out!"

•

A Red Cross worker on a remote Pacific island called up the Army command and said—"We have a case of beri-beri here. What shall we do with it?" "Oh, give it to the Seabees. They'll drink anything."

•

A whimsical professor, trying to emphasize a point in logic, asked his class: "If the U. S. is bounded on the east by the Atlantic Ocean, on the west by the Pacific, on the north . . . etc., etc. . . . how old am I?" The bright students sat dumbfounded, but the dopiest of all spoke up. "You'd be 44." Dumbfounded in turn, the Prof. said, "That's right, young man, but how did you know?"

"That's easy. I have a brother who's half nuts and he's 22."

•

A lawyer was attending a funeral. A friend arrived and took a seat beside him whispering, "How far has the service gone?"

The lawyer nodded toward the clergyman in the pulpit and whispered back: "He just opened the defense."

A patient in an insane asylum was trying to convince an attendant that he was Napoleon.

"But who told you that you were Napoleon?" inquired the attendant.

"God did," replied the inmate.

"I did not!" came a voice from the next bunk.

•

Sedgewick—Terribly sorry you buried your wife yesterday.

Watleywood: Had to—dead, you know.

•

He: Your husband is a brilliant looking man. I suppose he knows everything.

She: Don't be silly. He doesn't suspect a thing.

•

An engineer dining in a very swanky restaurant finally finished his dinner and the waiter brought him a fingerbowl. A few moments later the waiter was horrified to see him washing a spoon in the fingerbowl. Calling the manager they both hurried to the engineer's table.

"What's the matter here" asked the manager. "Why on earth are you washing your spoon in the fingerbowl?"

"Well, replied the engineer with a scowl, "do you think I want to get ice cream all over my pocket!"

•

A proud mother walked in to the "Small Monthly Payments" store clutching a small payment.

"There," she said as she threw it on the counter, "that's the last one on our baby carriage."

"And how is the baby?" asked the friendly clerk.

"Fine, fine," said she, "she's getting married next week."

•

Engineer—Last night I dreamed that I married the most beautiful woman in the world.

Co-ed—Were we happy?

•

Don: If you had $10 in one pocket and $15 in the other, what would you have?

Bert: Someone else's pants.

Staff

THE RETIRING STAFF

Ken Cummins who is bowing out as Business Manager of the Engineer is completing a year's service on the staff that merits a great deal of commendation. His efficient and business like handling of the business staff and unbounded enthusiasm have served as an example for the rest of the staff.

While in the N.R.O.T.C. unit stationed at Wisconsin Ken was co-chairman of the Navy section of the 1946 Badger. He became affiliated with Sigma Nu Social Fraternity and has served the past semester as its social chairman. The Navy claimed his services for two years, one year of which was spent at Wisconsin.

At present he is a senior in the N.R.O.T.C. unit on the campus and is going on a three week cruise off the Eastern Coast as a final hurdle for his commission in the Naval Reserve. Scouting has commanded his attention from boyhood days and at present when time permits he takes part in troop leading and counseling.

An ME, Ken is planning to get some Commerce work behind him before entering the field of industry.

Hailing from Portal, North Dakota, Ken, who was born in 1924, was Editor of the local high school newspaper and earned a letter playing basketball.

Retiring as Editor of the Engineer, Hal is the man who has bore the brunt of the constant criticising questions but seldom accepted his due of recognition for pushing the Engineer over the hump of its first fifty continuous years and given it a grand start on its second half century.

Returning from two years in the Navy as a radio technician, mostly on a minesweeper in the Pacific, Hal fell heir to all the innumerable problems of successfully publishing the Engineer. Practically a whole new editorial staff had to be assembled, instructed and prodded continually so as to make the monthly 'dead lines' a reality.

Over and above his work on the staff Hal who is an ME is a member of MESW and ASME, past president of the Neuman Club and the Catholic Eating Co-op. At present he is the social chairman of the Neuman Club. Prior to his naval service he spent two years on the staff as a feature writer and Assistant Editor.

Born 1924 in Mineral Point, Wisconsin, he attended the local high school. It was there that May started his great variety of social activities. He helped put out the school annual, was a graduating class officer, a cheerleader, took part in forensics, and graduated with honors. In his spare time he takes particular delight in enjoying his hobbies which are photography, beer drinking, and women.

(continued on page 23)

Changes

PRESENTING YOUR NEW STAFF

The newly elected editor, Emil Kasum is a man who has had the journalistic urge since his boyhood days as a newspaper carrier in Milwaukee. Coming to the Wisconsin Campus for the first time in the Spring of 1946, he immediately joined the staff of the Wisconsin Engineer and his outstanding work was not long in seclusion. One of the few members remaining from last spring's staff, Emil's efforts at organizing the staff in the fall, earned him the position of assistant editor during the past year and that of editor for the coming year.

Born in Milwaukee in 1922, he attended Milwaukee Technical High School where his time was divided between football, editing the school paper and his books. Evidently his books were not entirely forgotten as he graduated as valedictorian of his class in 1941.

The next two years were spent as an electrical maintenance man in Milwaukee, with the evenings taken up at extension school attempting to learn the requirements of an electrical Engineer. The usual program interruption came to Emil in January 1943 when he joined Uncle Sam's infantry. Three years later after a "walking tour" of Europe he accepted his ruptured duck and within two weeks was attending classes at the U. of W.

Emil has taken an active part in many campus activities. Besides his work on the Wisconsin Engineer, he is an active member of A.I.E.E., and is vice-president in charge of pledging at K.H.K., the Electrical Engineering Fraternity.

William Gottschalk, the newly elected business manager of the Wisconsin Engineer, steps into this position after having worked on the staff for two years. During the past year he has served as circulation manager and is thus well versed on the problems in the Business department.

A native of Milwaukee, Bill attended Whitefish Bay High School and graduated from Milwaukee University School in 1940. That same year saw his name in the registry at the University of Wisconsin as a freshman in Mechanical Engineering. Two years later he returned to Milwaukee where he worked as a process inspector for Globe-Union Inc. for a short time before enlisting in the Army Air Corps. After completing the pilot training program Bill piloted a B-17 with the Eighth Air Force in the European Theater. After thirty-three months in service he finally inherited his discharge and returned to the Wisconsin Campus.

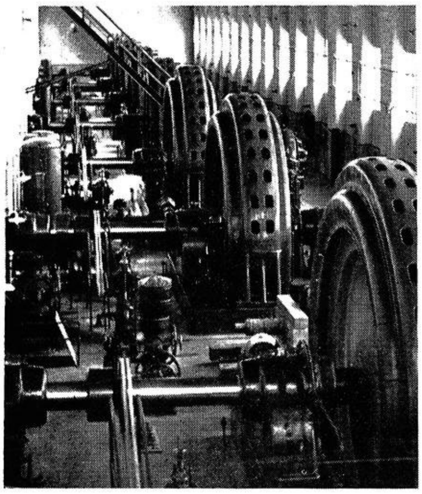
Besides his work on the Wisconsin Engineer, Bill was publicity chairman for M.E.S.W., and is an active member of the A.S.M.E.

Campus Highlights

by John Tanghe e'grad

EE's Visit Hydro Plant

Members of the student branch of AIEE traveled by bus to Prairie du Sac, Wisconsin, on Saturday afternoon, March 1, to visit the Wisconsin Power & Light Company's hydro-electric plant. The group of 52 who made the trip were conducted through the station by Mr. John Radlund, Jr., district manager, and Mr. B. C. Lueders and Mr. L. F. Kohe, chairman and secretary, respectively of the Madison Section of AIEE.



Hydro-generators at the Prairie Plant.

The plant visited was one of the first ever built on sand, a large portion of the station begin supported on submerged wood piles. When the plant was built on the Wisconsin River in 1915 the equipment consisted of four 60-cycle and four 25-cycle horizontal generators with a total capacity of 30,000 kilowatts.

The 25-cycle generators, originally used to supply the street-car load for the T.M.E.R.&L. Company in Milwaukee, were rebuilt prior to the war to furnish 60-cycle power; during the war nearly two-thirds of the plant's output went to the Badger Ordnance Works. Six 66-kilovolt, two 33-kilovolt, and two 6.9 kilovolt transmission lines radiate from the station and tie together the southern section of the system.

Arrangements for the field trip were made by Art Falk and Mel Griem.

•

Note that this issue's "STATIC" was written by Dean Withey's secretaries. tsk, tsk.

•

Kappa Eta Kappa Activities

Final plans for the annual spring alumni and initiation banquet to be held at the Capital Hotel on Saturday evening, March 29, were made at a recent meeting of Kappa Eta Kappa, professional electrical engineering fraternity. The speaker at the banquet will be Professor William B. Sarles.

Arrangements for the spring formal to be held in conjunction with Triangle Fraternity were also made at the meeting. The dance is scheduled to be held at the K.C. Hall on Friday evening, May 2. Phil Wanzek, social chairman, is in charge of preparations.

At the meeting Myron Larson, chapter president, submitted his resignation to become effective with the election of a new president. Larson was elected national expansion vice-president at a recent regional meeting of the fraternity.

Sideglances—St. Pat's Day

A barber had been hired to shave St. Pat at the St. Pat's Ball, but "trouble with the wife and kids" kept him from coming.

* * *

We're still wondering if the holder of ticket #506 ever heeded the threats posted on the bulletin board and paid for his ticket.

* * *

A real feud nearly started when some paint-brush wielders started painting over the "Oscar is at Triangle" sign on the library quonset hut. Triangle men who dashed to the scene expected to confront lawyers, but instead found students from a commerce fraternity innocently painting an "I.F. Ball" sign.

* * *

St. Pat winner Harry McMahon and his campaigners accounted for exactly half of all the St. Pat's buttons sold by the five contestants.

* * *

The chairmen of the St. Pat's Dance and their dates were somewhat perturbed when their pre-dance banquet at a local restaurant dragged out for 2½ hours due to slow service. The size of the tip left for the waiters reflected their disgust.

* * *

Credit for the design of this year's St. Pat buttons goes to John Slater, CE 3—the pattern was drawn up to resemble that used on buttons in previous years. The dance programs, patterned after the buttons, were designed by Ed Hammer.

(continued on page 24)

Lost-Wax Casting

(continued from page 11)

sible to machine or forge. To grind the whole turbine blade would be a Herculean feat, both financially and mechanically, for the aircraft superchargers during the war. During the peak of production, 2,100,000 blades per month were produced.

The method used by the early statue makers consisted of making a rough clay model of the statue, slightly

Silica and binder is poured on the patterns to form the molds.

smaller than the desired size. This model was then covered with wax, which was worked into the desired shape and finish of the finished statue. Bars of wax were then fused to the original to form runners and gates in the finished mold. The whole of this was then covered with very fine molding material, dried, and then encased in clay and bound with iron. After air drying, the mold was heated and the wax melted out. Further heating hardened the mold and vaporized or burned out the remaining wax. The molten metal was then poured into the thin space between the rough core and outer mold, replacing the wax. This space was maintained by bronze rods driven into the mold. After cooling, the outer shell was broken away, revealing the bronze casting in the exact shape of the wax model, with all in fine details. The inner core was chipped up and removed through a hole in the bronze shell if necessary.

Occasionally the original was made of other material, such as plaster, and a regular sand mold of many parts made, from which a wax reproduction containing a core was cast. Parting lines and other imperfections of the wax model could be readily removed, and detauks added and then the process proceeded as before. In this way the original is preserved in case of an imperfection in the casting, and it is possible to reproduce many statues.

This second method is the one generally used in making solid castings in industry—that is, the wax model is cast from a mold of the original, rather than the wax model being the original.

The process as used today can be well demonstrated by following through the manufacture of a gas turbine blade, as done by Westinghouse.

Master molds are prepared of a low melting point alloy by casting or spraying against the master. From these master molds are made patterns of a wax compound of high hardness, low shrinkage, and high melting point, by injecting the wax into the mold in a manner similar to die casting. From these wax patterns parting lines can be readily removed, whereas the final material is unmachinable.

Several of these patterns are then fused to a wax crossbar with heated tools. This crossbar forms the runner and gate in the completed mold. A pre-coat of very finely powdered silica and binder is then applied which hardens to a thin layer of refractory material with all the surface smoothness of the wax pattern.

The precoated patterns are then placed in a metal flask and completely covered with a coarser mixture of silica and binder to form the molds. The mold is then vibrated for several minutes to be sure that there are no air pockets, and is then air dried to harden it.

Ninety eight per cent of the wax is melted out by inverting the mold over a steam table. The mold is then baked in an oven to red heat to dry and harden the mold. The remaining wax is burned out by this process.

The flask is then inverted and clamped on the top of a small electric furnace containing the exact amount of the molten metal. The furnace is inverted and the metal forced into the mold by air pressure in order to fill all the crevices completely.

The investment is pushed out of the flask after cooling and broken apart to recover the casting. Conventional abrasive tools are used for cut-off and cleaning operations. In very precise work, the part can be completed by one or two grinding operations.

An excellent example of the use of this process is

(continued on page 32)

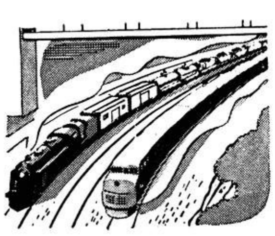
We're not so hot on POGO STICKS

Lots of people like to play jack rabbit. Still, as a way of going to work every morning, we don't see much of a future for Pogo Sticks. Not even *aluminum* Pogo Sticks.

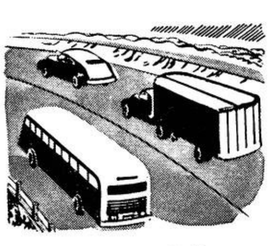
But mention any other means of locomotion or transportation and our aluminum "Imagineers" get a gleam in their eyes. After all, what is more logical than vehicles made of aluminum? Less weight to move. More payload.

We turned our imagination loose on that idea years ago . . . then engineered our thinking into trains, trucks, planes, ships. Alcoa's Development Division has a staff of "Imagineers" who think of nothing else but better ways to transport people, products, and materials by using aluminum. Actually, we have *four separate* staffs of transportation engineers, one each on railroads, highway vehicles, ships and aircraft.

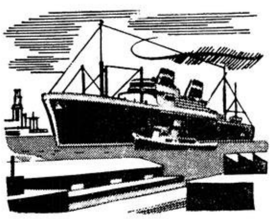
Whatever you do after college, you'll benefit from that. If you go into transportation, these Alcoa engineers will be working with you to cut costs, speed schedules, improve facilities. Or if you choose some field of production, they'll be helping to transport your materials and finished goods cheaper and faster. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.



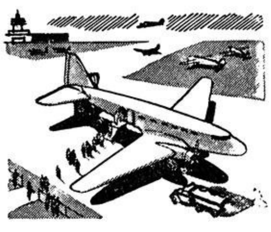
Passenger streamliners, refrigerator cars, hopper cars and tank cars built of Alcoa Aluminum are serving American railroads.



Alcoa Aluminum is finding more and more uses in buses, trucks and trailers. Yes, in passenger car manufacture, too.



Newest thing in shipbuilding is the aluminum superstructure, developed by Alcoa with marine architects and engineers.



Ever since Kitty Hawk, Alcoa h[illegible] worked with the aircraft indus[illegible]try in developing better alumi[illegible]num for better planes.

ALCOA FIRST IN ALUMINUM

ALCOA

Metal Coating Plastics

(continued from page 12)

thermal expansion limits the thickness of the coating to a few thousandths of an inch, however, a surface with ridges and depressions is effected less than a plain surface.

The preparation of the surface of the plastic to be coated governs the success of the adherence of the coating. After the surface is slightly roughed by mechanical or chemical means, it is sensatized by various reagents depending upon the type of plastic. A perfectly clean surface is necessary before any metal coating can be applied.

Even though metal spraying and vacuum deposition apply the metal directly upon the surface, a more complex chemical reaction method which is readily adaptable to mass production is in greater use. It is a chemical reduction of a highly conductive and adherent silver film on the plastic by an ammoniacal silver nitrate solution and a suitable reducing agent. This silver film is coated with a layer of electrodeposited copper followed by the plating of the final layer of the desired surface metal.

WORK TO START SOON ON GOVERNMENT ATOMIC LABORATORY

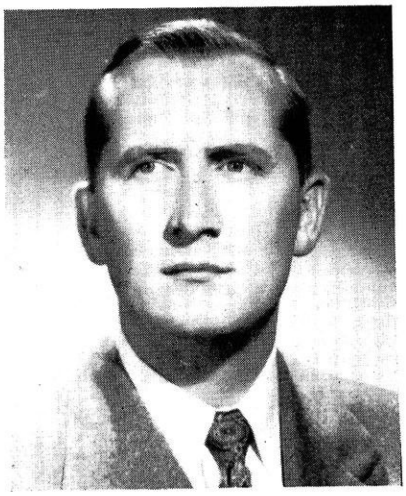
Construction of the Knolls Atomic Power Laboratory to be built near the Atomic Energy Commission will start this spring. This was announced by L. E. Johnston, Area Engineer for the Commission. The laboratory is being erected under the supervision of the General Electric Company, which will operate it for the government when completed. Mr. Johnston said the scientist and engineers will probably begin to occupy the new building by the middle of 1948.

A number of scientists for the project have already been recruited, said Dr. Suits, and are at work in the present G-E laboratory buildings. More are being employed as rapidly as qualified men and women can be found. Physicists, metallurgists, chemists and chemical engineers—technical men of all kinds—are needed, he declared.

A numer of buildings will form the Knolls Atomic Power Laboratory. In one will be located an experimental pile. Such a pile, it is expected, will form the firebox and boiler of future atomic power plants. Other buildings of the group will be devoted to offices, metallurgy, chemical engineering and chemistry. Another building will house a 3,500,000-volt electrostatic, or Van de Graff, generator, for atom-smashing studies. J. Gordon Turnbull, Inc., of Cleveland, is the architect for the new laboratory.

Staff Changes

(continued from page 16)



Harlan Skatrud, or 'Skat' as he is called, terminates three semesters work on the business staff of the Engineer when he graduates this May. The last two of these semesters he has served in the capacity of advertising manager.

Skat has kept the printer well fed with advertising plates for each issue with never an erroneous or misplaced plate. And if by chance a plate should be late in arrival telegrams issue forth from his desk bringing the special delivery man at the office door early in the morning with the erring plate.

A civil engineer, Skat has had practice in the field which has given him a definite tangible idea of the why and wherefore of his career. For five years he worked as a senior draftsman at the Manitowoc Shipbuilding Company and last summer he worked for the Ground Water Division of the United States Geological Survey.

In addition to his staff duties Skat has presided over the Polygon Board for one term and served as Vice President of the local chapter of ASCE.

Born 1920 in Manitowoc, he graduated from the local Lincoln High School in 1938. After graduation he accepted the drafting position which he left in 1943 to enter Wisconsin. In 1945 he joined the ranks of the married men on the campus.

Campus Highlights

(continued from page 18)

Placement Office Announcements

D. J. Mack, head of the Engineering Placement Office, announced the following interviews to be held on the dates indicated:

April 14—Detroit-Edison Company

April 17, 18—Carnegie Illinois Steel Company

April 23—Toledo-Edison Company

April 23, 24, 25—Standard Oil of California.

There are a number of other interviews being arranged, but it appears that none of the companies plan to hold interviews after May 1. So seniors, better make up your mind soon!

Mr. Mack wishes to send out another appeal for all seniors to fill out personal data forms. These blanks can be procured in his office at 266 M. E. Building. The completed forms are retained in the files not only for placement work but also to serve as the alumni record. Seniors who accept job offers are asked to convey that information to the Placement Office so the address can be entered on their data sheet.

New Physics 55 Lecturer

EE's have long taken pride in having their own special physics classes and likewise their own special lecturer, Prof. H. B. Whalin. They were somewhat surprised to find that Prof. Whalin had "deserted" them this semester by not teaching Physics 55. Prof. Wahlin has made it clear, however, that his abandonment of the course is only temporary and that he intends to stick with the EE's.

At present his position in the course is being filled by Mr. Hugh Richards, who came to the campus last spring.

(continued on page 26)

Campus Highlights

(continued from page 24)

Engineer Lawyer Basketball Game

Maybe it will not go down in history as a sports classic, but the basketball game played at the old gym on Saturday, March 15, between the Engineers and the Lawyers might start a new rivalry in the traditional St. Pat celebrations that have been off and on for many years on the campus.

Fred Anderson, the team manager, then chose his starting line up and the game was on. Omitting the monotony of a play by play account, it is sufficient to know that the Engineers made the first field goal to go ahead and stay there for the remainder of the game. At the final gun the score stood at 53 for the Engineers and 31 for the Lawyers, showing that the Engineers were the better men for the day.

Russ Hoff played beard and all, while Al Ryser playing guard drove the Lawyers to despair with his deadly shooting from the guard position. In the meantime Chuck Mitasik did his best to keep the ever-mounting score straight. Considering the fact that the Lawyers have always been poor at figures, they must be given credit for being as honest as they were. At no point in this gigantic job of scorekeeping were the scorekeepers more than two points in disagreement. At one time, strangely enough, they were two points on our side. Just what is the profession coming to? Times have certainly changed.

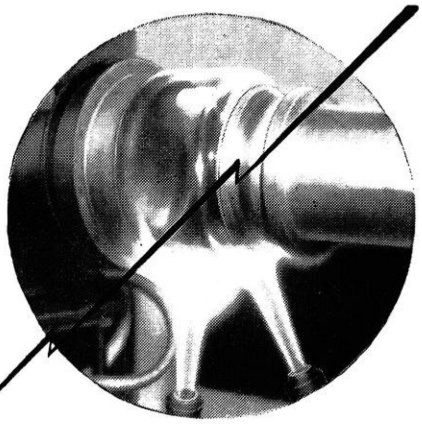
Yes, this has been a fine St. Pat's Day celebration for the Engineers. Precedent has been set and tradition upheld. The Engineers are looking forward to a follow through of this type of group rivalry.

(continued on page 28)

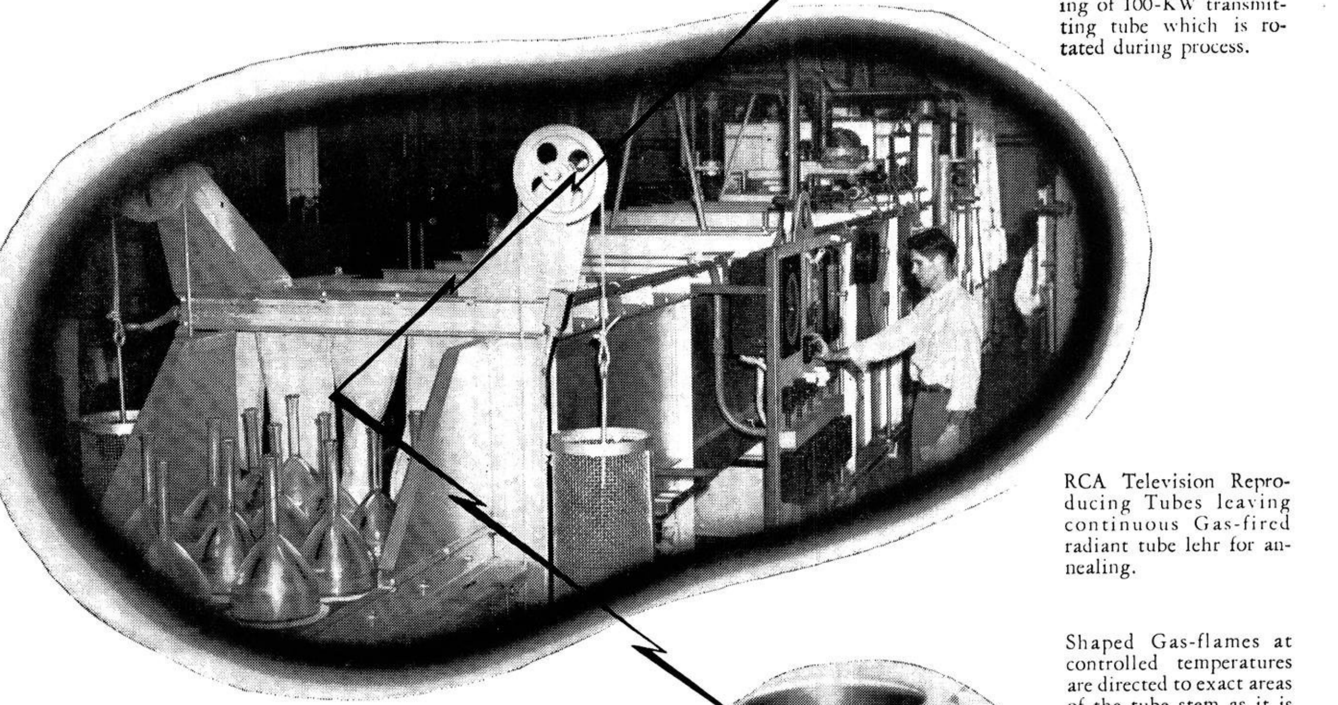
Flexible GAS Speeds

RCA TELEVISION

Tube Production

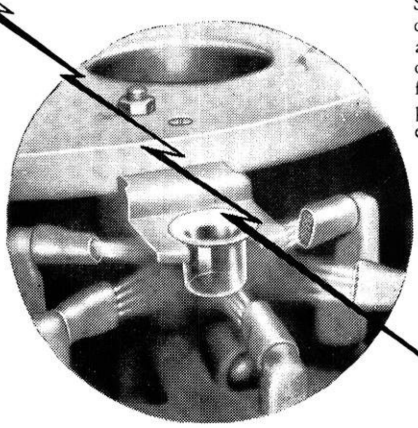


Direct Gas-flame annealing of 100-KW transmitting tube which is rotated during process.



RCA Television Reproducing Tubes leaving continuous Gas-fired radiant tube lehr for annealing.

Shaped Gas-flames at controlled temperatures are directed to exact areas of the tube stem as it is formed, on indexing-head press, to hold the tube elements.



IN the manufacture of television transmitting and receiving tubes the productive flames of GAS demonstrate the full scope of their flexibility and controllability.

Production engineers and equipment designers at RCA tube plant in Lancaster, Pennsylvania, have utilized GAS as a production-line tool throughout the vast, modern plant devoted to electron tube manufacturing.

With shaped-flames, radiant-tube lehrs, direct-annealing flames—with a wide range of accurately controlled temperatures—with burners of all types assembled as integral elements of continuous process machinery, RCA productioneers have taken full advantage of the universal adaptability of GAS and modern Gas Burning Equipment.

GAS and modern Gas Equipment are making major contributions to increased production in heating and heat treating operations throughout industry.

AMERICAN GAS ASSOCIATION

420 LEXINGTON AVENUE, NEW YORK 17, N. Y.

MORE AND MORE...

THE TREND IS TO GAS

FOR ALL INDUSTRIAL HEATING

Campus Highlights

(continued from page 26)

The valiant men of St. Pat who defended his honor upon the basketball court are:

Ralph Falione
Fred Anderson (Manager)
Al Ryser
Roger White
Kenneth Ladd
Russ Hoff
G. Schreiber
Vernon A. Nelson
Dick Bruning
Walt Lovell
Mort Luck
Morrie Rhude
Robert D. Woodburn
Charles Mitasik

ASCE Meeting

Members of ASCE met on March 6 in the university Hydraulics laboratory. Dr. A. F. Lenz of the hydraulic engineering department lectured on dams in the United States and showed colored slides in conjunction with his talk. The meeting was concluded with the serving of refreshments.

AIEE Discusses Safety

"The EE looks at Safety" was the topic about which the March 11 meeting of AIEE centered. Mr. Fred D. Mackie, Superintendent of Distribution for the Madison Gas and Electric Company, spoke on the technical aspect of the subject, while Prof. R. L. Moberly, Director of the university's Industrial Management Institute, discussed the problem from the psychological viewpoint. The movie, "How It Happened," showed typical fatal accidents, served to further illustrate the topic under discussion.

At the business meeting which followed the program a nominating committee was appointed to select candidates for the election of officers to be held April 8.

Du Pont *Digest*

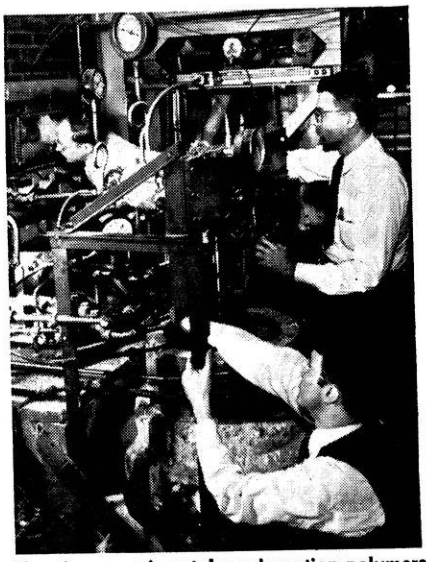
Items of Interest to Students of Science and Engineering

Research Problems in the Manufacture of Nylon

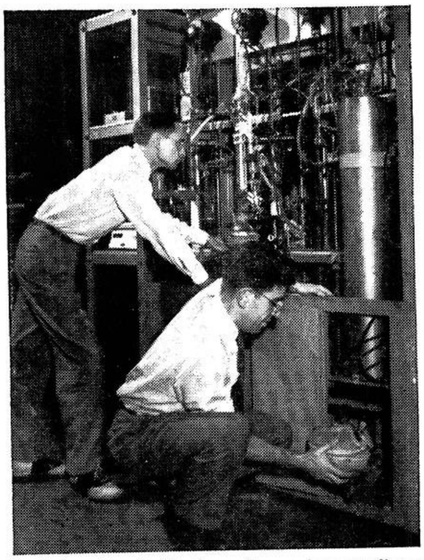
Last month in this space the development of nylon was traced from a fundamental research study on linear polymers to the first synthetic organic fibers, the superpolyamides. This installment deals with the complex manufacturing research problems that followed.

From the start there were obstacles to the production on a commercial scale of the "66" polymer—so named because the adipic acid and hexamethylenediamine from which it is made have six carbon atoms each.

Although adipic acid was being produced in Germany, it was necessary to develop a new process to meet conditions at Du Pont's Belle, W.Va., plant, where, because of the catalytic technique involved, it was decided to make this intermediate. Hexamethylenediamine was only a laboratory curiosity, and a process for its commercial production had likewise to be worked out. Fortunately it was found that the diamine could be made from adipic acid by new catalytic processes. The results of these investigations may be summarized as follows:



Charging experimental condensation polymers to a spinning machine for evaluation: O. C. Wetmore, Ph.D. Organic Chemistry, New York University '44; D. A. Smith, B. S. Mechanical Engineering, Purdue '40; C. O. King, Sc.D. Chemical Engineering, Michigan '43.



Studying the distillation of new intermediates for condensation polymers: T. J. Dickerson, B. S. Mechanical Engineering, Virginia '43 and E. E. Magat, Ph.D. Organic Chemistry, M.I.T. '45.

$$\underset{\text{Benzene}}{C_6H_6} \xrightarrow{H_2} \underset{\text{Cyclohexane}}{C_6H_{12}} \xrightarrow{O_2} \underset{\text{Adipic Acid}}{(CH_2)_4(COOH)_2}$$

$$\xrightarrow[-H_2O]{+NH_3} \underset{\text{Adiponitrile}}{(CH_2)_4(CN)_2} \xrightarrow{H_2} \underset{\text{Hexamethylenediamine}}{(CH_2)_6(NH_2)_2}$$

$$\underset{\text{Adipic Acid}}{(CH_2)_4(COOH)_2} + \underset{\text{Hexamethylenediamine}}{(CH_2)_6(NH_2)_2} \longrightarrow$$

$$\underset{\text{Nylon Salt}}{[HOOC(CH_2)_4COOH \ldots NH_2(CH_2)_6NH_2]_x}$$

$$\underset{\text{A Nylon Polymer}}{[\ldots CO(CH_2)_4CONH(CH_2)_6NH \ldots]_x}$$

The synthesis of intermediates was only part of the problem. Nylon polymer was an entirely new material with properties different from any previous synthetic product. It provided the first example of spinning fiber from a molten polymer (m.p.263°C) and required entirely different techniques from rayon spinning. Information was acquired only by painstaking experimentation at each step.

Manufacturing Process Outlined

The process as finally developed for the manufacture of nylon and its fabrication into yarn may be briefly outlined as follows:

Nylon salt is heated in an autoclave with addition of stabilizers to control molecular weight and viscosity. A long-chain linear polymer is formed with a molecular weight of 10,000 or higher.

The melt is converted to solid chips that are later re-melted and extruded through a spinneret to form filaments at a speed of 2,500 feet a minute. The filaments are then drawn out to about four times their original length in order to develop the desired textile qualities characteristic of nylon.

These operations sound simple enough, but some of the problems encountered were extraordinarily difficult. For example, a specially designed grid for melting the polymer was necessary because of the poor thermal conductivity of the polymer; pumps had to operate at 285°C with only polymer as a lubricant; special abrasion-resistant steels that did not soften or warp at 285°C were necessary; the spinning assembling required radically new engineering developments to produce the necessary fiber qualities.

All of these chemical, physical and mechanical engineering problems had to be solved and dove-tailed into a unified process before manufacture of nylon could be undertaken. In all, about 230 technical men and eight manufacturing and staff departments share the credit for making nylon the important part of American life it is today.

Lost-Wax Casting

(continued from page 20)

furnished by the Haynes Stellite Co. in the manufacture of a slide for high speed cloth cutting machines. The original part was machined from bar stock in 42 operations, heat treated, and then passed through 4 grinding operations. The part as produced by the lost-wax process of stellite requires no machining or heat treating and only 4 grinding operations. It increased the production, halved the cost, and lasted 3 times as long.

Like any other engineering technique, lost-wax casting is not a cure-all. It is a specialized production tool that does several things better than any other available means. Specifically, the process is of greatest value in the following applications:

For casting of parts of alloys that cannot be machined or forged, such as gas turbine blades, or swaging dies for tungsten rods.

For casting of parts requiring complicated shaping, but not precise dimensional accuracy of a high order, such as turbine blades.

For casting of tools or parts requiring high metallurgical properties, complicated shapes, and precise dimensions on only one or two easily ground or machined edges or surfaces.

For casting of small parts in quantity of an alloy that is expensive to machine, but which can be produced without machining by the lost-wax method; stainless-steel pipe fittings, or parts for development models of certain apparatus.

The lost-wax process is highly suited to the manufacture of fairly accurate reproductions of many small metal parts, and provides excellent reproduction of curved shapes, fine detail, and good surface conditions. It has a relatively low tooling cost and the equipment is not excessively expensive. The production time is fairly short.

Being a highly specialized process, it has certain limitations. The best dimensional accuracy is from 2 to 5 mils per inch, although shrinkage effects can be largely compensated for in the design. The number of steps and the manual labor required often prevent sufficient cost reduction to make its use feasible. Labor saving methods will be developed in time. Present practical weight limits vary from 3 to 15 pounds, depending on the article and the skill of the foundry.

Regardless of the limitations, which may be eliminated in the future, the process is a significant addition in the technique of industrial casting, particularly the casting of alloys difficult to machine or forge. These include the refractory alloys of stellite and vitallium.